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New York State Museum Bulletin

Entered as second-class matter November 27, 1915, at the Post Office at Albany, N. Y., under the act of August 24, 1912. Acceptance for mailing at special rate of postage provided for in section 1103, act of October 3, 1917, authorized July 19, 1918

Published monthly by The University of the State of New York

Nos. 239-240 ALBANY, N. Y. November-December 1920

The University of the State of New York
New York State Museum
JOHN M. CLARKE, Director

SEVENTEENTH REPORT OF THE DIRECTOR OF THE STATE MUSEUM AND SCIENCE DEPARTMENT

INCLUDING THE SEVENTY-FOURTH REPORT OF THE STATE MUSEUM, THE FORTIETH REPORT OF THE STATE GEOLOGIST AND THE REPORT OF THE STATE PALEONTOLOGIST FOR 1920-21

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ALBANY
THE UNIVERSITY OF THE STATE OF NEW YORK
1922

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THE UNIVERSITY OF THE STATE OF NEW YORK

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The University of the State of New York
New York State Museum, February 3, 1922

Dr Frank P. Graves
President of the University

SIR: I beg to transmit herewith my annual report as Director of the Department and to request its publication as a bulletin of the State Museum.

Very respectfully
JOHN M. CLARKE
Director

Approved for publication

President of the University

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The University of the State of New York

New York State Museum

JOHN M. CLARKE, Director

SEVENTEENTH REPORT OF THE DIRECTOR OF THE STATE MUSEUM AND SCIENCE DEPARTMENT

INCLUDING THE SEVENTY-FOURTH REPORT OF THE STATE MUSEUM THE FORTIETH REPORT OF THE STATE GEOLOGIST AND THE REPORT OF THE STATE PALEONTOLOGIST FOR 1920–21

INTRODUCTION

This report is written in the solitude of the evergreen woods where every sound and glance tells of the service this Museum is endeavoring to render to the people of this State. The breeze whispers through the boughs of cedar and balsam and whistles among the tall tops of spruce and hemlock. In the shadows on a carpet of finest needlework, where the brown leaves of the evergreens have fallen, spring many-hued mushrooms and pallid clumps of Indian pipe; the clearing burns with crimson fireweed and glows with goldenrod. From tree to stump and from bough to bush, the spider has displayed his aerial engineering; butterflies in passing touch the blue vetch and dindle; chattering rodents, restless artists that they are, chase back and forth; the junco, the goldfinch, sapphic warblers of many sorts and voices are starring in these groves, while the blue canopy overhead, supported by a wall of towering spikes of spruce, is crossed by the flapping raucous crow and the soaring herring gull; and into all the beauty of this hermitage intrudes the gray moss crowding out the life of the spruce branches, and an unseen army of other parasites at whose scant mercy lies the whole host of life. As a rug is spread upon the solid and essential floor, so all this living picture is stretched out on, and overshadowed by, a foundation of rocks which tell an ancient story of a different life upon the earth.

The measure of service which this Museum can render is the degree in which it can inspire in the people of the State the appreciative love of these works of Nature, and with that the ideals and spiritual purpose which can be drawn from an understanding thereof. Politics and expedients aside, there can be no denial that this is and must be the first purpose of such an institution; therein lies its paramount service; and the large-minded legislator on his way from politics to statesmanship has never failed to recognize the spiritual value of it.

It is well to distinguish between the educational and informative worth of a scientific museum. There are more facts in the anatomy and physiology of a house fly than the average trained mind cares to, or can, assimilate; a single mind may become clogged with them and yet only thus the working of the organism be understood, as an engineer understands the working of his engine to its last bolt and valve. To the selected mind this is knowledge and to others it may be information; but to neither is it education unless made to bear on the higher life of the individual; that is, unless lessons are learned from it which will guide us in the better ordering of our own life. Life is all one life; we shall do righteously only as we direct our share of it by recognition of the laws which can be easiest read in the simpler forms of living nature.

The educative functions, therefore, of the State Museum are to the community of the first order of quality. Literature is the record of the best of human thinking best expressed; history a human guess at the facts and motives of human events; mathematics in practice is the statistical and angular combination of material units, in the abstract it is the rhythm and the poesy of the material universe. With these may be placed in premier order, the understanding, or the effort to understand, the laws which govern the living works of Nature, today and since the beginning; and the bearing of these laws on our own life and destiny. To this end a large part of the service of the Museum is given both through its researches, its exhibited collections and its publications.

In another educational aspect, second in importance and merit, but essential to every commonwealth, is the comprehension of the sources and uses of the natural material wealth with which the State is endowed. In New York these natural supplies are very great and even though they lack in such high essentials as coal and gold, silver, copper and platinum, yet the production is varied and the total puts the State in the front rank of mineral producers. The geological workers of the State Museum have been in no inconsiderable measure responsible for pointing out and encouraging a mineral production which amounts to nearly fifty millions annually in raw materials. They endeavor also to enlighten the people as to the never-ending evil practices carried on within the boundaries of the State in the promulgation of hopeless, often deliberately dishonest mining propositions; alleged exploitations of invisible and intangible supplies of the precious metals; the selling of certificates in joint stock mining companies; dealing in mysteries set forth in a garniture of modern technical patter — in all of which the citizens of this and other states are mulcted in heavy amounts; matters in which we are without mandatory power, but in which very things the people of the State need guardianship as well as scientific advice. It has been the policy of the State hitherto to let a citizen play the fool with his money if he will. Perhaps it is the most effective cure. Experientia docet.

We seek, furthermore, a true history of the original owners of our domain, the red man and his progenitors. For this we depend on no schedule of official documents, no contemporary letters, no diaries or other evidence of events as they seemed to the lookers-on; but rather by every means within our control to interpret the assembled relics of the workmanship of these people, from which a comprehending mind may draw the picture of their civilization from the material objects necessary to its development.

1 The State Museum has not yet succeeded in reaching the objective laid out for it by the statute expressing the purpose of the citizens. Here lies a duty unfulfilled; one which it would seem must wait upon a better comprehension of the influence of the Museum on the cultural interests of the people and the exaltation of such functions to at least an equivalent plane to those of commerce and industry. The statute of the State has called for a Museum laid out on broadest lines, wherein may be brought together not alone a panorama of her natural resources but in addition thereto, a visible record of the history of the civic State, of the gradual development of its agricultural procedures, of its arts and industries and of its art. Of these, Science, the creation and display of orderly knowledge, is now alone the recipient of the State's patronage. What has been done for the natural resources of the State remains yet to be done for history, industry, agriculture and art. The State Museum indulges in no fads, it experiments with no popular or passing fancies in science. It seeks to invest the slender provision made for its service in ways that serve best and without waste, and that experience has certified. Doubtless in so imperial a State as this, its

own dignity is impaired in failing yet to recognize the full competency of these functions. No state has lived long or taken a high place in the development of civilization which has put aside these things as trivial. It stands to the credit of New York that she has done well in comparison with her sister states, but she stands far behind the older communities of the world in the deference she pays and the sacrifice she makes at this altar of intellectual life.

2 A troublesome misconception exists as to the title of the Museum, which in no small measure can not fail to influence the provision made for its maintenance. By statute the institution is the State Museum (Education Law, section 53). By Regents rule which has the effect of statute it is also the Science Department. The former term may imply the visible side of it, but the latter was expressly intended to specify the work of scientific investigation and publication. In service to the people the latter function is by far the more important, but nevertheless it is the former that is the term in common use and by this very fact conveys too often the idea that the institution is represented solely by a collection of material objects. Notwithstanding this misuse which is attended with danger to the Museum, it is not well to change the title. The trouble here lies in a disorderly use of the word museum. A museum is not a collection of material objects of special or exceptional interest. In its correct application the word means (and was so used when this Museum was established) a center of knowledge exemplified by specific objects and a fountain of new knowledge derived from investigation; and it is this comprehensive sense that the word still conveys in connection with all the great museums of the world.

3 The State Museum has acquired an established reputation among the people as the proper depository for objects of scientific interest, so far as they pertain to this State; gradually it is being recognized as a suitable resting place of objects of purely historical interest relating to our civic history and our agricultural development. Considerable accessions have lately been made of such objects and these will form the nucleus of the larger museum to come.

4 It is a first duty of the Museum to keep the citizens of the State informed as to the actual and potential natural resources of the Commonwealth. The mineral resources are immense; the people have a right to exact official knowledge of them, of their chances of further development and production. The agricultural interests of the State are of primary moment, an original source of livelihood; the people have a right to every safeguard which can be thrown about the crop production; to know their insect enemies and how to

fight them, how to combat insidious plant diseases; they are to be encouraged to recognize the vast aid rendered to agriculture by the activities of the birds, and the intelligent cultivator of the soil will care to know the relation of all the lesser animals to the operations of the farm. In prosecuting investigations of the insects and their habits, determining those that are vicious toward human interests, and the procedures effective in checking their ravages; in claiming protection for those that are friends to man; in seeking methods to control disease-creating plants; in many other lines of investigation of living nature, the scientific staff of the Museum render a daily service. Menaces to these great community interests must be foreseen and anticipated. Associated departments of state government with larger police power must be warned and advised in impending danger. Issues at court must be determined with exact knowledge; individual enterprises which may make for profit or for loss are to be so advised that they may not take the wrong path.

The people are also entitled to knowledge of the rock foundation of the State, its geological structure, the source of its underground wealth as well as of its soils, so exact as to require the most careful delineation and classification of the rock strata on maps, charts, and sections. As such work can be executed only by an accurate analysis of the contents and composition of these rock strata, mineral and organic, that is by the chemical and mineral structure of the rocks and the nature of the fossils they contain, all such necessary investigations have a direct bearing on the understanding of our natural resources and on the welfare of the people.

There is a further and higher relation to the welfare of the State in these studies of the fossil contents of the rocks; less tangible perhaps in direct application, but of first order of merit in their relation to intellectual progress. Two-thirds of the area of New York is underlain by rocks which carry the records of the life of the earth which preceded by vast ages the life of the present. They hold the ancestral stock of existing life and only by a comprehension of these early forms of life in their simpler expression can we fully grasp the modes and procedures of development which have led to the more complicated and higher life of today.

5 It is obvious that such activities as are above indicated can not be given their full value or the results be made of service to the State unless they are *published*. These results are the property of the State which has stood sponsor for them. It is not fair to the people that they should be given to the public through technical or scientific journals of limited circulation, even were this often practicable. Gravely inadequate provision is now made for such

general publication of the results and investigations; much less than was formerly done. As a consequence, important scientific manuscripts have accumulated until the publication of work done has fallen far into arrears. This is a regrettable condition, one hard to justify in view of the uninterrupted activities of the scientific staff, and one which ought to be corrected by provision of adequate printing funds.

6 The exhibition halls of the State Museum have reached their limit of expansion. Only the vertical walls remain available for increase of exhibits and these are of little use. A progressive scientific museum, with behind it a slowly developing plan for a general museum, would of necessity soon overpass the very limited quarters allotted to it in the Education Building. Could this building be enlarged by carrying it along the Hawk and Elk street fronts, sufficient additional space would be provided to meet the demand of growth for perhaps a generation, doubtless with needed relief to overcrowded departments elsewhere in the building. But it is beyond question that such relief of pressure is not the correct solution of its present and future requirements. The Museum should have its own independent building and equipment. It requires offices, workshops and laboratories, it must have large storage space, corridors and extensive exhibition halls. Until it gets these it will be far from attaining the purpose of the statute or affording the service contemplated by it. The question is not whether such independent museum building is to come, but how soon it will come. The need for it plainly existed when the Education Building was constructed, and this need is all the more felt now by the fact that should the Museum vacate the Education Building soon, great relief would be afforded to the other departments in the building — a relief which might avoid expense in the provision of additional quarters for these departments. The Director of the Museum has, by invitation, appeared before the Roosevelt Memorial Commission created by the Legislature, and presented to them effective reasons for regarding a new State Museum building a suitable memorial to the late Colonel Roosevelt; not alone for the pressing reasons stated above, but added thereto the additional fact of Colonel Roosevelt's intimate interest in such affairs of public concern as the Museum is engaged with, and his personal contact with it, not only during his term as Governor of the State, but especially by his extraordinary and impressive address made at the formal rededication of the present Museum, which was the last of his great speeches. It is felt that this suggestion is entitled to support and will receive full consideration by the commission.

Present active functions of the Museum. With advancing growth and the passage of time the functions of the Museum become broader and more diversified, in response to the natural and obvious growth of intellectual and industrial concerns of the State.

1 **The Geological Survey.** This is a continuing activity. It embraces (*a*) the progressive operations in the perfection of the geological map of the State on the topographic scale of 1 mile to the inch. Nearly one-half of the 50,000 square miles which constitute the area of the State has been surveyed on this large base scale, though not all these maps have been published. Work on such dimensions gives room for and requires a high refinement of field work and laboratory determinations. Following is a list of the topographic quadrangles which have been geologically worked out and printed:

*Albion
Albany
Alexandria Bay
Amsterdam
Attica
Auburn
*Ausable
*Batavia
*Berne
Blue Mountain
Brier Hill
Broadalbin
*Brockport
Buffalo
*Caledonia
Canandaigua
Canton
Cape Vincent
Clayton
Cohoes
Depew
*Eden
Elizabethtown
Elmira
Geneva
Genoa
*Glens Falls
*Gouverneur
Grindstone
*Hamlin
Hammondsport
Hempstead
Honeoye
*Lake Bonaparte
Lake Placid
Lake Pleasant
Little Falls
*Lockport
Long Lake
*Lowville
*Luzerne
*Lyon Mountain
*Medina
Mooers
Mount Marcy
North Creek
Nunda
*Oak Orchard
Ogdensburg
*Olcott
Olean
Ontario Beach
Oyster Bay
Ovid
Paradox Lake
Portage
Port Henry
Port Leyden
Poughkeepsie
Penn Yan
*Phelps
Red Mills
Remsen
*Ridgeway
Rochester
*Russell
Salamanca
Saratoga
Schroon Lake
Schuylerville
*Silver Creek
Syracuse
Theresa
*Tonawanda
Tully
Watkins
Wayland
West Point
*Wilson

* Those marked with a star (*) are not yet printed.

The latest of these maps to be published with accompanying detailed account of the areal and structural geology are the Mount Marcy and the West Point quadrangles, the former by Prof. James F. Kemp, the latter by Dr Charles P. Berkey and Marion Rice. Both are important as covering areas of special public interest, the one embracing much of the area of the Tahawus region or the so-called "Victory Park," the other including the location of the site and vicinity of the United States Military Academy and which it is believed will be helpful to its students in affording means of instruction in the application of geology to the arts of war. This map was begun during the late war with this very end in view and as a part of the activities of this State in connection with the National Research Council's War Committee on Geology. This survey has been very skilfully executed and constitutes an important addition to the geology of the State, as the area covered is one of complex structures difficult of resolution.

Additional studies of the complicated Adirondack and the Highland regions are in progress. A report on the Ausable quadrangle is in press, and continuous investigations in route on the sedimentary rocks of central New York and the Hudson valley. An effort is being made to establish a reasonable subdivision of the Catskill formation in the Catskill mountains and to determine if a division of this massive into its Devonian and Carboniferous elements is practicable. The factors and effects of glacial flow and postglacial drainage over the southern tier of counties are engaging active attention.

In the *industrial applications* of the science constant contact is maintained with all active operations and advice and counsel given freely in a great variety of mining and quarry adventures. The mineral industry of the State is not only highly varied but it increases rapidly in variety. While its magnitude is impressive, its variety is a more striking feature of the industry as a whole. A very large capital is involved in the mineral production and manufacture, and for the benefit of this industry as well as for the general information of the public, the Museum has just issued a comprehensive report entitled "The Mineral Industry of New York," which is the first general treatise on this theme since the publication of Lewis C. Beck's "Mineralogy of New York," issued in 1843. This will serve as a statement of the present development of the mining industry in this State and a succinct compendium of our knowledge of the subject. Investigations also continue in special industrial fields, as with iron, gypsum and salt, from which separate reports may be expected, but we here specially desire to emphasize.

The petroleum problems of this State. The producing oil fields of New York comprise some 70,000 acres, mostly in the counties of Allegany and Cattaraugus, but with small areas in the western part of Steuben. These fields have produced oil continuously for a period of more than 40 years. During the last 20 years there has been but little development of new territory, nearly all the new wells having been drilled in the established oil pools between other wells. It is not likely that the present bounds of the pools will ever be much extended, their limits having been pretty well established by border drilling. At present there are about 13,000 producing oil wells in the State. The period of greatest activity was in the early eighties when the production amounted to over 5,000,000 barrels annually. During the last 30 years there has been a gradual decline in the production which has, however, averaged more than 1,000,000 barrels annually. For 1920 the production will be over 900,000 barrels, an increase in output over the annual output of several years preceding. The maintenance of the output at such an even rate for such a long period reflects much credit to the producers for their policy of conservation and economy. The force of the above statement can be best comprehended when it is understood that the average production a well is less than one-fourth of a barrel daily. The wells, although small, have a longer life than in most other fields, and a few wells have produced for a period of over 40 years and a large number continuously for a period of more than 30 years, but each year with a decrease in the amount of oil pumped.

From the small daily production credited to most of the wells it is evident that in the near future most of them would have to be abandoned on account of being no longer profitable, unless some method be employed to increase the productiveness of the wells. With the continued use of the method employed for many years for obtaining oil it is estimated that the total future production in the State would not exceed 20,000,000 barrels. It is well known that in any oil field when a well is abandoned but a small percentage of the oil in the pores of the oil-bearing sand drained by the well has been obtained. This is due mainly to reduced pressure caused by the loss of confined gases which, during the productive period of the well, were active agents in forcing the oil through the pores of the sand to the bottom of the well. The amount of oil left in the sands of the New York fields after the abandonment of the wells is probably as much as 80 per cent. In other words, not over 20 per cent of the total amount of oil contained in the sands is recoverable by methods heretofore in common use.

In order to recover part of the oil that is left in the sand when the wells can no longer be profitably operated by the old method of pumping, another method is being introduced for increasing the production of oil wells, known as *restored pressure* or "flooding." This method is not successful in all oil fields, but the oil sands of New York and northern Pennsylvania lend themselves more successfully to extraction of oil by flooding than any other known oil pools.

Briefly the method of obtaining oil through restored pressure is as follows:

Water is introduced into a well and by reason of the hydrostatic pressure thus established by the water, the oil is forced away in advance of the slowly moving water from the bottom of the well, thus creating an oil flood. Wells are drilled in advance of the oil flood which continue to produce until they are reached by the water flood, after which, unless they are subjected to cross and reversed flooding, they function only as pressure wells forcing the oil beyond into an ever increasing area where new wells are drilled to obtain the flood oil.

This new method of obtaining oil by restored pressure is not without its problems, for flooding is a new business venture and probably less than 5 per cent of the New York fields have been subjected to this process of extracting oil. Floods travel slowly, depending mainly on the pressure applied and the porosity of the oil sands. The average progress of a flood varies from 50 to 200 feet a year. Although gratifying results have been obtained from the areas already flooded there are grave dangers of costly mistakes unless scientific studies are made of the best methods of applying the flood. Such studies should include the spacing of the wells, because there are many factors which determine the proper number of wells in a given area. It is evident that the operator desires to obtain the maximum amount of recoverable oil with the fewest number of wells possible. At present the number of wells an acre in flooded territory varies from two or three to as many as ten in exceptional areas. The proper number of wells to drill on various leases will of course vary with local conditions. These local conditions will involve a study of well logs, dips, domes, anticlines and other clinal structures, the depth of wells, thickness of sands, rate of movement, direction and control of floods, pressure


13
GROVE
WN.
WARD
MADISON HILL
POOL
WELLSVILLE
VILLE
WILLING


MAP SHOWING LOCATION OF OIL POOLS IN NEW YORK STATE
SCALE OF MILES
CHIPMONK SAND
STRAY SAND
SECOND SAND
BRADFORD OR THIRD SAND
VARIOUS SANDS 3RD, 4TH, PENNEY, FULMER VALLEY, WAUGH + PORTER
EXHAUSTED AREAS SHOWN BY BROKEN LINES
THESE POOLS ARE 13 MILES NORTH OF LOCATION HERE SHOWN.
GROVE
SHORT TRACT
HUMPHREY POOL
HUMPHREY
ALLEGANY
CARROLLTON
RED HOUSE
CHIPMONK POOL
RICE BROOK POOL
RED HOUSE POOLS
ALLEGANY
OLEAN
OLEAN
PORTVILLE
BRADFORD POOL
ROCK CITY
CATTARAUGUS COUNTY
CLARKSVILLE POOL
CLARKSVILLE
WIRT
RICHBURG
BOLIVAR
BOLIVAR
RICHBURG POOL
GENESEE
ALLEGANY COUNTY
AMITY
SCIO POOLS
SCIO
WARD
MADISON HILL POOL
WELLSVILLE
WELLSVILLE
ALMA POOL
ALMA
WILLING
ALFRED
HARTSVILLE
ANDOVER POOL
ANDOVER
ANDOVER
FULMER VALLEY POOLS
GREENWOOD
POTTER OR MERVINE POOL
MARSH POOL
INDEPENDENCE
WEST UNION
STEUBEN COUNTY
STATE OF PENNSYLVANIA

to be applied, specific gravity and viscosity of the oils, porosity of the sands and normal, cross and reversed flooding, probable oil content and possible percentage recovery of oil from the sands.

Among other studies that should be made is the possibility of practical application of the use of natural gas and air which can be introduced into wells under pressure and which produce effects similar to those of water flooding. Concentrating the oil by air or natural gas must be accomplished before the introduction of water floods, for water floods when used leave the oil not obtained by this method practically irrecoverable. The use of air and natural gas for restoring pressure in the New York oil pools has not met with any marked degree of favor among the oil men as the air used frequently mixes with the natural gas and spoils it for commercial purposes. A more extended use of natural gas would be made were it not for the scarcity of natural gas, which is needed either directly or indirectly to run the pumps. The fact that natural gas from which gasoline has been extracted can be used to give increased pressure when forced into an oil well and that the gas so used is made richer as a result of passing through the gas and oil sands, should encourage further attempts with natural gas for restoring pressure in oil wells, with the ultimate recovery of the gas so used. However desirable from the point of view of greatest possible recovery of oil by use of air or natural gas preliminary to water flooding, it appears probable that only flooding by water will be used extensively in the New York oil fields. The correct application of the principle of scientific flooding is greatly desired by the oil producers. Not enough of the area has been flooded, and so not enough experience has been gained by the oil producers to guide them as to how they should best conduct future operations. In line with their past policy of caution and economy they are asking when and how they should flood so as to produce the best results and the greatest amount of oil from the oil sands.

In order to avoid dangers from loss of oil through careless or ill-advised flooding and to apply the best scientific methods for the recovery of the oil, the producers have asked that a scientific study be made of the New York oil fields. This is a matter that not only concerns the oil producers but it is of vital importance to all the people of the State that the best scientific methods be employed in the oil fields to insure the recovery of the largest possible amount of oil from the pools in our State. A resolution asking state aid was introduced and adopted at the annual meeting of the New York

State Oil Producers Association held at Olean, September 21, 1921. The resolution is as follows:

Whereas, We believe that all the petroleum resources in the Allegany county and Cattaraugus county oil fields of southwestern New York contain millions of barrels of oil yet in the ground which can be profitably produced if the best scientific methods of restoring pressure are adopted; and whereas, our oil producers need geologic knowledge to assist in such production to prevent waste;

Resolved: That the New York State Oil Producers Association, representing more than 1000 small producers, through its officers, petition the Director of the New York State Geologic Survey to make a geologic survey of the Allegany and Cattaraugus oil fields; and, if possible, to do the work during 1922 so that we may gain geologic knowledge while we most need it.

This resolution was favorably acted upon September 22, 1921, by the Regents of the University and a request was made by the Director through the State Board of Estimate and Control, that an appropriation be granted by the State Legislature, which is now in session, for the purpose of carrying out a geologic survey of the oil fields of the State. Of the important oil areas of the State only the Chipmonk pool, whose productive sand is higher in the series, being above the Bradford or Richburg sand of the other pools, is regarded by many producers as not being capable of being flooded successfully. The remaining areas which can be successfully flooded, excluding certain portions in the Bradford and Richburg pools, comprise about 60,000 acres. The results thus far obtained by the use of restored pressure or flooding are most gratifying. Certain leases have reported a production from 2000 to over 5000 barrels per acre from areas that were practically exhausted under the old method of operating. Theoretically an acre of fully saturated sand one foot thick with a porosity of 10 will contain 775 barrels of oil. The thickness of the oil sands which can be flooded in New York State vary from a few feet to over 50 feet and a fair average for the fields to be flooded is 20 feet. The porosity of the New York oil sands ranges from 10 to 18. Assuming the lower figure for porosity and the thickness of sand as 20 feet, the oil content of an acre is over 14,000 barrels.

Many estimates have been made of the probable amount of oil that has been left in the sands after they are regarded as exhausted by the old methods of production. The usual estimates have placed the amount not recovered between 80 and 90 per cent. The amount of oil left in the sand that can be recovered by restored pressure or flooding is not readily determinable. Aside from theoretical considerations, practical results in the field seem to show that more oil can be obtained by flooding than has been obtained from leases that have become exhausted by the old method of operation. The past and future production of oil in New York by the old method of operation will total around 90,000,000 barrels and it is believed that a like amount additional can be obtained through the use of restored pressure or flooding.

(Statement prepared by C. A. HARTNAGEL)

The staff of the State Geologist, permanent and temporary, engaged in the solution of such problems as have here been indicated is as follows:

R. Ruedemann. Occupied with studies on the fauna of the Lorraine and other earlier formations of the Capitol District and the areal rock survey of the Albany-Berne quadrangle.

C. A. Hartnagel. On the geology of the Clinton group and the various phases of industrial geology.

D. H. Newland. A former member of the staff. On the problems of salt and gypsum.

Winifred Goldring. On the study of paleobotany, the ancient plant growth of the State.

Charles P. Berkey. On the areal survey of the West Point, the Tarrytown and Schunnemunk quadrangles and their problems, in which he has had associated with him Marion Rice and F. Holzwasser.

R. J. Colony. On the iron regions of southeastern New York.

James F. Kemp. On the areal geology of the Mount Marcy and Ausable quadrangles with which he has been discontinuously engaged for several years.

William J. Miller. On surveys and problems in Adirondack geology, in which field he has recently completed the Blue Mountain Lake, Russell and Luzerne quadrangles and is now engaged with the Gloversville quadrangle.

O. D. von Engeln. Specially concerned with the determination and interpretation of glacial and postglacial drainage phenomena in southern New York.

H. L. Fairchild, who continues his long service to the State in the present study of the evolutionary history of the Susquehanna river.

Harold L. Alling. Engaged with problems of precision in optical geology pertaining specially to secondary changes in rocks.

J. J. Galloway. Provisionally occupied with the study of the Catskill mountains.

William L. Russell. Occupied with the collection of statistical reports on the petroleum industry of the State.

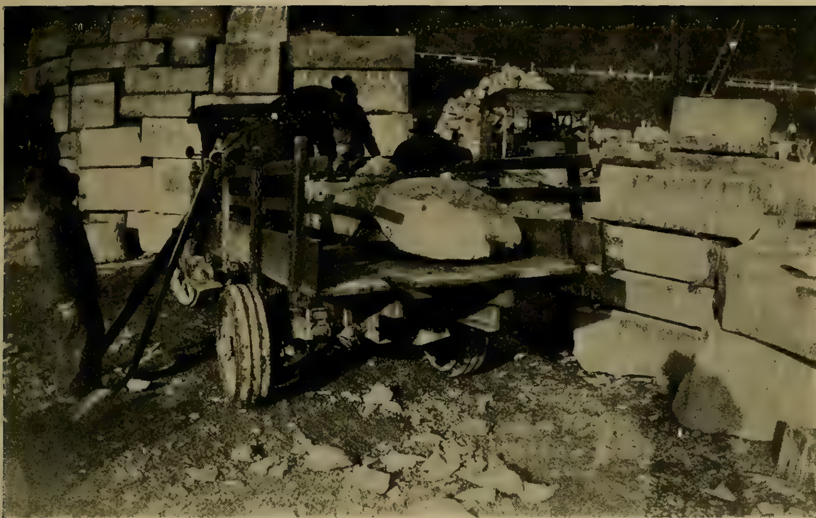
John H. Cook. In continuation of studies of the postglacial geology of the Albany region.

Contributory to the foregoing studies are the important researches which pertain to the past life of the earth. In this department advances of high significance have been made.

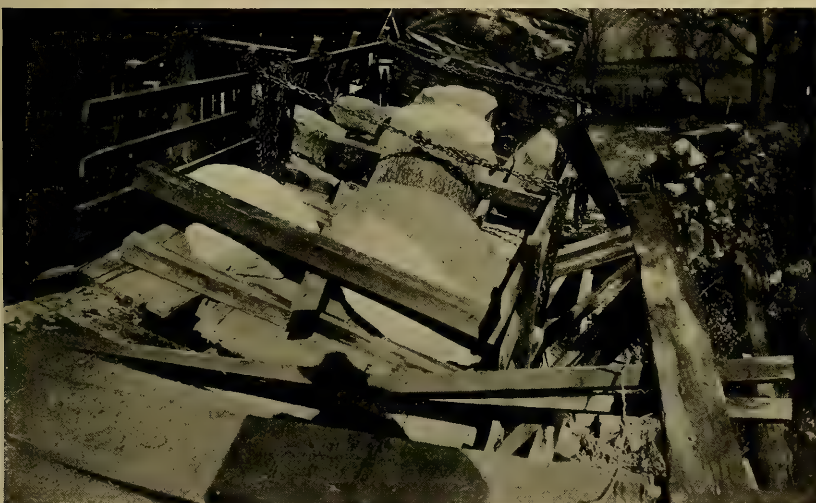
Fossil trees of Gilboa. In the Devonian period of our development the continental land lay off to the east of the Catskills, extending far into the present area of the Atlantic. The present Catskill mountains were then the low shore of a shallow sea lying at the west, covering the interior of the State and country and receiving the heavy drainage from the eastern land mass. That lost land of the east was wooded with a primitive vegetation, and its westerly rivers brought down the débris of this woodland and scattered its remains, its stems and leaves, through its vast delta and shore deposits. It is the lower or earlier part of the Catskill terrane that shows most abundantly this close intermixture of terrestrial and marine conditions; the earliest of the fresh-water mussels which burrowed in the sands of the river mouths; the forest growth carried at times by the river and coast currents far out among the marine deposits and mingled with the animal remains of the salt sea. Perhaps nowhere else in the known records of the rocks is there such an extraordinary accumulation of the land flora of this geological age as in these sands which underlie the slopes of the Catskills westward into the Allegany plateau. Along the unstable coasts of those days a forest growth of trees of most primitive character, still not understood, grew thick and to notable heights of 20 to 40 feet, spreading down to the water's edge. By occasional submergence of the coast these trees were carried beneath the water and the sediments piled up about their bases. The rising of the land again lifted the coastal forest out of the sea. Thus we have found these remains of the buried forests, standing as erect stumps in the rock beds, just as they grew. The first evidence we had of these most ancient of all forests was developed some 50 years ago by a heavy washout in the upper reaches of the Schoharie creek at Gilboa. Nothing more was heard of them until 1897 when Prosser of this survey reported finding, at a higher horizon, several small specimens lying loose by the roadside at the Manorkill falls over a mile above Gilboa. With the beginning of the present operations at Gilboa and vicinity in the construction of a dam for a reservoir of Schoharie water to swell the supply for the New York City water system, it was deemed advisable again to visit the region in the hope of finding more specimens and to determine whether the localities where the forest stumps had been found would be under water as a result of the creation of the artificial lake. In 1920 no specimens were found

Quarry at Gilboa where the stumps were found at the 960 foot level. The stumps rested on a thin shale and extended upward into one of the layers of dimension stone. The shale bed is seen just under the loaded bucket.

Some fossil stumps from the quarry at Gilboa from the 960 foot level. These are now in the State Museum.



A truck load of fossil trees at the Gilboa quarry.



Paleontological difficulties. An auto truck with 3 tons of fossil trees has fallen through a bridge over the Breakabeen Creek.

at the original locality but at the Manorkill, 6400 feet south, several tree trunks were found in place by the side of the road near the bridge over Manorkill falls. Five specimens were taken from this site and they constitute the highest horizon in which these stumps have been found. The elevation here is 1120 feet above tide and 100 feet higher than the old locality at Gilboa. When the Gilboa reservoir becomes filled the flow line will be a few feet above this spot. In 1921 the old locality, which is directly at the spot where the dam is being built, was again uncovered and seven trees were found, some of which were too badly broken to permit removal. One of the specimens taken weighs nearly a ton and has a circumference of nearly 12 feet. The elevation of this horizon is 1020 feet.

From a new quarry, 2300 feet north of the old locality and at a horizon 60 feet lower, a remarkable series of excellent specimens was taken. This quarry was opened for the purpose of obtaining dimension stone to be used in the construction of the dam. From an area 50 feet square, eighteen specimens were obtained. In all three horizons where the stumps have been found their bases rest upon shale and in each case the trunk has been found upright extending into the coarse sandstone above. The thickness of the shale bed varies from 6 inches to as much as 2 feet. It is worth noting, however, that at the lowest horizon the trees were most abundant at a place in the quarry where the shale was only 6 inches thick. Although most of them have been confined to the three horizons mentioned, others are occasionally found at other levels. In the lower quarry a small stump is reported to have been found 6 feet above the shale layer on which most of the stumps rested. A single specimen was observed in this quarry 12 feet above the main layer. The stump was a small one a foot in diameter. Its position was upright and at its base was a layer of black shale one inch thick. Five feet from the stump the black shale entirely disappeared and there was actually no division line in the sandstone. It is possible that this specimen may have drifted and settled in its upright position. The presence, however, of the thin bed of shale once dark mud, limited to the vicinity of the stump, suggests that it was actually its place of growth. The only other example of a stump not occurring in one of the three main horizons is one from the middle or old locality where a specimen was obtained 6 feet above the shale band on which rested the other stumps that were found.

The geologic horizon of the occurrence of the Gilboa tree trunks is apparently that of the Ithaca formation. No red beds characteristic of the Oneonta are found as low as any of the horizons containing tree trunks. At the Manorkill, red beds characteristic of the Oneonta are shown just a few feet above the locality for the tree stumps at the Manorkill. It is apparent, however, from collections made at a higher horizon at the intake of the tunnel 4 miles to the south that here the Ithaca fauna prevails and we have an intermingling of Ithaca and Oneonta sediments. The presence of the fresh-water unio Amnigenia catskillensis in a massive sandstone 1½ miles northeast of Gilboa and some 600 feet above the river at Gilboa clearly indicates that the horizon of this shell is above the tree trunks found at Gilboa. The presence also of an Ithaca fauna on the hillsides above Gilboa indicates that we have an interfingering of the Oneonta and Ithaca sediments.

This gives us the record of three distinct horizons for the occurrence of these Devonian trees. The geological record is that of three distinct submergences of the land which brought the forest growth down into the water and at least three corresponding elevations of this forest-covered land beyond the reach of the water. The total number of these tree stumps thus far collected, excluding those destroyed in quarrying operations, including those of the first and earlier series, is thirty-five, and all those of the later series the Museum owes to the courtesy of the Commissioners of the New York Board of Water Supply and of Mr J. Waldo Smith, chief engineer, who decided that with the exception of a single specimen presented to the American Museum of Natural History, the emphatic and impressive effect of this most extraordinary occurrence should not be lessened by any further dispersion of these relics. The State Museum therefore possesses practically the entire record of this phenomenon, and the effort has been made this year to restore the occurrence in the form of an exhibit in the central hall of the Museum. Unfortunately this restoration was made when but two tiers of the trees had been uncovered, so that while it is incomplete in effect, it serves an admirable purpose in elucidating the mode of occurrence of these ancient forests. What these trees were, how related to present and ancient vegetation, is still a mystery — one of the problems to be solved.

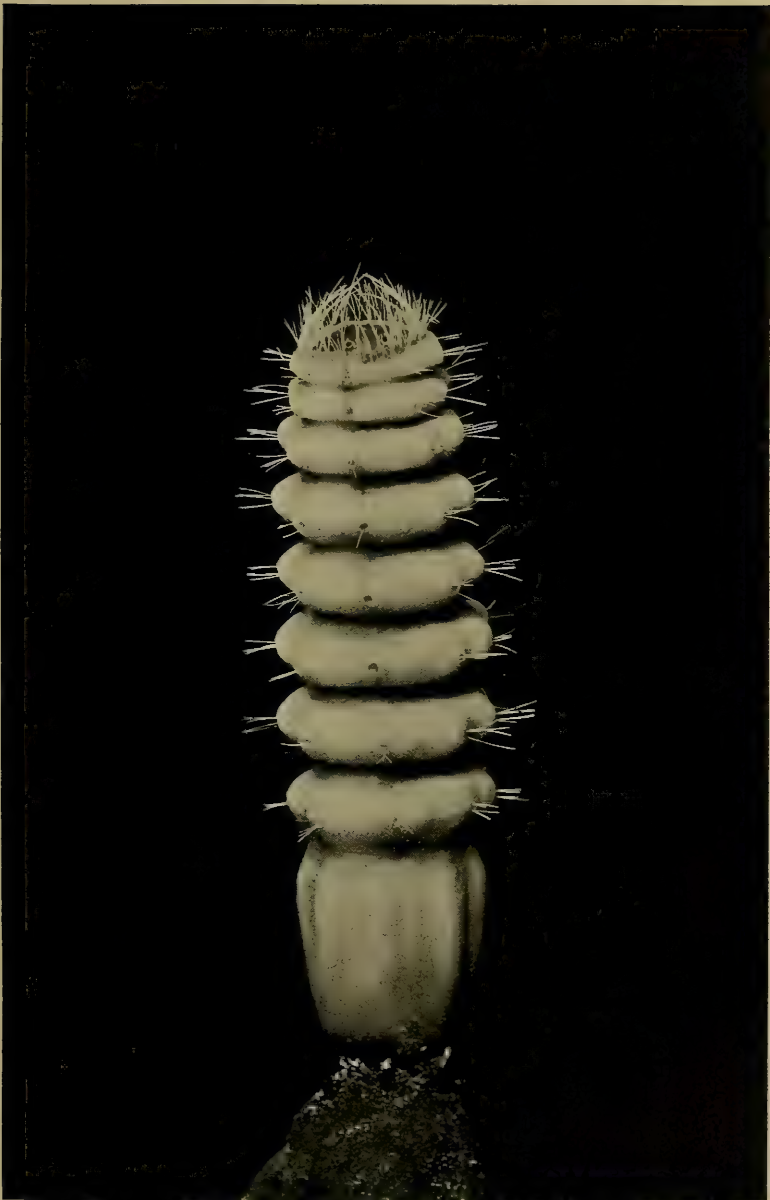
Further restorations of fossil invertebrates. The Museum has installed several exhibits showing the sea bottom of various periods in the geological history of the State. These have proved the most effective means of visualizing the life of the Great Past as they rehabilitate the creatures of the ancient seas in accordance with our best understanding of their structure. They are in all cases the

The Higgins group of restorations of fossil glass sponges from the Upper Devonian rocks in the vicinity of Olean, N. Y. Fifteen different species of these graceful creatures are here shown in a submarine cave. The restorations have been delicately wrought out in the most exacting manner possible by Henri Marehand. Size of the group 6 feet x 4 feet.

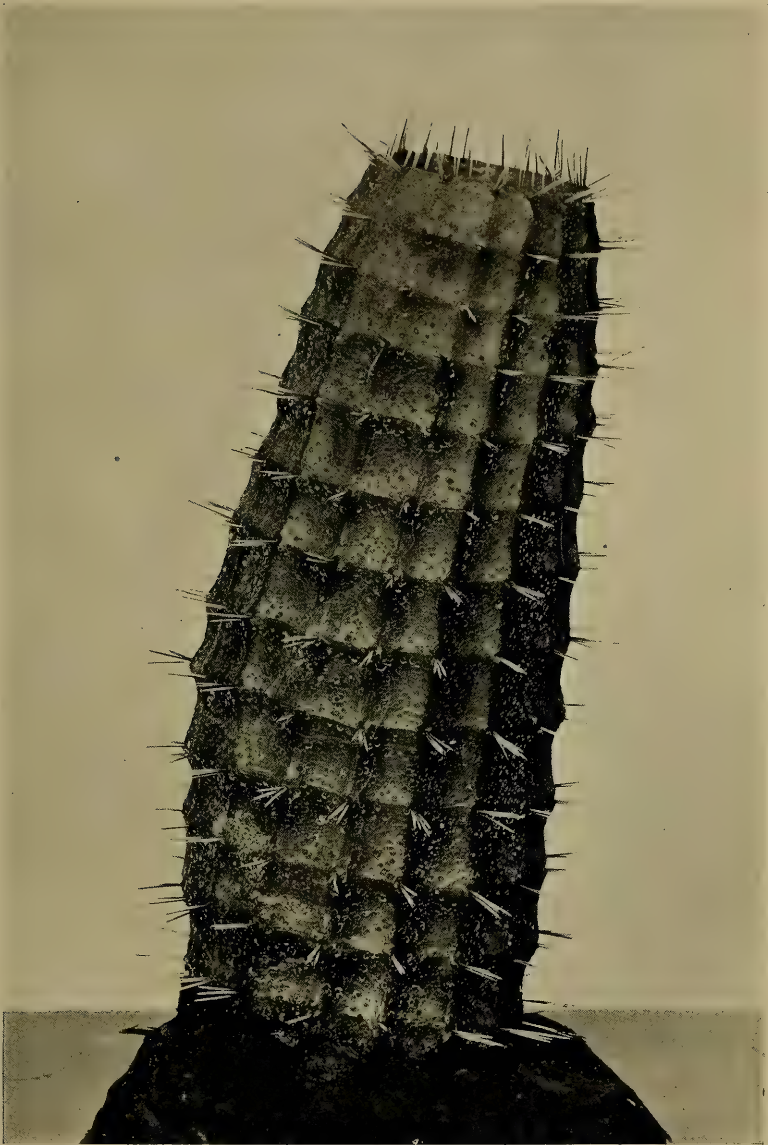
Devonian glass sponge
OZOSPONGIA JOHNSTONI Clarke

Devonian glass sponge
ARMSTRONGIA ORYX Clarke

Devonian glass sponge
HYDNOCERAS MULTINODOSUM Hall & Clarke



Devonian glass sponge
HYDNOCERAS WALCOTTI Clarke



Devonian glass sponge

THY[SANODICTYA HERMENIA Hall & Clarke

Devonian glass sponge
BOTRYODICTYA RAMOSA (Lesquereux)

renditions of the accomplished artist based on the studies of comparative anatomy which the department has carried out. Four of these have now been constructed, namely

1 Showing the Eurypterids of the Silurian period.
2 The assemblage of marine animals constituting in part the fauna of the Portage (Upper Devonian) formation.
3 The fauna of the Helderberg period.

The 4th has just been constructed and completed. It represents a submarine colony of the extinct glass sponges in extraordinary variety and beauty of coloring, as they are believed to have lived and looked in the waters of the Chemung (Upper Devonian) period — an exemplification of the remarkable plantations of these creatures which in their day covered the sea bottoms of Cattaraugus, Allegany and Chautauqua counties. This group has been constructed by Henri Marchand of the Museum staff and is a gift from Mrs Frank W. Higgins of Olean, as a memorial of her husband, the late Governor Higgins, during whose term of office and with whose official aid the construction of the present halls of the State Museum was provided for.

Museum reservations. The Museum controls four parcels of real estate which have been taken over for preservation, through the generosity of its friends, because of their features of extraordinary scientific interest. They are

1 The Cryptozoon Ledge or Lester Park, in the town of Greenfield, near Saratoga Springs.
2 Stark's Knob Volcano, at Stark's Knob Station 2 miles north of Schuylerville.
3 Clark Reservation, near Jamesville, Onondaga county.
4 Squaw Island, in Canandaigua lake.

Such care and wardenship as can be given to these reservations is at the cost of the general maintenance fund of the Museum. Since the acquisition of these interesting properties the committees of the Legislature have taken the attitude that special provision for their maintenance shall not be made, an attitude that is illiberal and out of harmony with the traditions of the State, as well as discouraging to the effort which, in a State so great as this, should be continuously made to preserve from destruction its spots of scientific and educative value. Could some proper guaranty of adequate care have been given, an area of some acres at and about the falls of the Chittenango creek, notable for its geological and botanical interest, as well as for its scenic beauty, would probably by this time have been added to these reservations; and with anything like an appreciative response, there would before this have been annexed to the State Museum the remarkable Aboriginal Flint Quarries which have been described elsewhere in this report by the archeologist.

A special examination by W. Goldring, of the Pleistocene or Postglacial fossils in the Lake Champlain and St Lawrence valley clays, has led to the noteworthy conclusion that the changes in these faunas southward from the St Lawrence area through the Lake Champlain area indicate a gradual freshening of the sea in that direction. The discussion of this interesting evidence is set forth in a paper appended to this report.

GIFTS

TO THE GEOLOGICAL DEPARTMENT

Mrs Frank W. Higgins, Olean, N. Y.

A restoration of a group of fossil glass sponges as they grew in the Chemung rocks in the vicinity of Olean, N. Y. An account of this group is given in the preceding pages.

Emerson McMillin, New York City

The Temple Hill mastodon, a nearly complete skeleton of a rather large-sized animal found on the farm of Antonio Fishera. This is the third skeleton in order of completeness, out of more than 100 records of occurrence, that has been found in the State.

Prof. Gilbert D. Harris, Ithaca, N. Y.

A specimen of a fossil glass sponge from the Chemung rocks south of Ripley, Chautauqua county, and given in the name of Mrs H. A. Burton. This is a fine fragment of a gigantic individual of the genus Ceratodictya, by far the largest specimen of a fossil dictyosponge known.

J. Waldo Smith C. E., and the Commissioners of the New York City Board of Water Supply

An extensive series of fossil trees found in excavations for the reservoir of the Catskill aqueduct at Gilboa, Schoharie county. Some account of this is given in the preceding pages.

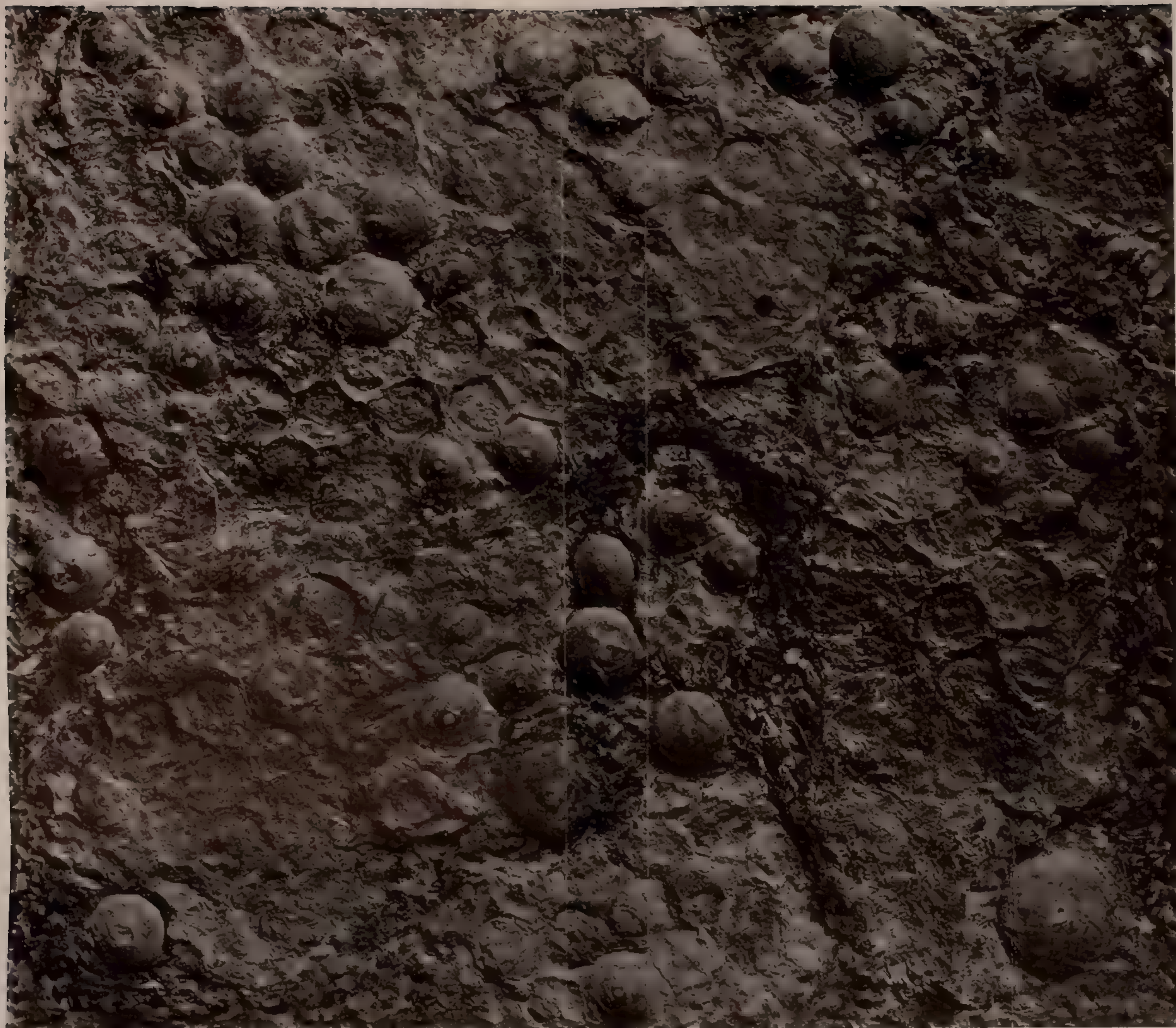
Prof. Thomas Johnson, Royal College of Science, Dublin

Fossil plants from the Upper Devonian, Kiltorkan, County Kilkenny, Ireland.

Dr W. A. Parks, University of Toronto

Slabs of fossil plants from the Belly river formation.

A portion of a slab covered with specimens of an undescribed Receptaculites,
fossil iron ore, one mile southwest of Verona Station, Oneida County. T
of over 2 inches.



A portion of a slab covered with specimens of an undescribed Receptaculites, from the Clinton green shale 15 feet below the upper or fossil iron ore, one mile southwest of Verona Station, Oneida County. The largest individual shown in the picture has a diameter of over 2 inches.

K. B. Mathes, Batavia, N. Y.

Devonian fossils from western New York.

W. P. Judson, Broadalbin, N. Y.

Large example of the brachiopod Amphigenia from the Erie canal, Genesee street, Buffalo.

Howard S. Scholes, Albany, N. Y.

Devonian fossils from the vicinity of Thompson's lake.

Lesley W. Jones, Amsterdam, N. Y.

Fossils from the quarry in the Amsterdam limestone.

Dr Francis C. Nicholas, President, Maryland Academy of Sciences, Baltimore

Cystids from the Keyser formation, West Virginia.

Special collections of Devonian fossil plants made by Winifred Goldring, Joseph Bylancik, Vincent Ayers, D. Dana Luther and H. P. Woodward from the rocks in the vicinity of Gilboa, Margaretville, Walton, Cadosia, Hancock, Shinhopple, Downsville, Oxford, Norwich, Sidney, Monroe, Naples, Honeoye. 2100 specimens.

STAFF OF THE DEPARTMENT OF SCIENCE

The members of the staff, permanent and temporary, of the Department, as at present constituted, are:

ADMINISTRATION

John M. Clarke, Director
Jacob Van Deloo, Secretary of the Museum
Anna M. Tolhurst, Director's Stenographer and Secretary

GEOLOGY AND PALEONTOLOGY

John M. Clarke, State Geologist and Paleontologist
Chris A. Hartnagel, Assistant State Geologist, Curator of Geology
Rudolf Ruedemann, Assistant State Paleontologist, Curator of Paleontology
William L. Bryant, Honorary Custodian of Fossil Fishes
Winifred Goldring, Associate Paleontologist
Charles K. Cabeen, Mineralogist
Esther K. Bender, Draftsman
Noah T. Clarke, Scientific Technician
H. C. Wardell, Technical Assistant
Edith A. Lipschutz, Stenographer
Charles P. Heidenrich, General Mechanic

Stephen D. McEntee, Clerk
John L. Casey, Custodian of Museum Collections
William Rausch, Cabinetmaker
Jerry Hayes, Laborer
Floyd S. Teetsel, Laborer

Temporary Experts

Areal Geology

Prof. W. J. Miller, Smith College
Prof. W. O. Crosby, Massachusetts Institute of Technology
Prof. Charles P. Berkey, Columbia University
Prof. A. F. Buddington, Princeton University
Prof. J. J. Galloway, Columbia University
Howard A. Meyerhoff, Columbia University

Economic Geology

R. J. Colony, Columbia University
W. L. Russell, New Haven, Conn.

Geographic Geology

Prof. Herman L. Fairchild, University of Rochester
James H. Stoller, Union College
John H. Cook, Albany
O. D. von Engeln, Cornell University

Paleontology

Florrie Holzwasser, Columbia University
Herbert P. Woodward, University of Rochester

BOTANY

Homer D. House, State Botanist

Temporary Expert

Helen La Force, Schenectady

ENTOMOLOGY

Ephraim P. Felt, State Entomologist
D. B. Young, Assistant State Entomologist
Margaret Felt, Stenographer
Raymond R. Logan, Page

The Temple Hill Mastodon found on the farm of Antonio Fishera who is here holding the left ramus of the mandible showing three fully developed teeth.

The Temple Hill Mastodon; a femur.

The Temple Hill Mastodon. View showing the character of the ground in which the skeleton was found. The upper layer of dark vegetable mold was underlain by a bed of white calcareous tufa on which the bones were lying.

Temporary Experts

Hall C. Carpenter, Massachusetts Agricultural College
William A. Hoffman, Cornell University

ZOOLOGY

Sherman C. Bishop, Zoologist
Benjamin Walworth Arnold, Honorary Curator of Ornithology
Fanny T. Hartman, Assistant to Zoologist
Arthur Paladin, Taxidermist

Temporary Experts

Dr H. A. Pilsbry, Philadelphia
Roy W. Miner, New York

ARCHEOLOGY

Arthur C. Parker, Archeologist

Temporary Experts

Everett R. Burmaster, Irving
George Stevens, Albany
J. D. Ray, West Coxsackie

BOTANY

Scientific investigations. The investigative work of the State Botanist during the year 1920 has been largely devoted to a study of the native vegetation, and its ecological relations, in several localities. Early in June a few days were spent at Bonaparte lake in northern Lewis county, in a continuation of a study of the large swamp, known as Bonaparte swamp. The last two weeks of July were spent in and about the township of Newcomb, Essex county, in the Adirondack mountains. A preliminary account of this work will be submitted later; it is proposed to continue the study of the vegetation of this section as a supplement to the "Plants of North Elba," by the late Doctor Peck, published as Bulletin 28. North Elba is located northeast of Newcomb and separated from it by Mount Marcy, Mount MacIntyre and other high mountains. The distance between the two sections is not great, but Newcomb is drained largely by the Hudson river, while North Elba is drained by the Ausable and Saranac rivers, and hence lies north of the divide between the Atlantic and St Lawrence basins. While both sections possess in general the typical Adirondack vegetation, there are many minor differences in the character of plant life, which will be more fully elaborated through future investigations.

During August a few days were spent at Lake Pleasant in Hamilton county. Other brief trips for the purpose of studying plant life and making collections, were made to various localities of northern, central and eastern New York. In September, through the kindness of friends interested in the wild life of northern New York, a tour of general reconnaissance was made which covered practically all the Adirondack region.

During the season there were collected 830 specimens of ferns and flowering plants, and 250 specimens of fungi, mosses and lichens. Approximately 600 of these have been added to the state herbarium, as a record of the plant life of the sections studied. The other specimens, with duplicates of those added to the herbarium, have been disposed of in exchange with other institutions.

Considerable progress has been made in the compilation of a complete flora of the State. This is now in substantially a completed form and awaits publication. The work is fully collated with references to published notes from all sources relating to the vegetation of the State, and with citation of localities for the rarer species, affords a work which will prove of value to the students of plant life.

Cooperative investigations have been carried on with Prof. John Dearness of London, Canada, on certain parasitic and saprophytic forms of fungi; and with Dr H. H. Bartlett, director of the botanic gardens, University of Michigan, on the native species of evening primrose, belonging to the genus Oenothera. The genus Oenothera is classic in the study of mutation, and our native species have yielded most interesting material in this connection. Seeds, gathered by the State Botanist and by correspondents in many widely separated localities, were grown by Doctor Bartlett. The scientific papers representing the cooperative work with Doctor Bartlett and with Professor Dearness will be presented with the regular botanist's report to be submitted later.

Noteworthy contributions. The chief additions to the state herbarium during the past year in the form of contributions and exchange, are presented in the following list of contributors, which also indicates the number of specimens received from each.

The most important contribution was the herbarium of the late F. E. Fenno, of Earlville, donated by Mrs Fenno. Mr Fenno had for many years, in addition to his duties as a teacher, been interested in botany, and has contributed much of value to our knowledge of the plant life of the State. In State Museum Bulletin 67 (1903) he published an account of the " Plants of the Susquehanna Valley and Adjacent Hills of Tioga County." Supplementary accounts to this work appear in Museum Bulletins 75 and 217–218.

Mrs F. E. Fenno, Earlville	400
E. Bartholomew, Stockton, Kan. (exchange)	282
H. M. Denslow, New York City	62
Dr Anne E. Perkins, Collins	40
New York Botanical Garden (exchange)	23
M. S. Baxter, Rochester	13
D. M. White, Rochester	10
W. A. Matthews, Rochester	10
Mrs O. P. Phelps, Wilton	4
N. W. Fitch, Albany	3
Dr F. C. Stewart, Geneva; E. Bethel, Denver, Col.; George M. Pendleton, Sisson, Cal.; Miss G. S. Burlingham, Brooklyn; Dr L. H. Pennington, Syracuse; W. M. Beauchamp, Syracuse, each 2	12
Dr G. P. Clinton, New Haven, Conn.; S. H. Burnham, Hudson Falls; J. A. Crabtree, Montgomery; Charles Gilbert, Honeoye; E. A. Eames, Buffalo; A. B. Brooks, Albany; S. N. Cowles, Otisco; Miss Mabel Martin, Broadalbin; Dr Emmaline Moore, Albany; Miss Charlotte Bogardus, Coxsackie; and Dr George M. Reed, Washington, D. C., each 1	11
Total	870

Additions to the herbarium. The number of specimens which have been added to the herbarium from all sources during the year is 1471. Of these, 870 were received in exchange or as contributions as indicated above. The remaining 600 were collected by the staff in the counties of Albany, Essex, Franklin, Hamilton, Lewis, Madison, Oneida, Oswego, Rensselaer, Warren and Washington. The number of species added to the state herbarium which were not previously represented by specimens therein is 52.

Identifications. The State Botanist's office has been called upon to identify 260 specimens of plants, including many edible and poisonous fungi. These identifications were asked for by 140 different persons.

Ferns and Flowering Plants New to the Herbarium

Agropyron pseudorepens *Scribn. & Merr.*
Carex Frankii *Kunth*
" Hassei *Bailey*
Aster persaliens *Burgess*
Comandra livida *Richards.*
Asclepias intermedia *Vail*
Froelichia gracilis *Moq.*
Ranunculus boraeanus *Jordan*
Raimannia laciniata (*Hill*) *Rose*
Linnaea americana, forma candicans *House*
Sherardia arvensis *L.*

Fungi New to the Herbarium

Apospheria major *Syd.*
Cercospora catenospora *Atkinson*
" cerasella *Sacc.*
" erythrogena *Atkinson*
" ferruginea *Fckl.*
" Lespedezae *E. & D.*
" Kalmiae *E. & E.*
" Lippiae *E. & E.*
" omphalodes *E. & H.*
" vexans *C. Massal*
Cercosporella aceris *Dearn. & Barth.*
" trichophila *Davis*
Cintractia subinclusa (*Korn*) *Magn.*
Cladosporium citri *Massee*
Chrysomyxa Weirii *Jackson*
Coleosporium Plumierae *Pat.*
Coniophora sistotremoides (*Schw.*)
" vellereum *Ell. & Cragin*
Cylindrosporium Tradescantiae *E. & K.*
Cytospora maclurae *Ell. & Barth.*

Colletotrichum solitarium *Ell. & Barth.*
Cylindrosporium spiraeicolum *E. & E.*
Diatrypella missouriensis *E. & E.*
Didymaria conferta *Syd.*
Doassansia opaca *Setch.*
Gloeosporium ramosum *E. & E.*
Gymnosporangium corniculans *Kern*
Hainesia rhoina *E. & S.*
Haplosporella dulcamara *D. & H.*
Hypochnus rubiginosus *Bres.*
" subvinosus *Burt*
Melampsoridium betulae (*Schum.*) *Arth.*
Melampsoropsis chiogenis (*Dietel*) *Arth.*
Microdiplodia spiraeocola *D. & H.*
Mycosphaerella cruris-galli (*E. & K.*) *Dearn.*
Ovularia pulchella (*Ces.*) *Sacc.*
Pestalozzia monochaetoidea, var. parasitica *D. & H.*
Puccinia conglomerata *Schum.*
" tenuiastipes *Rost.*
" tuberculans *E. & E.*
Parodiella grammodes (*Kze.*) *Cooke*
Peniophora eichleriana *Bres.*
" sera (*Pers.*)
Russula davisii *Burl.*
" disparilis *Burl.*
Ramularia occidentalis *E. & K.*
Septoria pallidula *D. & H.*
Schroeteria cissi (*DC.*) *DeToni*
Spegazzinea rubra *D. & H.*
Sphaeropsis betulae var. lutea *D. & H*
" gleditschiaecolae *Cooke*
" populi *E. & B.*
Sphaerulina acori *D. & H.*
Thecaphora trailii *Cooke*
Uredo erythroxylonis *Graz.*
Uromyces anthyllidis (*Grev.*) *Schroet.*
Urocystis occulta (*Wallr.*) *Rab.*
Ustilago levis (*Kellerm. & Swingle*) *Magn.*

ENTOMOLOGY

The following is a brief summary of the Entomologist's work and the conditions he has found in various parts of the State. More detailed information is given in his annual report.

European corn borer. The activities of the past season have shown a comparatively slight extension of the territory infested by this insect in the Schenectady area and a material increase in the western section, this latter due in all probability to the fact that there was no time in the fall of 1919 to determine fully the area then infested, and thus the increase recorded in the Entomologist's report is more apparent than real.

The developments of the past season have again indicated but one generation for the New York areas, while certain data brought to attention during the past few months suggest that in eastern Massachusetts there may have been but a partial second brood each session instead of the previously supposed two complete generations. This of itself indicates less difference between the infested area in New England and the New York sections than previously had been supposed to exist.

It is furthermore worthy of note that a very small second generation developed in both the infested areas in New York and in Canada in 1921.

The discovery in 1920 of the European corn borer in Ontario, Canada, one infestation just east of Buffalo and another centering approximately upon St Thomas, has had a marked influence upon the situation. It has demonstrated, for example, the impossibility of attempting extermination with such extensive and widely distributed infestations. The conditions, climatic and agricultural, in Canada are practically identical with those obtaining in New York State and are of particular interest, because in the vicinity of St Thomas large areas of field corn were seriously damaged, some 70 to 90 per cent of the stalks being infested and approximately 50 per cent of the ears. The commercial damage in one of the more seriously affected fields was placed at from 20 to 25 per cent. This was produced by one generation and in a section where the insect presumably had not been sufficiently abundant the preceding season to attract general notice. It obviously follows that such conditions may develop in the infested areas in New York State and that with substantially no warning, unless precautions are adopted to prevent an unrestricted increase of the pest. It may be added in this connection that there was greater injury over larger areas in Canada in 1921, the damage being greatest in early planted corn, and while there was somewhat of an increase of the pest in the New York areas, it was by no means proportional.

Prior to the discovery of this insect in Canada, an attempt was made by the Entomologist and other interested persons to secure the cooperation of the Federal Government in a comprehensive campaign to clean up and if possible exterminate the insect in at least a portion of the sparsely infested New York area. An effort of this kind would have demonstrated possibilities and would at the same time have assisted very materially in checking the westward spread of the pest. This attempt failed on account of various conditions and as the borer had not caused serious losses to corn in New York State, it was deemed inadvisable to request large appropriations from the Legislature for the purpose of continuing the policy of 1919.

The European corn borer is of such general importance and its habits in New York State are so different from those in Massachusetts that application was made to the Legislature for a special appropriation for the investigation of the status of this insect and $5000 was made available for the purpose. The money has been used in a careful field study of the pest to ascertain the rapidity of spread, the amount of injury and the possibilities of control or repressive measures. The work was placed in charge of D. B. Young, who was temporarily detailed from the Entomologist's office, Mr Hall B. Carpenter of Somerville, Mass., was engaged as a special assistant for this work and an intensive study of the Schenectady area was made. The results are given in considerable detail in the body of the Entomologist's report. These studies sustain the opinions formulated in 1919 and demonstrate a considerable difference in habits of the corn borer in New York State as compared with the infested areas of Massachusetts. There is, for example, but one generation normally with a consequent limitation upon probable injury. The insect appears to be confined in New York State almost exclusively to corn, a condition very different from that obtaining in eastern Massachusetts, where it breeds freely in several plants and is found in numbers in many others. These variations are of much practical importance, because of their bearing upon quarantine restrictions and other methods designed to prevent further spread. Conclusive data were also secured as to the efficacy of thoroughly plowing under infested corn stalks, a matter of much importance, since it makes possible the destruction of many borers with practically no additional cost.

The appointment of the Entomologist as collaborator of the Bureau of Entomology, United States Department of Agriculture, specifically authorized to investigate corn borer control in the states of New York and Massachusetts, has been continued for the year beginning July 1, 1920. This has facilitated studies immensely and has enabled the Entomologist to keep in close touch with developments in the various infested areas and has also made possible closer cooperation between the various federal and state agencies.

The Entomologist has participated in a number of conferences in Albany, Buffalo, St Thomas and Guelph, Ont., Boston, Mass., and Washington, D. C., for the purpose of assisting in working out methods of dealing with existing complications and the varying conditions in different sections of the country.

Late in the fall of 1920 the federal authorities started clean-up operations upon an extensive scale in the more badly infested area about Silver Creek, Chautauqua county, with the understanding that the state authorities would cooperate in an educational campaign to bring about better conditions in the more sparsely infested outlying sections. A brief statement of the situation with a series of recommendations, which were indorsed at a conference of federal and state officials at Buffalo, was prepared by the Entomologist and has been widely distributed in the infested areas as Circular 199 of the Bureau of Plant Industry, Department of Farms and Markets, through the cooperation of farm bureau managers. The distribution of literature was followed with public meetings and the utilization of all available agencies in promoting the general adoption of a modified type of agriculture unfavorable to the successful development of the European corn borer.

Quarantine regulations practically identical with those of Massachusetts have been enforced in the New York areas by both federal and state authorities despite the fact that although the insect has been carefully studied for two seasons in New York State, it has been impossible to find it habitually breeding in anything but corn and very rarely has the borer been found in the stems of other plants and then only when they were in the immediate vicinity of corn. The marked difference in this respect between eastern Massachusetts and the New York territory has led the Entomologist repeatedly to question the advisability of maintaining such a strict quarantine in sections where the borer produces but one generation as compared with those where at least a partial second brood is the rule. It is very probable that there will be material modifications of the quarantine in the near future.

It has proved impossible to continue the careful field work of 1920 in the Scotia area, since the special appropriation of 1920 was not supplemented by an item the following year. The corn borer is a real menace to the agricultural interests of the country and consequently the State of New York should keep in close touch with all developments in order more intelligently to safeguard its own interests.

A detailed account of the European corn borer in New York State and a discussion of control measures will be found in the Entomologist's report.

Other corn insects. The late summer and fall of 1921 was marked by an unprecedented outbreak of the corn ear worm, a southern species rarely attracting more than local notice in most of New York State. The varicolored caterpillars, about 1½ inches long when full grown, work in the ears, especially near the tips, and in the case of sweet corn only a little injury suffices to render it unmarketable. The pests were reported in greater or less numbers from practically all counties, most of the injury being in the central and western parts of the State, particularly in Madison county. The loss was greatest on sweet corn, in some instances approaching a considerable proportion of the crop, though field corn and pop corn did not escape damage and in at least one instance, wax beans were seriously infested. Available data indicate a close relation between this outbreak and the unusually mild winter of 1920-21, and it is believed that natural agencies will prevent a repetition of these losses the coming season.

The lined corn borer, which attracted so much attention in 1919, was hardly noticed in 1920, indicating that it is one of the somewhat rare insects occasionally very abundant.

There were a number of complaints of injury by the common stalk borer, due mostly to fears that it might prove to be the much more injurious European corn borer.

Grass webworms were relatively nearly as abundant as in 1919 and caused considerable injury here and there in the State.

The advisability of having at hand literature making it comparatively easy to distinguish between the various pests affecting corn led the Entomologist to prepare a small folder giving briefly the characteristics of the more common borers likely to be found in corn and grasses in particular. This has been available for distribution to all interested in such pests.

Small grain insects. The Entomologist's studies of the wheat midge, begun in 1918, were continued during the past season and the data collected show that this insect was relatively much less abundant than in earlier years, particularly in 1918. There are some areas, however, notably Genesee, Livingston, Monroe and Orleans counties, where this insect appears to be somewhat prevalent and where under favorable conditions it might become much more numerous and cause an appreciable amount of injury. The data collated this year show, as in previous seasons, a close relationship between the abundance of maggots and the number of shrunken or blasted kernels of grain.

The Hessian fly is one of the most destructive and best known wheat pests; through the courtesy of Prof. C. R. Crosby, Cornell University, the results of a field survey have been placed at the disposal of the Entomologist and the details are given in the body of his report. It will be noted, on referring thereto, that Genesee, Livingston, Monroe, Niagara and Orleans counties show a higher average percentage of infestation than others, conditions in this area apparently being exceptionally favorable for both this insect and the related wheat midge.

Data in relation to the abundance of these wheat pests are of importance, since the returns from year to year indicate plainly areas where the insects are most likely to cause serious losses and if such figures are recorded from year to year, they in time may show a distinct though irregular periodicity and lead to a clearer understanding of the factors producing these fluctuations.

Observations by the Entomologist last year showed that partly grown army worm caterpillars hibernated successfully in Saratoga county. They have been confirmed by finding similar conditions in the early spring of 1920.

Other field crops. The ordinary pests of farm crops attracted comparatively little attention, though in early spring there was considerable complaint of an unusual abundance of asparagus beetles in the vicinity of Albany. They caused trouble, as in 1919, not only on account of their feeding upon the shoots, but because the numerous black eggs necessitated very careful washing before the asparagus could be marketed.

The cold, wet weather of the spring was unusually favorable for root maggots and as a consequence there was considerable damage by both cabbage and onion maggots.

Several species of wireworms caused rather severe injury in the vicinity of Albany. It appears very probable that this damage was favored to an appreciable extent at least by cool weather preventing the plants from readily outgrowing the injuries by wireworms

Codling moth. Field studies of the codling moth have been continued by the Entomologist in cooperation with the Bureau of Plant Industry of the State Department of Farms and Markets. L. F. Strickland succeeded, through the cooperation of George W. Mead of Barker, in securing exact records of evening temperatures as well as the maxima and minima. The accuracy of this work was materially increased, as was the case last year, by the cooperation of the United States Weather Bureau in loaning thermographs and providing for the supervision and setting up of the instruments. The intimate relations existing between evening temperatures and codling moth oviposition are graphically represented in a chart by Mr Strickland, who was also responsible for observations upon egg deposition in the orchard. The demonstration of this relationship is a necessary preliminary to the solving of the vexatious problem of codling moth control in the western part of the State.

The series of experiments to determine the relative efficiency of the several sprays for the control of the codling moth in the western part of the State has been continued. The most marked results, as was to be expected, were obtained with the first or calyx spray and under the conditions obtaining in the experimental orchard the past season, the figures would appear to indicate an increased infestation on trees sprayed twice as compared with those receiving but one application. These data must be interpreted or erroneous conclusions may be drawn. The real explanation is that the apparently higher percentage of infested fruit on the plot sprayed twice is due to the smaller crop on these trees rather than to an increase in the number of apple worms. Complications of this character are almost unavoidable in experimental work and when the cause is not known may vitiate results.

A comparatively rare apple pest. The rose leaf beetle, a rather common feeder upon roses and widely distributed in the State, appeared in a somewhat unfamilar role the past season on account of its feeding upon and somewhat seriously injuring young apples. In some instances 10 to 20 per cent of the fruit was affected so seriously that most of the apples dropped or were badly deformed.

Shade tree insects. Shade trees, as a rule, were comparatively free from serious insect damage, though the elm leaf beetle was locally abundant and injurious, especially in the upper Hudson valley and the lower portion of the Mohawk valley. The comparative scarcity of this insect in many of the cities and villages where it formerly caused so much damage is presumably due largely to well-directed control measures, which in some cases at least have served to keep the insect within bounds for several years.

Forest insects. The snow-white linden moth was sufficiently abundant in portions of Otsego county to defoliate large areas of woodland. The numerous moths appearing in Albany the latter part of July probably originated from these areas.

The white pine weevil has been abundant and injurious in young plantings of white pine. It is one of the common pests breeding freely in woodlands and presumably spreading readily into nearby plantings; consequently the protection of these latter is rendered difficult by the continual influx of weevils from adjacent forests.

Lectures. The Entomologist has delivered a number of lectures or participated in discussions and conferences on insects, mostly economic species, before various agricultural and horticultural gatherings, some of these being in cooperation with farmers' institutes or county farm bureaus. A considerable proportion, owing to conditions prevailing during the past two years, have related to the European corn borer and its control. Some of the more important of these in relation to the European corn borer are mentioned in the outline of activities relating to this insect and given above.

Gall midges. The 35th report of the Entomologist contains part VIII of " A Study of Gall Midges." It consists of a recapitulation of our knowledge of this group and contains keys for the separation of the genera of the world. This brings to a conclusion an investigation which has been in progress as opportunity offered for about 14 years and has resulted in systematizing the facts concerning a large, complex and comparatively unknown family containing a number of species of great economic importance. The better knowledge of the group resulting from this investigation will prove of very material service in determining the best methods of controlling such species as are injurious or may become so in the future. It is not planned to continue the extended investigations of the gall midges, though somewhat incidental additions to our knowledge of the biology and systematic relationships may be expected in the future.

The chrysanthemum gall midge, a serious pest first recognized in this country by the Entomologist, has been reported in injurious numbers from several localities in the State.

Gall insects. The " Key to American Insect Galls," State Museum Bulletin 200, published in 1919, was out of print within a few months after issue and it is now very difficult to secure copies. The

Entomologist has been keeping records of galls described subsequent to the appearance of the Key in the hope that a revised edition of this bulletin might be issued.

Publications. Owing to delays, the reports for 1918 and 1919 have not appeared and the publications of the Entomologist have been restricted to various popular articles relating to injurious insects, such as a special folder on "Corn Borers and Grass Insects," a brief summary of the "European Corn Borer and Call for General Control," issued as Circular 199 of the Division of Agriculture, Department of Farms and Markets, and several technical papers on gall insects, mostly exotic, and published in Indian and African journals.

Collections. A number of desirable additions to the state entomological collections have been made during the year, some of the best material being reared in connection with studies of insect outbreaks or secured as a result of requests for information concerning previously comparatively unknown forms. Special attention has been paid to the acquisition and preservation of immature stages, since these are very difficult to obtain; this is particularly true of a number of borers similar to the European corn borer and found in corn or in the stems of various plants. The special work upon the European corn borer has resulted in numerous very desirable additions to the state collections.

D. B. Young, assistant entomologist, donated from his personal collections of earlier years a large series of Coleoptera consisting of 648 specimens belonging to 369 species previously unrepresented in the state collections. This large addition has necessitated the rearrangement of many of the Coleoptera and in addition it has involved the study and identification of numerous obscure species. This work has been prosecuted in addition to many identifications for correspondents and other routine duties.

Office matters. The correspondence the past season has required much attention, especially that in relation to the European corn borer. The usual routine as outlined above has fully occupied the time of various members of the staff. The assistant entomologist, as heretofore, has been in charge of the office and responsible for correspondence and other matters during the absence of the Entomologist.

The special work on European corn borer authorized by the last Legislature necessitated the temporary transfer, effective June 1, 1920, of Mr Young to take charge of the work and the appointment of W. H. Hoffman to fill the temporary vacancy. Hall B. Carpenter of Somerville, Mass., was appointed special assistant in corn borer work.

Miss Hartman, prior to her transfer from this office in midsummer, was fully occupied, in addition to the usual duties of an assistant, by translations of technical literature needed in systematic work, the making of numerous microscopic preparations of small insects and the arrangement and care of pressed specimens of insect work and the extensive accumulation of alcoholic material.

The vacancy created by the transfer of Miss Hartman has not been filled owing to the difficulty of securing a qualified assistant at the very nominal compensation available. The loss of an assistant must inevitably circumscribe the work of the office and may result in serious limitations.

The many additional calls upon the staff incident to work upon the European corn borer have greatly restricted the amount of time which could be given to the identification and arrangement of collections, though some progress has been made along these lines. Work of this character is very exacting and time-consuming and it is impossible, as pointed out in previous reports, to build up the state collections of insects in a satisfactory manner without more funds and adequate assistance.

Horticultural inspection. The nursery inspection work of the Bureau of Plant Industry, State Department of Farms and Markets, has resulted, as in former years, in a number of specimens representing various stages of insect development, some in very poor condition, being submitted to this office for identification. Satisfactory determination of specimens originating in various parts of the world requires an intimate and wide knowledge of the literature and insects in both this and other countries.

General. The work of the Entomologist has been materially aided as in past years by the identification of a number of species through the courtesy of Dr L. O. Howard, Chief of the Bureau of Entomology, United States Department of Agriculture, and his associates. There has been very effective and close cooperation with the State Department of Farms and Markets, particularly the Bureau of Plant Industry, the State College of Agriculture at Cornell University, the State Experiment Station at Geneva, the county farm bureaus and various public welfare organizations. A number of correspondents have donated material and rendered valuable service by transmitting local data respecting various insects and assisting in other ways.

ARCHEOLOGY AND ETHNOLOGY

General scope of activities. The work of this division of the Museum may be divided into three subsections as follows: office work, research, and field work. Office work covers the routine and special correspondence, the curatorial work incident to the collections, cataloging and consultation. Research covers the field of investigation and embraces the work of preparing manuscripts covering reports or accounts covering the subjects investigated. Field work in a measure is research but it is concerned more with original sources than with written accounts. Through field work we conduct our excavations in ancient Indian village sites, through it we inspect the various sites, we explore archeological areas, we collect directly from sites, we acquire collections from those who have already made examinations of sites and we visit the various Iroquois reservations in the State and collect ethnological specimens from the living Indians. Museum work includes the sorting and classification of the specimens brought in from the field or acquired from collectors, but equally important is the placing of this material in the exhibition halls of the Museum.

The direct reaction upon the public of this work comes as a result of our research, exhibition, publications, correspondence and through personal consultation.

Activities of the Archeology division. The activities of this division may be classified under the following heads: (1) archeology, (2) ethnology, (3) museum, (4) living Indians, including assistance to Indian agricultural and welfare organizations, (5) State Indian Commission, (6) information service.

1 Work in the field of archeology is concerned with the excavation of ancient sites and a study of the culture of these sites. This work must be done within the next few decades in order to obtain any results whatever. The requirements of agriculture and of building are rapidly causing the destruction of archeological sites, thereby obliterating forever the sources of information concerning our aborigines. The problem of archeology is primarily one of the study of race origin, the relationship of races, migrations and culture characteristics. New York State comprises a particularly important field in American archeology.

2 In the realm of anthropology, ethnology forms a twin science with archeology. Through our ethnologic researches we examine

the customs, folk lore, folk music, folk ways, ceremonies, religious beliefs, material culture and social organization of the tribal Indians of the State, especially those septs still clinging to the practice of their ancestral culture traits.

The ethnology of the New York Indians is a fascinating and an important subject. Nearly all major works on primitive society, elementary forms of government and sociology cite the Iroquois of New York, so much so that among the peoples of the earth below the status of civilization the Iroquois have a conspicuous place. Additional information is eagerly sought and its publication is received with attention throughout the scientific world.

3 The general public gains its closest contact with this division of the Museum through our exhibits in the Museum halls. Here are placed the specimens secured by collection in the field. These specimens are arranged in several ways, namely, by individual sites, by areas, by cultures, by groups to show methods of manufacture and uses and in groups so that cultural differences may be compared. The sorting and classification of the thousands of specimens is a lengthy and arduous task but is necessary in order to prepare the exhibit. After an exhibit is installed it requires constant oversight to keep it clean and in order. In the instance of the ethnological exhibits and the Indian groups, constant care is necessary so that the proper amount of moisture is provided and moths kept from propagating.

In our museum activities our aim is to provide exhibits that are easily understood by the average visitor and which will be interesting as well as instructive. The special student, however, is not neglected and exhibits are provided answering the needs of the specialist.

It is interesting to note that our methods of exhibition have been highly commended by experts and offered as an example of how archeological museums can make a scientific subject popular. Needless to say our ethnological groups have inspired other museums to similar undertakings. Frequently museum experts come to our exhibits for data on methods and arrangement.

4 The Indians of this State living on six reservations and numbering more than 5000, to a considerable extent look to this department for information and advice. Frequently delegations visit us, coming not only from the New York tribes but from Canada also. These delegations and individual visitors generally seek information as to their treaty relations with the state or federal governments, or other documentary evidences affecting their interests and status.

Our publications have been of much use to these tribes, particularly the History of the Iroquois, the Code of Handsome Lake, and the Constitution of the Five Nations.

During the World War the reservation Indians sought to extend their work in agriculture and stock raising. They were successful to a large degree and since that time we have sought to promote their interests in these lines of productive activity. Two years ago the Legislature made an appropriation of $10,000 for extending agricultural work and in providing scholarships at the State School of Agriculture for Indian boys and girls. Last year a similar appropriation was made. We have been glad to foster this work, believing that through intensified industry the state Indians will advance faster and find a happier situation in civilization.

In this work of using the data of archeology to promote human weal we have encouraged the program of the New York State Indian Welfare Society which came into being in 1919 as an expansion of the Onondaga Welfare Society organized by Dr Erl A. Bates, now of the State College of Agriculture. This society is a concerted effort on the part of the New York Indians to solve their own problems and is a healthful indication of the desire of the Indians to achieve greater things. The society lays special stress on better education for the children of the race.

5 Under chapter 590 of the Laws of 1919, the Legislature created the State Indian Commission and provided for the appointment of its membership. The Governor upon signing the bill appointed the Archeologist of the State Museum as commissioner representing the Education Department, and upon the formation of the commission the Archeologist was elected secretary. To meet the needs of the commission the Archeologist has visited each reservation and made a collection of documents bearing on the legal status of the Indians of the State.

6 The office of the Archeologist and Ethnologist is in daily receipt of many letters from citizens asking for information relating to Indian names, customs, legends, history, laws, foods, reservations, institutions etc. We are asked to supply facts and citations for pageants, plays, books, poems, paintings, for schools, colleges, associations and literary societies and the like. More than 700 persons from various parts of the State visited the Archeologist's office within the year and requested information, which was supplied. More than 3000 wrote for information.

But, beyond the general public, the various state departments use this office as a source of information on Indian matters.

Frequently the work of answering inquiries on the part of citizens and state officials requires considerable research, and a large share of our office work is consumed in assisting inquirers to obtain needful data. The public receives a direct benefit of this phase of our activity.

Archeological field work. During the year our archeological investigations have been confined largely to a study of the Algonkian occupation of the Hudson valley, particularly the portion between Albany and Catskill. During the autumn of 1920 we made a field reconnaissance of parts of Staten island, Rockland county near Nyack and part of Greene county, particularly that portion lying below Catskill.

With the assistance of members of the staff of the Museum of the American Indian we secured from an ancient site south of Tottenville a series of shell objects from which it is possible to demonstrate the process employed by the precontract Indians in the manufacture of wampum and other shell beads.

From the refuse beds of the village site (early Algonkian), we secured the shells of the Busycon carica and canaliculata in all stages, from the complete valve to the worked columellae with incisions made for the bead segments. The process employed was to break away the shell of the Busycon (Pyrula) until the columella alone remained. This was then dressed down into a uniform diameter and smoothed. Bead lengths were then measured out and incisions made for the individual beads. These were cut off one by one, drilled and finally polished.

Wampum was an important article with the early Indians and its value did not depreciate with the coming of the whites. As soon as the European traders saw how useful wampum was as a medium of exchange they began the manufacture of wampum by machinery.

Through the kindness of Mrs B. Joseph Carpenter jr of White Plains we learned of an old wampum mill situated near Nyack, Rockland county. We visited this and obtained a considerable number of specimens showing the process of making wampum by machinery. The mill was erected and run by the Campbell family and made wampum early in the last century for the Hudson Bay Company and for the Astor fur traders. The mill was in operation as late as 1875 when it made pipestem wampum for the western Indian traders.

Specimens secured included a dozen or more Mexican conch shells (the material out of which the wampum was made), sawn sections of the shell, ground sections, cylindrical sections, as shaped to the size of the bead, and a number of drilled or partly drilled beads.

Each method of making wampum (the Indian and the European) is illustrated by an exhibit in the Museum, based upon the specimens obtained in the sites named above.

During the period from September 15th to October 15th we made an examination of the banks of the Hudson, south of Catskill where numerous flints had been found. Through the kindness of Mr Egbert Beardsley of Catskill we located a spot near Green Point on the Van Orden farm 4 miles south of Catskill. Here were extensive fresh-water shell heaps composed mostly of *Unio complanatus* shells. These shells were the product of the dried shellfish industry that once flourished there. Intermixed with the shells were the bones of various animals and fishes and numerous implements. We found the broken parts of a three-toothed comb in one pit. This is a very rare specimen from an Algonkian site. Other specimens include pendants, parts of gorgets, celts, hammers, spears, pestles, arrow points, bone awls, bone harpoons, etc.

An examination of the shore line north of this site revealed an extensive workshop and the presence of numerous chippings strewn over an area of 40 or 50 acres on what is known as the North lot or Ham farm. We traced these chippings along the shore of Embought bay south to Smith Landing where at Duck Cove a considerable village site yielding Algonkian pottery was located. A small island in the cove has a layer of Indian refuse 2 feet thick but we did not attempt excavation on account of the thick beds of poison ivy.

The immense amount of flint chippings made us curious as to the source of supply and we began an investigation of the flint-bearing limestones of the region to the east, back from the river and known as the Kolerberg or "Collarback." Here in the rocky hills west of Alsen we found numerous caves and rock shelters. In some were found implements but the majority showed little or no signs of human habitation. Some were raccoon, fox and snake dens, and in ancient times were probably used by bears. In the cave region locally known as the "Indian ovens" were numerous cache pits but no artifacts could be found in them.

In October, just before returning to the Museum, we learned of certain extensive flint quarries situated near Coxsackie and at the invitation of Mr Jefferson D. Ray and Dr A. W. Van Slyke visited them.

From our field examination and the artifacts obtained it was possible to determine that the west shore of the Hudson showed long occupation by certain indeterminate Algonkian tribes ranging from remote times up to the late historic period.

During the spring of 1921 sites were inspected in the counties of Rensselaer, Albany, Washington, Greene, Montgomery and Schenectady.

Upon the invitation of Mr Jefferson D. Ray of West Coxsackie the flint quarry site near Coxsackie was visited and a preliminary inspection made. The place proved of unusual interest and answered the inquiry as to the location of the flint supply of the aborigines.

Excavations and survey of Flint Mine hill. On May 15th expedition equipment was taken to Coxsackie and set up on Flint Mine hill on the West Shore Railroad property. Permission to conduct an examination of the site had been granted through President A. H. Smith of the New York Central lines.

Flint Mine hill is located about 1½ miles south of Coxsackie station on the West Shore Railroad and is bounded by the Arthur Spore farm on the south and the F. W. Cole farm on the north. Entrance may be had through the farm road of Colonel Jacob Dunaef.

The hill is about 1 mile long and one-fifth of a mile wide. Its highest elevation is about 200 feet above the zero station established at a rock cut at the roadway entrance of the Dunaef farm.

The survey and excavations conducted from May 15th to June 15th led to many interesting discoveries relating to the methods of flint mining by the ancient Indians. About 200 flint pits and three large quarries, one of them 150 feet long and 40 feet wide, were discovered. In places on the hill were the sites of sorting stations, chipping stations, workshops and refuse dumps. Some of the dumps were 10 or more feet thick and several hundred feet long, and contained the refuse from the quarries after the flint seams had been picked out. The quarry pits contained heaps of flint in chunks ready for taking to the testing stations. A number of fine blocks of flint were secured as specimens. In the pits were hundreds of stone maul heads and hammers. The dumps were full of them. More than a thousand were picked up from the quarries and the investigators then ceased to collect them because of their numbers. Not a single hammer from the site was of the pitted variety, which leads us to believe that at this site at least pitted "hammers" served other uses. Among the interesting forms of tools from the site were the chipped disk-shaped hammers. These varied in size from 2 to 10 inches and all followed a general lens-shape as a pattern; that is, they are thick in the center and thin at the circumference. About fifty of these were secured for museum specimens.

In the various stations were numerous chippings and partly finished blades. These were generally scattered over the surface of the ground, but excavations in the surface refuse demonstrated that they were scattered throughout the refuse on all parts of the hill. The largest workshops where blades were finished were on the flats below the hill. Mr Ray, who worked on these sites, procured for us more than 1500 finished blades of various sizes.

Much of the time was spent in making a detailed survey of the hill for mapping purposes, it being the intention to make a relief map of the site. In the technical work of examination and survey we were assisted by Mr E. R. Burmaster, whose many years of expedition work rendered him an able helper. Mr Ray, through whose descriptions we were led to make this examination, gave a month of his time to the expedition as a volunteer helper.

This locality is the first untouched aboriginal quarry site in the State examined by the Museum and seems to be unique. It must have been worked for several centuries and two or three hundred workers must have been continuously engaged in the excavating and chipping.

The Museum is enriched, through this work, by 3000 flint implements in all stages of manufacture, 500 hammers, 50 disks, 3 gorgets unique in form, a fine mortar and a copper chisel. Beyond this are the valuable notes on aboriginal quarry methods.

New York State Archeological Association. This association of citizens of the State interested in archeology, ethnology, folk lore, Indian history and Indian welfare, has its nominal headquarters in the State Museum with which institution it is in hearty cooperation.

During the year the association has held eight lectures and public meetings and has conducted various field tours. On February 25th the annual session and banquet were held under the auspices of Morgan Chapter at the Rochester Club, Rochester, with President A. H. Dewey presiding. The annual report shows that two publications have been issued and that three are in process of publication.

During November 1920 Morgan Chapter acted as host o the New York State Indian Welfare Society which held its semiannual session in Rochester. The chapter provided the badges, printed matter and luncheons to the Indians from the Six Nations of the Iroquois that attended the conference.

The chapter during the Indian Conference made its annual visitation to the tomb of Lewis Henry Morgan, where appropriate memorial exercises were conducted. Indians from each of the Six Iroquois Nations gave addresses in English and in their own native tongues. Miss Elsie Elm, an Oneida, sang in the Oneida language a hymn of invocation and Reverend Honyost gave the benediction in his native Oneida. A report of the proceedings of these memorial exercises was published by Morgan Chapter.

New York State Indian Welfare Society. This society came into being in November 1919 as an expansion of the Onondaga Society. It is composed of members of the various Iroquois tribes in New York and their citizen friends. It represents an attempt of the progressive Indians of the State to get together on matters of the common tribal needs of the Iroquois. At the semiannual conferences statistical records and accounts are given of reservation conditions and progress; historical accounts, appeals to progress, and other pertinent matters are discussed.

The members of the society are in general the progressive leaders of their several tribes, and with the influence of the society back of them have achieved some remarkable results. Conferences have been held in Syracuse, Rochester, Malone and on the several adjacent reservations.

New York State Indian Commission. During the year this commission, of which the Archeologist of the State Museum is secretary, visited all the Iroquois reservations in the State and conducted councils with the Indians. The object of this visitation was to acquaint the members of the commission, most of whom are members of the Legislature, with the actual conditions on the New York reservations and to listen to the representations of the people living on them.

It appears that the precise status of the New York Indians has never been legally determined. This causes confusion in legal matters and it is now questioned whether the State ever had a right to pass legislation covering the New York tribes. Certain opinions of the Attorney General seem to indicate that some of the tribes, if not all, are to be regarded as independent governments with whose internal affairs neither the State nor the Nation may interfere. If the courts sustain this opinion we must then admit that these Indian domains are not in the State but "surrounded by it." The Indians contend that they were never within the State and never subject to its jurisdiction. The Indian Commission, of which Assemblyman E. A. Everett is chairman, has this difficult situation to adjust.

Interdepartment relations. This section of the Museum has supplied information and worked in cooperation with a number of state departments and officials, especially in connection with Indian affairs. We have supplied facts for the Attorney General's office, assisted the Adjutant General's office through the Bonus Commission, conferred with officials in the State Board of Charities, the State Department of Health, and supplied data for various members of the Legislature.

Public interest. The interest of the public in this division of the Museum is evidenced by the numerous visitors and inquirers who come for information and advice. In this statement we do not include those who merely visit the exhibition halls.

We have frequent requests from authors, playwrights and directors of pageants for facts bearing on their special subjects. During the year we have given detailed outlines of plans or rendered special assistance by way of reports or addresses to the following institutions or bodies: the Eastern States Exposition, junior achievement activities; Genesee county fair in its historical pageant; Livingston county centennial; Boy Scouts of America; the New York State Archeological Association; the Indian Welfare Society; the New York State Indian Commission; the Federal Board of Indian Commissioners; the Interchurch World Movement; the Holland Land Company Historical Society; the Ontario County Historical Society; Rochester Municipal Museum; the Mohawk Indian Village of Boy Scouts; and the Order of Mound Builders. We have likewise assisted by way of information and documents the Six Nations of Canada and the Mohawk Nation of Tayendanagea, and assisted the Indians of the World War League in their bonus difficulties.

By far the greater amount of time, however, is given to the individual citizen interested in or concerned with Indian matters, either legal, social or archeological, and the number of personal visitations by these is almost overwhelming when it is considered that other forms of office work must also receive attention.

Staff personnel. The staff of the archeological division consists of the archeologist and one clerical assistant. With a field of endeavor so extended and diversified it is increasingly difficult to handle the various subjects that come before us. There is no museum in the United States of this scope and having a department of archeology with so small a staff and so little clerical help. It is not difficult to see that with a larger staff much more might be accomplished.

ZOOLOGY

In field work during the past year the chief concern of the zoologist has been the collection and preparation of fresh-water fishes to augment the exhibit series of mounted specimens in the State Museum. Several hundred individuals representing about seventy species were taken from central and eastern New York waters, and given preliminary treatment in the field.

The use of seines, nets and traps in the various waters for collection of desired specimens represents only a small part of the work involved. To aid in the restoration of color and correct proportions, sketches and plaster molds were made and these, with the skinned and salted specimens, were packed and shipped to the preparator. The mounting and painting of the skins has been in charge of Mr Francis West of Falmouth, Mass., whose skill in this line of work has produced specimens remarkably lifelike in character. Four new wall cases have been installed to accommodate the growing collection and the entire exhibit series has been rearranged.

A group designed to show the winter activities of the short-eared owl, a beneficial species protected by state law, was installed in Zoology Hall and attracted considerable interest because of the wintering of a large flock of these birds within the limits of the city of Albany.

The collection, classification and description of New York spiders has continued as opportunity permitted but the ultimate completion of the undertaking will be delayed until the services of an artist trained in araneid anatomy can be secured. In addition to descriptions and keys to families, genera and species, it is proposed to figure the structures of importance in classification, particularly the epigyna of the females and the palpal organs of the males.

A revision of the family Pisauridae, a group comprising some of the largest of our true spiders, has been brought to completion following a study of materials belonging to the American Museum, New York, the National Museum at Washington, the Museum of Comparative Zoology and the extensive collections of Cornell University. Other institutions and individuals have also furnished valuable specimens and data bearing on the problem of distribution.

In June 1921 the State Museum received notice of the discovery of mastodon remains near Temple Hill, Orange county, where, four years before, the lower jaw of another individual had been unearthed. An examination of the skeleton showed it to be, with the exception of the famous Warren mastodon in the American Museum, New York, the most complete so far found and it was immediately acquired for the Museum.

The bones were well preserved but in need of thorough cleaning to permit application of protective coats of thin shellac. Considerable labor was involved in removing adhering muck and marl and applying the preservative. The separate bones were wrapped and in some cases carefully reinforced by a light but strong framework and packed in straw and excelsior. The collection filled twelve large packing cases.

Orange county has furnished thirty-one separate records of the mastodon and seven of the eight skeletons found in the State which were complete enough to warrant mounting. The labors of Charles Wilson Peale in 1801 resulted in the recovery of sufficient material to restore two skeletons, one of which was for a time exhibited in the Baltimore Anatomical Museum. This skeleton was later disarticulated and sold to Doctor Warren of Boston and is now in the American Museum, New York. The second Peale skeleton was exhibited abroad and in various cities at home and finally placed in the Peale Museum of Philadelphia. It is thought to have been lost in the fire that destroyed the Philadelphia Museum.

The famous Warren mastodon discovered in 1845 near Newburgh, is a large and practically complete skeleton. It was the subject of an elaborate memoir by Dr John Collins Warren and now stands in the American Museum.

A skeleton complete except for bones of the hind legs was exhumed in 1874 at Otisville and secured for the Yale Museum by Prof. O. C. Marsh.

Bones found at Little Britain in 1879 formed the principal part of the Whitfield skeleton at one time mounted at the American Museum but later dismantled and sent to the Senckenburg Museum in Germany.

In 1899 a considerable number of bones were found on the farm of F. W. Schaeffer near Newburgh. Restoration of missing parts was made from other individuals, and the skeleton mounted for the Brooklyn Museum.

The Temple Hill specimen will stand in the State Museum and form a notable addition to the already valuable series of mounted skeletons.

The only other mastodon skeleton from the State which has been mounted is the specimen found under unique circumstances at Cohoes in 1866 and acquired for the State Museum by James Hall.

Cooperation. The Division of Zoology has continued to cooperate with various state agencies having educational, scientific or administrative functions concerned with the animal life of the State. For the Conservation Commission identifications of birds, mammals and fishes have been made to aid in the operation of the conservation law. Information bearing on the life histories, habits and economic importance of various forms of life in the State concerning which legislation for protection, control or extermination was proposed, has been furnished the Conservation Commission for presentation to the Legislature. In cases involving identification of specimens taken in violation of the conservation law, the zoologist has been called as expert witness for the State.

Accessions for 1919

Donation

MOLLUSCA

Cooke, Robert, Albany
Slug, Limax maximus (*Linn*), Albany, N. Y.
Thompson, Edith, Greenville
Collection of shells, etc., Bahama Islands

ARANEIDA

Young, D. B., Albany
Araneus arabescus (*Walck.*)
Araneus patagiatus *Clerck*
Araneus stellatus (*Walck.*)
Cicurina sp.
Evarcha hoyi (*Peckham*)
Hypselistes florens *Camb.*
Linyphia marginata *C. Koch*
Lycosa carolinensis *Walck.*
Mangora gibberosa (*Hentz*)
Pardosa emertoni *Chamberlin*
Pirata aspirans *Chamberlin*
Steatoda borealis (*Hentz*)
Tetragnatha laboriosa *Hentz;* Wells, N. Y., and vicinity
Hartman, Fanny T., Albany
Clubiona abbotti (*L. Koch*), Albany, N. Y.

FISHES

Fuller, Mrs A. W., Albany
Porcupine fish, Bahamas
Titcomb, J. W., Albany
White perch, Morone americana (*Gmelin*), Hudson river, Poughkeepsie, N. Y.

BATRACHIANS

Schoolcraft, J. T., Schenectady
Leopard frog, Rana pipiens *Schreber*, Niskayuna, N. Y.
Dietrich, H., Ithaca
Red-backed salamander, Plethodon cinereus (*Green*)
Four-toed salamander, Hemidactylium scutatum (*Schlegel*), Ringwood, near Etna, N. Y.

REPTILES

Rich, W. S., Lebanon Springs
Red-bellied snake, Storeria occipitomaculata (*Storer*), Lebanon Springs, N. Y.
Cook, David, Albany
Musk turtle, Kinosternum odoratum (*Latr.*), Burden lake, Rensselaer co., N. Y.

Goldring, Fred, Slingerlands
Wood turtle, Clemmys insculpta (*Le Conte*), Normanskill, near Slingerlands, N. Y.

BIRDS

MacNaughton, Mrs A., Albany
Great blue heron, Ardea herodias herodias *Linn.*
Conservation Commission, Albany
Barred owl, Strix varia varia *Barton*, Mechanicville, N. Y.
Bowen, Mrs B. L., Wells
Starling Sturnus vulgaris *Linn.*, Wells, N. Y.
Bombeck, Mrs H. C., Glenmont
Great horned owl, Bubo virginianus virginianus (*Gmelin*), Glenmont, N. Y.
Wissler, George M., Albany
Nighthawk, Chordeiles virginianus virginianus (*Gmelin*), Albany, N. Y.

BIRDS' EGGS

Strain, Anna E., Niverville
Royal tern, Sterna maxima *Boddaert*
Least tern, Sterna antillarum (*Lesson*)
White ibis, Guara alba (*Linn*)
Least bittern, Ixobrychus exilis (*Gmelin*)
Great blue heron, Ardea herodias herodias *Linn.*
Little blue heron, Florida caerula (*Linn*)
Green heron, Butoroides virescens virescens (*Linn*)
Black-crowned night heron, Nycticorax nycticorax naevius (*Boddaert*)
Yellow-crowned night heron, Nyctanassa violacea (*Linn*)
Clapper rail, Rallus crepitans crepitans *Gmelin*
Purple gallinule, Ionornis martinicus (*Linn*)
Florida gallinule, Gallinula galeata (*Lichtenstein*)
Red-backed sandpiper, Pelidna alpina sakhalina (*Vieillot*)
Killdeer, Oxyechus vociferus (*Linn.*)
Mountain plover, Podasocys montanus (*Townsend*)
Turkey vulture, Cathartes aura septentrionalis *Wied*
Black vulture, Catharista urubu (*Vieillot*)
Red-tailed hawk, Buteo borealis borealis (*Gmelin*)
Bald eagle, Haliaetus leucocephalus leucocephalus (*Linn*)
Black-billed cuckoo, Coccyzus erythrophthalmus (*Wilson*)
Southern downy woodpecker, Dryobates pubescens pubescens (*Linn*)
Red-shafted flicker, Colaptes cafer collaris *Vigors*
Chuck-will's-widow, Antrostomus carolinensis (*Gmelin*)
Nighthawk, Chordeiles virginianus virginianus (*Gmelin*)
Chimney swift, Chaetura pelagica (*Linn*)
Kingbird, Tyrannus tyrannus (*Linn*)
Western flycatcher, Empidonax difficilis difficilis *Baird*
Magpie, Pica pica hudsonia (*Sabine*)
Yellow-billed magpie, Pica nuttali (*Audubon*)
Blue jay, Cyanocitta cristata cristata (*Linn*)
Fish crow, Corvus ossifragus *Wilson*
Red-winged blackbird, Agelaius phoeniceus phoeniceus (*Linn*)

Boat-tailed grackle, Megaquiscalus major major (*Vieillot*)
Snow bunting, Plectophenax nivalis nivalis (*Linn*)
Song sparrow, Melospiza melodia melodia (*Wilson*)
Towhee, Pipilo erythrophthalmus erythrophthalmus (*Linn*)
Cardinal, Cardinalis cardinalis cardinalis (*Linn*)
Painted bunting, Passerina ciris (*Linn*)
Loggerhead shrike, Lanius ludovicianus ludovicianus *Linn*
Red-eyed vireo, Vireosylva olivacea (*Linn*)
White-eyed vireo, Vireo griseus griseus (*Boddaert*)
Black-poll warbler, Dendroica striata (*Forster*)
Pine warbler, Dendroica vigorsi (*Audubon*)
Mocking bird, Mimus polyglottos polyglottos (*Linn*)
Catbird, Dumetella carolinensis (*Linn*)
Carolina wren, Thryothorus ludovicianus ludovicianus (*Latham*)
Short-billed marsh wren, Cistothorus stellaris (*Naumann*) from St Simon's island and south Atlantic coast, etc.

Cary, Miss E., Albany
Mourning dove, Zenaidura macroura carolinensis (*Linn*)
Kingbird, Tyrannus tyrannus (*Linn*)
Phoebe, Sayornis phoebe (*Latham*)
Red-winged blackbird, Agelaius phoeniceus phoeniceus (*Linn*)
Orchard oriole, Icterus spurius (*Linn*)
Baltimore oriole, Icterus galbula (*Linn*)
Purple grackle, Quiscalus quiscula quiscula (*Linn*)
Goldfinch, Astragalinus tristis tristis (*Linn*)
Cedar waxwing, Bombycilla cedrorum *Vieillot*
Yellow-breasted chat, Icteria virens virens (*Linn*)
Mockingbird, Mimus polyglottos polyglottos (*Linn*)
Brown thrasher, Toxostoma rufum (*Linn*)
Short-billed marsh wren, Cistothorus stellaris (*Naumann*)
Bluebird, Sialia sialis sialis (*Linn*)

BIRDS' NESTS

Cary, Miss E., Albany
Chimney swift, Chaetura pelagica (*Linn*)
Hummingbird, Archilochus colubris (*Linn*)
Wood pewee, Myiochanes virens (*Linn*)
Orchard oriole, Icterus spurius (*Linn*)
Goldfinch, Astragalinus tristis tristis (*Linn*)
Chipping sparrow, Spizella passerina passerina (*Bechstein*)
Field sparrow, Spizella pusilla pusilla (*Wilson*)
Swamp sparrow, Melospiza georgiana (*Latham*)
Towhee, Pipilo erythrophthalmus erythrophthalmus (*Linn*)
Yellow warbler, Dendroica aestiva aestiva (*Gmelin*)
Chestnut-sided warbler, Dendroica pennsylvanica (*Linn*)
Redstart, Setophaga ruticilla (*Linn*)
Wood thrush, Hylocichla mustelina (*Gmelin*)
Robin, Planesticus migratorius migratorius (*Linn*)
Collection of Henry A. Slack from vicinity of Pine Hills, Albany, N Y.

DOMESTIC FOWLS

Whitney, C. L. A., Albany
Rhode Island red (cock)
Barbarola, Mrs D., Rensselaer
Four-legged chick

MAMMALS

Downing, Dr Augustus, Albany
Skunk, Mephitis putida *Boitard,* Albany, N. Y.
Conservation Commission, Albany
Beaver, Castor canadensis canadensis *Kuhl,* two specimens from Beaver river, N. Y.
Manning, John A., Loudonville
Moose, Alces americanus *Jardine,* mounted head
Agnew, F., Oneonta
Virginia deer, Odocoileus americanus borealis *Miller*
Skull of albino taken October 16, 1919 at Blue Ridge, Essex co., N. Y.
Emmons, G. Z., Albany
Horse, Equus caballus *Linn.,* teeth

Collection

ARANEIDA

Bishop, S. C., Albany
Araneus cavaticus (*Keyserling*)
Linyphia marginata *C. Koch,* Thacher Park, N. Y.
Lycosa erratica *Hentz*
Pirata sp., Ballston Lake, N. Y.
Lycosa helluo *Walck.*
Pardosa moesta *Banks,* Featherstone lake, N. Y.
Hypomma trilobata (*Banks*), Mc Lean bogs near Ithaca, N. Y.

BATRACHIANS

Wright, A. H. and Bishop, S. C.
Newt, Notophthalmus viridescens viridescens (*Raf.*)
Dusky salamander, Desmognathus fuscus fuscus (*Raf.*)
Purple salamander, Gyrinophilus porphyriticus (*Green*)
Red-backed salamander, Plethodon cinereus (*Green*)
Mc Lean and Chicago bogs near Ithaca, N. Y.

Purchase

BIRDS

Ashley, G. W., Chatham Center
Mourning dove, Zenaidura macroura carolinensis (*Linn*)

MAMMALS

Goldring, Fred, Slingerlands
Skunk, Mephitis putida *Boitard,* four young from Slingerlands, N. Y.

Accessions for 1920

Donation

ARACHNIDA

Goldring, Winifred, Slingerlands
Collection of spiders, scorpions, tarantulas etc., from Cienfuegos, Cuba
Schoonmaker, W. J., Rensselaer
Cicurina pallida *Keys.*
Hypselistes florens *Camb.*
Lycosa helluo (*Walck*)
Pardosa milvina *Hentz*
Pardosa moesta *Banks*
Pardosa xerampelina *Banks*
Pedanostethis riparius *Keys,* May 10, 1920, Rensselaer, N. Y.
Lycosa gulosa *Walck*
Lycosa helluo *Walck*
Pardosa lapidicina *Emerton*
Pardosa moesta *Banks*
Pardosa saxatilis *Hentz*
Pardosa xerampelina *Keys.*
Pirata minutus *Emerton,* June 3, 1920, Rensselaer, N. Y.
Linyphia clathrata *Sundevall*
Lycosa helluo *Walck.*
Pardosa moesta *Banks*
Pardosa saxatilis *Hentz*
Pardosa xerampelina *Keys.*
Schizocosa crassipes (*Walck*), June 17, 1920, Rensselaer, N. Y.
Young, D. B., Albany
Clubiona riparia *L. Koch*
Pardosa saxatilis *Hentz*
Xysticus versicolor *Keys.*
Dendryphantes brunneus (*Emerton*)
Dendryphantes clarus (*Keys*)
Xysticus acquiescens *Emerton,* May–June 1920, Scotia, N. Y.
Hoffman, W. A., Albany
Theridula opulenta (*Walck*)
Theridion spirale *Emerton,* Albany, N. Y.

BATRACHIANS

Dietrich, H., Olcott
Notophthalmus torosus *Rathke*
Batrachoceps attenuatus *Esch.*
Aneides lugubris lugubris *Hallowell*
Bufo boreas halophilus *Baird and Girard*
Hyla regilla *Baird and Girard*
Gerrhonotus coeruleus *Wieg,* vicinity of Berkeley, Cal.

REPTILES

Dietrich, H., Olcott
Sceloporus occidentalis occidentalis (*Baird and Girard*)
Plestiodon skiltonianum *Baird and Girard,* vicinity of Berkeley, Cal.
Brown, Samuel W., Albany
Wood turtle, Chelopus insculpta (*Le Conte*)

BIRDS

Conservation Commission, through Marshall McLean, Albany
White-breasted nuthatch, Sitta carolinensis carolinensis *Latham,* Albany, N. Y.
Talmage, Mrs D. W., East Hampton
Redpoll, Acanthis linaria linaria (*Linn*), East Hampton, N. Y.
Donor unknown
Peacock, Pavo cristatus *Linn.,* Selkirk, N. Y.
Brown, Samuel W., Albany
Loon, Gavia immer (*Brunnich*)
Canada spruce grouse, Canachites canadensis canace (*Linn*)
Ruffed grouse, Bonasa umbellus umbellus (*Linn*)
Ptarmigan, Lagopus lagopus lagopus (*Linn*)
Black-crowned night heron Nycticorax nycticorax naevius (*Bodd*)
Prairie chicken, Tympanuchus americanus americanus (*Reich*)
Sharp-shinned hawk, Accipiter velox (*Wilson*)
Cooper's hawk, Accipiter cooperi (*Bonap.*)
Goshawk, Astur atricapillus atricapillus (*Wilson*)
Red-tailed hawk, Buteo borealis borealis (*Gmelin*)
Barred owl, Strix varia varia *Barton*
Hairy woodpecker, Dryobates villosus villosus (*Linn.*)
Northern pileated woodpecker, Phloeotomus pileatus abieticola (*Bangs*)
Bobolink, Dolichonyx oryzivorus (*Linn.*)
Goldfinch, Astragalinus tristis tristis (*Linn.*)
Towhee, Pipilo erythrophthalmus erythrophthalmus (*Linn*)
Cedar waxwing, Bombycilla cedrorum *Vieillot*
White-breasted nuthatch, Sitta carolinensis carolinensis *Latham*

DOMESTIC FOWL

De Graff, E. T., Albany
Rhode Island red (cock)

MAMMALS

Brown, Samuel W., Albany
Mink, Mustela vison vison *Schreber*
Weasel, Mustela novaboracensis novaboracensis (*Emmons*)
Pine martin, Martes americana *Turton*
Fox squirrel, Sciurus niger neglectus (*Gray*)
Red squirrel, Sciurus hudsonicus loquax *Bangs,* Adirondack mountains, N. Y.
Gibson, Langdon, Schenectady
Fragments of hide, hair, muscular tissue and adipocere of the northern mammoth, Elephas primigenius *Blumenbach,* from Eschscholtz Bay, Alaska

Kilmer, Isaiah, Jackson's Corners
Canada lynx, Lynx canadensis *Kerr.*, Jackson's Corners, Dutchess co., N. Y. Shot March 10, 1920.

Collection

ARANEIDA

Crosby, C. R. and Bishop, S. C., Albany
Ceraticelus fissiceps *Camb.*
Ceratinopsis nigriceps *Emerton*
Dictyna sublata (*Hentz*)
Linyphia communis *Hentz*
Pardosa moesta *Banks*
Pirata insularis *Emerton*
Pirata marxi *Stone*
Pisaurina mira (*Walck.*)
Theridion differens *Emerton*
Xysticus gulosus *Keys*, June 26, 1920, Northumberland township, Saratoga co., N. Y.

Bishop, S. C., Albany
Coelotes fidelis *Banks*
Dendryphantes audax (*Hentz*)
Dendryphantes purpuratus (*Keys*)
Drassodes auriculoides *Barrows*
Steatoda borealis (*Hentz*), Greenville, Greene co., N. Y., April 17, 1920
Cicurina arcuata (*Keys*)
Cicurina brevis (*Emerton*)
Coelotes fidelis *Banks*
Cyclosa conica (*Pallas*)
Schizocosa saltatrix *Hentz*
Scotolathys pallida (*Marx*), Meadowdale, N. Y., May 1, 1920
Agroeca pratensis *Emerton*
Bathyphantes micaria *Emerton*
Crustulina guttata (*Wider*)
Hypselistes florens *Camb.*
Dendryphantes purpuratus (*Keys*), Guilderland Center, N. Y., May 5, 1920
Agelena naevia *Walck.*
Ariadna bicolor *Hentz*
Clubiona pallens *Hentz*
Dendryphantes audax (*Hentz*)
Dendryphantes flavipedes *Peckham*
Dendryphantes purpuratus (*Keys*)
Dictyna foliacea (*Hentz*)
Drassodes auriculoides *Barrows*
Enoplognatha marmorata *Hentz*
Lycosa helluo *Hentz*
Lycosa pratensis *Emerton*
Pardosa saxtilis *Hentz*
Pardosa xerampelina (*Keys.*)
Pellenes viridipes *Hentz*
Theridion murarium *Emerton*, Wappingers Falls, N. Y., May 27, 1920

Ceraticelus atriceps *Emerton*
Ceratinopsis interpres *Camb.*
Clubiona sp.
Cornicularia auranticeps *Emerton*
Crustulina guttata (*Wider*)
Dictyna brevitarsis *Emerton*
Dictyna volucripes *Keys*
Grammonota pictilis (*Camb.*)
Hahnia cinerea *Emerton*
Hypselistes florens (*Camb.*)
Linyphia communis *Hentz*
Linyphia marginata *C. Koch*
Mangora placida *Hentz*
Microneta longibulbus *Emerton*
Neon nellii *Peckham*
Pocadicnemus longituba *Emerton*
Oedothorax bidentatus (*Emerton*)
Oedothorax rectangulatus (*Emerton*)
Sittacus striatus *Emerton*
Theridion differens *Emerton*
Tmeticus conicus *Emerton*
Tmeticus simplex *Emerton*, Little Pond, Orange co., N. Y., May 25, 1920
Araneus nordamanii *Thorell*
Ceraticelus laetabilis *Camb.*
Ceraticelus minutus *Emerton*
Coelotes fidelis *Banks*
Dendryphantes flavipedes *Peck.*
Lathys foxii *Marx*
Microneta persoluta *Camb.*
Neon nellii *Peck*
Phrurolithus alarius (*Hentz*)
Phrurolithus formica *Banks*
Scotolathys pallida (*Marx*)
Tetragnatha laboriosa *Hentz*, Sam's Point, Ulster co., N. Y., May 24, 1920
Lycosa avida *Walck*
Lycosa helluo *Walck*
Pardosa saxatilis *Hentz*
Pedanostethus spiniferus *Emerton*
Steatoda borealis (*Hentz*), Goshen, Orange co., N. Y., May 20, 1920
Bathyphantes zebra *Emerton*
Hypselistes florens (*Camb.*)
Microneta persoluta *Camb.*
Neon nellii *Peck*
Oedothorax rectangulatus *Emerton*
Pardosa xerampelina (*Keys*)
Pedanostethus riparius *Keys*
Scotolathys pallida (*Marx*), Maratanza Lake, Ulster co., N. Y., May 24, 1920
Ceraticelus laetabilis (*Cambr.*)
Clubiona obesa *Hentz*
Linyphia phrygiana *C. Koch*

Linyphia pusilla *Sundevall*
Microneta persoluta *Cambr.*
Microneta viaria *Black*, Cragsmoor, Ulster co., N. Y., May 24, 1920
Dendryphantes flavipedes *Peck*
Linyphia marginata *C. Koch*
Lycosa avida *Walck*
Lycosa frondicola *Emerton*
Lycosa helluo (*Walck*)
Pirata montana *Emerton*
Oedothorax oxypaederotipus *Crosby*, Paradise, Orange co., N. Y., May 26, 1920
Ceraticelus minutus (*Emerton*)
Ceratinella brunnea (*Emerton*)
Clubiona abbotti *L. Koch*
Coelotes fidelis *Banks*
Hahnia agilis *Keys*
Hypselistes florens (*Cambr.*)
Lophocraenum arenarium *Emerton*
Lophocraenum coriaceum *Emerton*
Pardosa milvina (*Hentz*), Pine Island, Orange co., N. Y., May 19, 1920
Agroeca ornata *Banks*
Araneus arabescus *Walck*
Araneus nordmanni (*Thorell*)
Bathyphantes zebra *Emerton*
Ceraticelus fissiceps *Camb.*
Ceraticelus laetus *Camb.*
Ceratinopsis interpres *Camb.*
Clubiona obesa *Hentz*
Cyclosa conica (*Pallas*)
Dendryphantes brunneus *Emerton*
Dendryphantes capitatus *Hentz*
Dictyna foliacea *Hentz*
Enoplognatha marmorata (*Hentz*)
Lepthyphantes nebulosus (*Sund.*)
Linyphia marginata *C. Koch*
Mangora placida *Hentz*
Neon nellii *Peck*
Oedothorax oxypaederotipus *Crosby*
Philodromus rufus *Walck*
Phrurolithus alarius *Hentz*
Pirata montanus *Emerton*
Prosopotheca directa *Camb.*
Scotolathys pallida (*Marx*)
Theridula opulenta *Walck*
Theridion unimaculatum *Emerton*
Ulesanis americanus *Emerton*
Uloborus americanus *Walck*
Zygoballus bettini *Peck*, Oakland Valley, Sullivan co., N. Y., May 26, 1920
Araneus cavaticus (*Keys*)
Caseola alticeps *Emerton*
Clubiona obesa *Hentz*

Crustulina guttata *Wider*
Meta menardi *Keys*
Pardosa xerampelina (*Keys*)
Phrurolithus alarius *Hentz*
Pirata montanus *Emerton*, Thacher Park, Albany co., N. Y., May 29, 1920
Pardosa lapidicina *Emerton*
Schizocosa saltatrix (*Hentz*), near Kenwood, Albany co., N. Y., May 14, 1920
Dendryphantes purpuratus (*Keys*)
Dolomedes scriptus *Hentz*
Drassodes neglectus *Keys*
Ero furocata (*Villers*)
Gnaphosa gigantea *Keys.*
Habrocestum pulex *Hentz*
Hahnia agilis *Keys*
Linyphia marginata *C. Koch*
Lycosa avida (*Walck*)
Lycosa frondicola *Em.*
Lycosa helluo (*Walck.*)
Pardosa emertoni *Chamb.*
Pardosa lapidicina *Em.*
Pardosa saxatilis *Hentz*
Pardosa xerampelina (*Keys*)
Pirata isularis *Em.*
Pirata minutus *Em.*
Salticus scenicus (*Clerck*)
Steatoda borealis (*Hentz*)
Xysticus limbatus *Keys*, Dormansville, N. Y., June 24, 1920
Araneus nordmannii (*Thorell*)
Bathyphantes nigrinus (*West*)
Ceraticelus fissiceps *Camb.*
Ceratinopsis nigriceps *Emerton*
Dendryphantes capitatus *Hentz*
Dendryphantes flavipedes *Peck*
Dolomedes scriptus *Hentz*
Drassodes robustus *Emerton*
Hypselistes florens *Camb.*
Linyphia marginata *C. Koch*
Lycosa rubicunda *Keys*
Pardosa moesta *Banks*
Pardosa xerampelina (*Keys*)
Pirata febriculosa *Becker*
Pirata insularis *Emerton*
Tetragnatha elongata (*Walck*)
Tetragnatha extensa (*Linn.*)
Tetragnatha laboriosa *Hentz*
Theridion frondeum *Emerton*
Theridion sexpunctatum *Emerton*
Xysticus formosus *Banks*
Xysticus triguttatus *Keys*, Tackawasick pond, Rensselaer co., N. Y., June 25, 1920

Lycosa helluo *Walck.*
Pardosa lapidicina *Emerton*
Paradosa xerampelina (*Keys*)
Pirata insularis *Emerton*
Pirata minuta *Emerton*
Tetragnatha laboriosa (*Hentz*), Pike pond, Rensselaer co., N. Y., June 25, 1920
Pardosa saxatilis (*Hentz*)
Pirata febriculosa (*Beck*), Myosotis lake, Rensselaerville, N. Y., July 2, 1920

MOLLUSCA

Bishop, S. C., Albany
Pond Snail, Viviparus malleatus (*Reeve*), pond on golf links, Niskayuna, N. Y.

MYRIAPODA

Bishop, S. C., Albany
Polyxenus fasciculatus *Say*, Guilderland Center, N. Y., May 5, 1921

Purchase

FISHES

West, Francis, Falmouth, Mass.
Landlocked salmon, Salmo salar sebago (*Girard*), from Grand Lake, Maine
Smelt, Osmerus mordax (*Mitchill*), Massachusetts coast

THE EXISTENCE AND CONFIGURATION OF PRE-CAMBRIAN CONTINENTS

BY RUDOLF RUEDEMANN

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THE EXISTENCE AND CONFIGURATION OF PRECAMBRIAN CONTINENTS

BY RUDOLF RUEDEMANN

Introduction

Paleogeography has, both in Europe and America, become a recognized branch of science that is fundamentally based on facts furnished by stratigraphic and paleontologic investigations and that also receives valuable information from the recent distribution of the organic world.

Precambrian geology has thus far been drawn upon but incidentally, and nowhere, to the author's knowledge, in a systematic way. As a result the series of paleogeographic maps of either the world or of one of the hemispheres or continents, that have been published in the last score of years — and that have done so much to broaden our conception of the development of the face of the earth — have all stopped short at the Lower Cambrian.[1]

The cause for this failure to go beyond the beginning of the Cambrian into the vast and dim Precambrian era is readily seen in a whole number of perplexing problems that at once arise if one attempts to push the inquiry into the metamorphosed and nonfossiliferous rocks. To cite only a few of these: the distinction in these Precambrian beds of originally marine and terrestrial, deep-sea and continental formations; the almost uniformly and intricately folded and foliated, faulted and injected nature of the beds, which apparently is so irregular as to furnish no directive lines; and further the uncertainty as to the correlation of the various series distinguished on the different continents.

If, in the face of these discouraging and apparently unsurmountable difficulties, the author ventures to suggest some possible fundamentals of Precambrian paleogeography, he wishes to state beforehand that he feels he is treading on uncertain ground and

[1] Schuchert (1910, p. 517) states this fact concisely when he says: "From the beginning of the Paleozoic, paleogeography can be made out with certainty, but back of that period all is shrouded in obscurity, owing to the absence of a paleontologic record."

entirely out of his chosen field of investigation. This paper is largely intended to direct attention to the possibility of going beyond the Cambrian paleogeography and to invite to the task others who are more competent to do so.[1]

It is our purpose, at present, to survey the data that may be competent to indicate the existence and configuration of Precambrian continents.

Survey of Views on Origin and Age of Continents and Oceans

Our forefathers in geology assumed that the earth, upon emerging from its molten stage, was a fairly regular geoid with but unimportant prominences, except the equatorial bulge due to the rotation of the earth, and that it was evenly covered by a vast primordial ocean. This ocean had entirely come out of the atmosphere and it was one of the terrible geologic possibilities that were presented to us in the days of our youth, that this ocean might all be used up in the hydration of the earth crust.

In contrast to these early views, some of the foremost geologists of the present age consider the continents as original and persistent features of the face of the earth. Dana was probably the first to clearly proclaim the *constancy of the continents and oceans*. According to his view (see Barrell, 1919, p. 282), the major relief of continent and ocean floor was obtained in the original freezing of a crust and consequent upon the faster cooling and shrinkage of certain portions. It was Dana who conceived the idea of the North American continent growing from an Azoic nucleus, the Laurentian shield of later authors, flanked by a deeper channel on either side. Osmond Fisher assumed that the fundamental features of the face of the earth are primarily due to the rotation of the earth; the latter having rotated so fast in primordial times that a part of the siliceous crust, that of the Pacific hemisphere, was thrown off and formed the moon. Portions (America and Australia) of the remaining siliceous crust floated away and drifted toward the great Pacific depression, and thus divided the original siliceous crust into continental masses separated by oceanic basins. The untenability of this view has been asserted by Barrell. Suess, in his *Antlitz der Erde* has elaborately worked out the hypothesis of the gradual formation of the ocean basins at the expense of (originally all embracing) continents

[1] A preliminary note, entitled "On Some Fundamentals of Precambrian Paleogeography," has been published by the writer in the Proceedings of the National Academy of Sciences, 1919, 5:1–6.

by *continental fragmentation*, by which process he conceived the margins of the continents to have been faulted down into periodically widening oceanic basins. This hypothesis has found strong adherents in this country, as Hobbs (1907, p. 233), who, by his seismological investigations, believes to have found evidence that "the ocean-basins of the present day have been formed largely as a result of sinking of great orographic blocks." He thus disputes the permanency of the present ocean basins. On the other hand, Schuchert (1916, p. 91) inclines to the view that the enlarging oceanic basins are the most permanent features of the earth, while the ancient continental platforms originally were not only arranged differently (latitudinally) than at present (longitudinally), but also that their areal extent, including their emerged and submerged portions, was originally greater than at present; and vast land masses, such as Oceania (Australia, New Zealand) and Gondwana-land have permanently been taken possession of by the oceans.

Suess's hypothesis has been subjected to critical analysis by Barrell (*Nature and Bearings of Isostasy*, 1919), who points out that Suess formed his theory of continental fragmentation before the theory of isostasy had been developed and proved by the quantitative data now available. "These data indicate that a continental platform can not break down broadly into an ocean unless there has been a previous or accompanying increase in density in the lithosphere. Such increase in density might be made locally by the rise of great masses of basic or ultrabasic magmas, but there is no independent geologic evidence that this has occurred on the scale demanded by the theory of Suess, nor that it could be effective on such a scale." Barrell does, however, not exclude the possibility of broad density changes and concludes that if the geologic evidence of continental fragmentation should become regarded as compulsory, the conditions of fragmentation and isostatic compensation might conceivably be reconciled by the existence of a third and otherwise unsuspected condition of changes of density in the lithosphere.

Chamberlin, in his classic work *The Origin of the Earth* and in other publications, has advanced an independent theory according to which the origin of continents and oceans dates back even to the middle growth-stages of the earth and the latter is believed to have begun to hold an ocean by the time it contained 30 or 40 per cent of its present mass. Through various influences, notably those of wind and water, the denser planetesimal dust tended to be segregated into the primitive ocean basins, while the lighter dust accumulated in protuberant areas, which became the continental platforms. These original differences were maintained as the earth was built outward. This theory leads to the view that the earth is composed of a number of conical sectors (see postea, p. 141), whose apexes lie deep in the central core of the earth, while the ocean basins form the bases. These continental and oceanic sectors are assumed to be in approximate hydrostatic equilibrium, thus giving a form of isostasy in which the compensation extends downward more than a thousand miles (Barrell, 1919) and which postulates a perfect constancy of oceans and continents (Chamberlin, 1914; 131). Barrell (ibid.) has pointed out that the demonstration of this theory depends upon competent mathematic investigation and especially the quantitative measurement of the relations of the density of the crust of the earth to the relief of its surface.

Meanwhile Barrell (1918) has advanced a view of his own, which Schuchert (1919, p. 49) who accepts it calls the *volcanic theory*. According to this theory the continents and oceans arose in Archeozoic time, but from densities in ocean bottoms and continents that are but "skin deep," reaching to about 150 miles in the outer shell, and that result from a molten condition of the earth at the completion of its growth. This condition (Barrell, 1918, p. 26) is, in contrast to Chamberlin's theory, derived from the chemical character of the igneous rocks, the limited depth of density variations in the crust, the limited amount of salt in the sea and the rotation periods of the moon and planets. Barrell pictures to himself the process of the formation of ocean basins in such a way, that fractional crystallization caused first a density stratification of the crust, the heavy basic crystals which formed first tending to work down. The remaining magma was then siliceous and the original crust consequently granite. Into or through this crust broke, in certain regions, dense molten matter from the depth of the earth, on a gigantic scale, eruption following eruption until the widespread floods had weighted down broad areas and caused their subsidence into ocean basins. This action went forward with widening radius, leading to the circular outlines characteristic of ocean basins and leaving angular segments of the original lighter crust as continental platforms.

Schuchert (1916, 1919, p. 50) estimates that the continents were formerly 25 per cent larger, and that the periodic shrinking of the earth causes a periodic enlarging and deepening of the oceans, that can be traced back at least to Permian time. While the continents are thus gradually breaking down, the enlarging ocean basins are the most permanent features of the earth.

Daly has lately (1918, 1920) advanced views similar to those held by Barrell, but based on different lines of investigation. He also holds that the surface of the earth was in a molten or gaseous state after our globe had grown full size, basing his view mainly on the condition of the other planets and of the moon, which by its maria and lunar pits[1] indicates such a condition in a late stage. He points out that the Precambrian basement terranes are granitic on the average, while the eruptives of the ocean floors are almost entirely basaltic or derivatives of basalt, and he considers both as primeval differentiates, the basalt being the sunken part of an intermediate magma, of which the other risen part is the material now constituting the granitic terranes of the Precambrian (Daly, 1918, p. 120). He thus assumes a density stratification that is due to a fluid earth and that led to an original separation of continental and oceanic tracts. The dominant gneisses and granites of the early Precambrian complexes, however, do not represent the primitive crust but its rearranged material.

Similar views are held by Willis (1920) as to the origin of the ocean depressions from original basalt masses and the repetition of epochs of melting; and their consequent persistence from early geologic or Precambrian time. A tendency to gradual widening is supposed to have been induced by the formation of marginal shearing surfaces.

Summarizing the views of American authors who have speculated on the age and origin of the oceans and continents, it will be seen that they stand in essential agreement on the primordial age and essential permanency of these fundamental features of the framework of the earth; but as to their origin they do not agree.

This American view, as we may well call it, which emphasizes the permanence of the oceans and continents is not so generally accepted in Europe. This may well be traced back to the subtle mental influence of the geology of the two continents; on one side the grand, simply built American continent with its broad Archean nucleus in the north, vast Paleozoic expanse in the middle, and a narrow margin of marine Tertiary rocks; and on the other hand the shattered and complex European continent which suggests continuous restlessness in its geologic history.

In Europe we can discern at least two groups of writers, a larger

[1] Arguments which, incidentally, have since been repudiated by Chamberlin (1920, p. 690).

one which follows Suess, and a smaller one which considers the geosynclines as the fundamental feature of the framework of the earth.

As is well known, Suess, following the suggestions of American petrographers, divided the earth crust into three concentric divisions, namely, the central *Barysphere*, which he termed the *Nife* (Ni-Fe); the *Sima* (Si-Mg); and the *Sal* (Si-Al). The latter two have been united by Wiechert as the stone crust or *lithosphere*, the Sima corresponding to the heavier basic, and the Sal to the lighter eruptive rocks. The sedimentary envelope or " stratosphere " of Suess is almost entirely formed at the expense of the Sal. While formerly one sought to explain the anomalies of gravity by the assumption of a thinner layer of the lithosphere above the barysphere, or a " coming up " of the barysphere under the oceans (see Kayser, 1913), one is now inclined to consider the continents as lighter bodies, consisting of Sal, that float upon and are partly imbedded into the heavier Sima that also underlies the oceans (see Wegener and Andrée). As it is recognized that there could not have been an exchange on a large scale of these masses, the permanence of the oceans and continents is a corollary of this view. But it has also led to the hypothesis of " horizontal continental displacements " of Wegener, according to which the lighter continental masses have moved upon the heavier Sima during geological history, a view which is thought to explain — perhaps in combination with larger relative polar wanderings induced by the summation of small absolute polar wanderings — the occurrence of glacial deposits in tropical regions and of fossil tropical plants and coal beds in arctic regions, and the connections of widely separated continents postulated by biogeographers (see Dacqué p. 56, 85).

The permanence of the oceans and especially of the great ocean depths has been doubted after the discovery that the abyssal faunas are not of older than Mesozoic origin. This fact has, however, been explained in various ways (see Walther, Soergel, Dacqué, Chamberlin) without the assumption of a late origin of the abysmal depths and it has, on the other hand, been pointed out by Penck by means of a simple calculation that the middle depth of the ocean may at all times have amounted to about 2640 meters, since at all times there is evidence of dry land; and that even if one assumes a contribution of 10 per cent to the hydrosphere by juvenile water, there still remains a depth of water of 1800 meters above the middle level of the crust for the beginning of the Paleozoic age. He therefore concludes that the middle depth of the oceans was always abysmal and that these abysmal depths always existed in the areas of the present oceans.

A theory that stands in direct opposition to the view of the permanence of the oceans and continents as advanced by the American authors, is that of Haug (1900) of the supremacy of the geosynclines in the history of the face of the earth (see Gortani, 1920, p. 46). Haug's theory, as originally presented in 1900 and since then more fully developed in his paleogeographic maps, assumes that a system of relatively narrow but deep geosynclinal canals represents the mobile part of the earth crust, from which the ocean waters advanced in times of transgression and into which they withdrew in times of emergence of the "continents." The latter comprise all the immense tracts between the geosynclines. He thus constructed (see fig. 5) a North Atlantic, a Sino-Siberian, a Pacific, an Africano-Brazilian and an "Australo-Indo-Malgash" continent for the Mesozoic and suggests that their structure goes back to Paleozoic time. Andrée (1914, p. 27) points out that these geosynclines correspond to the present intercontinental mediterranean and the marginal seas, as the east-Asiatic, to which adjoins the greatest depth known today; and that the assumption of a Pacific continent is purely hypothetic (as Haug had himself conceded).[1]

A view which in a measure combines the hypotheses of the American authors with those held in Europe has been lately advanced by Holtedahl in connection with his thorough studies of the Paleozoics of the Atlantic-Arctic region (Holtedahl, 1920). Holtedahl considers it hopeless to advocate the permanency of the oceanic basins as far as the North Atlantic is concerned; for this region has been the area of the greatest vertical movements in the Paleozoic era and while thus through long geologic periods it had the tendency to rise, it has now sunken deeply. He recognizes a geosyncline of post-Ordovician folding extending through Norway, Scotland, Newfoundland and the Appalachians and sees in the geosynclines

[1] Eduard Suess in a letter of March 8, 1909, to the writer has, in answer to the latter's statement in "The Graptolites of New York," that the graptolite shales prevailingly occur in geosynclines, expressed an interesting view on these structures which it may be worth while to publish in this connection. He says (not translated) "I have with great interest read what you say on shields, but I do not believe in geosynclinals. No existing ocean has a synclinal structure, except by superimposed sediments, and the Pacific troughs are no synclinals."

This statement explains why Suess in his classic work never uses the expression geosyncline. It appears, however, that the "Vortiefen" or "fore-depths" which he recognizes in front of the greater mountain ranges (see Suess, 1911, p. 102) correspond to the geosynclines in position and as the situs of later mountain folding. As pointed out by Suess, they are, however, no synclines, as "they are not caused by folding," as "one side is formed by the foreland while the other is the front of a folded chain."

the bordering zones between the more stable continental and the unstable oceanic areas.[1]

As this admittedly very imperfect survey of the opinions held by competent authors on the permanence of the oceans and continents shows, there still exist wide differences between their views, which become still more apparent when the causes are sought out (see postea) which they assign to the fundamental changes in the surface of the earth. While this is not an occasion for entering on a general discussion of the problems of the constancy of continents and oceans beyond pointing out the lack of uniformity of opinion regarding them, it is yet to be emphasized that the problem of the Precambrian continents which it is intended to discuss here, has an important bearing on the larger question of the general permanency of the continents and oceans.

It is the writer's belief, that fairly direct evidence of the existence and configuration of the Precambrian continents can be derived from the geologic data at hand and that this evidence suggests that *the continental masses of the present day are recognizable in Precambrian time* and further that these early continents occupied much larger areas than their recent descendants.

Our evidence is taken from the following groups of geologic facts: (1) the Precambrian fold systems, (2) the Postcambrian fold systems, (3) the configuration of the Cambrian continents, (4) the character of the Precambrian deposits.

Actuality of Precambrian Folding and Fold Systems

Prof. W. M. Davis has lately in a review of Suess's " Face of the Earth " pointed out that " wisely directed attention might be given to the ancient deformations of the long afterwards undisturbed regions, like Laurentia, Angara and Gondwana; and coordinated effort might thus be made to extend the beginnings already outlined

[1] It likewise appears that European authors (see Th. Arldt, Die Verbindung Madagascars mit Africa in der geologischen Vorzeit, in Geol. Rundschau, 10:63 ff. 1919; Gerth, H. Die Fortschritte der geologischen Forschung in Argentinien und einigen Nachbarstaaten während des Weltkrieges. ibid. 1921, 12:74 ff., and especially E. Jaworski, Das Alter des süd-atlantischen Beckens, ibid., 12:60, 1921) are not inclined to accept the permanence of the south Atlantic. Also the Argentine geologists, under the leadership of H. Keidel (Ueber das Alter, die Verbreitung und die gegenseitigen Beziehungen der verschiedenen tektonischen Strukturen in den argentinischen Gebirgen; Compt. Rxend. 12 Int. Cong. 1913, p. 671–88; and La Geologia de las Sierras de la Provincia de Buenos Aires y sus relaciones con las montañas de Sud Africa y los Andes; in An. de Min. de Agric. de la Rep. Argent. Secc. Geol.; Min. y Mineria, v. 9 no. 3, 1916) prefer to support Clarke's inference that the peculiar character of the Antarctic Devonian can be explained only by the assumption of a large south Atlantic continental mass, separating the Antarctic Devonian sea from the Mediterranean sea.

in the direction of interpreting the Archean framework of the earth upon which the more modern framework that Suess deciphered has been superposed."

It is an established fact that the Archean basement complex (representing the Archeozoic era) has undergone not only complete metamorphism but also a worldwide intense folding. The later Precambrian rocks (classed formerly as Huronian, then as Algonkian and more recently as Algoman, Huronian and Algonkian rocks, representing Proterozoic time) have escaped metamorphism and folding in some interior parts of North America but elsewhere have undergone like folding as the Archean basement complex and with few exceptions in the same sense; for example, in the eastern Laurentian shield, where both are folded from the southeast. This worldwide folding of the Precambrian rocks stands in striking contrast to the localized folding of the earth crust in all later time. It is this folding that we shall make first the object of our analysis in search for criteria of Precambrian continents. We shall show that this folding exhibits *uniform directions* over enormous tracts of the earth, thereby indicating *primordial masses of the earth crust that responded to the folding agencies as units*, and that we, for that reason, consider as *fundamental elements* of the framework of the earth, corresponding to the *continents* of later geologic history.

Before we can enter upon an investigation of the directive lines of these Precambrian fold systems, however, it is necessary to attain clearness as to the actuality of the folds and as to their cause. It is obvious from a perusal of the literature that there exists as yet no consensus of opinion regarding the cause of the universal Precambrian folding.

In Europe one has pointed to the closely compressed folds of the Precambrian terranes, whose " strikes are tortuous and wavy curves and often subcircular and even angularly broken lines " (Uhlig, 1904, p. 10), such as have been mapped in the Precambrian of Bohemia (Fr. Ed. Suess, 1902) and Sweden (Törnebohm, Holmquist, 1910) and concluded that this close uniform folding is to be explained by a uniform contraction of the entire earth crust which then had a " fairly homogeneous composition " (Uhlig, 1904, p. 20). Andrée (1914, p. 10) and Reyer (1907, p. 156) would invoke, besides the general contraction, the influence of enormous masses of eruptive material as an additional factor.

In America a certain diversity is still apparent in the literature, as to whether the crumpled structure of the Precambrian rocks actually represents a folding. Thus Barrell (1915, p. 511) has expressed the view that "the gnarled and twisted rocks of the Archean speak of the presence beneath them of molten magmas rather than of an enormous degree of compressive forces upon them," and W. J. Miller (1916) has stated it as his belief that none of the published Adirondack maps or available data affords any reasons to believe that the Grenville strata were ever profoundly folded or compressed, qualifying his statement in another place in saying, "that the Adirondack Grenville strata are more or less folded is . . . admitted, . . . but, in the light of recent studies, the writer (Miller) doubts the interpretation of folded, tilted and foliated structures as due to intense lateral compression."

As in this latter case a distinct area, the Adirondacks of New York, has furnished the evidence, and the question is thus clearly circumscribed and also representative of the whole problem, we shall consider it a little more fully.

Those pioneers of Adirondack Precambrian geology, Cushing, Kemp, Newland and Smyth, have all directly claimed, and presented strong evidence, that intense orogenic forces have acted upon the Precambrian gneisses of the Adirondacks with the conspicuous result of isoclinal folding. Likewise has Martin (1916) in a publication that is contemporaneous with Miller's asserted a folded character for the gneisses of the Canton quadrangle in the northern Adirondacks, and still more lately have Newland (1917), Alling (1919) and Buddington (1919), in view of Miller's conclusions paid special attention in their researches in the Adirondacks to the evidence of folding and all found such of a conclusive character. Alling (1919, p. 67) concludes "that the Grenville strata have been extensively isoclinally folded" and Buddington (1919, p. 101) infers that his observations, "for the most part confirm Miller's conclusions as to the primary origin of most of the foliation in the igneous gneisses, but on the other hand they conform to the belief that strong orogenic forces of mountain-building intensity have affected the rocks of this district" (in the northwest).

Chamberlin, in discussing the order of the magnitude of the shrinkage of the earth, in his truly path-finding series of articles on "Diastrophism and the Formative Processes" (1920, p. 5) finds diastrophism displayed in three great fields, namely, (1) "the deformations of the distinctly stratified terranes, chiefly those of the Paleozoic and later ages," (2) "the complicated distortions and the metamorphosed phases of the Proterozoic and Archean complexes," and (3) "the deeper and more massive deformations of the earth body."

In regard to a possible computation of the crustal shortening expressed in the Precambrian folds, this master of analysis states: "No one, so far as I know, has thus far had the temerity to offer an estimate of the amount of shortening implied by the intricate crumpling of these old formations on any great circle of the earth. That it was large, however, goes without the saying."

Like Chamberlin, Barrell has also seen in the Precambrian folds "Manifestations of mountain-making forces on a prodigious scale" (1915, p. 19).

Suess based his "Leitlinien" or directrices of the recent continents in linking mountain chain to mountain chain, mainly on the strikes of the axes of the folds, but also on the strike of schistosity, and on the trend of intrusive rock masses, because he knew that the three are intimately related; are expressions of the same deep-seated forces and therefore bound into the uniform parallelism of direction so generally observed. Willis (1920, p. 289) points out that the foliation of the metamorphic rocks falls into the same class of phenomena and exhibits the same parallelism with the directrices. It is, however, to be regarded as the primary response of the rock to deformative movements. While, as Barrell (1915, p. 512), Willis (1920, p. 289) and others show, the normal mode of yielding in the upper zone of fracture of the lithosphere which is thin, brittle and relatively weak, is by jointing and faulting, and also by folding in stratified rocks; the rocks of deeper origin yield by massive flowage as their foliated structures and crystalline textures show when they are exposed by erosion. It seems not essential for our inquiry to decide here whether the foliation observed in metamorphosed plutonic rocks (igneous gneisses, etc.) arises, as Miller believes, during the process of consolidation of the magma, resulting from its efforts to shoulder aside the Grenville gneiss with which it is intrusive, or whether, as Willis (1920, p. 290) states, the batholiths in their linear form and arrangement follow an earlier foliation parallel to their present trend. The important fact for our inquiry is that of the parallelism, in the Archean rocks, between foliation and folding and direction of intrusives. As Chamberlin and Salisbury, in their textbook of geology, state, "the most satisfactory explanation of the prevalent foliated structure of the Archean seems to be that which refers it to the movements of the outer part of the earth, in Archeozoic and later time." We therefore can properly link the foliation with the folding and the longitudinal extension of the early intrusive masses as various expressions of the same deformative and compressive forces.

What these deformative forces may have been can be more advantageously discussed after the trend of the folds and associated phenomena has been traced over the earth. Before, however, we can take up this most important part of our inquiry, the question of the *correlation of the Precambrian rocks of the different continents* has to be settled; for it would clearly be an idle undertaking to attempt to trace the general direction of the strikes of these rocks on the earth, if the probability of entirely different ages of the rocks and of their diastrophic movements on the different continental platforms had to be inferred.

American geologists seem to be in full agreement that at least two eras have to be distinguished in the Precambrian, that are separated by a great unconformity. These are the Archeozoic and Proterozoic eras. The former term is applied to the dominantly igneous or meta-igneous complex below and the latter to the dominantly sedimentary or metasedimentary series above (see Chamberlin and Salisbury, 1909, Pirsson and Schuchert, Miller and Knight 1915, Schuchert, 1916). The sedimentary rocks of the Archeozoic era (Archean rocks) are known as the Grenville series; the igneous series as the Keewatin. The Archeozoic era closed with the great Laurentian revolution, which thoroughly deformed and injected the Archean rocks with the Laurentian granite-gneiss. This was followed by an erosion interval of immense duration, the Ep-Archeozoic interval. In the rocks of the Proterozoic era there can again be recognized a great unconformity. The Proterozoic era has therefore been subdivided into the Huronian and Algonkian periods. Schuchert (1916, p. 479) proposes to recognize these two periods as eras, in recognition of the fact that the Huronian again closes with a great mountain-making revolution and a period of great granite intrusions (the Algoman intrusives), which produce a major unconformity such as he considers as diagnostic of the termination of an era in the geologic succession. For reasons of priority he would term the earlier one (also known as Timiscamian), the Agnotozoic, and the later (also termed Algonkian and Animikean, see Miller and Knight, p. 592) the Proterozoic era.

While the rocks of the lower Huronian or Agnotozoic era are still highly metamorphosed, those of the later stages of the Proterozoic era are metamorphosed scarcely at all. They likewise have undergone much less violent diastrophic movements than those of the preceding eras and are sometimes fossiliferous. They have therefore been even referred to the Paleozoic (Lawson, 1916), although separated from the Paleozoic system by another great unconformity and corresponding great erosion interval.

Prof. J. F. Kemp (1911) after becoming personally acquainted with the Precambrian geology of Scandinavia at the occasion of the eleventh International Geological Congress, has compared the American and Scandinavian series of Precambrian rocks and expressly commented (op. cit., p. 105) on the profound impression of similarity and resemblance " that remained in the minds of the Americans, notwithstanding some differences "; adding, " so much so, that when in the field the Americans in the end became embarrassed at their constant and almost irrepressible tendency to remark upon it to their Swedish hosts." The table given by Kemp (p. 95–105), after the works of Högbom and Sederholm, shows an *almost identical succession of rocks and diastrophic events in the Scandinavian-Finnish and American Precambrian series.* Over there are distinguished as main divisions or eras, the Archean, Jatulian and Jotnian, which going downward in the progressive development of metamorphism and general crustal unrest, as well as their lithologic characters, closely correspond to the American series. The Archean is there, as here, closed by a period of huge granite intrusions (the Post-Bottnian or Serarchean granites) and intense diastrophic activity, followed by a long interval of erosion. Likewise the Jatulian era is closed by a period of strong mountain-folding and much volcanic activity, which produced the peculiar Rapakivi granites, by final elevation and land surface denudation (" epijatulian folding " and " subjotnian land surface denudation and igneous rocks "). The Jotnian, finally, is compared by Kemp with the Torridonian of Scotland and the Keweenawan of the Lake Superior region. Like the latter, the closing stage of the Proterozoic in America, it is more local in its development and distribution as compared with the Archean and Agnotozoic rocks.

In regard to the Asiatic Precambrian nucleus, Bailey Willis (1907, v. 2, p. 4) has shown a succession that is also divided by two major unconformities into three systems that exhibit progressive metamorphism, volcanic intrusions and diastrophism in a downward direction. Adams (1908, p. 117) states in regard to a correlation of this Asiatic Precambrian with the American: " Applying therefore this criterion of diastrophic periods to the correlation of the Precambrian succession of these widely separated portions of the *great northern nucleus* we obtain an identical result in both cases, *the diastrophic movements seem to have affected the nucleus as a whole.*" (italics ours).

While in none of the other large Precambrian massifs the presence of two major unconformities, beside several smaller ones, has, p. 80, been demonstrated as yet, it is, however, true that wherever Precambrian rocks are developed and exposed on any larger scale there is a distinct succession of rocks of Archean aspect (a granite-gneiss series) to more dominantly sedimentary schist series of the Proterozoic era. It is not necessary to dwell on this fact at any length, for it has been clearly stated in the textbooks, as Kayser's, Geikie's, Lapparent's etc. In Germany one distinguishes the "Urgneisformation" from the younger "Urschieferformation"; in Great Britain the fundamental gneiss (Lewisian of Hicks) from rocks of Algonkian age (Pebidian). Kayser (1913, p. 34) points out, that if the large unconformities observed on the Laurentian and Fenno-Scandinavian shields within the Precambrian rocks and between the latter and the Cambrian, have not yet been clearly recognized in other regions, this is mainly due to the fact that these unconformities have been entirely obscured by later folding. Nevertheless indications of the presence of the principal unconformity, that between the Archeozoic and Proterozoic, are found in the literature of many Precambrian massifs in all parts of the world.[1]

There is for these reasons no doubt in our mind that *the principal divisions of the Precambrian are of worldwide distribution* and will be recognized as such as more elaborate investigation extends to the as yet little known Precambrian areas of Asia, Africa, South America and Australia; and especially as gradually the metamorphic rocks of Paleozoic and Mesozoic age are recognized and separated from the Precambrian rocks.

In the same way as the succession of systems elaborated in the Precambrian in North America, Europe and eastern Asia will in time be recognized to be as worldwide as the Paleozoic and Mesozoic systems are;[2] so also the principal diastrophic events will, from present indications, be found to have everywhere the same order of magnitude and succession. The Archean is now everywhere known to be more intensely folded, crumpled, foliated and sheared than the lower Proterozoic (Agnotozoic), and this again more so than the later Proterozoic.

As several authors have pointed out, we see now in the Precambrian rocks the results of three revolutions and a number of

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[1] The Indian Precambrian has been roughly correlated with the Canadian by Sir Thomas Holland (The Archean and Purana Groups of Peninsular India; Compt. Rend. 12 Intern. Geol. Congr. 1913, p. 370 ff.) and an unconformity pointed out in the Archean corresponding to that separating the Laurentian and Huronian and another one separating the Archean and Purana groups, which latter (consisting of the Gwalior and Vindyan) is correlated with the Algonkian.

[2] It is, for example, recognized in Brazil by Harder and Chamberlin (1915).

disturbances, all of which were of Precambrian time. It is further to be remembered that geologists agree that these diastrophic movements, especially those at the end of the Archeozoic time, extended over an immense length of time; and those that involved the Archean rocks were worldwide. We see then before us the algebraic sum of the various diastrophic movements that successively disturbed the Precambrian rocks. If then, notwithstanding these facts that greatly complicate the problem of Precambrian diastrophism, we shall find that the directive lines of the Precambrian diastrophic movements, as expressed in the folding and foliation of all rocks and the strike of the eruptive bodies, present a striking uniformity of direction over tracts of continental size, it is to be inferred that these tracts responded as units for very long intervals of time, if not continuously, to all diastrophic forces.

After these preliminary discussions of the bearing of the folded structures of the Precambrian rocks on the probability of their indicating continental areas of the earliest recognizable surface of our earth, we can turn to the evidence that is found in the literature of such folds and their principal directions.

Description of Precambrian Fold Systems

In an attempt to trace out the primary direction of folding of the Precambrian rocks it is necessary to exclude:

1 All areas of metamorphic rocks which are either proved to be or suspected of being younger than Precambrian age; such as are found in Greece, Asia Minor, the Andaman and Antillean islands (serpentines of Cuba, etc.), the Coast range and in Lower California, New England etc.

2 All rocks of Precambrian age involved in later folding, as those of North Africa, Spain, France, western Germany, the Alps, eastern Australia, etc.[1] It is to be noted here, however, that even in these cases, keen observers have often enough found that the Precambrian nuclei of mountain ranges retain an independent original direction of folding, and further that in some cases the new folds have clearly followed old lines of folding ("posthumous folds"). There are further left, even in those regions that were overrun by the crustal waves of later time, "islands" or blocks that remained undisturbed and that give important information on the original direction of

[1] Many of these crystalline rocks have also been proved to be metamorphosed rocks of Paleozoic—and some even of Mesozoic—age. To this class belong the metamorphic nuclei of the Alps, Carpathians, Betic Cordillera, Iranian arch, the Himalaya, the Andes, etc.

folding in the Precambrian basement complex. Such undisturbed blocks are found in the Rocky Mountains, in Bohemia, Cambodia etc.

The large areas that are then left and that lend themselves directly to our inquiry, are: the greater part of North America, small regions of South America, eastern Europe, northern and eastern Asia, all inner Africa and western Australia. The general facts gleaned from these are complemented by those obtained from the unfolded " islands " or blocks and the posthumous folds.

The most important source of information for this inquiry has been Eduard Suess's " Das Antlitz der Erde " where there is not only a large store of information as to the directions of Precambrian rock folding in various regions but where also the facts of the general directions of Precambrian folding in Asia and eastern Europe are clearly set forth. For North America, Van Hise and Leith's " Precambrian Geology of North America " and the folios of the United States Geological Survey furnish the principal data.

Fig. 1. Chart of the trend lines of folding and foliation of Precambrian age, indicating the Precambrian continental areas. I Archi-America. II Archi-Eurasia. III Archi-Gondwana. Observed direction of trend lines; Inferred directions; fold directions of post-Proterozoic age in Precambrian rocks, in part probably of posthumous character.

a Precambrian Fold System of North America

Beginning with the *Adirondack massif* of New York, where the uniform northeast-southwest direction of the folds and foliation first attracted the attention of the writer, we have, as stated before, the unequivocal testimony of Cushing, Kemp, Newland and Smyth of the older authors and that of Alling, Buddington and Martin of the younger investigators, that the entire massif exhibits strong folding and a general strike of the beds in a northeast-southwest direction. This is especially well brought out in the limestone and graphite belts, and readily recognized on the geologic map of New York in the northwestern section of the massif.

The "*Canadian shield*" or *protaxis* (*Laurentia*) has become well known through the thorough investigations of Adams, Barlow, Coleman and Miller in the east; through Lawson, Van Hise and others in the west. Adams and Coleman, in the *Problems of American Geology* (1915) have vividly described the "epochs of intense folding and metamorphism, accompanied by great batholithic granite intrusions" that marked the end of the Archeozoic and the middle Huronian eras in the east. In both cases, they state, the thrust was from the southeast, resulting in a uniform northeast strike of the folds. Detailed investigations of restricted areas, as those of Cooke (1919) in northern Quebec, verify their statements of the remarkable parallelism of the axes of folding, although there are local diversions from the general direction, as in northern Quebec where it swings more toward an eastern direction and cross folding is developed which sometimes becomes more intense than the general folding. In the eastern part of Ontario, Adams and Barlow (1913) have also found a general N 30 E direction of the planed-down mountain ranges, which direction is also shown by the batholiths and their foliation.

Along the eastern coast of *Labrador* a northwest to north-northwest direction of the Precambrian folds appears, but this, according to Adams, is due to Tertiary folding. The cross folds observed by Cooke in northern Quebec may be an expression of the same later diastrophic influence. Along the west coast of *Greenland*, however, according to the observations of Kornerup (see Suess v. 2, p. 90; v. 3, pt 2, p. 291) the northeast direction prevails again in the Archean gneisses as far as northern Greenland (Suess, v. 2, p. 57). Above this are found locally what appear to be Huronian quartzites, quartz-schists etc. (Hovey, 1918). These beds are usually less disturbed than the older formations. In the east of Greenland a north-south direction has been mentioned along some of the fjords, but observations are as yet still very incomplete. As Suess (v. 3, pt 2) points out, Greenland is clearly a part of Laurentia and, as he suggests, the Laurentian Precambrian rocks may extend under the ocean to the western Hebrides.

While in *eastern Ontario*, as we have seen, the Precambrian rocks clearly strike northeast and also the later Proterozoic rocks, as the nickel-bearing Algoman and Keweenawan rocks at Sudbury and Cobalt (see Miller and Knight, 1915 and 1917, p. 174; also personal information from D. H. Newland; see also Adams, 1915, p. 52) are involved in this folding, as is also well shown in the geological map of the Dominion of Canada published with the Guide book no. 1; this direction of folding changes in *western Ontario*, north of Lake Superior, into an east and west direction. This is again distinctly shown on the above-mentioned map in the strikes of the Lower Huronian beds, and we have it also on personal information from D. H. Newland in regard to the Rainy Lake region. According to Coleman (1915, p. 135) the Huronian in this, its original, region to the north of Lakes Huron and Superior, has not undergone much deformation by folding. Along the margin of the shield, however, *southwest of Lake Superior* it has often been subjected to great folding (Coleman, 1915, p. 136). In the well-known Marquette region a distinct east-west folding has extended to all divisions of the Precambrian (Van Hise and Bailey, 1897); and this general direction holds true southward through the middle of the continent; although local irregularities as the bending of the strikes toward southwest, around the western end of Lake Superior may occur. The *Baraboo range* in Wisconsin (see Van Hise & Leith, 1909, p. 720) is a great east-west striking syncline, and associated outcrops in Wisconsin, consisting of Huronian and a basement complex considered as Archean, show corresponding strikes.

The *northwestern part of the Canadian shield*, west of Hudson Bay, is as yet but very little known. There is, however, no doubt that the Precambrian rocks have there swung into a north-south and northwest direction. This is brought out by the before-mentioned map of Canada and the recent observations of Camsell (1916) in the Northwest territories. He found, between the Great Slave lakes and Lake Athabasca, the Archean basement complex to have a north and south trend, "corresponding more to the Cordilleran line than to those of East Canada."[1]

[1] F. J. Alcock and E. L. Bruce (Precambrian rocks of Manitoba. Bul. Geol. Soc. 32, no. 2, p. 272, 1921) report a close folding, indicating a northwest trending structure in the Athapapuskow lake area.

This northwest and north direction of the Precambrian rocks in the western part of the Canadian shield, can, like the east-west direction of the middle part, be traced southward into the middle of the continent; for we find in the Archean basement complex of the *Ozark mountains* in Missouri a N 50° W strike (Van Hise & Leith, p. 734), in that of the *Black Hills* (ibid., p. 728, 732, 733; see also Sundance Folio) a northwest to north direction; farther south in Oklahoma a west-northwest — east-southeast direction (ibid., p. 738), and in the important inlier of Precambrian (Archean of earlier writers, probably Algonkian according to Paige) rocks in *Burnet county, Texas*, above Austin the folds form two major anticlinal axes that have a general northwest-southeast trend (Sidney Paige, 1912; Comstock, 1891, p. 553ff; Suess v. 3, pt 2, p. 82; Van Hise & Leith, 1909, p. 746).

Suess (v. 3, pt 2, p. 284) defines *Laurentia* as comprising not only the Canadian shield but also all the Precambrian basement complex on which the Paleozoic rocks rest in flat position. He thus includes Greenland and possibly the North Atlantic and extends Laurentia to its "natural boundaries" which are, in his view, the Caledonian and Appalachian mountains in the east, the Rocky mountains in the west and the United States range in the north. Although he cites the mountain ranges of Oklahoma as western continuations of the Appalachians (western Altaid system of mountains), he includes the inlier in Burnet county into Laurentia, considering it as a monadnock of the old abraded Precambrian surface; and he thus extends Laurentia southward as far as 30° n. l., suggesting (ibid., p. 282) that also the Colorado plateau may represent a part of Laurentia.

Suess (ibid., p. 290) also held that Laurentia, although a very ancient unit that acts as a block or foreland against all younger folds, has no uniform structure, but, as shown in the Lake Superior region, is composed of various systems of folds, unconformities and transgressions. With the later evidence here brought forward in regard to the folded structure of Laurentia, it seems to us to possess a *remarkably uniform structure*, the entire system of Precambrian folds forming a single curve of northeast folds in the east, of east-west folds in the middle and northwest folds in the west. This is clearly true of the Canadian shield and can be traced through the middle of the continent to the southern extremity of Laurentia, as defined by Suess.

We will now turn to the *eastern and western boundaries of Laurentia*, in whose determination Suess agrees with the earlier conception of Dana of a continental nucleus flanked by two geosynclines. Suess (ibid., p. 290) states that the strike of the Precambrian folds of Laurentia is entirely independent from that of the Appalachians and western Cordilleras.

We have seen that the folds of the eastern part of the Canadian shield strike northeast or, as Adams and Barlow have stated, approximately parallel to the St Lawrence river. This, however, is also the direction of the *Appalachian folds* and the evidence is accumulating that these folds were initiated in Precambrian time. Thus Keith (Asheville Folio, 1920) has observed interlocking northeast-southwest bands of different gneisses, showing ancient folding in the southern extension of the Precambrian basement complex in the Appalachian and Piedmont systems. Lebling in his excellent essay "Tektonische Forschungen in den Appalachen" (1914, p. 511) has, from the studies of Walcott, Grabau and Crosby, pointed out the presence of a longitudinal bar already in the Lower Cambrian of eastern North America, which separates the sea into two faunistically and lithologically different provinces, the western of which contains Olenellus thompsoni, the eastern Holmia, Paradoxides and Olenus. Crosby reports that in the Boston basin the grain of the Cambrian sediments decreases in size from northwest to southeast, while on the other side of the bar in New York the opposite takes place. This initial Cambrian bar indicates folding of Precambrian age in the direction and in the place of the Appalachian geosyncline and in line with the Precambrian folding of eastern Canada. This folding has then continued in that area and direction with interruptions throughout Paleozoic time.

Berkey has found as well in the Highlands of the Hudson (1907) as on Manhattan island, both the Archean Grenville series (Fordham gneiss, Yonkers gneiss, etc.) and the younger (Proterozoic) series (Manhattan schist, Inwood limestone) which are separated as everywhere else by an overlap unconformity. Both are intensely folded and the strike of the axes of the anticlines and synclines is everywhere northeast-southwest. Similar observations have been made farther south in Carolina by Keith. One may well ask himself whether much of this folding of the Precambrian rocks of the Appalachian region is not also of Precambrian age. We must remember that it agrees in direction with the Precambrian folding of eastern Canada, that such folding existed already on the site of the Appalachians in Precambrian time, as indicated by the abovementioned observations of Keith, Walcott, Crosby, Berkey and others, and further consider that, as Gilbert already emphasized, the Appalachian folding was of deep-seated origin, as revealed by the great erosion, and that such deep-seated folding is more likely to follow predetermined lines such as are given by the Precambrian folds. We are strongly inclined to infer from this evidence that the Appalachian folding is largely of a posthumous character (see p. 113) or of folding along older lines. These older lines, however, are those of the eastern margin of Laurentia.[1]

American geologists, including Willis, Clarke, Ulrich, Schuchert and Grabau, have long agreed that the continent formerly extended eastward for a considerable distance (100 miles or more) east of the Appalachians, forming *Appalachia*. The strike of the Precambrian rocks of the Piedmont plateau leaves little doubt that also this former extension of North America into the ancient Atlantic ("Poseidon" of Schuchert) conformed, in its basement complex with the general structure of Laurentia and was an integral part of it.

The *Rocky mountains* with their intense folding, faulting and overthrusting of Mesozoic age seem at first a hopeless field for a recognition of the Precambrian fold directions. A perusal of the literature, however, brings out the fact that the rocks of the basement complex in several areas have clearly retained a direction of folding and foliation that is independent of the Mesozoic and Tertiary folding.

The general trend of the Rocky mountains is northwest and the boundaries of the Precambrian rocks which form the backbones of the ranges as a rule have the same direction. Thus in Colorado where the waves of the Rocky mountains have been stopped, reflected and bent by the impact with the Colorado massif, they assume a Y-shaped form (see R. T. Chamberlin, 1919, p. 150), two folds merging into one southward; a feature which is faithfully reflected in the Precambrian backbones. Where the first wave has been stopped in the Uinta mountains it has assumed an east-west direction (Suess, v. 3, pt 2, p. 438). Successively the waves have swung around more to the north. It is probable that it is under the influence of such violent bending of the mountain system that the Archean gneisses and schists of the Needle Mountains quadrangle (Whitman Cross *et al.*, 1905) change their strike as shown

[1] In a recent publication, Berkey and Rice (C. P. Berkey and Marion Rice, Geology of the West Point Quadrangle, N. Y., State Mus. Bul. 225–26, 1921, p. 51) have claimed a northeast-southwest folding for the Grenville beds of "very ancient Precambrian time," finding their evidence in the marked control over all igneous intrusions resulting in a similar orientation of them and indicating that the Grenville formation which is the oldest in this region must have had this structure before the igneous history began.

in the schistosity and banding from a few degrees east of north in the southwest part of the quadrangle to an east-west direction farther north, differences of 90° being observed even within a mile; and the Algonkian sedimentaries change their strike from northwest in the southeast corner to nearly east-west in the northwest part of the sheet. On the Silverton quadrangle, however, which is directly south of the Needle Mountains quadrangle, Whitman Cross (1905) and his associates found that the Archean gneisses and schists show in their schistosity and banding a distinct northeast-southwest strike and a nearly vertical attitude. The Proterozoic (" Uncompahgre ") quartzite is too massive to make out its structure, but it is in that case also clear that the structure of the broad anticlines of late age is independent of the Algonkian structure. On the Engineer Mountain quadrangle (Whitman Cross & A. D. Hole, 1910) which is southwest of the Silverton quadrangle and between the Needle and the Rico mountains, the Archean line of schistosity swings from a north-south direction in the north, into a northeast-southwest and finally into an east-west direction, while the Uncompahgre, exposed in the northeast is thrown into compressed folds, whose boundaries run west-northwest.

On the Rico quadrangle, which is in the southwest corner of Colorado, bordering the St Juan mountains, Whitman Cross and Ransome (1905) found the Uncompahgre formation, consisting mostly of quartzite, likewise striking in a northeast direction (N 10° — 30° E), and steeply dipping toward the southeast. Other quadrangles as the Pueblo, southeast of Pike's Peak, where Gilbert found a north to northwest direction of the schistosity in the Precambrian rocks, support the conclusion that the Precambrian rocks where apparently least disturbed by later folding show a north-south to northeast-southwest direction in their original structure. This original direction has been greatly disturbed locally by the northwest direction of the mountain system imposed upon it.

The bending of the Precambrian rocks in the Needle Mountains quadrangle seems to be an expression on a smaller scale of this general tendency of all Precambrian Rocky mountains axes to turn toward the northwest, for as Suess states (v. 1, p. 726) all the Archean masses of the Rocky mountains strike from south to north with a tendency to turn toward north-northwest or northwest.

The most important area for the proper conception of the Precambrian fold system of the Rocky mountain region is, however, the Yellowstone Park and the country adjoining it north and east; or in other words north Wyoming and south Montana. Here, according to the comprehensive summary of Suess (v. 3, pt 2, p. 441 ff.) a large block has broken down and remained so free from later folding that the Cambrian is still resting horizontally upon the eroded surface of the Precambrian. This condition is especially well shown in the Gallatin range, Buffalo plateau and the Snowy range (Bear Tooth in the east), the Bridge range and the Great and Small Belt ranges. It is, as Suess expresses it, an entirely foreign block in the Rocky mountains. It was in this region that the late Precambrian deposition of the Belt terrane, reached its greatest thickness, and the rocks though separated from the following Cambrian by a distinct unconformity are but little disturbed and metamorphosed. The earlier Proterozoan rocks, however, and especially the Archeozoic rocks, are here as everywhere in the world, intensely folded. They are described as vertical by Arnold Hague and his associates (see Hague, 1899, p. 4), and it is stated that " the pronounced lamination or schistosity of the whole body of rocks is quite uniform in its position, the layers standing at high angles or nearly vertical, with a general north-south trend."

Farther south in the Laramie-Sherman folio (Wyoming, see Darton *et al.*, 1910), the dominating structure of the Archean according to Blackwelder is the schistosity, and this also shows a general trend east by north, averaging N 70° E; and the boundary lines of the Archean rocks also strike north by east.

Summing up the somewhat confusing evidence from the Precambrian rocks of the Rocky mountains, we may state as a fairly true conclusion that the original strike of the Precambrian rocks seems to have been in north-south direction, with an original tendency to turn northeast. Upon this original direction has in many localities been imposed the later northwest direction of the Rocky mountain folding, which has in places turned the folding and foliation even east-west.

If we compare this original north-south direction of folding of the Rocky mountain Precambrian with that observed in the northwestern part of the Canadian shield, which is also north-south, we can hardly avoid the conclusion that the *Rocky mountain Precambrian folding* thus found to be directed exactly parallel to the western Laurentian folding, *is a western continuation of the same system of Precambrian folding.*

We have seen before that the *Colorado plateau* acted as a block against which the Rocky mountain folds coming like waves from the north were reflected and bent. The Colorado river has eroded through this plateau and exposed one of the most wonderful sections of the world. From Walcott's excellent description (1895, p. 312) of this section we know that the river has cut into the Archean gneiss which, as everywhere, is intensely folded. Upon this rests unconformably the Algonkian or Proterozoic series, which again in its turn is folded and eroded and overlain by the little tilted Cambrian. Since that time the Colorado plateau has not been folded again. A recent reconnaissance of the Archean complex in the Canyon (Noble & Hunter, 1917) and a number of folios of the Colorado plateau afford fairly conclusive evidence of the direction of the Precambrian folding there. Noble (p. 113) who did the field work, found that nearly all the Archean rocks were recrystallized and "acquired a gneissoid or schistose banding which has a dominant northeast strike and a nearly vertical dip." It is added that this structure suggests that the compressive forces acted either from the northwest or from the southeast, and that a similar structure has been found to characterize the Archean complex in the Globe region described by Ransome (1903), and the complex on the west and southwest border of the Grand Cañon district described by Schrader (1909).

The general northeast to north-northeast strike of the Archean, underlying the Colorado plateau, is clearly brought out by a number of folios.

Ransome (1904, p. 2, 3) in the Globe folio (north of the Gila river and of Tucson) states that the schistose cleavage of the rocks ("Pinal schist," probably equivalent to the Algonkian "Vischnu" series of Walcott in the Grand Cañon) which is roughly parallel to the banding, due to differences in composition of the schists, strikes to northeast and thus runs nearly at right angles to the dominant trend of the present mountain ranges of the region. Also the "Schultze granite" forms narrow northeast-southwest intrusions in the schist. The dip is to the northwest. Ransome (1904) found the same condition on the Bisbee quadrangle, which is on the Mexican line, where the dominant trend is north-northeast—south-southwest. On the Clifton quadrangle, 80 miles east of the preceding and near the New Mexico line, Lindgren found the schistosity striking in various directions, and likewise variable indications of stratification in the schists, the outcrops, however, too small and scattered to allow the establishment of the general trend. Wherever the outcrops are large and continuous, as on the Bradshaw quadrangle (Jaggar & Palache, 1905), which lies southeast of Flagstaff in central Arizona, there the Proterozoic ("Algonkian") schists show a distinct northerly trend, as distinctly brought out on the map by the lines of trend and the direction of the numerous conglomerate, limestone and quartzite lenses, that are carefully entered upon the map. The authors add that this structure can be traced north from the Bradshaw mountains to the Jerome quadrangle, where the schists are invaded by granite intrusions that show a similar northerly trend; and still farther north is the Proterozoic Vischnu terrane of the Grand Cañon, which shows a north-northeast trend. Jaggar and Palache state that the schists lie in isoclinal folds as the result of tight compression by a horizontal force which acted from northwest to southeast. This northeast-southwest trend is found as far east as the northwest corner of Texas (Richardson, 1914).

From the cited publications which could be supplemented by others, it follows that the *general trend of the Precambrian folds in the Colorado plateau is north with a tendency toward east*, which leads to variations to north-northeast and northeast. This, however, is the exact direction of the original Precambrian folding in the Rocky mountains and the western part of the Canadian shield. The most natural conclusion is then that the *Precambrian folding of the Colorado plateau is a direct continuation of that of the Rocky mountain region* and that both belong together as far as their Precambrian structure is concerned, in spite of the contrast between the two as expressed in their present structure. This latter contrast led Suess, as has been noted before, to suggest that the Colorado plateau might be an outstanding southwestern block of Laurentia. Our inference of the agreement of the Precambrian structure of this plateau with that of Laurentia seems to corroborate this suggestion.

That the plateau of northern Mexico, which is but a southward continuation of the Colorado plateau, would then also become linked to Laurentia is an unavoidable corollary; the lack of any knowledge of Precambrian rocks forbids, however, the discussion of this conclusion in this place.

The *Western plateau and Pacific coast* regions have as yet not afforded any conclusive evidence in regard to the trend lines of the Precambrian folding for although there are large areas of metamorphic rocks of Precambrian aspect, their true age is in most cases still quite uncertain and the presence of gneisses and mica schists of Tertiary age is reported from the Coast range and lower California. The presence of genuine Precambrian (Proterozoic) rocks has, however, been reported in recent years from Oregon, Idaho and California (Smith & Packard, 1919, Knopf, 1917 etc.), as well as from western British Columbia (Daly, 1912, p. 560). The regions where these rocks occur are, however, involved in the intense folding of later age of the Pacific side of North America and there are now but few data[1] available as to their original or Precambrian folding. The same is true of the northern continuation of this plateau and mountain region into Canada[2] and Alaska. Where observations on the trend lines of metamorphic rocks have been made in these regions, they indicate a general direction parallel to the coast line (Blake, 1886, p. 242, etc.)

Briefly reviewing the principal or directive lines of the Precambrian folding of North America, just described, we find that the northeast of America, including Greenland, exhibits a distinct northeast direction; that this, in spite of later folding, or rather in part through the latter, is recognizable along the entire east coast of North America. This northeast direction swings in the interior of the continent into an east-west line, and the latter turns into a north-south line as it approaches the Rocky mountain region. *The Precambrian folding of North America exhibits thus a grand and simple curvature (see plate 1) which clearly proves this part of the earth crust to have reacted as one unit against the diastrophic forces active in Precambrian time;* or, in other words, a continuation of the Precambrian " nucleus " or protaxis seems to underlie the entire continent as far as Greenland and Mexico, and " Laurentia " originally comprised all this wide territory. The special meaning of the northeast trend in the east, the east-west trend in the middle and the north-south trend in the Rocky mountain region will be discussed in connection with the dominant trends of the other continents.

b Precambrian Fold System of Eurasia

It was Richthofen who was first impressed with the wonderful uniformity of the trend lines of the folds of the Precambrian platform of northern China (Richthofen 1882). His observations have been verified by Willis (1907) and others, but it was left to Suess to decipher the grand divergency of the trend lines in the

[1] Those available (as Calkins & Jones, 1913, p. 83, for Idaho), indicate a northwest-southeast trend of the folds.

[2] From observations of Daly (1915, p. 531) in British Columbia it follows that in the middle or interior mountain group also, as in the above-cited Rocky mountain area of Montana and Wyoming, a block of Precambrian rocks (Shuswap terrane) has escaped the Cordilleran folding, that has affected the overlying younger formations, excepting in certain narrow zones; but in this terrane, excepting minute crumples, folds are very rare, thereby suggesting, in our view, a much farther extent westward into the Pacific of Archi-America than is at present assumed.

vertex of Asia into two directions, which we will find to extend over the greater part of Eurasia.

Richthofen found that the Precambrian basement complexes in East Shantung, Liantung,[1] Korea etc., which are overlain by flat Cambrian and younger deposits, everywhere display a strong folding which is mainly directed northeast. Also in the region north of Nanking wherever the Precambrian (Archeozoic and Proterozoic) rocks appear from below the old table-land, they hold the same position. A like direction had already been recognized by Pumpelly (1866) to be a general law for the mountain ranges of eastern China. He had termed this system the *Sinian* system of mountain folds. Richthofen (1882, p. 637) concluded from the parallelism between the Precambrian folds, that were already abraded again before Cambrian time, and the later folds of the Sinian system, that new folds (or also faults) in an already folded country are apt to follow the old trends. We shall refer to the significance of these so-called "posthumous folds" in another place.

Suess has repeatedly (in volumes 2 and 3) depicted the structure of "Angaraland," the ancestor of Asia, and it is not necessary for us to go here into details. After showing that entire eastern China and Siberia are controlled by the Sinian direction, which already is established fully in the Precambrian basement complex, Suess proceeds to demonstrate, mainly from the publications of I. D. Tscherski (1886, 1889) that the folds of the ancient Precambrian mountains in the amphitheater of Irkutsk, east and west of Lake Baikal, strike in opposite directions and converge toward the south (see figure 1). The northeast or east-northeast strike which exists east of Lake Baikal he terms, after Tscherski, the *Baikal direction*, and that to the northwest or west-northwest which prevails west of the lake, the *Sayan direction*. Between these two principal regions the folds become crowded together and acquire a more or less north to south direction and it is evident that the folds were pressed inward or toward the axis of the amphitheater. This amphitheater is the exposed Precambrian area of the ancient vertex of Asia. A younger vertex developed later in the Altai, and from this proceeded,

[1] While Suess considers in volume 2, page 231, the northeast direction as the principal one, it is stated in a note (ibid., p. 254), that Richthofen observed in several places still another direction which is recognizable in the oldest gneiss, while the younger mica schists, marbles etc. strike in northeast-southwest direction. In volume 3, part 1, page 256, Suess accepts the steady north-northwest direction of the older gneisses in Shantung and Liantung as the principal and hence an irregular one, but adds that in the adjoining provinces of North Tshili and North Shansi, which lie nearer to the Gobi desert, the regular east-northeast trend controls again the Precambrian folding.

as Suess has unfolded so masterfully, a large part of the successive waves of folds (the Altaides) which have overrun Asia. The older vertex has, according to Suess, probably never been occupied again by the sea, in its central parts, but has been widely transgressed by the Cambrian along the margin. The trend lines of the folds of the Sinian basement complex in China, which are buried under unfolded Cambrian, seem to us to demonstrate that also this immense complex is a southeastern continuation of the Asiatic nucleus.

The Precambrian trend lines are traced by Suess to the lower Amur and the Pacific coast, southward to the Gobi desert and southwest to the Changai, with hardly any deviations from the two general directions.

The ancient continent whose existence in the north of Asia is demonstrated by this Precambrian basement complex and which has continued as the nucleus of Asia almost uninterruptedly to the present time, is the *Angaraland* of Suess. It corresponds to Laurentia, the ancient ancestor of North America.

In central Asia the thick deposits of the *Tethys*, the great Mediterranean sea of Paleozoic and Mesozoic times, now thrown into gigantic fold systems, effectively hide the basement complex, and certainly in India and probably also in Cambodia, where again Precambrian complexes appear on the surface, different trend lines from those of the Asiatic nucleus prevail (see *postea*).

India was recognized by Suess as an entirely foreign element of Asia belonging to ancient Gondwana-land and thereby to a different continental crust segment, while Cambodia probably belongs to Aequinoctia, an old Paleozoic continent lately distinguished by Abendanon (see *postea*). As Suess has stated, the modern Asia consists of different elements, ancient Angaraland, the Sinian block, the ancient Tethys bottom, and the Indian block left of Gondwanaland.

Tracing the Precambrian rocks westward from the ancient vertex Suess found that the *Altai mountains*, which later formed a new vertex, were themselves originally a part of the Sayan section of the ancient vertex. Along the north coast of Siberia, west of the Taimyr island, extensive areas of gneiss and mica schists have been observed by Nordenskjöld (see Suess, v. 3 pt 2, p. 376) and at Cape Tscheljuskin he observed schists striking west-northwest-east-southeast, suggesting the Sayan system.

By means of the trend lines of the Ural mountains, which is a posthumous fold system of the Sayan system of folds of the Asiatic vertex produced by pressure from the east, and the adjoining Timan system, as well as by the folds of the Precambrian basement complexes, (Archeozoic granite gneisses, etc.), which appear from under a cover of younger sediments north of the sea of Asow and along river courses between Dnieper and Bug, and in Volhynia, it has been shown *by Suess* (*v. 3. pt 1*) from the work of Karpinsky and other Russian geologists that *the Russian basement complex is a western continuation of the Sayan moiety of the ancient vertex of Asia.* Suess (v. 3, pt 1, p. 478) further demonstrates that in the large Fenno-Scandinavian or "*Baltic shield*" again the Sayan direction of trendlines appears, namely, in middle Finland and in northern Russia north of the Ladoga and Onega lakes one finds a north-northwest trend of the Precambrian folds, which often closely approaches the meridional direction and corresponds to the main direction of the Ural. North of Onega lake this direction changes by a flat curve into a north-northeast direction, that in its turn corresponds to the northern portion of the slightly convex Ural folds. On the other hand, the middle Finnish north-northwest direction continues northwestward into the peninsula of Kola, where it becomes first northwest and finally west-northwest. West of Ladoga lake the north-northwest strike still prevails and continues into northern Sweden. In the middle of the Baltic shield, in middle Finland, in Småland and north of there, immense batholiths appear which locally dominate the direction of the Precambrian folds between them. A long meridional line of disturbance (line of the Wettern), more than 5 degrees long, separates the eastern and western Scandinavian Precambrian areas. The nature of this line is, according to Suess (v. 3, pt 1, p. 479), not yet quite certain. In southwest Sweden the granite gneiss has a dominant north-south strike; in Norway, however, the Finnish north-northwest direction reappears and prevails as far as the trough of Christiania. *The Baltic shield, Sederholm's Fenno-Scandia, appears thus as an integral part of the Precambrian platform of Russia, and thereby as a further continuation of the Sayan moiety of the Asiatic vertex.*

Suess (v. 3, pt 1, p. 454; v. 3, pt 2) vividly describes how this ancient Precambrian platform is in Europe on most sides invaded by the younger folds; in the west by those of the Caledonian system, west of which in the western Hebrides, as well as in a number of Scottish peninsulas, we have to see already Atlantic, or eventually Laurentian elements. How far this Eurasian Precambrian shield, which is known to underlie the island of Bornholm between Germany and Sweden, may have originally extended toward Belgium, can not now be established. In the south it plunges under the Carpathian folds and the other more recent fold systems.

The outstanding feature of this immense Precambrian segment extending through the greater part of Asia and Europe is the grand uniformity of the Precambrian fold directions which remained rather uninfluenced by all later folding. This immense block has thus remained utterly independent from and immobile against the orogenic movements that have involved the rest of Asia and Europe.

That part of Europe which is outside of the Eurasian Precambrian platform just described, namely, *southwestern and southern Europe*, is involved in later folding to such an extent that the original Precambrian trend of folds can no longer be recognized, with the important exception of the Bohemian block, the Hebrides and perhaps certain small Precambrian massifs in Greece. The Precambrian nuclei of the Vogesian mountains, the Black forest, Spessart and Taunus, possess a northeast strike, those of the Hartz mountains, Frankenwald, Thuringian forest, Erzgebirge, Riesengebirge a northeast to east-northeast strike. These strikes, which are entirely independent from the present strikes of these mountain ranges, prove that they are relics of an ancient mountain system, the Variscan system, that arose toward the end of Carboniferous time through tangential pressure exerted from south-southeast. This system meets and combines in a syntaxis (Schaarung) with the equally old Armorican system in the central plateau of France. The Armorican system of mountain folds with its northwest and west-northwest direction, dominates the Precambrian massifs of the Bretagne in France and of Cornwall in England. As is well known, this mighty fold system has been found to reappear in eastern North America.

The *Bohemian* Precambrian body did not become involved in the Variscan folding, but in its turn profoundly affected the latter (see Suess, v. 3, pt 2, p. 25; v. 4, p. 26 of English translation). Its boundaries toward the Variscan Fichtelgebirge and Sudets are marked by sudden changes of strikes; the principal trend lines of the body are northeast and east (see Katzer, 1892, p. 56).

Another foreign body is represented by the Precambrian of the *Hebrides* and some *promontories of western Scotland*. This is described by Suess (v. 3, pt 1, p. 484; English trans., v. 3, p. 386) as an ancient foreland of Archeozoic (Levisian gneiss) and older Proterozoic rocks, that were folded and eroded before the deposition of the late Proterozoic Torridon sandstone. The latter has remained unfolded, thus occupying a similar position as the Jotnian series in Finland, and proving that this ancient body of Precambrian rocks remained free from the Caledonian orogenic diastrophism, and *possibly is the terminus of the Laurentian continent.*

Another ancient Precambrian nucleus appears to be present in the gneissose mass of the *Cyclades*, which, according to Philippson, has determined to some extent the position and trend of the arc now observable in the later folds (Dinarids) (see Suess, v. 3, pt 1, p. 417; English trans., v. 3, p. 331). A further remarkable fact is that in another region, on the island of *Cerigo*, between Greece and Crete, ancient phyllite strikes east-northeast and is unconformably overlain by the Mesozoic limestones which strike southeast (see Suess, ibid., p. 418).

There are apparently no independent Precambrian blocks known from the Spanish and Apennine peninsulas.

The combined facts of the prevailing northeast to east trends of the Bohemian massif, the remnants of the Variscan fold system which probably followed the older Precambrian folds and the small patches in the Greek islands, seem to suggest the possibility of a larger Precambrian platform in southwestern Europe with a northeast or east trend. The Armorican folds, if also posthumous in nature, would add, however, a different northwest element to the Precambrian basement complex.

c Precambrian Fold System of Africa

While the old continent of Africa has long been known to be composed over vast areas of granite, gneiss and other metamorphic rocks of Precambrian aspect and in most cases also Precambrian age, it is difficult to find conclusive evidence of the dominant trend lines of these regions.

In the broad belt of Precambrian rocks that extends across the Sahara desert south of Morocco the north-south direction of the lines has been found as a remarkably persistent feature by the expeditions that have crossed this belt. Suess (see Suess-Sollas, p. 94) says of this belt: "The Archean zone, formed of gneiss, crystalline schists, phyllite, cipolin and granite, is steeply folded; its prevalent north and south strike is a noteworthy feature. . . . The north and south strike, interrupted at most by local deflections, which is observed in the Archean basement and the beds folded in with it, dominates all the central part of the Sahara from the Tidikelt (lat. 27° N) onwards, and neither to east, south nor west are its boundaries to be found." This north-south strike has been traced to the bend of the Niger by Chadeau, throughout Dahomey by Huber, it is known along the Niger between lats. 15° 30′ and 10° 30′ and the same structure may be also seen in a great part of Togo (see Suess-Sollas *ibid.*).

More recent investigations in other districts of Central Africa fully corroborate this general north-south direction of the Precambrian trend lines. Thus Williams (1920, p. 436) found in northern Nigeria, in the Ningi hills southwest of Lake Chad, a general north-south foliation and a north-south direction of the longer axes of the granite intrusions. A local foliation in equatorial direction (near Keffi Filani) is, according to this author, probably induced by the (Mesozoic) Ningi granite, the longer axis of which is due east-west, along its contact with the Precambrian gneiss.

There is some doubt as to the age of these meridional Precambrian folds of the western Sahara and Nigeria. They have been found to be overlain by undisturbed Devonian beds and in a few localities also by Upper Silurian graptolite shales. On account of their Predevonian age and meridional direction, they have been compared with the Caledonian system by Haug (see Suess-Sollas, p. 95). Suess, accepting this view, points out that while the Caledonides in Europe are Predevonian in age, the folds of western Africa are Preupper-Silurian. He continues: "In accordance with the principles of tectonic classification we have hitherto adopted, we may assign them to the submeridional, sublinear system which was completed in Europe before the deposition of the Devonian, and in Africa even before that of the Upper Silurian. It may, however, be objected that the unconformity at the base of the African ranges may be much older than the graptolite shales; we shall therefore term them, following a suggestion in an instructive letter from M. Chadeau, the *Caledonides of the Sahara* or the *Saharides*."

It follows from this statement that the age of these folds is not known. All that is known is that they are Preupper-Silurian in age. We believe to have good reasons for concluding that they actually are of Precambrian age. While Suess refers only to the north-south direction of the Archean belt extending through the western Sahara and Nigeria and Togo to the neighborhood of the gulf of Guinea, one should consider in the same connection the north-south direction observed in areas outside of this belt, as farther east near Lake Chad (Williams), in southwest Africa and East Africa (see below). In fact, *the predominant strike of the foliation is so widely north-south in central Africa* that the

Encyclopedia Britannica (1910, p. 323) states this fact as *a salient feature of the geology of Africa.*

The Precambrian basement complex, overlain unconformably by Mesozoic or younger sediments, but forming the surface rock over vast stretches of land, extends from the region just discussed eastward to upper Egypt (Khartum) and the shores of the Red sea, southeastward to former German East Africa and southward to South Africa.

Wherever in these wide areas data on the strike of the Precambrian folds, foliation and major axes of intrusives become available, a dominant north-south direction is apparent. For *Nigeria* and western *Liberia* we have the investigations of J. Parkinson (1907, 1908). From the Oban hills in southern Nigeria (adjacent to Kamerun), this author gives fifteen measurements of strikes of foliation throughout the large district; all of these strikes have the north direction as their main component, and the average direction is less than one degree west of north. Locally, as in the Kukuruku hills in southern Nigeria where the two measurements of the foliation of the gneiss that were made gave N 45° W, considerable variation may occur, which, it seems, increases as the sea coast is approached, as in western Liberia, where Parkinson found a mean foliation striking N 68° E Gürich (1887, p. 119, 120) reports a north-south strike of gneiss from several localities on the Niger below the mouth of the Benuë. A large portion of the Congo Free State has been traversed to the Nile by Preumont (1905, p. 641). He found (ibid., p. 655) that in this northeastern portion of the Congo basin " the granitic and metamorphic primary rocks are present across the whole country from east to west and from north to south, uncovered by any other rocks except the alluvial sands and clays and the nearly related ferruginous rocks." Wherever the strike of the gneisses and other metamorphic rocks is mentioned, it is north-south and it is expressly stated (p. 653) that also in the valleys of the Kidju and the Kaja, western tributaries of the Nile, " whole series of gneisses and metamorphic rocks are met with, striking nearly due north and south." In the *Nile valley* itself, north of Lake Albert and south of the Sudan, a N 40° W strike was found to be " both regular and persistent."[1]

Dantz (1907, p. 46) found an enormous area of gneiss developed in northern and central *German East Africa*, consisting of a central

[1] A. Holmes (The Pre-Cambrian and associated rocks of the District of Mozambique; Quar. Jour. Geol. Soc. London, 74:33, 1918) has found the strike in Mozambique to be most commonly along, or a little north of a northeast to southwest direction; though in the Ribawa district and near the coast belt, it swings around to a nearly north and south direction.

area where the strike is "more frequently NNW-SSE than from W-E, and a peripheral zone with prevailing WNW-ESE strikes." Tornau (1907, p. 65) designates much of this rock as typical granite, a fact which may explain the varying strike of the peripheral zone. For *Rhodesia*, in southeastern Africa, Chalmers and Hatch (1895, p. 200) furnish some data. Wherever the strike of the Precambrian is given, usually in connection with that of the strike of the metalliferous veins, it is north-south or northwest-southeast.[1]

In *German Southwest Africa*, Voit (1905, p. 85) found a vast belt of gneiss and schists, which he refers to the Archean era. These metamorphic rocks are folded (see plate 23) and the folds and their massive granite injections have a general northeast-southwest strike, which locally (see p. 97) changes to a north-northeast — south-southwest direction.

It is to be noted that this territory of German Southwest Africa adjoins South Africa where a younger system of east-west folds has developed but where, as Voit (1906, p. 106) observed, also the "Fundamental gneiss" is exposed in the Limpopo flats and there exhibits a vertical position and east-west strike. The significance of this east-west strike of the fundamental complex in South Africa will be discussed in an other connection. Suess (1909, p. 322), following Rogers, Schwartz and Voit, describes the syntaxis of the ancient (probably Prepermian) southern and western marginal mountain ranges; the southern range (the Zwarte mountains) is folded from south toward north; the western (Cedar mountains) strikes north-northwest and the folding is from west. The north-northwest strike of the Cedar mountains continues far north, across the Orange river, in the gneiss.

The geology of Africa may be summed up in the words of Gibson (1910, p. 323): "The crystalline *massif* presents a solid block which

[1] For the Precambrian terranes in the Egyptian desert region east of the Nile river and the Sinai peninsula, the facts have been assembled by Max Blanckenhorn in the "Handbuch der regionalen Geologie." (Aegypten. 9, Abt. 23 Heft. Heidelberg 1921). Blanckenhorn finds that there is no uniform strike of the beds and mountain chains but repeated, abrupt changes, connected with dominant faults. He records, however, a south-southwest strike of the gneisses on the east side of the Sinai (ibid., p. 27), a north-south or north-northwest to south-southwest trend of the mountains west of the Suez canal and a north-south trend of the granite massives west of the Red sea (ibid., p. 31). There occur also fault blocks with east-west and northeast-southwest strikes of the Precambrian rocks.

To the north of German East Africa, directly south of Abyssinia, J. Parkinson (Geology and Geography of the Northern Part of the East Africa Protectorate, with a note on the Gneisses and Schists of the District. Colonial Reports. Misc. no. 91, East African Protectorate, 1920, p. 20) has lately reported granitoid gneisses and other Precambrian rocks in strong development. The strike of the gneisses is mostly north-south or north-northeast in some districts; the quartzites of the Turoka series, however, strike northeast.

has remained elevated since early Paleozoic times and against which earth waves of several geologic periods have broken." (In the south folds through movement from south toward close of Mesozoic period, in the north the folds of the Altaide system of relatively recent date.) None of these earth movements affected the interior and throughout the vast interior Precambrian areas of central Africa the predominant strike of the foliation and folding is north-south. Toward the margins, we have seen, this strike may vary somewhat toward the west and east.

As none of the Paleozoic and Mesozoic orogenic disturbances was able to enter the solid crystalline massif of Africa except at the margins, it follows that *the predominant north-south foliation and folding of the metamorphic rocks is a primary structure of Precambrian age.*[1]

Madagascar. Going east of Africa in our search for Precambrian lines of trend we meet in Madagascar a large area of rocks considered as of Archean age. The researches of Grandidier, Mullens, Cowan, Lemoine and others have shown that this Archean region extends over the central and eastern portions of the island and occupies about two-thirds of the latter. It is composed of crystalline schists and mostly gneiss. The Encyclopedia Britannica (v. 17, 1910, p. 271) gives the following general survey of the strikes of the Archean rocks: " The general strike of the rocks is the same as that of the trend of the island itself (NNE-SSW), but in its western portion the strike is frequently from NNW-SSE." Madagascar has not been folded since Precambrian time and the *north-south fold system of the Archean rocks is therefore undoubtedly of Precambrian age.*

The *Seychelles*, situated far to the north-northeast of Madagascar, consist of granite and, lying in the direct strike of the backbone of Madagascar, undoubtedly indicate a further extension of that horst in the Indian ocean.

d Precambrian Fold System of Australia

Australia is described by J. W. Gregory (1910, p. 943) as " essentially the fragment of a great plateau land of Archean rocks. It consists in the main of an Archean block or ' coign,' which still occupies

[1] J. W. Gregory (The Rift Valley and Geology of East Africa. Seeley, Service & Co. Ltd. London, 1921; Review, Amer. Jour. Sci., 5 ser. v. 2, 1921, p. 353), has explained the great Rift valley of Africa as connected with this dominant north-south structure of the continent, considering the rifting as having " broken through an especially stable part of the earth's crust, which consisted of a Pre-paleozoic mountain chain that extended from Asia Minor to Natal." The rift was first formed as a long, low arch, with the axis trending north-south; the tension which caused the rupture was due to the formation of the South Atlantic and Indian oceans.

nearly the whole of the western half of the continent, outcrops in northeast Queensland, forms the foundation of southern New South Wales and eastern Victoria, and is exposed in western Victoria, in Tasmania, and in the western flank of the southern Alps of New Zealand. These areas of Archean rocks were doubtless once continuous. But they have been separated by the foundering of the Coral sea and the Tasman sea; and the foundering of the band across Australia from the Gulf of Carpenteria through western Queensland, and western New South Wales, to the lower basin of the Murray has separated the Archean areas of eastern and western Australia." The entire southwestern and western areas of the western moiety of the continent consist of granite and gneiss with overlying metamorphic schists and a belt of Paleozoic rocks along the west coast. The folds of western Australia are described as running north and south with a slight trend to west (Encycl. Brit., ibid.). Suess (v. 2, p. 259) states that these folds are convex toward the east and Maitland (1917) describes the coastal region as being affected by Prepermian Carboniferous folding. (H. P. Woodward thought they were Devonian, but this can not be proved in the absence of fossils.) These folds, however, run conformable to the trend of the Precambrian strikes and may therefore be well considered as of posthumous character. This is especially suggested by the fact that the north-south strike of the Precambrian basement complex apparently continues throughout the west of Australia and reappears from under the Mesozoic and Tertiary strata of the Nullarbor plains in the metamorphic rocks of southern Eyre peninsula in south Australia (Tilley, 1920, p. 450). Tilley considers this latter region expressly "as a southeasterly prolongation of the great Precambrian shield of western Australia." These metamorphic beds (gneisses, schists and quartzite dolomites) of Eyre peninsula strike in a north-south direction, with a high angle of dip to the west (75° to vertical).

Eastern Australia and Tasmania are traversed by cordilleras that are the result of late Paleozoic folding, but also there folds show nearly everywhere a meridional strike (see Suess, v. 2, p. 194), except in the north, in Queensland, where it changes to north-northwest; then to northwest-southeast and finally to west-east (see Encycl. Brit. v. 2, p. 732).

Like Africa, Australia is a crystalline massif that has acted as a solid block and been invaded by later folding only in the western, southeastern and eastern marginal regions. *The Precambrian folding appears* like that of Africa *to possess a prevalent north-south trend* *of the folds and strikes;* and since also the Paleozoic mountain systems follow this direction, one may well ask if they have not simply followed the older trend lines (see postea, p. 114). This is especially suggested by the bending of the folds into an east-west direction in northeast Queensland, where, as we shall see later, a block with dominant east-west folding of the Precambrian rocks, the Aequinoctia of Abendanon (see next chapter) is approached. Another significant fact in this connection is the divergent strike of the metamorphic and younger rocks in *New Caledonia.* Suess (v. 2, p. 204, 205), following Heurteau, points out that the younger rocks (Triassic coal-bearing beds, and the nickel and chrom-bearing serpentines) strike with the major axifis of the island in a northwest direction; the mica schists and roofing slates (with inclosed crystalline limestones), however, which appear on the north coast, possess an entirely independent northeast strike, and only in the northernmost part of the island they also turn to northwest. Suess would not commit himself on the meaning of this observation; we incline to see in the strike of the metamorphic rocks a relic of the original Precambrian strike preserved in a block that remained unaffected by late folding, within the folded zones, such as have been described before from the Rocky mountains, etc.

If the Precambrian basement complex of Australia also possesses a predominant north-south strike, as we have fair reason to believe, the question arises whether this block was not, in Precambrian time, *continuous with Madagascar and Africa*, or, in other words, whether these three are not remnants of a much larger Precambrian block that is characterized by its north-south trend lines. No connecting links are found in the vast expanse of the Indian ocean between Madagascar and Africa in the west, and Australia in the east, but such a one is supplied by the *Indian peninsula*, which Suess has already shown to be a foreign element in the framework of Asia.

Suess (Suess-Sollas, v. 1, p. 401) has built upon the work of the many specialists of the geological survey of India a comprehensive picture of the geology of India, from which we take the following remarks. The Indian peninsula, which comprises the part south of the Ganges, is the foreland of the Himalayas to the north. The often high mountain ranges in the peninsula are, with the exception of the extremely ancient Arávalli mountains in the northwest, not controlled by the strike of the rocks but by faults and erosion. The unfossiliferous Precarboniferous (Pregondwana) rocks are distinguished into the Archean (chiefly gneiss and very ancient schists) and the Vindhyan group (sandstone, shale, limestone), which probably corresponds in age to a large part of the Paleozoic era, but has not yet furnished fossils. The gneiss-mass of the Archean is exposed from Ceylon along the east coast to near the bend described by the Ganges and at 16° latitude on the west coast. To this great dominant mass of Archean rocks, two smaller ones must be added; one situated in Bundelkhand, and the other distributed in long folds and ridges forms the Arávalli mountains on the northwest border of the peninsula. Suess emphasizes the facts that these Arávalli mountains which strike with their composing rocks in N 36° E direction "present us with one of the most ancient folded ranges to be seen anywhere on the globe" (ibid., p. 402) and "that the strike of these primaeval folds is completely independent of the trend of the existing great mountain ranges of India" (ibid., p. 403). Far to the north, on both sides of the river Chenab, in the isolated Korána mountains, we find even a mountain range composed of rocks which resemble the ancient quartzites and schists of the Arávalli and whose ridges strike northeast-southwest and approach to within 65 kilometers of the outer border of the great folded mountains of the Himalayas.

Lake (1893, p. 309), who since Suess has discussed the "Growth of the Indian Peninsula," divides the Pregondwana division into the Gneissic, Dharwar "Transition" and Vindhyan series; and distinguishes three main masses of gneiss, namely, the southern mass, the Bundelkhand mass and the northeastern mass. The southern mass is described as consisting of gneissic and granitoid rocks, traversed by a number of nearly parallel bands of schist, together with conglomerates, hematite beds and lava flows, to which has been given the name Dharwar series. "The direction of the bands is NNW-SSE; and it is clear that the Dharwars originally covered the whole, and that they were afterwards thrown into folds running NNW-SSE. . . . The folding and denudation of these rocks was completed before the deposition of the next set of beds, which were laid down as a fringe on the N, NE and E sides of the gneiss mass. . . . Those on the east side (Kadapah basin) lie quite flat on the gneiss in the western part, on the eastern side they are folded, the direction of the folds is N-S. The same condition holds true of the Godàvari basin, to the north of the southern gneiss mass. On the northeast of the gneiss mass (in the Kaladgi basin) the beds have been thrown into folds running W by N to E by S."

The direction of the folds of the Bundelkhand mass is not given by Lake.

"To the north of the Bundelkhand we find very much the same thing," states Lake. "Close to the gneiss, at Gwalior, we have almost undisturbed Pre-Vindhyan beds while further away, in the Arvali hills. the Pre-Vindhyan beds are strongly folded. the folds running about NE-SW. . . . In the space between these folds (the folds to the SE and the folds to the NW), we find a large spread of Vindhyan rocks. These are little disturbed and may at one time have covered the whole of the gneiss mass."

Summing up, we find in India, as in Africa and Australia, a Precambrian basement complex, consisting distinctly of an older series of gneisses and of Archeozoic aspect and a younger series of less metamorphosed rocks apparently corresponding to the Proterozoic series of other continents, while the Vindhyan series may be Paleozoic in age, at least in part. The two earlier series are thrown into folds that are Precambrian in age and entirely independent of the much later Himalayas and other north Indian folds. These early folds have clearly a dominant north-south direction, running directly north-south in the Kadapah and Godàvari basins; north-northwest — south-southeast in the southern gneiss mass, northwest-southeast in the Kaladgi basin and N 36° E in the Arávalli mountains.

If this last inference is true, it follows that the *Indian peninsula agrees in its Precambrian fold direction with that of Africa, Madagascar, and western Australia;* and the conclusion would seem proper that *all these areas once belonged to a segment of the earth crust* that reacted as a *unit* to the diastrophic agencies.

e Aequinoctia

We have so far left out of our consideration the large area north of Australia, east of India and south of China. In our preliminary paper (p. 4) we had mentioned the presence of blocks in Cambodia and Borneo that apparently had remained undisturbed by the later folding that overran all this country. These blocks are pointed out as such by Suess. The mass of Cambodia (Suess, v. 3, p. 285; Suess-Sollas, v. 3, p. 225) consists of widely distributed occurrences of granulite and granite along the lowest course of the Mekong river. This mass lies in the region of the separation of the ranges of the Altaids of southeastern Asia. There are, it seems, no data as to the predominant strike of this mass available at present.

Another block or Archean horst that seems to separate the folded ranges, somewhat after the fashion of the larger mass of Cambodia seems, according to Suess (see Suess-Sollas, v. 3, p. 253), to lie in the southwest of Borneo.

The East Indian Archipelago has since been discussed by E. C. Abendanon (1919, p. 562) in his paper, "Aequinoctia, an old Paleozoic Continent."

Abendanon takes as a starting point his own observation that through the whole of central Celebes there extends a formation of crystalline schists that are strongly folded and that by their east-west strike indicate an oldest folding running in that direction. After eliminating a number of rocks that do not belong to the gneiss and crystalline schists, but originated from more recent contact zones and that have led to considerable confusion, the author finds that "it must be accepted that there exist in the Dutch East Indian Archipelago three series of rocks which are unquestionably of similar age, and which form the basis of the other geological formations." He continues: "Of these, the gneiss and the mica schists are the earliest member. This double series appears as large complexes, principally in the north of Sumatra, the southeast of Borneo, on very extensive areas in central Celebes, and in the islands of Boeroe and Ceram. As in other places, it is possible to see the lowest strata, viz. the gneiss formation, in this latter island and elsewhere in the Archipelago, but especially and very clearly in central Celebes. In its upper part, the crystalline schists seem to grade into the 'old' schists, which constitute the second essential member of the oldest formations." These schists, particularly the mica schists in central Celebes, occupy such an extensive surface and reach such a great thickness (certainly some thousands of meters) that they can not have originated from contact metamorphism, as the younger mesozoic metamorphic rocks of these regions have, but must be the result of regional metamorphism of ancient date.

Suess (v. 3, pt 3) had already mentioned, as Abendanon points out, the presence of a large massif of Archean rocks with east-west strike in the islands of Boeroe and Ceram. Similar rocks having the same strike are recorded from the Peling-Misool islands (Suess, v. 3, pt 3) and the northwestern peninsula of New Guinea. New facts have led Suess to the suggestion that the territory extending from Celebes to southeastern New Guinea and beyond (island Rossel) may be a geological entity and Abendanon has fully verified this hypothesis by finding the east-west strike repeated "in a very remarkable way in the schists and gneiss formations" of central Celebes, "although the older ranges of central Celebes and Ceram have a northwest to southeast direction, owing to the post-Lutesian folding."

From these facts Abendanon arrives at the important conclusion that "until the contrary is proved, one must infer, that the gneiss and schist massifs from central Celebes to the island of Roon, are parts or horsts of an old massif which stretched formerly throughout this whole extent. . . . Without being able to assert it dogmatically, one may say that this old massif, folded in an east-west direction, is prolonged to the west, and that it reaches the middle of Borneo, where Molengraaff and other explorers have also found tectonic entities striking almost east and west." By tracing the early Paleozoic rocks of Cambrian, Ordovician and Silurian age to the north, south and southeast of the East Indian Archipelago and noting that these rocks, as the Cambrian in the north lean against and although often strongly folded, still retain their fossils, but are as such entirely absent in the Archipelago; it is concluded (ibid., p. 576) (1) that the gneiss, the mica schists, the phyllites, and the real "old" schists (thus with the omission of the rocks which do not make part of them) must be Archean and Precambrian rocks; (2) that they once built up an old Paleozoic continent, which extended at least over an area of 45° in latitude, between the tropics from the southeast of Asia to the east of Australia, and from Sumatra to the Philippine islands; (3) in the central part of this continent, north and south of the equator, mountain ranges of an almost east-west direction must have played an important part in this very old continent. Later Cambrian, Silurian and Devonian transgressions passed over the border areas, and folding occurred in these border sediments; then in the Middle Carboniferous, denudation and leveling took place and lastly, in Upper Carboniferous and Permian time the continent itself was invaded. For this continent of the old Paleozoic, Abendanon proposes the name *Aequinoctia*.

Schuchert (1916, p. 98) has in a series of small charts of the paleogeography of Australasia traced the history of this continent and graphically brought out its relative constancy in early Paleozoic time.

The problem which above all interests us here concerning the Paleozoic continent Aequinoctia and that is indicated by the presence of the Precambrian rocks of the Archipelago and the absence of earlier Paleozoic rocks and fossils, is whether the uniform east-west folding of the Precambrian rocks that extends over such a large area, is the primary folding of these rocks, or a superimposed early Paleozoic folding. In the former case, the conclusion that we have here a separate Precambrian entity located between that of Eurasia and that of Afro-Australia is justified; in the latter case this Precambrian basement complex may be either independent, or may have been a further extension of either of the two others.

The fact that Cambrian deposits are entirely lacking upon central Aequinoctia, but can be found leaning against it in the north (see Abendanon, p. 577), is in itself evidence that this Paleozoic continent extends backward into Precambrian time as a land mass. Schuchert's chart shows this continent, in Cambrian time to have extended from northern Siam and Cochinchina across the entire East Indian Archipelago to eastern Australia and New Zealand. It is separated from the Indian peninsula by the Cambrian invasion from China and from western Australia by the Cambrian transgression of middle Australia. Its extension toward the Pacific as pointed out by Abendanon is unknown.

As the Cambrian transgressive beds rest in Asia and Australia not on a transitional series from Precambrian to Lower Cambrian beds such as have been asserted to have been found in parts of the Rocky mountains, but the contact is distinctly unconformable, it is clear that the Precambrian ancestor of Aequinoctia was connected, at least in the last period of the Precambrian, by land with the Indian peninsula and West Australia. The latter two have, however, been shown before to have probably formed an entity with Africa and Madagascar as indicated by the predominant north-south strikes of their Precambrian rocks. One may, therefore, well ask himself whether the east-west strike of the Precambrian rocks is not of later than Precambrian age and thus no criterion for the Precambrian independence of this Paleozoic continental mass.

As the East Indian Archipelago was not invaded until the Carboniferous period, the folding may have taken place at any time during the preceding part of the Paleozoic era. The mountain folds of eastern Australia from Tasmania northward, have Cambrian, Ordovician and Devonian beds folded in with the Precambrian rocks, and these mountain folds while striking north-south in southeastern Australia, turn northwest and finally east-west as they approach the East Indian Archipelago, as we have seen before. We believe that this fact suggests a Precarboniferous Paleozoic age for the initiation of the east-west fold system of the Archipelago that may have been so powerful that it involved the Precambrian basement complex and overpowered and obliterated the earlier strike directions, as has been done in other younger fold systems.

The east-west direction of the Precambrian rocks extending from Borneo to New Guinea is repeated (see Abendanon, p. 567, footnote) in the isle of Java, and in the chain of the small Sunda islands. Therewith, however, it seems to fall in with the general sigmoidal flexure of the chains performed by the southeast Asiatic fold system between continental Asia and Australia.

For the present, we therefore believe the evidence is not sufficient to claim the Precambrian age of the east-west direction of the folds of that system or for the assumption of the existence of a separate Precambrian earth segment in the East Indian Archipelago.[1]

f Precambrian Fold System of South America

It has long been known that South America is built on essentially similar lines in its present framework as North America. Suess (v. 2, p. 139 of English trans.) has pointed out that not only the Cordilleras of the west are the result of an identical movement but he also states, following Derby, that the Predevonian mountain chains of the east are built so that " the older rocks lie toward the east, and the folding movement was directed toward the interior " and that this important observation " assigns the Serra do Mar in the continent of South America a position similar to that occupied in North America by the Appalachians."

Between these marginal fold systems we find again, as in North America, a great Precambrian basement complex, " *die alte brasilische Masse* " as Suess calls it, largely covered by younger formations, but still exposed over immense areas.

Branner (1919, p. 203), in his comprehensive " Outlines of the Geology of Brazil to Accompany the Geologic Map of Brazil " has pointed out our present great lack of knowledge of this great basement complex. He writes: " The rocks referred to the Archean in Brazil are granites, gneisses, quartzites, marbles and crystalline schists. Too little is known of these old rocks at present to warrant such a separation of them as has been made of similar rocks in North America; for that reason they are called the Brazilian complex. . . . But little is known of the structure of the Brazilian complex. Much information on the subject is scattered through the literature, but widely separated areas can not be confidently tied together with

[1] J. Wanner (Die Geologie von Mittel-Celebes nach den neueren Forschungen E. C. Abendanons und anderer. Geol. Rundschau, 10:45, 1919) has meanwhile claimed that Abendanon's inference of an east-west mountain system of Precambrian age is based on insufficient data, since most observations fail so far to indicate a regularity or constancy in the strike of the Precambrian rocks. The hypothesis of an east-west fold system is, according to Wanner, not supported by the boundaries of the gneiss-granite and schists, which have northwest-southeast directions and by the results of Abendanon's journey which show that in the schists always younger zones appear from west to east, indicating a general north-south trend of the folds.

It will be noted that if Wanner is right in his conclusions, particularly the last mentioned, Aequinoctia clearly falls in with the general Precambrian fold direction of Africa, India and West Australia and probably was a part of the ancestral Gondwana land, as we had believed before seeing Abendanon's paper.

the data now available. Even the ' chief lines of elevation or folding ' suggested by Dr John W. Evans, are not supported, so far as Brazil is concerned, by our knowledge of the local details. Over much of the Archean area are scattered infaulted remnants of old Paleozoic rocks."

It appears from Branner's survey of the basement complex of Brazil that the time has not yet come to draw conclusions as to the original directions of trend of the Precambrian rocks. Nevertheless there exist a few data of observations that at least promise to give a hint as to the possible directions. These we shall briefly cite.

Evans (1906, p. 89) found along the Madeira in Matto Grosso, near the boundary of Bolivia and far away from the Cordilleras, outcrops of the Precambrian complex, that show a northwest strike in their foliation or one that is parallel to the western Cordilleras. He believes that he can recognize this as the predominant trend far to the northwest by the direction of the ridges and the courses of the rivers. Suess (v. 3, pt 2, p. 533) holds the view that this strike is already controlled by the orogenic movements of the Andes and he pictures the overwhelming of the western portion of the foreland " Brazilia " by the gigantic folding movement of the Andes, that was dir ected eastward in the Argentine chains and the adjoining country to the north. He considers the isolated Sierra de Córdoba, which consists almost entirely of Precambrian rocks and whose folds strike predominantly N 25° W, as also due to the extensive folding of the foreland and points out this folding as a unique feature.

Under these conditions the strikes of the western portion of the Brazilian mass can not be safely considered as indicating the Precambrian strike directions of the rocks.

We find not much better evidence in the east. The mountain ranges (Sierra do Mar, Sierra de Mantiqueira, etc.) that parallel the coast and which have been so carefully investigated by Orv. Derby, consist of folded Precambrian rocks striking in a northeast direction. But the Silurian has been found to be folded in with the Precambrian and it is therefore indeterminate to what extent the folding dates back to Precambrian time. We saw before that Suess compares these mountain ranges to the Appalachians.

Likewise the east-west folds of the Precambrian in northern Brazil and Guiana are by the infolded Paleozoic beds proved to be of younger than Precambrian age.

In the province of Buenos Aires, in *Argentina*, two ranges, the Sierra de la Ventana and Sierra Tandil, exhibit Precambrian rocks together with Silurian quartzite in folds that strike northwest-southeast. The southernmost of these, the Sierra de la Ventana, is according to Suess (v. 3, pt 2, p. 546) a branch of the Andes; the Sierra Tandil, however, is regarded by him as a border formation of the Brazilian mass, the latter itself having been reached in a boring at Buenos Aires at a depth of 300 meters.

While there is thus no doubt of the existence of a great Precambrian basement complex, the " Brazilian mass," in South America, the folds and strikes of this complex seem everywhere so involved with later orogenic movements that no safe conclusion can be reached regarding the Precambrian fold directions. We believe, however, that some of this folding bears the earmarks of posthumous orogenic movements and may thus indirectly give a suggestion of probable Precambrian trends[1] (see next chapter).

Evidence from Posthumous Folding

Richthofen not only recognized the remarkable persistency of the northeast-southwest folding in the Precambrian basement complex of northeastern China, but also observed that the later mountain ranges are inclined to fall in with the same direction. R. Godwin Austen (1856, p. 62), however, in his famous treatise, " On the Possible Extension of the Coal-measures beneath the South-eastern Part of England ", had recognized already long before that younger folds of Mesozoic age extend from Belgium into southern England and follow the trend of the ancient Paleozoic folds; and he had " even maintained " (see Suess-Sollas, v. 11, p. 93) " as a

[1] E. Jaworski (Das Alter des südatlantischen Beckens. Geol. Rundschau, 12:68, 1921) states that the north-south trend of the Precambrian beds, south of Cape St Roque (the farthest eastern region of Brazil) is established.

The same author points to the occurrence of a gneiss block on Tristan d'Acunha, to the granite foundation of Ascension island, the peridotite composition of St Paul and the finding of coarse sands of plutonic rocks and crystalline schists at the bottom of the south Atlantic (by Phillipi, see Andrée, Geologie des Meeresbodens, v. 2, 1920) as connecting elements between the Precambrian massifs of Africa and Brazil and as indicating the late existence of a South-Atlantic land of Precambrian rocks.

H. Keidel (op. cit., 1913 and 1916) has found that the Precambrian folding (extending to Permian time) and strike is dominantly northwest, in contrast to the north-south strike of the Tertiary Andine folds, in western Argentina and the Pampine sierras, with a subordinate northeast-southwest strike of Precambrian faulting. G. Bodenbender (El nevado de Famatina, Bol. Acad. Nac. Cient. Cordoba, 1916, p. 100–82; review by H. Gerth in N. Jahrb, 209–11, 1921) records north-south folding in the Precambrian of the Pampine sierras. The prevailing northwest strike of the Precambrian can be traced to the Upper Marañon, as we saw before. The Precambrian of Argentina and western Brazil may then exhibit either marginal phenomena of the Archean Gondwana structure, with an average north-south direction, or have been part of another continental mass, extending westward. The former conclusion seems to be supported by Keidel's last important publication on the precordillera of San Juan and Mendoza in western Argentina (ibid., 1921, p. 97) in which he considers this range and its component Ordovician, Silurian, Devonian and Gondwana glacial beds as indicating the western border of a part of the Gondwana continent.

universal law that when any zone of the earth's crust is considerably folded or fractured, subsequent disturbances follow the previous lines, and this simply because these lines appear to be lines of least resistance." Suess (loc. cit., p. 95) emphasizes the wonderful constancy of this folding which extends first with a west-northwest and then a west strike through the south of England to Weymouth and the Mendips and states, "The region was folded, as we have seen, at the close of the Carboniferous period, was covered with younger sediments and subsided; then there occurred in the same place a folding of the younger sediments, and this more recent folding coincides in direction with the older folding which preceded it." He proposes to term this phenomenon *posthumous folding*, adding, "It is very likely that in most other mountain systems repeated movements in the same direction have occurred at very different times; but seldom do we witness so striking an episode as is here presented in the subsidence of a great segment of a mountain arc between successive periods of folding; and in this example we find already displayed the extraordinary constancy in the direction of the folding force."

In applying this important principle in the relations of the Paleozoic mountain systems to the Precambrian fold directions one can not help but be astonished at their general parallelism; and this coincidence of trends can not be attributed to Paleozoic folding that overwhelmed the Precambrian complex since the Paleozoic folding has as a rule affected only the marginal regions, as is most clearly evidenced in the cases of North America, Africa and Australia but also seen in the southeast and southwest portions of the Eurasian basement complex and probably in the eastern margin of South America.

In the case of the Appalachians it has been persistently claimed by the best authorities on the stratigraphic relations of their component formations, as notably Ulrich (1911) and Campbell (1894), that these prove that the folding "has been practically continuous from since early Paleozoic times" (Campbell, loc. cit.). Ulrich, in the diagram of the inland migration of folding in southeastern North America (1911, fig. 18, p. 440) extends the folding from "earliest Cambrian" to "late Tertiary."[1]

If we further consider that we find at the beginning of Cambrian time two geosynclines, one in the place and direction of the Appala-

[1] Also in regard to the Variscan folding of the "Rheinische Schiefergebirge" analogous observations have been made by W. Bornhardt and especially by Denckmann (1912), who have found that the Variscan folding of Carboniferous age was there preceded by Devonian folding, and in the Saar basin followed by Permian folding; the latter folding not being observable in the Rheinische Schieergebirge on account of the absence of younger beds (see Andrée, p. [illegible]

chians and their northern and southwestern continuation, and another in that of the Rocky mountains, as has been so clearly demonstrated by Walcott (1891, pl. 3; see also Schuchert, 1910, pl. 51); and that b th these depressions exactly follow the trends of the Precambrian folds in the east and west, the conclusion seems unavoidable that these later fold directions were inherited, at least to a large extent, from Precambrian time. Likewise the generally westward trend of the Arbuckle and Ouachita mountains in Oklahoma, which are considered as indicating the western extension of the Appalachian system stands in remarkable agreement with the east-west trend of the Precambrian folds of the middle segment of the continent as seen north and south of Lake Superior, and it would seem that even where the later pressure came from a somewhat different direction, the folds would, at least in part, tend to fall into the old direction, which is that of least resistance in that case. This would at least be indicated by the observation of C. W. Honess (1920, p. 121) that in the southern Ouachita mountains a high angle is made by the east or southeast trending axes of many folds with the axis of the principal anticlinorium which trends northeast.

If the principle of posthumous folds, which to us seems rather one of persistent or inherited folding, with "prenuncial" as well as "posthumous" folding, preceding and following the main orogenic outburst; if this principle has the wide application that it seems to us to possess where Precambrian and Paleozoic folding are compared, then vice versa we may well draw conclusions as to the probable Precambrian fold directions in cases where Paleozoic folding agrees in its direction with that inferred for the Precambrian folding from other inferences, without committing the error of a circulus vitiosus. This may well be the case with the Paleozoic folds trending in northeast and north-south direction, of eastern Brazil and it would fully explain the north-south direction of some of the folds in the western Sahara, if these should be found to contain Paleozoic elements. It should be further noted that the Paleozoic north-south folding of eastern Australia agrees with the north-south Precambrian folding found from western Africa to South Australia. We are inclined to see in these Paleozoic folds of both eastern Brazil and eastern Australia segments of larger fold systems that in these particular regions have fallen in with previous fold lines.[1]

[1] Extremely powerful folding, of course, will follow its own lines as we have seen in India where the Himalayas have overridden the Precambrian folds from the north; or in Europe where the Carpathians and Alps have overwhelmed the Variscan system to a considerable extent. On the other hand, we have seen there may remain Precambrian blocks unaffected by later waves of folding, surrounding them, as in the case of the Bohemian massif and of the block of Montana and Wyoming.

We have seen in the chapter on the Precambrian fold systems of Eurasia, how the later folds of the Urals and the Timan, in a large part, coincide with the Precambrian folding of the region, which is a western continuation of the Sayan system of the Angara shield; and it is also noteworthy that the Predevonian Caledonian folding, which according to Suess (v. 3, pt 2) is intercalated between supposedly Laurentian remnants and the western portion of the Asiatic structure, follows in general the trend lines of eastern Laurentia. Likewise, the metamorphic rocks of Tonking and Cochinchina, together with younger rocks, strike like the original Precambrian basement complex of eastern Asia, that is, toward northeast, the metamorphic rocks of Formosa to north-northeast and those of Japan to east-northeast; thus all remaining in the same quadrant with the Precambrian folding.

It may therefore be stated as a general proposition that apparently *a great portion of the Paleozoic folds do not diverge greatly in their directions from the preceding Precambrian trend lines* and thus have remained, to a large extent, under the influence of the original trend lines inherited from Precambrian time.

It is readily seen that the evidence of the posthumous folds is largely corroborative of the conclusions drawn in regard to the existence of large entities of Precambrian fold and foliation systems, in so far as it shows the marginal regions of these large entities invaded by folds that run approximately parallel to the original Precambrian fold directions.

In summing up the conclusions from the Precambrian and posthumous Paleozoic folds we have reached thus far the following propositions:

The Precambrian fold and foliation systems prove that there existed in Precambrian time several large crustal segments that reacted as entities against the universal Precambrian folding of the crust of the earth. These entities comprise as far as known, Eurasia, North America-Greenland, Africa-Madagascar-East India-West Australia. Certain nuclear or central parts of these large entities became early so intensely folded, that they became "stiffened" blocks (Suess & Stille, 1909) and have been avoided by all younger folds. The most noted of these "shields" are the Angara shield in Asia, the Baltic shield in Europe and the Laurentian shield in North America. The greater part of Africa represents a similar shield that has remained free from younger folding and acted as a folded older block in the north and south against younger folding.

We have further seen that where these large entities were affected by Paleozoic folding, which mainly occurred in the marginal regions only, these Paleozoic folds on the whole correspond with or appear to be controlled by the earlier Precambrian folds.

It has been urged by the writer that these enormous areas of uniform or continuous Precambrian fold directions represent Precambrian segments of continental size and the term *arch-continents* has been proposed for these vast bodies in the preliminary paper in the sense that they were ancestral to the later Paleozoic continents. We shall now investigate the relations of these supposed Precambrian continental masses to the recognized continents of Paleozoic time.

Relations of Precambrian Continents to Paleozoic Continents

Suess (Suess-Sollas, v. 1, p. 600) has from his classical survey of the present fold systems of the earth distinguished the following units among the continents:

" The first of these is *Indo-Africa*, the greatest tableland of the earth, limited on its northern border, from the point where the Wady Draa discharges into the Atlantic ocean to the mouth of the Brahmaputra, by the folds of Eurasia advancing to the south, but elsewhere, as far as it is known to us, surrounded solely by faults and divided in two by the Indian ocean.

" The second unit is *South America*, a shield, as it were, girdled on three sides by mountain ramparts; broken off without perceptible trend lines on the east and northeast, and with open virgation of the branches of the mountains to the southeast between Cape Horn and Cabo Corrientes.

" The Cordillera of the Antilles shows a closer affinity to South than to North America. . . . . . .

" The third unit is *North America*; so far as folding is known in this continent it appears to be everywhere directed to the west, with a few exceptions caused perhaps by local overthrusting on to the subsidence at the outer border of the Rocky mountains; this westerly movement began in extremely ancient times, and manifests itself from the Atlantic coast to the Pacific, from the Appalachians to the Sierra Nevada and the coast chains. Toward the north, however, a very extensive ' plate ' without folding appears, which stretches nearly to the Arctic Archipelago. . .

" Least obvious as an organic whole, notwithstanding the extraordinary magnitude of the folded area on its southern border, is the unit of *Eurasia*. Here we are in the presence of much greater complexity and diversity; the description of its various parts is not yet advanced far enough to enable us to bring it into comparison with the other continents. For the same reason I must provisionally pass over Australia[1] in silence."

[1] Australia is shown by Suess in the fourth volume to be a remnant block surrounded by three arches of the Oceanides in the east.

From our survey of the Precambrian folding we have arrived at the distinction of similar units for Precambrian time namely, (1) the North American-Greenland unit, (2) the Eurasian unit, (3) the African-Indian-Australian unit. South America remained undefined as a unit through lack of evidence of original Precambrian folding, but the Paleozoic folds of the east coast, if posthumous in character, suggest its relation to the African-Indian unit.

We shall now compare these units, which we have considered as Precambrian continental units, with the Paleozoic continents in general and the early Cambrian continents in particular.

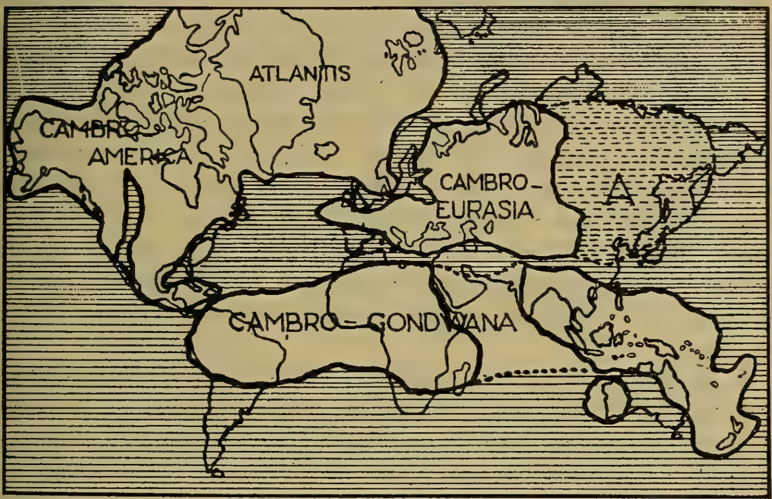

Fig. 2 Continents in Lower Cambrian time, after Frech, Arldt, Bölsche, Schuchert, Ulrich and Holtedahl.
A Lower Cambrian transgression of eastern Asia.

Walcott (1891) has published the first map of North America in Lower Cambrian time, on which the principal fact of the wide extent of the continent and of the presence of two interior continental seas that filled the two long troughs in the east and west was clearly brought out. These invasions did not occur along the continental margins but entered the continental platforms. Schuchert (1910) has through the accumulation of many new facts, mainly by Walcott, improved on the first map and Ulrich (1919, fig. 4) has lately published a map suggesting that the long arms of the sea distinguished by Walcott and Schuchert, were much more restricted as assumed before, and the eastern arm was separated into three different minor invasions. However that may be, all these authors agree according to their maps in the assumption of a former greater extent of the continent in early Cambrian time. Schuchert states (ibid., p. 517) that "from the extent and position of the Lower Georgic invasions, it is inferred that the North American continent was larger during the late Proterozoic than at any subsequent period." There is no doubt that North America extended not only considerably to the east of the Atlantic states in "Appalachia" but also in Arcadia, and especially in the far northeast, where it reached over Greenland to Europe. Holtedahl's map extends the Lower Cambrian continent over Iceland around Scotland to southern Norway. In the west the continent also reached beyond the boundaries of the present continental mass, as is evidenced by the absence of massive Cambrian deposits in the coastal regions.

In his "Paleogeography of North America" Schuchert has repeatedly pointed out that the Precambrian era closed with a great continental elevation. He states (ibid., p. 482), "Laurentide revolution.—This was one of the 'critical periods' of the earth when the seas were withdrawn from North America for a very long time. During this interval, of which only the later or eroding portion is known, the continent was larger than at present, possibly as great as at the close of the Paleozoic, or even greater than at that time."

In its general form, its northeast extension across the northern Atlantic and its eastward extension into the Atlantic, this early Cambrian continent fully agrees with the Precambrian continent inferred by us from the trend lines of the Precambrian folding and foliation. It was therefore already in Cambrian time a continental mass of long existence; dating back even into Archeozoic time according to the evidence from the Archean folds.

As a perusal of Ulrich's and Schuchert's authoritative charts will readily show, this continent has in its main body persisted through all later time as a distinct entity. It has been invaded by epicontinental seas from various directions, principally the four cardinal directions, but has frequently again emerged. The one great exception is the large continental extension to northern Europe across the north Atlantic. This mass of continental size existed as an undoubted land mass until Devonian time, where as the "Eria" of some paleogeographers and the "Atlantis" of others (see fig. 1), it comprised even the greater part of Great Britain, Scandinavia and northern Russia. The Atlantic was then restricted to the "Poseidon" of Schuchert whose northern boundary extended straight across from Labrador to middle Ireland. In more restricted form

Eria can still be traced until Triassic time. As Holtedahl (1920, p. 21) points out, this part of the crust had through long geologic periods the tendency to rise; but like the eastern part of Appalachia it has now sunken deeply. Suess, clearly recognizing the connection of the Armorican folds in the Bretagne with the Appalachian folds in America — with their northeast bend in Gaspé and Newfoundland — drew the northern shore line of the Poseidon along this sunken Devonian mountain range (see Suess, 1911, p. 102) and derived the northern Atlantic ocean from the breaking down of the Paleozoic continental mass of "Atlantis."

While the great unconformity of the Cambrian and later Paleozoic overlapping formations upon the Precambrian is clear evidence that the Cambrian sea invaded upon an old land mass that had undergone considerable, if not in some parts enormous denudation, it is still possible that some of the Precambrian rocks are marine deposits that, if they contained fossils and could tell their story would show the Precambrian continent of North America to have been invaded by the neighboring oceans, the same as after the Precambrian. No less an authority than Walcott has, however, steadily maintained that all the Precambrian sediments on the continent are nonmarine; and he seems to be supported by abundant evidence from various sources. There is further clear proof of shallow water origin of the sedimentary beds of the Precambrian in ripple marks, mud cracks, the lithology, etc., as far west as the Inyo range in California (Knopf & Kirk, 1918, p. 23), and in the immensely thick (37,000 feet according to Walcott) Belt terrane which formed in a relatively narrow Precambrian geosyncline within the continent (W. H. Emmons & F. C. Calkins, 1913, p. 29), as well as in the Proterozoic beds in Utah (F. L. Ransome & H. S. Gale, 1915, p. 169), and generally in the Rocky mountain plateau region. To this evidence of shallow water origin must be added that of direct land formation. The latter is seen in the successive great unconformities of which at least four are fully recognized; in the well-known discovery of glacial beds (bowlder conglomerate or tillite) of Proterozoic (Lower Huronian) age in Canada by Coleman, and in the observation of proofs of land-formed rocks by our best authorities of the American Precambrian. To cite a few examples, Leith (1913, p. 333) suggests that "the unconformity at the base of the Cambrian was developed by a process of cut and fill," and that "the common occurrence of late Precambrian terrestrial sediments is more than a coincidence, but is related to the development of the basal Paleozoic unconformity." Lane (1911, p. 32) states that after discussions with

Huntington, Barrell and Leith and by his own widening experience; he is " now inclined to consider the Keweenawan as more largely a land surface formation" than he did in earlier writings;[1] and Van Hise (see Leith, 1920, p. 101) believed that the " Precambrian rocks and history, from earliest known vestiges, indicate the same behavior and conditions of development as in later times " and " that Hutton's conception of uniformitarianism applies to the Precambrian." Indeed, from Lyell to Van Hise a long line of investigators both here and in Europe have claimed that all Precambrian gneisses are metamorphosed sediments and dynamometamorphically changed eruptive rocks; and that these immense masses of sediments can indicate only epicontinental and continental marginal deposits. If we add to this that the extensive graphite beds that appear as early as the Archeozoic Grenville beds, under the principle of uniformitarianism, indicate extensive swamp or at least shallow water conditions with algal growth, and that likewise the quartzite and marble beds with which they are associated are considered as epicontinental deposits,[2] it seems safe to assert that the existence of the Precambrian continental mass of North America, suggested by the uniform Precambrian fold lines, is well supported by the character of the sediments that have formed its component rocks.

Eurasia suffered such a wide transgression of its eastern portion in Cambrian time that it does not appear on maps of the early Cambrian as the vast continent we see it today. And yet the great unconformity which everywhere marks the contact of Precambrian and Cambrian beds in eastern Asia leaves no doubt of the former existence of a great continental mass in eastern Asia, and the later Paleozoic history with its alternating emergences and submergences of this area sustains the continental character of eastern Eurasia to the present time, although the great Mediterranean sea, the " Tethys " of Suess, passed across the continent from east-west from Devonian to Triassic time, separating the northern Angara land from the southern Gondwanaland.

In Europe we have in the Proterozoic age the great formation of the Torridon sandstone of Scotland, which even contains

[1] Camsell (1916, p. 478) also found in the Athabasca sandstone of Keweenawan age, at the northeast end of Tazin lake in the Northwest Territories a conglomerate deposit which he considers as of terrestric origin, and Coleman (1915, op. cit.) states that deposition during Keweenawan time was chiefly on the land in a warm dry climate.

[2] Daly (1909, p. 157) e. g. states that the Huronian sea was largely an epicontinental sea, an inference that can with equal force be applied to the preceding invasions, and Schuchert (1918, p. 64) states that of the 14 miles of coarse Proterozoic sediments in south-central Canada, probably more than three-fourths were deposited in fresh water.

"dreikanter" (see Walther, 1909, p. 287) and the Jotnian sandstones in Scandinavia and Finland with their ripple marks and mud cracks — not to speak of a 2-meter thick anthracite bed — as proof of continental conditions; and the distinction of four major unconformities in the Finnish series leaves no doubt of a series of great and enormously long, complete emergences of these continental areas that, if they correspond to the unconformities observed in North America and eastern Asia, would even indicate worldwide major continental emergences.

We see in these great unconformities of the Precambrian of North America and Eurasia strong evidence that the supposed continental areas responded as continental units not only to the orogenic forces that folded them, but also to the epeirogenic forces that elevated them from time to time. While the continents, according to the recent investigations of isostasy, are composed of positive and negative elements that owing to minor differences in relative density act more or less independently, they seem nevertheless to have formed units of a major grade that reacted uniformly in times of greater diastrophic events. This is, at least, strongly urged by the evidence of the great widely spread Precambrian unconformities that separate the different formations, both here and in the old world.

The evidence of repeated periods of wide continental elevation in Precambrian time that is afforded by the major unconformities is corroborated by the recognition of Proterozoic glaciation, not only on the Canadian shield as mentioned before, but also in Scotland, the Baltic shield, South Africa, India, South China, South Australia and Tasmania.

The great Precambrian continental mass of the southern hemisphere which the Precambrian folding by its continuous north-south folding, indicates to have extended from Africa over Madagascar to Middle Australia and East India — and if the folds of eastern Brazil and eastern Australia are posthumous in character, also to these regions — is the evident ancestor of the great Gondwanaland. Gondwanaland had its most glorious geologic period in Carboniferous to Triassic time when it extended, as a separate continental mass, from western South America across Africa to South Asia and beyond Australia. This vast continent with its characteristic flora and glacial period reached in Permian time in east-west direction two-thirds around the world. It broke down in the middle, where the Indian ocean now is, in Jurassic time, and Africa, East India, Australia and a large portion of South America are its remnants. (fig. 3 a-d)

Fig. 3a

Fig. 3b

Fig. 3c

Fig. 3d

Fig. 3, Continents in Lower Devonian (a), Upper Carboniferous (b), Permian (c), and Upper Triassic (d), times. After Lapparent, Frech, Arldt, Bölsche, Koken, Kayser, Schuchert, Ulrich and Holtedahl.

Clarke (1913; 1919) has shown that Gondwanaland existed in Devonian time, but was then connected with Antarctica, and has therefore proposed the name "Falklandia" for this earlier continental mass (1919, p. 103).

The evidence from the uniform direction of the Precambrian folds proves, in our view, that like the two northern continental segments, also the southern unit Gondwana was inherited from Precambrian time and persisted throughout Paleozoic time; for the Cambrian, Ordovician and Silurian periods were clearly such of land and of epicontinental seas over the three southern continents. This is indicated principally by the total absence of their rocks over most of these three continents of today; or where the rocks are present, by their fossil and lithic facies. Parts may have been temporarily invaded, as central Australia and a large part of the present Indian ocean, during Cambrian time (see Schuchert, 1916, p. 98), but such facts as the distribution of the Gangamopteris (Glossopteris) flora together with the widely spread glacial beds call for a vast Permian continent extending from South America to Australia (see Kayser, 1913, p. 276).

We believe to have advanced, in the preceding chapters, evidence from at least three mutually independent sources that there undoubtedly existed, at the end of Precambrian, and quite surely also far back into Archean time, three immense tracts of super-continental size upon the earth that behaved like continental segments or units in their reaction to orogenic and epeirogenic diastrophic forces, to marine invasions and in the character of their sediments. We have in the preliminary paper (1919, p. 5) designated these tracts as *arch-continents* to indicate their ancestral relation to the later and the present continents. In order to emphasize more fully this important relation and at the same time give expression to these differences in size and outline that distinguish them from their Paleozoic descendants, we propose to add the prefix "Arch" to the names of the continental masses which later appear in their place. We will then have the three primeval continental masses of *Arch-Eurasia*, *Arch-America* and *Arch-Gondwana*. Each of these arch-continents contains certain nuclei or shields, which are positive elements that remained undisturbed from later folding and more or less also from transgressions. These are the Baikal shield or the ancient Angara-land of Asia, the Baltic shield of Europe and the Laurentian shield of America. Nearly the whole of Africa, the "Brazilian mass" and west Australia hold similar positions of areas that remained relatively undisturbed.

It may in time become desirable to distinguish the continental masses in their changing outlines in the different periods by separate names. Clarke has, in recognition of the confusion possible from retaining one name for a changing continental mass, proposed the name "Falklandia" for the Devonian representative of Gondwanaland, because it was connected with Antarctica. We do not know whether the Precambrian ancestor of Falklandia and Gondwana was in any way connected with Antarctica and therefore can not properly use the name Falklandia for the still earlier development of the continent. It may be suggested that such stages could be distinguished by prefixing the name of the period to the continuous land mass, as Siluro-America and Cambro-Eurasia, retaining the names Eurasia, America and Gondwana for the three arch-continental masses, here described.

Relation of Precambrian and Paleozoic Continents to Present Mobile Tracts of the Earth

We have seen in the preceding chapter that the latitudinal extension of the Precambrian continents was preserved with remarkable persistence through Paleozoic time. The series of charts given in text figure 3 show at a glance this persistent character of the large primeval continental masses. The last chart, of late Triassic time, still clearly brings out the same original latitudinal direction of the continents. In the Jurassic period, however, the Indian ocean became definitely established by the foundering of a large portion of eastern Gondwana; and in Tertiary time the Atlantic ocean finally extended southward between Africa and South America and connected with the Antarctic ocean. As a result of these fracturings of the old continental masses the continents of the present day with their predominating longitudinal extension were formed.

It would then seem that the Precambrian continental outlines are lost in the present configuration of the surface of the earth. Nevertheless there is good evidence that the old boundary lines of the original Precambrian continents continue to exist as distinct features in the framework of the earth.

A comparison of figure 4 which represents the original "central massives" or nuclei and also the present mobile or earthquake tracts (together with the tracts of Tertiary folding), with the charts of the Precambrian and Paleozoic continents given before, brings out readily the fact that *these mobile tracts*, in a most remarkable manner, *pass along the supposed boundaries between the Precambrian*

Fig. 4 Chart showing the distribution of the Precambrian continental nuclei, marked by crosses; and of the *mobile tracts* separating them, marked by dots (earthquake belts) and horizontal lines (Tertiary and recent folding). I Libbey's circle, or subequatorial earthquake belt; II Circum-Pacific earthquake belt. After Kayser (1912, p. 709), Bolton (The Illustrated London News, 1921) and others.

continents as we have established them by the Precambrian fold directions and other evidence. This is especially clear in the case of the boundary between Eurasia and Gondwana.

The earthquake tracts distinctly form a latitudinal belt (also known as " Libbey's circle ") around the earth, separating North and South America, traversing the middle Atlantic and separating first Eurasia from Africa and then from the other Gondwana elements (India, Arabia and western Australia) and reaching again across the middle Pacific to Central America.

Another belt follows the eastern, northern and western boundaries of the Pacific ocean. It seems to be completed by the Antarctic seismic regions, as suggested on the chart. There are further known independent shorter longitudinal tracts in the Atlantic and Indian oceans, that indicate that the forces active along the later zones of fracturing which led to the breaking down of the eastern part of the old " Atlantis," and the separation of Gondwana into three continental portions, have not yet become extinct.

When we go backward from Recent and Tertiary times to the Mesozoic age, we find in the geosynclines as reconstructed by Haug (see fig. 5) for that era, an expression of the same mobile tracts, with the addition of a northern loop separating Asia and Europe.

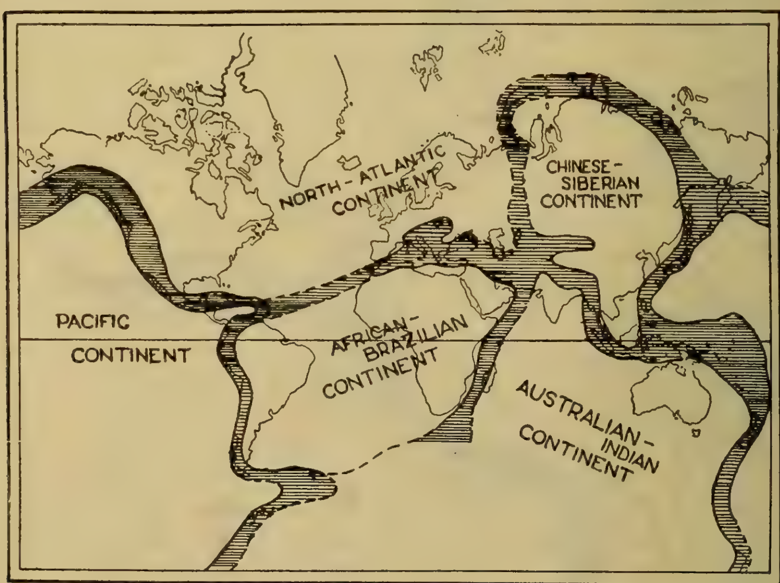

Fig. 5 Chart of geosynclines in Mesozoic time — From Haug (1900).

Finally the paleogeographic maps of the Paleozoic era, here reproduced in figures 2 and 3, clearly show that these same belts were also the tracts along which the principal movements of the seas and the separation of the continents took place in Paleozoic time as is, for instance, well seen by following the paleogeographic history of the Tethys.

There existed, however, in Paleozoic time still another important geosynclinal, folded and undoubtedly also seismic belt, namely that which extended from Scandinavia through Caledonia in Predevonian time and from Germany, France and southern England (Variscan system) in Devonian time to North America (Newfoundland and Appalachian system). This belt, which is now entirely inactive, developed along the boundary of Archi-America (Laurentia) and Archi-Eurasia and also marks the boundary of the eastern portion of Archi-America and the old Poseidon (Archi-Atlantic) between America and Europe and probably also (see Holtedahl's map, fig. 6) that between the old "Atlantis" or "Eria" and the Arctic ocean

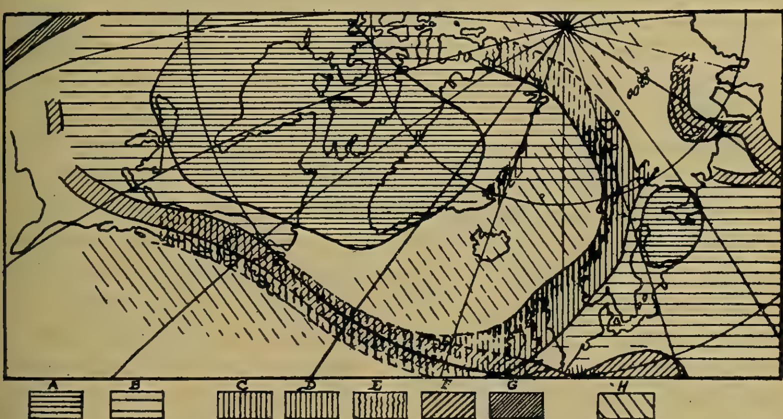

Fig. 6 The structural elements of the North Atlantic-Arctic regions. A and B the stable areas: A, the shields or positive areas; B, the neutral areas; C to G, the post-Ordovician zones of folding; C, Pre-Downtowian time; D, Predevonian time; E, Devonian; F, Late Paleozoic; H, areas of postulated greatest vertical movement. After Holtedahl (1920).

in the north. This ancient mobile tract has become submerged in the greater event of the foundering that led to the formation of the North Atlantic and that has produced a new mobile tract, intersecting the old one at nearly right angles.

From these facts we believe that there is little doubt that the principal mobile, seismic belts of the present earth in their general direction still retain the fundamental boundary lines of the primeval continents and oceans. These principal, still active, belts are the latitudinal (Libbey's) belt and the circum-Pacific belt. The trans-Atlantic belt of Paleozoic time, connecting Europe and the Appalachian geosyncline has become extinct; and new belts that originated later are the longitudinal belts of the Atlantic and Indian oceans.

Probable Causes of the Worldwide Extension and the Principal Directions of the Precambrian Folding

We have, in the preceding chapters, described the uniform direction of the Precambrian folding over vast areas; and assuming, as a working hypothesis, that this wide parallelism of the trend lines over these immense tracts indicates a uniform reaction of the latter as units to orogenic forces and thereby proves their character of entities in the framework of the earth; we have acclaimed these large units as primeval or arch-continents. By comparing their location and general form with that of the early Cambrian continents, as well as by considering the character of the Precambrian sediments we have shown that this tentative inference of the continental character of the large uniformly folded areas is well-supported by independent evidence.

The questions of the cause of this worldwide Precambrian folding and the interlocking one of the significance of the directions that the folding exhibits in different segments of the earth, arise as a natural sequence of the study of the parallelism of the trend lines; but their solution is not of critical importance for the problem of the Precambrian continents; the recognition of the latter being simply based on the grand arrangements of the trend lines as indicating segmental units of a continental order of magnitude. Nevertheless, the direction of the Precambrian trend lines is so intimately connected with that of the major axes of extension and the distribution of the arch-continents that it seems proper to inquire into the probable causes of the worldwide Precambrian folding that are suggested by the trend lines; an inquiry that had to be postponed until the folding itself had been traced over the earth and its general trend lines recognized.

The Precambrian worldwide folding may be due to one or several of three groups of causes. It may have originated as: (1) local folding by terrestrial forces that persisted through immense intervals of time and gradually involved the whole earth; (2) simultaneous worldwide folding by terrestrial forces; (3) worldwide folding by cosmic forces.

1 Long-time, gradual extension of local folding

The view that the worldwide Precambrian folding could have originated from a *long-time, gradual extension of local folding* has, to our knowledge, not been advanced or supported by any authors.[1] On the contrary such authors as Suess, Uhlich, Andrée, Van Hise, Schuchert who have touched the subject of worldwide Precambrian folding have contrasted it with the later localized folding and seen in it the evidence of one or more Precambrian profound and general revolutions that in magnitude far surpassed the later more localized revolutions, a view that also finds general expression in the text-books. Nevertheless, the possibility that this folding involving the whole crust of the earth may be only the expression of an immense length of time and a gradual wandering of the folding process over the whole surface of the earth, is suggested by several facts.

One of these is the recognition, in recent years, of the immense lapse of time that must be assigned to the Precambrian and that it equals or surpasses all later time of the history of the earth. This long Precambrian earth history finds its expression in the thickness of 32 miles of the combined Archeozoic and Proterozoic rocks as against the 21 miles for all subsequent fossiliferous strata (see Schuchert, 1918, p. 64). There is, hence, a perfect sufficiency of time for a gradual folding of the entire earth crust if other factors should favor such a process. The fact of the gradual wandering of the folding from the older chains into the foreland, after the partial denudation of the older chains, has been described as " zonal wandering of mountain formation " by Stille (1909), and well illustrated by Ulrich (1911, fig. 16) in his diagram of the origin of the Appalachian system. Suess has pictured in a masterly way the gradual extension of the Altaid folding over Asia from the vertex, and Grabau (1919) has lately even suggested a migration of geosynclines.

In the case of the Appalachian system this folding has wandered from the Atlantic coast into the continent. We know now from Adams, Barlow and Coleman's researches that the folding in the eastern portion of the Canadian shield also came from the Atlantic side (that is, southeast), and we also have seen before that the folding

[1] It is suggested by Blackwelder (1914, p. 637) for the Archean, when he states: " Whether these facts (greater deformation and metamorphism of Archean than Algonkian) are to be interpreted as indicating a single almost universal orogenic disturbance just before the Algonkian deposits were laid down, or several, if not indeed many, such disturbances affecting successive strips of the continent at different times, is not now determinable. Considering the periodicity and local effects of the foldings in later geologic time, the latter view is perhaps the more favored one."

is more intense near the eastern margin of the continent than in its interior. It could therefore be assumed as a working hypothesis that the Precambrian continent of North America which, as we have shown before, developed a uniform system of folding, that was convex southward and in the east and west parallel to the Atlantic and Pacific oceans, was affected simultaneously and through an immense lapse of time from these three sides by pressure that beginning its orogenic activity near the coasts led gradually to the continuous system of folds extending over the whole continent. Similarly the Precambrian folding of Eurasia could be conceived to have begun near the Pacific and Atlantic coasts and gradually wandered inward, until the two systems of folds met at the Baikal line.

There are also certain more general views regarding the origin of the folds recorded in the literature that would seem to support the possibility of a gradual development of the Precambrian folding near the coasts. Foremost among them is the hypothesis advanced by Reyer (1894) and Andrée (1914, p. 69) that the deeper cause for the form of the mountain ranges is to be found in the fact that the boundaries of the oceanic and continental crust portions favor the formation of the bands of geosynclines and mountain ranges and that the curved form of the latter, which some would attribute to torsional effects, is therefore the consequence of the curved outlines of the coasts near which the mountain ranges originated. Willis (1907, p. 117) holds a similar view, when he states that, "since progressive subsidence results in the development of initial dips in lines essentially parallel to the coast, and since initial dips determine the axial directions of folds during the next epoch of deformation by horizontal stress, it follows that the axial directions of folds conform to the general contour of the higher continental elements, to the land masses."

If this conception of the relation of the mountain ranges to the original coast lines is correct, it gives us a fair suggestion of the principal coast lines of Archi-America (from north to south in the west; northeast in the east; and possibly east-west in the south) and Archi-Eurasia (northeast in the east and northwest in the west); while Archi-Gondwana would suggest north-south coast lines both in the east and the west. As a matter of fact, these coast directions do indeed well agree with the supposed positions of the primeval oceans, the Poseidon (the present central Atlantic) and the Archi-Pacific ocean.

Another view that is favorable to the hypothesis of rather a gradual extension of the Precambrian folding instead of a simultaneous intense revolutionary folding such as is usually suggested to observers by the closely folded, crumpled condition of the Precambrian rocks, is found in the observations that laccolithic intrusions presuppose an orographic flexing to support the superincumbent strata (Keyes, 1918, p. 75) and that the large Precambrian complexes of generally laccolithic form at Duluth, Sudbury etc. resulted from intrusions extending over a large period of time and that they were developed where the lateral pressure was not great (Benson, 1920, p. 144). This, as also Daly's work, suggests that the universal development of batholiths, laccoliths and sheet intrusions marking several of the Precambrian revolutions may, in every case, also have been an extremely slow process that developed *pari passu* with the gradual folding of the arch-continent.

It may be mentioned in this connection that the metamorphism and the foliation of the rocks which are generally considered as a direct evidence of the intensity and profoundness of the Precambrian revolutions have lately been shown to be explainable by less intensive action. Thus Adams (1918, p. 180) has demonstrated by experiments that in certain types of rock schistosity or foliation may be produced by pressure alone, without heat and in the absence of moisture, and Barrell (1921, p. 11) has found that "metamorphism is not caused by deformation (folding), but recrystallization is largely and directly related to batholithic heat and emanations, while "the folding and mashing" are regarded "as related but independent processes, due to crustal compression, but going on most readily in the weak and recrystallizing roofs of batholithic chambers." Barrell is further arguing for a shallow depth for the Precambrian metamorphism, basing his argument on the completeness of the Archean metamorphism and the salt of the ocean as a measure of erosion.

The combined inference from these recent conclusions and observations is that the Precambrian revolutions possibly were, even though involving the whole crust of the earth, in kind and intensity not greatly different from the later orogenic revolutions of the earth. This, however, would again point to a probably gradual extension of the Precambrian orogenic revolutions over the whole earth.

2 Simultaneous, worldwide Precambrian folding

A simultaneous, worldwide Precambrian folding by terrestrial forces is assumed by some European writers (see above), who having made a close study of the Precambrian folding in Bohemia and Scandinavia incline to the view that this close uniform folding is to be explained by a uniform contraction of the entire earth crust which then had a fairly homogeneous composition. The influence of enormous masses of eruptive material as an additional factor in the folding is generally recognized, as is also the fact that the folding, foliation, schistosity and longitudinal direction of the intrusive masses (notably the batholiths) are all expressions of the same deformative and compressive forces, all having the same trend lines.

Suess (v. 3, pt 1, p. 7) has repeatedly emphasized the fact of the contrast between the worldwide Precambrian folding and the restriction of the present folding to local areas of more recent sedimentation and therefrom concluded (v. 3, pt 2, p. 720) that while once the lateral pressure due to contraction of the earth was active over the whole planet, it is now localized.

Among American authorities (see "Problems of American Geology") it is held that toward the close of the Archeozoic era a period of worldwide diastrophism ensued, which led to the profound folding of the Preproterozoic complex; and that several such orogenic revolutions followed thereafter in Precambrian time. Geologists are further agreed that these orogenies are probably due to periodic earth shrinkages (Schuchert, 1920, p. 401); but no longer, since the discovery of the fact that the earth is radioactive, consider the earth as a cooling body, but in agreement with Chamberlin's planetesimal theory one seeks the cause of shrinkage in other physical and chemical changes within the earth. Chamberlin (1920) has shown, by deducing the order of magnitude of shrinkage of the earth from Mars, Venus and the Moon, that the total shrinkage of the earth is greater than that of the other bodies adduced for comparison corresponding to the progressive nature of the compression from the least to the greatest, and he was the first to originate the idea that shrinkage originated in the deeper portions of the earth under the urgency of the enormous pressures by giving rise to slow recombinations of matter into denser forms. Geologists agree that this shrinkage due to condensation deep within the earth is the principal cause of the profound compressive forces that have been the chief agents in developing mountain structures, and Chamberlin (1920, p. 14) points out that the total shrinkage of the earth has been very large, and likewise that of Precambrian and especially of Archean time. It is estimated (Schuchert, 1918, p. 48) that the diameter of the earth "at the close of the growing period must have been 200 and possibly even 400 miles greater, for it is well known to geologists that throughout geologic time it (the earth) has been losing volume, due in part to the loss of heat into space, but probably in greater degree to internal molecular rearrangements."

From the great amount of this shrinking of the earth, that set in after the earth had reached its mature size, or directly before the Archeozoic era, and from its causal relation with recombinations and recrystallization in the depths of the earth, it seems entirely proper to infer that the shrinking process was most active in the earliest part of the geologic history, or in the Precambrian, and that it gradually will die out and thus lead to that featureless earth with its universal ocean, that will mean old age for the planet. A corollary of this view is that folding and its associated phenomena was then also more intensive and above all more widely spread over the earth than in these late days of localization of the folding process. This conclusion is strongly supported by the uniform presence of enormous intrusive masses throughout the world in the Precambrian rocks, which in the Proterozoic of south-central Canada have been estimated to have a thickness of 4 miles.

Consideration of the facts here set forth urges adoption of the view cited above that our geologic history began with a worldwide contraction of the earth and the resulting worldwide intensive and simultaneous folding and intrusive activity, suggested by the Precambrian rocks. In that case, we must ask ourselves how did the *uniform* trends of folding of large areas of supercontinental size come about?

Austrian and Scandinavian authors have agreed from the closely contorted and crumpled condition of the Precambrian rocks in their respective countries, upon a uniform contraction of the earth producing a tangential pressure acting from all sides. We have, however, presented ample evidence that the Precambrian folding, foliation etc. show a well-marked arrangement on a huge scale. There is, therefore, evidence that a uniform and probably relatively rapid contraction of the earth crust in Precambrian time, while producing the irresistible tangential pressure that has folded all Precambrian rocks, could not have been the controlling factor of the direction of folding. It has been inferred, as we have seen above, that the supposed irregular folding of the Precambrian indicates the contraction of a relatively homogeneous earth crust, acted upon from all sides and lacking such belts of weakness where folding would be most likely to become so concentrated, as it has been in later stages of the development of the framework of the earth. The amazing regularity and arrangement in distinct segments of the folding of the Precambrian on the contrary, proved in this paper, for the greater part of the earth, demand an explanation by another cause than the uniform contraction of a homogeneous earth crust. There appear to us two hypotheses worthy of consideration in this connection:

a The orderly arrangement of the Precambrian folds is mainly due to the influence of preexisting differences in the earth crust. These would consist, according to present knowledge of the composition of the crust, of lighter and heavier segments representing the continents and oceans. These differences are considered as original, as we have seen before, resulting either from the mode of separation of the planetesimal material that built up the earth, or the continuous outpouring of heavier lavas in certain regions that became the oceanic basins. We have, in this paper, attempted to demonstrate that the trend lines of the Precambrian rocks do, indeed, show a control by a preexisting regional differentiation of the earth crust, and that the regions thus recognized and marked off, correspond to the later continents.

b The Precambrian trend lines are mainly controlled by cosmic influences. As such we have cited, in the preliminary paper, the tidal waves of the earth crust and changes in the velocity of rotation of the earth.

3 Control of the trend lines by the continental segments

The first hypothesis, that of the *control of the trend lines by the continental segments*, is supported by all the evidence we have brought forward of the parallelism of the Precambrian trend lines with the coast lines of later continents and the general agreement of the arch-continents of Precambrian time with those of Paleozoic time. It is further supported by the present views of geologists on the processes of folding in general. While the older geologists currently considered the folding of the earth crust as a simply superficial process due to horizontal or tangential compression of the shortening earth crust from the surficial cooling of the globe, the conviction has been steadily gaining ground that this assumption is not able to explain the facts of arrangement of the mountain systems and other problems. Suess (v. 3, pt 2) from his study of the mountain ranges, especially of Asia, reached the view that the stratosphere and a large part of the salic crust do not fold themselves but are folded, are passive and carried forward, a view which seems to be supported by the recent experiments of Meade (1920, p. 521) who concluded that " most of the faults or folds are the result of the riding or dragging of the upper layers by the underlying materials." Suess pictured to himself the mountain chains as the crumpled edges of flat-based earth scales, a view that apparently finds support not only in the grand arrangement principally of the Asiatic ranges but also in the fact that the angles of the fold faults or thrust planes observed in connection with these folds, notably the Himalayas, are very flat (see Middlemiss, 1919, p. 565, also Quirke 1920).

Both in America and in Europe one has recognized the relatively deep-seated origin of folding. Gilbert had pointed already to that of the Appalachian folding, as revealed by the great erosion, and Dutton (1874, p. 163) had early urged that the surficial cooling of the globe could not account for the magnitude and the nature and distribution of the mountain folds. Under the leadership of Chamberlin the conclusion has been reached that the shrinkage of the earth originates in the deeper portions of the earth and that its controlling cause is the enormous pressure which induces slow recombinations and recrystallizations of matter into denser form. One has further concluded that the oceans are the principal sites of this condensation deep within the earth; and further that these condensations create the irresistible horizontal compressive forces. Under the influence of the forces created by the condensation, yielding by massive flowage takes place in the zone of rock flowage, which underlies the zone of fracture. The foliated structures and crystalline textures of the Precambrian rocks testify to the fact that they have been in the zone and under the influence of this flowage, through granulation and recrystallization. Experiments by Tammann (1903) on the rate of flowing of crystallized substances have shown that the flowing is not dependent upon a previous melting, but that the plasticity, the reciprocal interior friction, is a property peculiar to crystals and that it rapidly grows with the deforming force and increasing temperature and reaches large figures near the fusion curve. Tammann's investigations reveal complicated processes of crystallization and changes of volume that may have produced contraction and expansion at the same time at different places, as well as a general contraction or expansion. Such results lead to the view of the possibility of massive convection currents or "Unterströmungen," a hypothesis especially developed by Ampferer (1906),[1] and they also give a clue to a possible explana-

[1] Ampferer's hypothesis is distinct from that advanced by Willis (1907) and Hayford (1911), who adopting the mechanism of Dutton, have attempted to make a lateral *isostatic* undertow — the cause of all horizontal movements in the crust. Barrell (1909, 1914, p. 166) has rejected this hypothesis as inadequate.

tion of the " pulsations " or alternations of revolutionary and quiescent periods in the geologic history, now postulated on good grounds by geologists in this country, notably Chamberlin, Schuchert and Ulrich, and Stille (1911, see Andrée p. 83) and others in Europe.

It is thus the more recent trend of opinion to consider the shortening of the earth's crust as resulting from great compressive forces that originate in the depths of the earth from recrystallization and condensation and that lead to movements of the nature of convection currents in the zone of rock flowage which in their turn carry forward the upper portion of the crust, or the zone of folding and fracture.

While these movements of the deeper zone are of irresistible power, they are also very slow, but may at times become so extensive and quickened as to lead to the revolutionary periods of earth history. In Precambrian time these revolutions owing to the more rapid contraction of the earth, would seem to have been more extensive, or even world-embracing, and more violent. The result was the worldwide intensive folding, foliation and intrusion of the Precambrian rocks, which was for the most part carried out in the deeper zone, that of rock flowage; while the later more localized folding is that of the outer zone of faulting and folding. This latter, however, is also due to the carrying forward of the outer crust by the movement of the deeper zone. Observations like those of Holtedahl (1920, p. 23) of the wavelike motion of areas in Scandinavia during Paleozoic time, or the rhythmus observed between transgressions and emergences by Karpinsky in Russia and by Chamberlin, Schuchert and Ulrich in North America, suggest that this process of flowage continues on a smaller or less rapid scale almost perpetually, though with distinct pulsations and changes of direction.

Applying these views to the character and arrangement of the Precambrian folds and associated features, we infer that there has taken place *a broad movement of the material of the zone of rock flowage toward the arch-continents of North America (Laurentia) and Archi-Eurasia from the sites of the Pacific and middle Atlantic oceans, which has led to the orderly arrangement of the Precambrian folds of those continents on a huge scale.*

We have seen in the preceding chapters, first, that there exists evidence indicating a very slow folding process that gradually extended from the coast lines inward, and then that there is still more evidence suggestive of a more rapid folding during periods of revolutions and of more active contraction of the earth crust. A fair conclusion from these two groups of evidence combined would seem to us to be that there was a continuous movement that slowly extended the folding into the continents, and that not being very intensive, may have allowed the numberless batholithic and laccolithic intrusions, but that at times broke into a more violent character of worldwide orogenic paroxysms and then carried the folding and extensive volcanic and intrusive activities far into the interior and finally throughout the whole arch-continents.

Whether, however, a slow continuous movement or pulsatory, more violent movements of the zone of rock flowage, or both, carried forward the folding into the continents from the underbodies of the oceans; the fact that is important for our inquiry remains that the results of these movements postulate original differences in the density of the outer crust, which controlled the direction of the movements and of the resulting folding, while the movements themselves were only the agents furnishing the folding force.

4 Possible cosmic agencies of Precambrian folding.

We have, in the preceding chapters, seen how the grand uniformity between the general Precambrian folding in North America and Eurasia and the supposed coast lines of the two arch-oceans, there recognizable, indicate a controlling influence of the ancient boundaries between oceans and continents upon the forces that, emanating from the underbodies of these oceans, folded the Precambrian rocks throughout the continents.

There are, however, other elements recognizable in the general trends of the Precambrian folds that do not seem to be readily brought into correlation with the ancient continental coast lines, and that are so equally distributed within certain belts, around the earth, that they suggest another factor than is furnished by the Precambrian continents and oceans.

These elements are (1) the north-south directions of the equatorial belt of Precambrian folds and (2) the large east-west component of the folding in higher latitudes.

We have seen the north-south direction clearly developed in Africa, Madagascar and west and south Australia; predominant in East India and prevailing in folding that probably is more or less posthumous in character in eastern Australia and in South America.

The east-west component appears in the northeast and northwest directions of the Precambrian of the Sinian and Sayan systems in Eurasia; it is emphasized by its prevailing (east-northeast direction) in China and (west-northwest direction) in southern Russia. The same component is recognizable in the Variscan and Armorican folding which also, as we noted before, may contain in its character a strong posthumous element. In North America the east-west component appears in the Precambrian folding of northern Quebec where Cooke found the east component strongly prevailing over the other north component; but it is most apparent in the east-west strike of the Precambrian folding in the middle zone of the continent. On the southern hemisphere it is indicated by the east-west Precambrian and later folding of South Africa and the curving into more or less latitudinal direction of the Andean folding in Argentina.

These two belts, the northern belt of northwest and northeast directions and the equatorial belt of north-south directions of the Precambrian rocks are the two outstanding features of the trend lines of the Precambrian rocks.

It is significant that the Paleozoic continental platforms were characterized, in contrast to the present continents, by their latitudinal rather than their longitudinal arrangement, a fact pointed out by Schuchert (1916, p. 91).

It is further noteworthy that the great Tethys sea which formed an east-west sea extending from Central America eastward across Eurasia to the Pacific (see charts of Paleozoic continents and seas), separates the two belts of folding and thus indicates a zone of either less distinct or of transitional fold directions which also became one of weakness, geosynclinal sinking and subsequent local folding in Postpaleozoic time, which later folding has effectively hidden and obliterated the original Precambrian folding. If one enters the trend lines of the Precambrian rocks upon a polar projection, instead of the Mercator projection, it is more distinctly seen that the belt of the northern hemisphere, while distinctly circumpolar, has a somewhat zigzagged course, resulting from two deep embayments. These occupy the positions of the Pacific and middle Atlantic oceans (Poseidon; see Cambrian chart); their location makes it entirely probable that they, as the loci from which the folding pressure originated, supplied the northern components in the northwest and northeast directions on both sides of the embayments. In western North America the large Archi-Pacific ocean was able to overcome entirely even the east-west component of the trend lines.

In the case of the north-south folding of the entire equatorial or Archi-Gondwana belt, it is clearly difficult to try to explain this solely by the influence of the Pacific ocean that interrupted the belt on the eastern hemisphere; and to overlook the fact that the Poseidon sea, which was to the northwest of the African portion of the belt, should also have exerted a distinct influence in southeast direction, as it did toward Laurentia in northwest direction.

If then there is recognizable a distinct east-west component in the northern belt of Precambrian folding (to some extent also suggested by the folds of the southern hemisphere), and further, the north-south direction of the Archi-Gondwana or equatorial belt is not satisfactorily explainable by the influence of the two primordial oceans, we may well ask ourselves what these influences could have been.

The fact that these components of the fold directions appear in two, or more probably three (including that of the southern hemisphere) belts of folding, seems to suggest that factors of a greater scope than the primeval differences of density of the continents and oceanic underbodies may have controlled the trend lines of Precambrian folding.

These factors can be sought in changes of the velocity of rotation of the earth and in primordial tidal waves of the earth's crust.

We do not feel competent to enter upon a technical discussion of the influences of these cosmic factors upon the earth's crust. We shall therefore but roughly and briefly point out the possibilities of their influences, as we understand them.

Suess, although considering the contraction of the earth as the principal cause of mountain folding and believing the folding to arise from the dragging of the outer crust by deeper portions of the same, was nevertheless inclined to set beside this interior cause of the changing of the earth's surface features, also the exterior causes mentioned above. He says (Suess-Sollas, v. 4, p. 607):

" Darwin states that if bodily tides influenced the arrangement of the mountain chains, then we should expect to find at the equator a north and south strike, toward the north a northeasterly strike, and toward the south a southeasterly strike. This supposition holds for almost the whole of the Pacific region. The advance of the Antilles toward the east, the arrangement of all the arcs of eastern Asia and the Oceanides, and in particular the fact that almost all the Asiatic virgations open toward the west and southwest are consistent with the theory. But there is no lack of exceptions; the St Elias range is folded toward the west or southwest, likewise the great Burman arc and the Urals. The whole of that part of the western Altaides lying outside the horst of Azov is opposed to the rule.

" An attempt has been made to explain the arrangement from the rotation of the earth. Douvillé has adduced the earlier more rapid rate of rotation and obtains a prevalent east and west direction. Prinz, on the other hand, finds a prevalent north and south direction. We may also point to the folding, directed to the south, of the United States chain, situated on the other side of the pole, also of the Aleutian islands and the southern marginal arcs, and in particular to the Cape mountains directed towards the north; the exceptions are the same."

And again (p. 626, op. cit.) Suess states, pointing to the same evidence, that " we are led to consider whether in respect to this great part of the earth, we must not admit the action of *bodily tides* or of the *rotation*, in addition to the contraction of the planet, as a possible factor in determining the plan of the folded ranges. [1]

a Retardation of rotation

Andrée, in his excellent treatise (1914, p. 13 ff.) traces the origin and development of the theory of the *retardation of the rotation of the earth through the influence of the tidal waves* from William Thomson (1867), and G. D. Darwin to those authors who would apply this factor to the explanation of the mountain folds of the earth (Taylor, 1885), notably Böhm von Böhmersheim, and considers it as repudiated by later authors (notably G. von dem Borne and Ampferer) on geophysical grounds; the impossibility of assuming a sufficient flattening of the poles in these late periods of the earth's history to explain the Tertiary folds of the earth, the failure to produce similar effects by experiments,[2] and the equal failure to bring the present mountain ranges into this scheme, as it was attempted by Suess.

While thus the influence of changes in the velocity of rotation may be considered as nonexistent or negligible in the case of the Postproterozoic mountain folds, there is still a possibility that these changes may have been so much greater and more rapid during the Precambrian era of the earth that they did have a distinct effect upon the worldwide folding of that time. Indeed, it is claimed by Chamberlin (1916, p. 544) that rotation was the greatest

[1] The principal influence of the rotation, Suess (op. cit.) saw, however, in its producing the eustatic movements of the ocean. Later (1911, p. 107) he expressed himself as being now uncertain about the rotation being a *vera causa* of eustatic movements, since we do not know where the pole was.

[2] Keyes (1919, p. 87) has, however, lately stated that " recent experiments indicate that the larger relief features of the globe are not the complex dynamical phenomena commonly fancied, but merely somewhat different expressions of the same simple tangential force and direct resultants of the earth rotation " and " that the effects of tangential compressive force which many mountain structures display appear to be not the result of earth contraction, but of stress release due to retardation of the earth's rotation."

of the deformative agencies in the early history of the earth, and stated in "The Origin of the Earth," that periodical changes in the rate of rotation have been of the greatest importance among the shaping agencies of the framework of the earth.

The master features of the latter are seen by Chamberlin according to the ingenious hypothesis developed by him (op. cit.) "in a segmentation that sprang from primitive shrinkage stimulated and shaped by oscillating rotation and tidal strains." This segmentation would take place at times when the polar areas were in tension through a cracking that would produce yield zones at 120° to each other, that pass from the poles to the fulcrum zones not far from 30° Lat. N. and S., while between them there should be oblique trends. The protrusive effects of the rotational stresses are supposed to have been mainly felt at the angles where the yield tracts joined one another, and subordinately along the yield tracts themselves. The continents are therefore held to have grown up from these angles as centers while the oceans formed in the depressions between.

We can not enter here more fully into this fascinating hypothesis which is fully set forth and illustrated in "The Origin of the Earth,"[1] except to state that Chamberlin obtains three oval oceanic basins on the northern hemisphere, namely, the Pacific, North Atlantic and the Caspo-Mediterranean cluster of depressions, and three on the southern, namely, the south Pacific, south Atlantic and Indian oceans. The continental clusters are North America, South America, Eurafrica, Asia, Australia and Antarctica.

It will be seen at once that this arrangement of the primordial continents and oceans differs from the one at which we have arrived from the consideration of the Precambrian trend lines. It is, however, also obvious that Chamberlin's arrangement of the primeval continents and oceans is equally different from that found by paleogeographers at the beginning of the Paleozoic era; and further that it is based on the conception of a gradual growth of the earth from planetesimals without reaching a molten state, a view against which Barrell and Daly, as noted before, have advanced arguments tending to show that a molten condition of the surface of the fully grown earth must be postulated to explain various facts, and they have for that reason considered Chamberlin's segmentation hypothesis as not well supported.

However that may be, it is sufficient here for our purpose to emphasize the fact that Chamberlin's hypothesis is designed to

[1] See also article in Scientific Monthly, 1916, v. 2, on the "Evolution of the Earth."

reconstruct the *embryonic* framework of the earth, or that which was developed during the growing stage of the earth from the dominant influence of the changing rotation, and which concededly (see Chamberlin, 1916, p. 203, 204) was greatly obscured by secondary factors, such as dominant directions of wind and current movements and " the diastrophism that sprang from secular loading and unloading, and from the shrinkage of the earth-body which appears to have assumed the leadership in shaping the earth after growth ceased." It is precisely this last agency which produced the Precambrian compression phenomena upon which we have based our reconstruction of the Precambrian continents. We may therefore assume that theoretically the segmentation set forth by Chamberlin took place in the embryonic, growing stage of the earth, through the dominancy of the rotation factors, laying the skeleton work of its frame; that this, if not entirely obliterated by a molten or intensely volcanic stage, was at least obscured to a great extent when after full growth was attained, the shrinking of the earth and the resulting diastrophism put a different pattern on the surface of the earth, namely, that which we have traced and which explains the shape and arrangement of the Paleozoic and Precambrian continents. As Suess has repeatedly emphasized, several patterns of mountain ranges have been placed in the framework of the earth upon each other through successive changes in the direction of diastrophic movements. It is thus explainable that the present pattern of mountain ranges and even of continental arrangement is quite different from that of Paleozoic and Precambrian times.

It is logical to infer from these facts that the differentiation into continental and suboceanic matter conceived by Chamberlin to have taken place during the slow growth of the earth, as well as the segmentation along yield tracts — both of which characters by the very nature of their origin, must be deeply implanted into the structure of the earth, theoretically reaching to the center — should in spite of the various vicissitudes and obscuring later influences of the surface, persist in the framework and be able to reappear again in the face of the earth, and may therefore be now again recognizable in the form described by Chamberlin.[1]

[1] It certainly is very suggestive that the three great Precambrian nuclei of the northern hemisphere, the Canadian, Baltic and Siberian (Angara) shields, are 120° of longitude apart, a fact pointed out by Dacqué (1919, p. 97); and that these ancient shields are girdled in the east, west and south by old, now strongly denuded mountain ranges, which in their turn are surrounded on the outside by festoons of younger chains of Tertiary age. A similar strange homology is observable in the structure of the southern hemisphere, as fully set forth by Dacqué. The Baltic and Siberian shields are, however, not considered as belonging to different continental blocks that are separated by oceanic basins in Chamberlin's scheme, nor does the Precambrian folding described in this paper place them into different units.

We saw in the preceding chapter that Chamberlin, in the "Origin of the Earth" adduces the influence of oscillating rotation and tidal strains for the growing period of the earth, only leaving to later shrinkage the leadership in shaping the earth after growth had ceased. The same author had already in an earlier paper (in "The Tidal and other Problems," 1909 by Chamberlin *et al.*) investigated the possible retardation of the earth's rotation through the friction of the water tides and the tides of the lithosphere. It is shown, in this suggestive publication from computations by C. S. Slichter, that when the earth had a rotation period of 3.82 hours its equatorial circumference was 1131 miles greater than it is at present, while the meridional circumference was 495 miles less. "In changing to the present form, the tract immediately under the equator must have become shorter by 1131 miles. The tracts under the parallels adjacent to the equator north and south would have become shorter by less amounts, those still farther away by still less amounts, until a little beyond 30° latitude, north and south, parallels are reached under which the crust would have theoretically remained unchanged so far as this immediate factor is concerned." There is hence a neutral zone at about 35° latitude, north and south, and beyond this are large areas of expansion. We would then have a zone of powerful compression at the equator and two polar caps of similar extensive tension. Chamberlin estimates that the equatorial tract under such conditions must fold, crumple and overthrust on itself after the familiar fashion of folded mountains to such an extent that, using Heim's estimate of 74 miles of the crustal shortening for the Alps, it would require 15 ranges of the magnitude of the Alps across the equator, or 28 ranges of the order of the Pennsylvanian Appalachians (using Lesley's estimate).

Professor Chamberlin concludes (op. cit., p. 49) that no such condition is suggested "by an equatorial belt of land, much less an elevated girdle accidented by cross folds, or knots, or contorted protuberances," nor is there any evidence of the truncated remains of these. While this is true of the present condition of the equatorial belt, it seems, however, that it may well have been different in regard to the Precambrian equatorial belt, for there we not only have evidence of an equatorial belt, the Archi-Gondwana, which, if it was not continuous around the earth, quite probably reached three-fourths around; and what seems still more significant, that belt was provided with a complete system of strong north-south folds such as would be postulated by an equatorial compression due to retardation of rotation. Likewise one might find evidence of a neutral zone in the belt with little distinct trend lines which we saw suggested by the conditions in Bohemia, southern Asia, etc.

The progressive tension due to the expansion of the earth beyond the neutral zone would lead (op. cit., p. 50) to persistent fissuring or gaping radial from the poles, and " if to escape the difficulties arising from exceptional tension in high latitudes, it be assumed that the whole shell of the lower latitudes crowded toward the poles, this would involve meridional crowding and the formation of a system of folded ranges pointing to the poles, while east and west ranges should be absent proportionately, and thus the effects should be expressed in a distinctive manner." It is further inferred by Chamberlin that the earlier formations should show the most evidence of tension, the Archean most of all. " As a matter of fact," however, " the Archean of high latitudes, as of low latitudes, shows abounding evidence of compression," as Chamberlin himself could observe in Greenland in 1894 in latitudes as high as 77°, when he found " the same evidences of crumpling, contortion, foliation and thrust stress generally as are commonly shown by the Archean rocks in lower latitudes." There is, thus, everywhere evidence of pronounced tangential thrust in the Precambrian terranes of high latitudes, as of Canada, Scotland and Scandinavia, instead of the postulated tension effects, and further, as we have seen in the first part of this chapter, the Precambrian folds show a distinct east-west component instead of the postulated north-south directions.

Professor Chamberlin from his investigation concludes that there is no geologic evidence of a retardation of rotation from the beginning of Archean time onward; the evidence of the Precambrian trend lines, brought forward in this paper, which in the north-south directions of the folds of the Precambrian of the equatorial belt suggests the influence of retardation of rotation, is vitiated by that of the trend lines of the Precambrian beyond the neutral zones.

As Chamberlin arrives at the important result that neither the friction of the present water tides nor the tides of the lithosphere, which are chiefly elastic strains, would be sufficient as retardative agencies to have a noticeable effect on the earth's rotation, it appears safe to assume that the *north-south trend lines of the equatorial belt of the Precambrian are due to another agency than the retardation of the earth's rotation.*

b Acceleration of rotation

We have seen before that the principal factor in folding the Precambrian rocks undoubtedly was the considerable shrinkage of the earth after full growth was attained, due to pressure condensation, etc. in the interior. This shrinkage we have further seen may have amounted to two or three hundred miles in the radius and would have been especially intensive at the beginning or in Precambrian time. It is to be presumed that such a considerable shrinkage might cause an *acceleration of the earth's rotation* sufficiently great to cause the crowding of the crust toward the equator that is indicated by the east-west component and the close folding of the Precambrian rocks in the northern and southern latitudes; but the folding of the Precambrian beds is on the northern hemisphere, as in eastern Canada and Asia, by a pressure coming *from the south.* Nor could this acceleration account for the north-south trend lines and the close folding of the equatorial belt, which then would be the zone of tension. Chamberlin (op. cit., p. 59) shows that a reduction of a radius by 200 miles (from 4160 to 3960 miles) would reduce the day from 26 hours 29 minutes .08 seconds to 24 hours, an accelerative effect that would be greater than the retardative effect of the water tides and perhaps greater than all the tides combined, but — it follows from his analysis — hardly large enough to have served as controlling agency of the Precambrian folding, even if the indicated direction of the pressure were not opposite to that postulated by an acceleration of rotation. This factor can hence also be excluded with a good margin of safety from those that may have controlled the Precambrian trend lines.

c Body tides

There is finally to be considered the possibility of the influences of *body tides.* Darwin, as stated before, has pointed out that if bodily tides have influenced the arrangement of mountain ranges, the direction at the equator must be north-south, toward north they must strike northeast and toward south in southeast direction. It will be seen that the equatorial belt of Precambrian folds would fully agree with the postulated trend lines, but the northern hemisphere gives in its Precambrian trend lines no clear evidence of a dominating northeast, nor the southern hemisphere of a dominating southeast direction; for while the right wings of the Eurasian system (the Sinian moiety) and of the Laurentian system are characterized by the northeast direction of folding, the opposite wing or moiety, which is by far the longer in the Eurasian system, exhibits an equally distinct northwest direction, or just the diametrally opposite direction from that postulated; and the central section of Laurentia possesses an east-west direction that is entirely indifferent to tidal influence.

Possibly one might consider the north-northeast direction of the folds in India, and a like direction in the Colorado and Bohemian massives, as indications of a tendency of the north-south equatorial direction to change to northeast. It would, however, require the evidence of an entire circumpolar belt of this direction to prove the case.

It is further to be remembered that the assumption of body tides powerful enough to fold the crust would postulate a considerably greater nearness of the moon and a less rigid condition of the earth crust in Precambrian time than there is reason to assume on other grounds. Finally Chamberlin (1909, p. 25) has pointed out that there is a large body of geological evidence which seems to indicate that the lithosphere is able to accumulate stresses for long periods, which are then relieved by permanent deformations; continuing, " it is difficult to understand how an earth could be possessed of this ability if it yielded fluidally to such transient and moderate stresses as those of the tides of the outer part of the lithosphere. We therefore assume with confidence that, whatever the amount of the lithospheric tide, it is only an elastic strain which relieves itself almost instantly on the removal of the force which caused it and involves little friction."

As neither the retardation due to the tides nor the acceleration of the rotation due to shrinkage of the earth were found to be competent to account either for the direction or for the amount of the Precambrian folding of the equatorial and circumpolar belts, it follows, by exclusion, that the *shrinkage appears to have been the sole cause of the folding*, and *the existence and configuration of the continental and oceanic segments the controlling agency in the direction of the trend lines of the folds.*

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THE CHAMPLAIN SEA

EVIDENCE OF ITS DECREASING SALINITY SOUTHWARD AS SHOWN BY THE CHARACTER OF THE FAUNA

BY WINIFRED GOLDRING

Introduction

Recent collecting in the postglacial banks of the Champlain and St Lawrence valleys has brought out the fact that going southward there is evidence of a marked change in the Pleistocene fauna, similar to that seen in the living fauna of the Baltic sea today. Study of this fauna and comparison with the conditions found in the Baltic and elsewhere has led to the conclusion that the character of this postglacial marine fauna is due in large part at least to decreasing salinity in this direction in the waters of that time.

The normal salt composition of sea water permits the development of a fauna rich in species and genera. A reduction in the salt content of the water produces an impoverished fauna, poor in species, poor in lime, dwarfed in size but often rich in individuals (Shimer, p. 473; Walther, 1919, p. 60).

Marine animals are divided into three groups according to their ability to live in water of various degrees of salinity: (1) *stenohaline types* can not live in water with less than 30 or 35 permille[1] of salt (normal open sea); (2) *euryhaline types* can endure without injury a considerable freshening of the water; they need the salt but not a definite percentage, and will live as long as any salt remains; (3) *brackish-water types* are adapted to a small amount of salt and an increase of the salt content is just as harmful as a reduction of it. The brackish state of water has never been definitely delimited, but probably the upper limit would be a salinity of 2 or 3 permille. The stenohaline forms outnumber the euryhaline and brackish-water forms in all groups (Walther, 1894, p. 6263; Grabau, p. 1044).

Experiments have been undertaken with sea animals (by Beudant; Walther, 1894, p. 63) to determine whether they can be induced to live in gradually freshened water. It was found that if marine mollusks are brought suddenly into fresh water, almost all the species die; but many species can endure the gradual addition of fresh to salt water until eventually the water has become quite fresh.

[1] That is, parts in a thousand.

Among 610 individuals of various marine species which were gradually accustomed to fresh water, only 37 per cent died. Of the same number of the same species which were kept at the same time continuously in salt water, 34 per cent died; so that the mortality in the groups compelled to live in a strange element was only 3 per cent greater. These experiments show that sea animals are not bound to an absolute quantity of salt, but their stenohaline or euryhaline behavior is important in this, that they are able more easily or with more difficulty to adjust the salt content of their tissue to that of the surrounding water. It has been found that nearly related species behave very differently in this respect; one species may die immediately, another live on for several days. Foraminifera live mostly in pure salt water, yet in the estuaries of British rivers there are known 100 species belonging to 44 genera. In brackish sea water, in spite of the simultaneous increase in the lime content, the secretion of lime skeletons is diminished. Species of Foraminifera in the estuaries have shells poor in lime, while the same species secrete coverings rich in lime in the normal salty sea (Walther, 1894, p. 63; 1919, p. 123).

A noted area for studying the influence of a diminished salt content upon the animal life is the Baltic sea, which shows a very striking decrease in salinity eastward and in a large way the responses of the fauna to it. It is more static than estuaries; it lacks the tides which are characteristic of the latter and therefore does not show the pronounced changes from fresh to salt water twice a day. The North sea has the normal marine salinity of 35 permille which decreases steadily going eastward in the Baltic until at the northern end of the Gulf of Bothnia the water is practically fresh. In the Skager Rak the water has a salinity of 34 permille; off Skagen, the northeasternmost point of Denmark, 30 permille; in Kattegat, 22 permille, and 20 permille in Kiel bay. " Throughout the southern part of the Baltic, from the ' Scheren,' at the mouth of the Gulf of Finland, to Bornholm the salinity is from 7 to 8 permille at the surface and does not vary greatly in the depths. For instance, in the deepest part of the Baltic off the Island of Gotland, the salinity is only 12 permille, and in the Bay of Danzig, which shows a yearly average of 7.22 permille at the surface, it is only 11.66 permille (average) at the depth of 105 meters. In the Bay of Riga the salinity is 6 permille, in the southern part of the Gulf of Bothnia it is 4 permille and gradually diminishes until the water is entirely fresh (3 permille at Uleaborg, northern end; Grabau, p. 1045).

Fig. 1 Sketch map of Baltic showing permillage variations in salinity (after O'Connell, 1916).

Corresponding to these changes in salinity are certain very definite changes in the fauna." (O'Connell, p. 70; see also Grabau and Jacobsen).

As the salinity of the water decreases from that normal for sea water, the fauna changes from one typically marine to one in which only a few marine groups are represented and finally to a fresh-water fauna. Each phylum is affected.

Pouchet and de Guerne (p. 919–21), from a study of dredgings in the Baltic, reported from the Gulf of Finland a *crustacean* fauna made up almost entirely of fresh-water types. One of the types, Bosmina longirostris, shows a great abundance of individuals, for it represented by itself alone three-fourths of the mass of the animals obtained at the various stations. Associated with the fresh-water types is a marine pelagic form, Evadne nordmanni, which occurs more and more frequently in proportion to the increase in the salinity of the water (westward). In descending south the Evadnes tend more and more to replace the Bosminas, but the latter have been found even as far down as Kiel. Another abundant euryhaline crustacean is Podon intermedius. From the point of view of the pelagic fauna, the Gulf of Finland may be compared to a lake broadly opened on the Baltic (salinity of .73 permille at Cronstadt; 2.62 permille at Seskär). Along the extent of Gotland, the marine crustacean fauna is found in the Baltic as far as Kalmar sound between Öland and Sweden. One interesting copepod found is Temora velox, known for a long time as an inhabitant of brackish waters. This species appears to have adapted itself in a special manner to extreme conditions of existence in the Baltic, for it has spread out everywhere there and is so abundant as to play an important part in the nourishment of certain fish.

A change similar to the above has been found among the *Mollusca*. Species of Limnaea, such as L. palustris and pereger, replace the Littorina species. When the salinity of the water is low along the coast the two forms are found living together, and with them is also found a river form, Neritina fluviatilis. Common forms of Planorbis and Bythinia have been enumerated from the Baltic in addition to the Limnaeas and Neritinas. In the Gulf of Bothnia many of the common air-breathing pond snails have habituated themselves to the slightly saline waters of that part of the Baltic (Forbes, p. 90, 231; O'Connell, p. 71).

There is a very rapid decrease eastward in the number of species comprising the whole fauna. Möbius (1872, p. 279; 1873, p. 138) describes the Baltic as being faunistically divided into two basins, a western and an eastern; the former marked by a rich fauna, the latter by a strikingly impoverished one. In his earlier report on the Baltic fauna (1872, p. 277), he gives the total number of observed invertebrate animals as amounting to about 200 species (exclusive of infusorians and crinoids), only one-fifth of which were found in the eastern basin of the Baltic which begins between Rügen and the southern extremity of Sweden. In the later report (1873), this number is increased to 241 species for the western basin (exclusive of infusorians, rhizopods, ostracods) of which 69 have been found in the eastern. The following table (after O'Connell, p. 72) shows the rapid decrease in the species of the Baltic fauna and gives a comparison of that fauna with a normal marine fauna:

Comparative number of species of invertebrates in the Baltic, etc.

Phyla	*Waters around Great Britain*	*Baltic as a whole*	*Bay of Kiel*	*Bay of Trave-munde*
	35 permille	78 permille	20 permille	12 permille
Protozoa	69	....	....	....
Porifera	42	7	3	3
Coelenterata	98	28	24	8
Echinodermata	48	6	5	2
Vermes	101	68	50	26
Bryozoa	....	11	8	5
Crustacea	....	50	36	19
Mollusca	682	68	64	40
Tunicata	....	5	4	4
Total	1040	243	194	107

Another striking change has been noted in the character of the Baltic fauna which may likewise be correlated with the variation in salinity. As the stenohaline forms disappear entirely, euryhaline forms become *dwarfed*. Möbius (1873, p. 138) reports dwarfing of worms, and of a copepod, very noticeable even in the short distance from Arendal (Norway coast, on Skager Rak) to Kiel. The dwarfing of fishes has also been noted (*see* O'Connell, p. 72). The animals of the eastern basin are more dwarfed than in the western basin, and the best examples are found among the mollusks, in which group in addition to being dwarfed, the shells become poor in lime.

Mytilus edulis at Kiel attains a length of 8-9 cm; in the eastern basin (for example at Stolpe bank, Gotland and Dalarö) this mollusk reaches a length of only 3-4 cm. In the clayey mud of the sea bottom in various places in the eastern basin are found very many conchiolin coverings of Mytilus edulis and Macoma balthica (groenlandica); often the two brown conchiolin coverings are still bound together by the ligament at the back in complete shell form. This occurrence is readily explained. It has been found in the case of these two species, in the eastern basin, that the lime layers of the shell are extraordinarily thin, and therefore so brittle that they can be easily crushed between the fingers. Because of its thinness, the lime layer of the shells is very soon dissolved after the death of the animal (Möbius 1873, p. 138).

A very noteworthy case of dwarfing is exemplified by Cardium edule, the common European cockle, which has a large, rough, thick shell and thrives best under purely marine conditions. This species " in the North sea, of normal marine salinity, is the size of a small apple; at Stockholm, where the salinity is below 10 permille, the shell in the deeper, more saline water is only as large as a walnut and is even smaller along shore where the water is fresher. At Königsberg, with the decreasing salinity, the size reaches that of a hazelnut, whereas at Reval, it is only the size of a pea " (O'Connell, p. 72). The studies made of the Baltic sea have shown that the fauna of a brackish-water body of the nature of the Baltic is due to a mingling of marine species and fresh-water (river) species which, however, are modified. Only the most euryhaline marine species survive. A very important fact brought out is that, however dwarfed or otherwise modified the species may be, the marine forms of the Baltic are not different specifically from those living in water of normal marine salinity nor do the fresh-water forms differ specifically from those found in the rivers emptying into the Baltic or those in nearby fresh-water bodies (Forbes, p. 90; Pouchet & de Guerne, p. 920, 921).

Examples of dwarfing due to freshening of sea water have been noted elsewhere than in the Baltic. Cardium edule, which is common along the British coast, is found in a dwarfed condition in the brackish waters of the estuaries. The shell is invariably reduced in size, and in addition is thin and with less strongly marked external characters. The cockle of the Greenland estuaries is likewise thin, smooth and almost edentulous; in each valve of the young shells are found rudiments of a single tooth which finally disappear. This species of Cardium is very abundant in the Pliocene (Crag) of Suffolk and Norfolk, but is not now found in Europe (Forbes, p. 213–14; *see* Shimer, p. 474).

Both the Caspian and Black seas have fresher water than the Atlantic ocean, due to the many streams emptying into them. The fauna in each case is typically marine and the species are the same as those in the Atlantic, but in these seas they are practically all dwarfed in size as compared to the Atlantic specimens. Ten species of Cardium are found in the Caspian sea, small, thin, with lateral or central teeth or both suppressed. Often one tooth alone is preserved; at times it acquires a great development and is accompanied by great distortion of the shell on that side. These are all aberrant forms, all related back to Cardium edule. The same is true of the cockles of the Black sea (Forbes, p. 201–2, 211–15; *see* Shimer, p. 473, 474). Among other species dwarfed by brackish water are Mya arenaria and Littorina littorea.

In general, species that live in both normal sea water and in brackish water are smaller in the latter. There are some exceptions to this (Forbes, p. 230; *see* Shimer, p. 474), as, for example, Scrobularia and Mactra solida. These forms have become thoroughly adapted to a brackish water environment, and, moreover, attain their largest size there.

Modifications due to changes in the salt content of water are not confined to invertebrates alone; and while this paper is concerned with invertebrate species only, it is not amiss here to point out a case or two in which a higher group, the fishes, are affected. The dwarfing of fishes in the Baltic has been noted above. Forbes (p. 204) shows that the fishes of the Black sea are very indicative of the estuarine character of its waters. The number of species is remarkably small when compared with those of the Mediterranean; but on the other hand the number of individuals is marvelously great. Lull (p. 172) points out ontogenetic variation dependent upon the chemical content of the water in little fishes known as sticklebacks (Gasterosteus cataphractus). "Those living in salt water have from twenty to thirty bony plates along the back, in brackish water these are reduced to from fifteen to three, while in fresh water there are none at all."

Pleistocene Fossils of the Champlain Sea

Part 1 *Decrease in Species Southward*

A careful list, with localities, has been compiled of the marine Pleistocene invertebrate species collected by the writer and also all those reported by others in various publications; and these have been tabulated to show the distribution of the species from Labrador to the southernmost locality from which they have been collected in the Pleistocene of the Champlain valley.

Table showing distribution of marine Pleistocene invertebrate fossils

Species	Labrador	Anticosti	Rivière-du-Loup	Murray Bay	Quebec and vicinity	Montreal	Ottawa and vicinity	Valcour Is., N. Y.	Port Kent, N. Y.	Burlington, Vt. and vicinity	Willsboro, N. Y.	Port Henry, N. Y. and vicinity	Chimney Point, Vt.	Crown Point, N. Y.	Crown Point Station vicinity, N. Y.
FORAMINIFERA															
Nodosaria laevigata d'Orb.	...	...	...	...	...	×	...	...	...	...	...	...	...	...	...
Lagena sulcata (W. & J.)	...	×	×	×	×	×	...	...	...	...	...	...	...	...	...
Entosolenia globosa Will.	×	×	×	×	×	×	...	...	...	...	...	...	...	...	...
" costata Will.	×	×	×	×	×	×	...	...	...	...	...	...	...	...	...
" marginata Will.	×	×	×	×	×	×	...	...	...	...	...	...	...	...	...
" squamosa Will.	×	×	×	×	×	×	...	...	...	...	...	...	...	...	...
Bulimina presli P. & J.	×	...	×	×	×	×	...	...	...	...	...	...	...	...	...
Polymorphina lactea Adams	×	...	×	×	...	×	...	...	...	...	...	...	...	...	...
Truncatulina lobatula (W. & J.)	×	×	×	...	...	...	...	...	...	...	...	...	...	...	...
Orbulina universa d'Orb.	×	...	×	...	...	×	...	...	...	...	...	...	...	...	...
Globigerina bulloides d'Orb.	...	×	×	...	...	...	...	...	...	...	...	...	...	...	...
Pulvinulina repanda (F. & M.)	×	...	×	×	×	×	...	...	...	...	...	...	...	...	...
Polystomella crispa (Linn.)	×	...	×	×	×	×	×	...	...	...	...	...	...	...	...
Nonionina scapha (F. & M.)	×	×	×	×	×	×	...	...	...	...	...	...	...	...	...
Textularia pygmaea d'Orb.	×	...	×	...	×	...	...	...	...	...	...	...	...	...	...
Cornuspira foliacea (Phil.)	...	...	...	...	...	×	...	...	...	...	...	...	...	...	...
Quinqueloculina seminulum Linn.	×	...	...	...	×	×	...	...	...	...	...	...	...	...	...
Biloculina ringens d'Orb.	×	...	×	×	×	×	...	...	...	...	...	...	...	...	...
Triloculina tricarinata d'Orb.	...	...	×	×	×	...	...	...	...	...	...	...	...	...	...
Rotalina? turgida Wms.	...	...	×	...	...	...	...	...	...	...	...	...	...	...	...
PORIFERA															
Tethea logani Daw.	...	...	...	...	...	×	×	...	...	...	...	...	...	...	...
Tethea?	...	...	×	...	...	×	...	...	...	×	...	...	...	...	...
ECHINODERMATA															
Ophiacantha spinulosa M. & T.	...	...	...	...	...	×	...	...	...	...	...	...	...	...	...
Solaster (Crossaster) papposa M. & T.	...	...	...	...	...	×	×	...	...	...	...	...	...	...	...
Amphiura sp.	...	...	...	...	...	×	...	...	...	...	...	...	...	...	...
Euryechinus drobachiensis (Müll)	...	...	×	...	×	×	...	...	...	...	...	...	...	...	...
Echinus granularis Say	...	...	×	...	...	...	...	...	...	...	...	...	...	...	...
Psolus fabricii Dur. & Kor.	...	...	...	...	...	×	...	...	...	...	...	...	...	...	...
BRYOZOA															
Membranipora catenularia Jam.	×	...	×	...	×	...	...	...	...	...	...	...	...	...	...
" lacroixii Aud.	...	...	×	...	...	...	...	...	...	...	...	...	...	...	...
" lineata Linn.	...	...	×	...	...	...	...	...	...	...	...	...	...	...	...
Hippothoa expansa Daw.	...	...	×	...	×	...	...	...	...	...	...	...	...	...	...
Schizoporella hyalina John.	...	...	×	...	×	...	...	...	...	...	...	...	...	...	...
Lepralia pertusa Esper.	×	...	×	...	×	...	...	...	...	...	...	...	...	...	...
" quadricornuta Daw.	...	...	...	...	...	×	...	...	...	...	...	...	...	...	...
" spinifera? Bush	...	...	×	...	...	...	...	...	...	...	...	...	...	...	...
" violacea? John.	...	...	×	...	...	...	...	...	...	...	...	...	...	...	...
" variolosa John	...	...	×	...	...	...	...	...	...	...	...	...	...	...	...
" globifera Pack	...	...	×	...	...	...	...	...	...	...	...	...	...	...	...
Porella (Lepralia) belli Daw.	...	...	×	...	...	...	...	...	...	...	...	...	...	...	...
Porella elegantula (d'Orb.)	...	...	×	...	...	...	×	...	...	...	...	...	...	...	...
" compressa Sow.	...	...	×	...	...	...	...	...	...	...	...	...	...	...	...
Smithia producta (Pack.)	...	...	×	...	...	...	...	...	...	...	...	...	...	...	...
" trispinosa (John.)	...	...	×	...	...	...	...	...	...	...	...	...	...	...	...
Cribilina punctata? Hass.	...	...	×	...	...	...	...	...	...	...	...	...	...	...	...
Mucronella peachii John	...	...	×	...	...	...	...	...	...	...	...	...	...	...	...
" ventricosa Hass	...	...	×	...	...	...	...	...	...	...	...	...	...	...	...
Myriozoum planum Daw.	...	...	×	...	...	...	...	...	...	...	...	...	...	...	...
" subglaciale d'Orb.	...	...	×	...	...	...	...	...	...	...	...	...	...	...	...
Tubulipora fimbria Lam.	...	...	×	...	×	...	...	...	...	...	...	...	...	...	...
Idmonea atlantica Forbes	...	...	×	...	...	...	...	...	...	...	...	...	...	...	...
Diastopora obelia John.	...	...	×	...	...	...	...	...	...	...	...	...	...	...	...
Crisia eburnea Ellis	...	...	...	...	...	×	...	...	...	...	...	...	...	...	...
Alecto sp.	...	...	×	...	...	...	...	...	...	...	...	...	...	...	...
Lichenopora hispida (Flem.)	...	...	×	...	...	...	...	...	...	...	...	...	...	...	...
Celleporaria surcularis Pack.	...	...	×	...	...	...	...	...	...	...	...	...	...	...	...

Table showing distribution of marine Pleistocene invertebrate fossils (*continued*)

Species	Labrador	Anticosti	Rivière-du-Loup	Murray Bay	Quebec and vicinity	Montreal	Ottawa and vicinity	Valcour Is., N. Y.	Port Kent, N. Y.	Burlington, Vt. and vicinity	Willsboro, N. Y.	Port Henry, N. Y. and vicinity	Chimney Point, Vt.	Crown Point, N. Y.	Crown Point Station vicinity, N. Y.
BRACHIOPODA															
Rhynchonella psittacea Gm.	...	×	×	...	×	×	...	...	...	...	...	...	...	...	...
Terebratella labradorensis Sow.	...	...	×	...	...	...	...	...	...	...	...	...	...	...	...
" spitzbergensis David	...	...	×	...	...	...	...	...	...	...	...	...	...	...	...
LAMELLIBRANCHIATA															
Saxicava rugosa Lam. (= arctica L.)	×	×	×	×	×	×	×	×	×	×	×	×	...	...	...
Panopaea norvegica Speng	...	...	×	...	...	...	...	...	...	...	...	...	...	...	...
Mya arenaria Linn	×	×	...	×	×	×	...	×	×	×	...	...	...	...	...
" truncata Linn	×	×	×	...	×	×	...	...	×	...	...	...	...	...	...
Lyonsia arenosa Möll	...	...	×	...	...	×	...	...	...	...	...	...	...	...	...
Macoma groenlandicaBeck (=balthica L.)	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
Macoma calcarea Chem.	×	×	×	×	×	×	×	×	×	×	...	...	...	...	...
" inflata Stim	...	...	×	...	...	×	...	...	...	...	...	...	...	...	...
Cyrtodaria siliqua Daud	...	...	×	...	...	...	...	...	...	...	...	...	...	...	...
Venericardia borealis Con.	×	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Astarte laurentiana Lyell	...	...	×	...	×	×	×	×	...	...	...	...	...	...	...
" banksii Leach	×	×	×	...	×	×	×	...	...	...	...	...	...	...	...
" lactea Brod. & Sow.	×	...	×	×	...	...	...	...	...	...	...	...	...	...	...
" arctica Möll	×	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Cardium islandicum Linn.	...	...	×	×	...	...	...	...	...	...	...	...	...	...	...
" dawsoni Stim.	...	...	×	...	...	...	...	...	...	...	...	...	...	...	...
" (Serripes) groenlandicum Chem.	×	...	×	×	×	...	...	...	...	...	...	...	...	...	...
Cryptodon gouldii Phil.	...	...	...	...	...	×	...	...	...	×	...	...	...	...	...
Mytilus edulis Linn	×	×	×	...	×	×	×	...	×	×	×	×	...	...	...
Modiola modiolus Linn	...	...	...	...	...	×	...	...	...	...	...	...	...	...	...
Modiolaria nigra Gray	...	...	×	...	...	×	...	...	...	...	...	...	...	...	...
" corrugata Stim.	...	...	×	...	...	...	...	...	...	...	...	...	...	...	...
" discors Linn.	...	...	...	...	×	×	...	...	...	...	...	...	...	...	...
Nucula tenuis Mont.	...	...	×	...	...	×	×	...	...	×	...	...	...	...	...
" expansa Reeve	...	...	×	...	...	...	...	...	...	×	...	...	...	...	...
Leda pernula Müll	...	...	×	...	...	...	...	...	...	...	...	...	...	...	...
Leda minuta Fabr	×	...	×	...	...	×	×	...	...	×	...	...	...	...	...
Yoldia arctica Gray	...	...	×	...	×	×	×	...	×	×	×	...	×	...	...
" limatula Say	...	...	×	...	...	...	...	...	...	...	...	...	...	...	...
" myalis Couth	×	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Pecten islandicus Chem.	×	×	×	...	×	...	...	...	×	...	...	...	...	...	...
Ostrea virginiana Lister	...	...	...	...	...	×	...	...	...	...	...	...	...	...	...
GASTROPODA															
Philine lineolata Couth	...	...	...	...	...	×	×	...	...	...	...	...	...	...	...
Cylichna alba Br wn	...	...	×	...	...	×	×	...	×	...	...	...	...	...	...
" ory a Totten	...	...	...	...	...	×	...	...	...	...	...	...	...	...	...
" nucleola Reeve	...	...	...	...	...	×?	...	...	...	...	...	...	...	...	...
" occulta Migh. & Ad	...	...	...	×	...	×	...	...	...	...	...	...	...	...	...
" striata Brown	...	...	×	...	...	...	...	...	...	...	...	...	...	...	...
Haminea solitaria Say	...	...	...	...	...	×	×	...	...	...	...	...	...	...	...
Diaphana debilis Gould	...	...	...	...	...	×	...	...	...	...	...	...	...	...	...
Utriculus pertenuis Migh	...	...	...	...	...	×	...	...	×	...	...	...	...	...	...
Siphono-dentalium virtreum Sars	...	...	...	×	...	...	...	...	...	...	...	...	...	...	...
Amicula emersonii Couth	...	...	...	...	...	×	...	...	...	...	...	...	...	...	...
Puncturella noachina Linn	...	...	×	...	×	...	...	...	...	...	...	...	...	...	...
Acmaea testudinalis Möll	×	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Lepeta coeca Möll	×	...	×	...	×	×	...	...	...	...	...	...	...	...	...
Capulus ungaricus Linn	...	...	...	...	×	×	...	...	...	...	...	...	...	...	...
Crepidula fornicata Linn	...	...	...	...	...	×	...	...	...	...	...	...	...	...	...
Margarita helicina Fabr	...	...	...	×	...	×	...	...	...	...	...	...	...	...	...
" argentata Gould	...	...	...	...	...	×	...	...	...	...	...	...	...	...	...
" cinerea Couth	...	...	×	...	...	...	...	...	...	...	...	...	...	...	...

Table showing distribution of marine Pleistocene invertebrate fossils (*continued*)

Species	Labrador	Anticosti	Rivière-du-Loup	Murray Bay	Quebec and vicinity	Montreal	Ottawa and vicinity	Valcour Is., N. Y.	Port Kent, N. Y.	Burlington, Vt. and vicinity	Willsboro, N. Y.	Port Henry, N. Y. and vicinity	Chimney Point, Vt.	Crown Point, N. Y.	Crown Point Station vicinity, N. Y.
Cyclostrema costulata Möll						×									
" cutleriana Clark						×									
Turritella erosa Couth	×		×			×									
" reticulata Migh	×														
" acicula Stim	×		×												
Littorina rudis Martin			×												
" palliata Say			×												
Rissoa castanea Möll						×									
" exarata Stim						×									
Cingula jan meyeri Friele						×									
Bela harpularia Couth	×		×	×	×	×									
" elegans Möll				×		×									
" pyramidalis Ström						×									
" turricula Mont			×			×									
" trevelliana Turton	×		×												
" violacea Migh. & Adams						×									
" cancellata Migh. & Adams	×			×											
Natica cl usa Brod. & Sow	×	×	×		×	×									
Lunatia heros Say					×										
" groenlandica Beck		×	×		×	×	×								
Choristes elegans Cpr						×									
Velutina zonata Gould					×	×									
Scalaria groenlandica Perry			×		×										
Acirsa eschrichtü Holb			×		×	×									
Trichotropis borealis Brod. & Sow	×		×			×									
" arctica? Midd						×									
Admete viridula Fabr					×	×	×								
Aporrhais occidentalis Beck	×														
Ptychatractus ligatus (Migh.)						×									
Astyris holbolli Möll			×												
Menistho albula Möll			×												
Buccinum undatum Linn	×	×	×												
" totteni Stim			×												
" cyaneum Brug			×												
" groenlandicum Chem			×												
" tenue Gray			×												
" scalariforme Möll			×												
" ciliatum Fabr			×			×									
" cretaceum Reeve			×												
" glaciale Linn	×	×	×			×									
" plectrum Stim			×												
Tritonofusus krayeri Möll	×		×												
Sipho spitzbergensis Reeve						×									
Neptunea despecta Linn	×		×	×	×	×	×								
Trophon scalariforme Gould	×		×	×		×									
" clathratum Linn		×	×	×		×									
ANNULATA															
Serpula vermicularis Linn			×	×		×	×								
Vermilia serrula Stim			×												
Spiochaetopterus typus Sars	×														
Spirorbis glomerata Müll	×		×												
" vitrea Fabr	×		×	×	×	×									
" borealis Daud			×												
" lucidus Flem			×												
" nautiloides Lam			×												
" carinata Mont			×												
" sinistrorsa Mont			×												
" quadrangularis Stim			×												

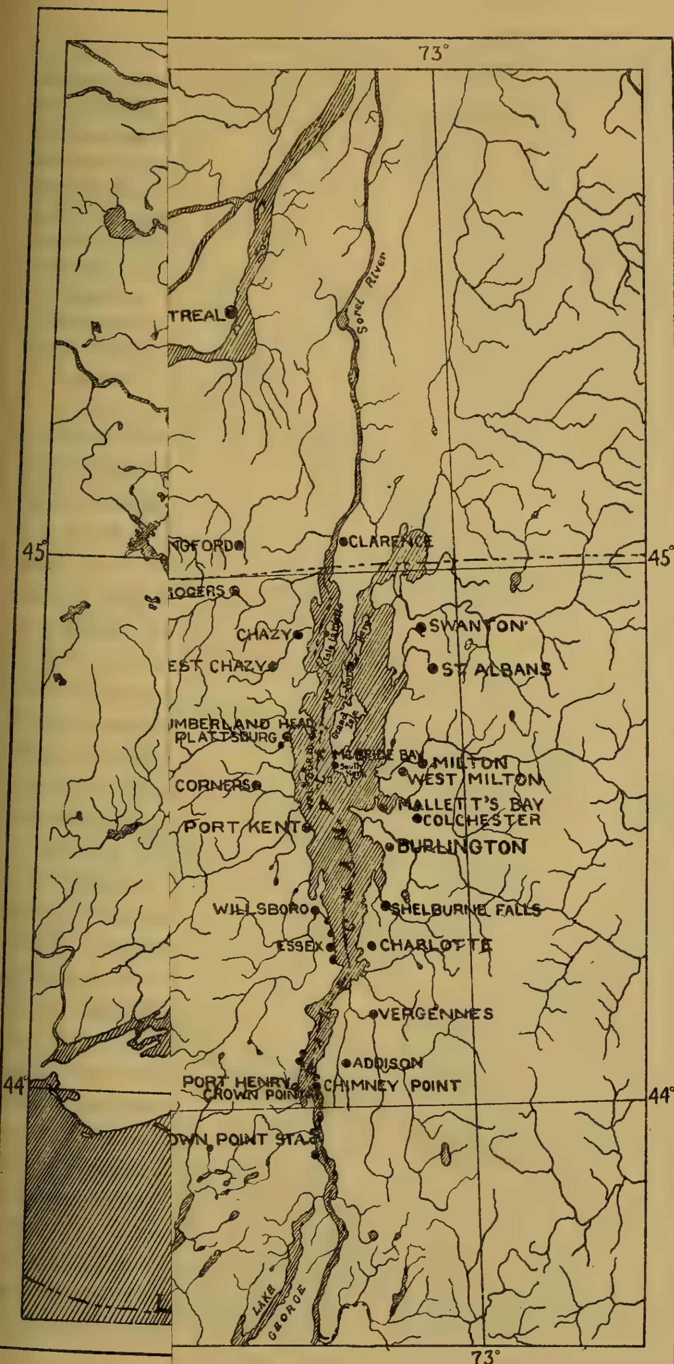
Table showing distribution of marine Pleistocene invertebrate fossils (*concluded*)

Species	Labrador	Anticosti	Rivière-du-Loup	Murray Bay	Quebec and vicinity	Montreal	Ottawa and vicinity	Valcour Is., N. Y.	Port Kent, N. Y.	Burlington, Vt. and vicinity	Willsboro, N. Y.	Port Henry, N. Y. and vicinity	Chimney Point, Vt.	Crown Point, N. Y.	Crown Point Station vicinity, N. Y.
CRUSTACEA															
Balanus hameri Asc.	...	×	×	...	×	×	...	...	...	...	...	...	...	...	...
" porcatus Da Costa	...	...	...	...	×	...	...	...	...	...	...	...	...	...	...
" crenatus Brug.	×	×	×	...	×	×	×	×	×	×	×	...	...	...	...
Eupagurus bernhardus? Fabr.	...	...	×	...	...	...	...	...	...	...	...	...	...	...	...
Hyas coarctata Leach	...	...	×	...	...	...	...	...	...	...	...	...	...	...	...

In addition to the species listed in the table there are nine species, each reported only from one locality but not from any of the lower St Lawrence localities: from Ottawa and vicinity, Dentalina sp., Leda pygmaea, Natica affinis, Nereis pelagica; from Port Kent, Tritonium anglicum, T. fornicatum (Emmons, Geol. of N. Y., 2d Dist., 1842, p. 128); from Burlington and vicinity, Yoldia obesa, Y. siliqua, Nucula abyssicola. An old collection of Pleistocene fossils from the Champlain valley in the State Museum contains Rhynchonella psittacea, Mya truncata, Buccinum glaciale, B. ciliatum, B. cyaneum, Balanus hameri; but as no localities were given for these species they can not be used in the lists. The distribution of the total number of species is summarized in the comparative table which follows:

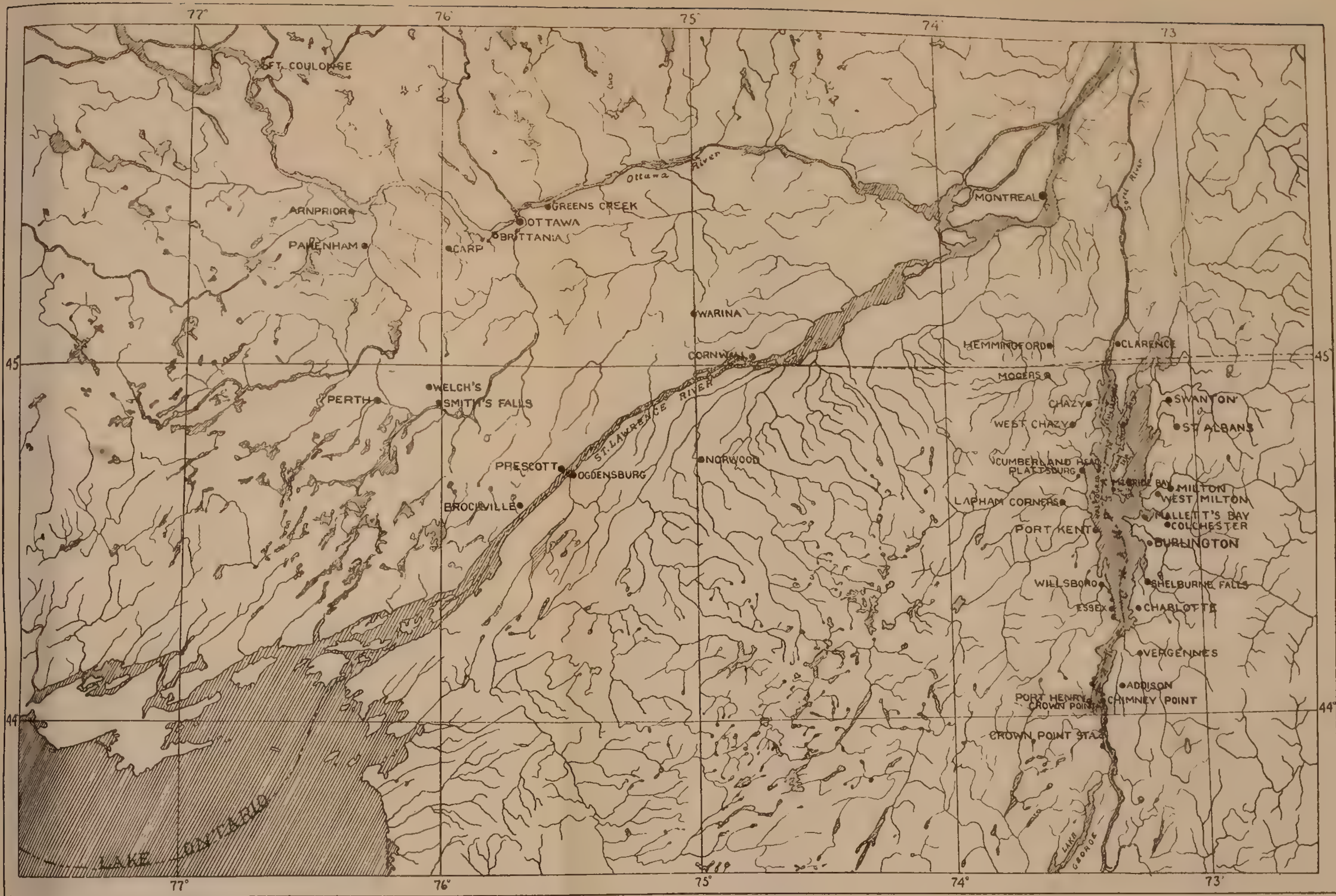
Phyla, etc.	All localities	Labrador to Rivière-du-Loup and Murray Bay	Quebec and vicinity	Montreal	Ottawa and vicinity	Valcour Is.	Port Kent	Burlington and vicinity	Willsboro	Port Henry and vicinity	N. of Chimney Point	Crown Point	Crown Point Station vicinity
Foraminifera	21	18	13	15	2	....	....	....	....	....	....	....	....
Porifera	2	1	....	2	1	....	....	1	....	....	....	....	....
Echinodermata	6	2	1	5	1	....	....	1	....	....	....	....	....
Bryozoa	28	26	5	2	1	....	....	1(?)	....	....	....	....	....
Brachiopoda	3	3	1	1	....	....	....	....	....	....	....	....	....
Mollusca { Lamellibranchiata	37	28	12	18	10	5	8	13(?)	4	3	2	1	1
Mollusca { Gastropoda	68	41	12	40	7	....	4	....	....	....	....	....	....
Annulata	11	11	1	2	2	....	....	....	....	....	....	....	....
Crustacea	5	4	3	2	1	1	1	1	1	....	....	....	....
Total	183	134	48	89	25	6	13	17(?)	5	3	2	1	1

Of the 25 species found at Ottawa and vicinity, 4 (listed above) have not been reported elsewhere; of the other 21 all except 1 (Porella elegantula) occur likewise at Montreal.



Map I. Map

$\frac{1}{\ 504000}$; approximately 15 miles to the inch.



Map 1. Map showing localities [●] in the Champlain basin, and a part of Canada, where marine Pleistocene fossils have been found. Scale $\frac{1}{950400}$; approximately 15 miles to the inch.

Ottawa and Vicinity

Dentalina sp.	Nucula tenuis
Polystomella crispa	Astarte banksii
Tethea logani	A. laurentiana
Solaster papposa	Cylichna alba
Porella elegantula	Natica affinis
Saxicava rugosa	Lunatia groenlandica
Mytilus edulis	Neptunea despecta
Macoma groenlandica	Admete viridula
M. calcarea	Haminea solitaria
Yoldia arctica	Philine lineolata
Leda minuta	Serpula vermicularis
L. pygmaea	Balanus crenatus

From Green's creek and Besserer's wharf, Ottawa river, about 8 miles below Ottawa, have been reported Saxicava rugosa, Macoma groenlandica, Yoldia arctica, Leda pygmaea, Nucula tenuis, Solaster papposa and Nereis pelagica. In addition there have been found in the clay nodules at this locality remains of three species of fish: a capelin, Mallotus villosus (abundant); a lump sucker, Cyclopterus; a species of stickleback, Gasterosteus. There have also been found remains of fresh-water plants, several birds, mammals etc., which show that the Leda clay was not far from the shore when clay with drift material was brought down by the rivers. Leda (Yoldia) may occur in moderately deep water; the other fossils suggest shallow water (Coleman, p. 131).

Marine Pleistocene shells have been reported from numerous localities in Canada, some of which are shown on the accompanying map of localities (map 1). The two commonest and most abundant shells reported are Saxicava rugosa and Macoma groenlandica. Brockville, Ont., is the most southern and most inland point at which Pleistocene fossils have been found. At Pakenham Mills, 30 miles southwest of Ottawa, the only marine shell reported is Macoma groenlandica, a species now found farther up in the estuaries than most others (Dawson, 1894, p. 58). The line marking the limit of known marine fossils extends from Brockville through Perth, northwest to Fort Coulonge on the Ottawa river. "Gravels, sands and clays not unlike the marine deposits...occur at various places west of Brockville...and some of them have been searched carefully for fossils, but without success, suggesting that for some cause the marine fauna could not advance into the Ontario basin" (Coleman, p. 134).

In New York State, marine fossils of this period cease in the westward extension before the beds reach Morristown, opposite Brockville. So far, the most western locality from which they have been reported is Ogdensburg. Marine fossils have been found in New York from north to south as follows:

1 Ogdensburg

Macoma groenlandica
M. calcarea
Saxicava rugosa
Cylichna alba (?)

2 Mooers

Macoma groenlandica
Saxicava rugosa
Yoldia arctica
Balanus sp. (fragments, rare)

3 Freydenburg's Mills, Saranac R.

Saxicava rugosa
Macoma groenlandica
Mytilus edulis
Balanus sp.

4 Cumberland Head, Plattsburg

Macoma groenlandica
Mya arenaria

5 Lapham Corners

Mytilus edulis
Macoma groenlandica

6 Valcour Is.

Saxicava rugosa
Macoma groenlandica
Mya arenaria
Astarte laurentiana (rare)
Balanus crenatus

7 Port Kent

Saxicava rugosa
Macoma groenlandica
M. calcarea (rare)
Mya arenaria
M. truncata
Mytilus edulis
Yoldia arctica
Pecten islandicus
Cylichna alba (not frequent)
Utriculus pertenuis (rare)
Tritonium anglicum
T. fornicatum
Turritella sp.
Balanus crenatus

8 Willsboro

Saxicava rugosa
Macoma groenlandica
Mytilus edulis
Yoldia arctica (rare)
Balanus crenatus

9 Port Henry (few miles north of)

Macoma groenlandica
Saxicava rugosa
Mytilus edulis (fragments, rare)

10 Crown Point

Macoma groenlandica

11 Crown Point station (mouth of Putnam Creek, ½ mile north)

Macoma groenlandica

12 Crown Point station (2 miles south, along shore)

Macoma groenlandica

In addition to the places listed above, Macoma groenlandica has been found at Norwood, in the vicinity of Chazy, and at Essex and southward.

In Vermont the greatest number of species have been reported from the vicinity of Burlington, probably because that area has been better searched. The writer has found in the clays about a mile north of Burlington a Balanus crenatus, not hitherto reported from that state, and in the clays just north of Chimney Point Yoldia arctica, not before reported so far south as this. The fossils in Vermont have been found from north to south as follows:

1 *McBride Bay, South Hero*

Mya arenaria
Macoma groenlandica
Saxicava rugosa

2 *Burlington and vicinity*

Macoma groenlandica
Saxicava rugosa
Yoldia arctica
Balanus crenatus (rare)

3 *Mallett's Bay, north of Burlington*

Ophioglypha sarsii
Lepralia sp.
Macoma groenlandica
M. calcarea
Saxicava rugosa
Mya arenaria
Mytilus edulis
Yoldia arctica
Yoldia obesa
Leda minuta
Nucula tenuis
N. expansa
N. abyssicola
Cryptodon gouldii

4 *Colchester*

Macoma groenlandica
Saxicava rugosa
Mya arenaria
Yoldia obesa
Yoldia siliqua
Tethea sp.

5 *Chimney Point*

Macoma groenlandica
Yoldia arctica (rare)

In addition, Mytilus edulis has been reported from Isle La Motte, Mya arenaria from Providence island, and Yoldia obesa from St Albans. Shells also have been noted at Swanton, Milton Falls, Milton, West Milton, Chickering Village, Shelburne Falls, Charlotte, Vergennes and Addison, but no lists of species have been given.

The above tables and lists bring out the fact that the number of Pleistocene species is considerably reduced at Ottawa and vicinity, while from Pakenham Mills about 30 miles southwest of Ottawa, not far from the most western limit for *marine* fossils, is reported only Macoma groenlandica. In the Champlain valley the number of species decreases rapidly until at Willsboro, N. Y., only five species are represented.

Emmons (p. 283) states that two species of Pleistocene fossils are found the entire length of Lake Champlain. As a matter of fact only one species, Macoma groenlandica, has been found at the southernmost locality (*see* Woodworth, p. 215). Emmons reports no species south of Crown Point, and I have nowhere found a record of any such southern extension of this fauna; but Prof. John H. Cook in the course of some field work for the State Museum recently (1920) discovered two new localities for Macoma groenlandica, both of them farther south than Crown Point. One locality is along the shore near the mouth of Putnam creek, about one-half of a mile north of Crown Point station; the other is about 2 miles south of Crown Point station, just east of Breeds Hill, and the specimens were not visible in the deposits along the shore, but were dredged from the clay in the lake bottom. This second locality is about 8 miles farther south than the Crown Point area.

Four species extend down the greater part of the Champlain valley. Yoldia arctica found recently, together with Macoma groenlandica, just north of Chimney Point, Vt., has almost as great a range as the latter. Saxicava rugosa and Mytilus edulis were found a few miles north of Port Henry, and have not been found farther south. Only fragments of Mytilus edulis were found and these infrequently, which would indicate that this species was not represented in large numbers as far south as this. Balanus crenatus has not been reported south of Willsboro, nor Mya arenaria south of the Port Kent and Burlington areas. No gastropods occur south of Port Kent, which is the only locality in the Champlain valley from which they have been reported; and only four species have been found here. This does not take account of the three species of Buccinum reported, without locality, from the Champlain valley. The other phyla, Foraminifera, Porifera, Echinodermata, Bryozoa, Brachiopoda and Annulata, are almost without representation in the Champlain area. A specifically unidentified sponge (Tethea sp.) is listed as occurring at Colchester, Vt., and a bryozoan (Lepralia sp.) at Mallett's Bay, Vt. From this latter place one echinoderm also has been reported. Rhynchonella psittacea has been reported from the Champlain valley without a locality and Euryechinus drobachiensis is similarly listed from Vermont; so these citations can have little value in the present problem.[1]

[1] The basin was also open to large marine animals, such as whales and seals (Dawson, 1894, p. 267, 268; Perkins, 1907–8, p. 76, 80, 81, 102).

So far account has been taken only of the occurrence of marine Pleistocene invertebrate fossils. While it is not intended here to place too great weight upon the occurrence of fresh-water fossils, nevertheless, considering the conditions found in the Baltic, the possible significance of the association of marine and fresh-water forms in Pleistocene deposits should not be overlooked. At Clarenceville, an outport of Missisquoi county, Quebec, between the Richelieu river and Missisquoi bay, four species of fresh-water fossils are found in the deposits with Mya arenaria and Macoma groenlandica. Three of these species, Unio rectus Lam., Unio cardium? Rafinesque, Unio ventricosus Barnes, are represented by large and thick shells better developed than those of the St Lawrence river at present. A species of Limnaea also occurs here (Dawson, 1894, p. 58, 238). A similar occurrence of fresh-water fossils has been noted (Ref. cit., p. 238, 245, 246, 248) at Pakenham Mills, in Lanark county, about 30 miles southwest of Ottawa, and about 20 miles east of the western limit of known marine fossils (Coleman, p. 130). A Sphaerium? was found here associated with fresh-water bivalves and Macoma groenlandica, but the specimens were too imperfect for certain determination. Other species reported from the Saxicava sand and Leda clay of this locality are:

Amnicola limosa (Say)	Valvata tricarinata Say
A. porata (Say)	Planorbis bicarinata Say
Limnaea palustris Müller	P. trivolvis Say
L. elodes? Say	P. parvus Say
Patula (Pyramidula) striatella Anthony	Campeloma decisum Say

From the villages of Avonmore and Monklands, south of Ottawa, Coleman (p. 132) reports fresh-water shells of at least eleven species. At Montreal were found two species of Limnaea, L. umbrosa Say and L. caperata Say (Dawson, 1894, p. 245), and from Mallett's Bay, Vt., (Perkins, 1909–10, p. 55) is reported Helix (Pyramidula) striatella found in the Leda clay. In the Montreal and Vermont areas the fresh-water species very probably were carried in by streams. The occurrence of fresh-water fossils together with Macoma groenlandica and Mya arenaria at Clarenceville is very suggestive of estuarine conditions. The Pakenham Mills area, to which fresh-water fossils are peculiar, is of great interest in this connection. Two of the genera, Planorbis and Limnaea, and one species, Limnaea palustris, which were found adjusted to the slightly saline waters of the upper Baltic, are represented here. It is quite possible that all or part of these forms were carried in by rivers; but the situation of Pakenham Mills near the western limit of known marine fossils is significant and in favor of brackish-water conditions there, and consequent adjustment of the fresh-water forms to this condition. Also, as noted above, the only marine shell found is Macoma groenlandica, which is now found farther up in the estuaries than most others.

There is evidence of freshening of the sea westward. In the region west of the fossiliferous beds, at higher levels, are beachlike deposits of sand and gravel and also stratified clays resembling the Leda clay which are believed by some to be of marine origin, but by others (see Coleman, p. 136, 145) to be of fresh-water origin. Coleman says: " That the old sea level at 350 feet continued into the Ontario basin, and may even have reached its western end seems very probable, and the fact that marine fossils are very abundant east of Brockville, but have never been found to the west, may be accounted for by the narrowing of the lower end of the basin forming a strait not very much wider than the present river and only 100 feet deeper; so that Niagara and the other rivers flowing into Lake Ontario were able to keep the waters fresh, or at least only brackish, in spite of their communication with the enlarged Gulf of Saint Lawrence " (Ref. cit., p. 136).

Part 2 *Dwarfing of Species and Other Modifications*

Dwarf faunas may be divided into two classes: (1) " faunas where the individuals are of smaller size than that to which the species grows under normal conditions; this is the result of an abnormal habitat; (2) faunas where all the individuals are small but of the normal size of the species; in this case some selective action has weeded out all the large and heavy species, leaving a dwarf but not stunted fauna. Dwarf faunas usually include representatives of both classes " (Shimer, p. 490). This, from the data gathered, seems to be true of the Champlain Pleistocene fauna. The dwarfed character of this fauna is well shown by five species: Macoma groenlandica, Saxicava rugosa, Mytilus edulis, Mya arenaria, Yoldia arctica (see plates 1-3). Through the kindness of Doctor Pilsbry, I have obtained for comparison recent specimens of these species, in addition to those in the State Museum.

It is well, perhaps, to give approximately some idea of the numbers of individuals of the different species, upon which comparisons are based. The specimens of Macoma groenlandica collected at Montreal numbered about 225; at Ottawa and vicinity, about 50; at McBride Bay, South Hero, 150; at Cumberland Head, over 300; at Valcour island, over 160; at Lapham Corners, 115; at Port Kent, over 1000; at Burlington and vicinity, over 200; at Willsboro, several hundred; at Essex, over 150; at Port Henry vicinity, over 250; at Chimney Point, about 150; at Crown Point, over 150. The specimens of Yoldia arctica collected at Ottawa and vicinity numbered over 450 (about 375 at Ottawa); at Burlington and vicinity, about 75 (largely fragmentary); at Port Kent, over 350; at Willsboro, about 20; at Chimney Point 12 (fragmentary). The specimens of Saxicava rugosa, collected at Montreal numbered 110; at Ottawa and vicinity (almost entirely Green creek), about 275; at South Hero, 3 (small); at Burlington and vicinity, 7 (fragmentary); at Port Kent, about 300; at Willsboro, about 300. The specimens of Mytilus edulis collected at Lapham Corners numbered several hundreds; at Port Kent, 20+ (fragmentary); at Willsboro, 25+ (fragmentary); at Port Henry, few small fragments. Specimens of Mya arenaria were collected to the number of several hundreds at McBride bay, South Hero, and at Cumberland Head; at Valcour island, about 25+ specimens (largely fragmentary).

Macoma groenlandica is the only species found extending the entire length of Lake Champlain, the most southern occurrence, as noted above, being 2 miles south of Crown Point station. Professor Cook, in reporting the two new occurrences for this species stated that, so far as he could recall, the shells in size and character resembled those from Crown Point. The writer has not, as yet, had any opportunity for studying the shells collected in the vicinity of Crown Point station; and therefore it is the specimens from the Crown Point area, about 8 miles farther north, that are used here for purposes of comparison. The recent shells used in comparison are from the New Jersey and New York coasts. The largest recent shell examined has a length of 33.4 mm and a width of 25.5 mm. The other shells vary from 25 mm to 31.3 mm in length by 19 mm to 26 mm in width. The largest shells found at Montreal were in a fragmentary condition, but in proportion to the measurements of the other shells must have reached a length of 24 mm to 25 mm with a width of 20 mm to 21.5 mm. These very large shells were found to be fewer in number; a large proportion measure from 19 mm to 22.5 mm in length by 16 mm to 20 mm in width. The majority of the shells found, or what might be termed the average shells, are around 17 mm to 18 mm in length by 14 mm to 16.5 mm in width. At Crown Point, the largest shell found had a length of 15 mm and a width of 11.6 mm. The large shells are few and run from a little under 13 mm to 14 mm in length by 10 mm to 11 mm in width. Average specimens measure 10 mm to 12 mm in length by 7 mm to 10 mm in width. These measurements show that at Montreal the largest shells of M. groenlandica found are about the size of the average-sized recent individuals; while the average-sized Montreal specimens run much under this. The largest shells found at Crown Point are less than one-half the size of the largest recent ones and less than three-fifths the size of the largest shells from Montreal. The average Crown Point shells are half, or less, the size of average recent shells, and three-fifths, or slightly over, the size of average Montreal specimens. The Montreal specimens may be regarded as typically marine, and those from Crown Point as dwarfed. Other localities show various gradations between these two points, but there is a general decrease in size southward. (*See* plate 1, figures 6, 7, 8.)

M. groenlandica in the vicinity of Ottawa runs smaller, so far as specimens collected show, than at Montreal. The largest specimens found at Green's creek measured 19.2 mm to 20 mm in length by 14.7 mm to 17.5 mm in width; a number of shells measured from 17.2 mm to 18.3 mm in length by 14.3 mm to 15.6 mm in width; the majority of the shells from here are even smaller, the average running 15.2 mm to 16.5 mm in length by 12 mm to 13.7 mm in width. The average-sized shells here then are 2 mm to 3 mm smaller than at Montreal. At Cumberland Head, near Plattsburg, N. Y., the largest shells, very few in number, run from 17.5 mm to 21 mm in length by 15.4 mm to 16.3 mm in width; medium-sized shells measure 15 mm to 16.7 mm in length by 12.4 mm to 14.3 mm in width; the majority of the shells are smaller yet, ranging in size from 13.8 mm x 12 mm to 14.6 mm x 11.9 mm. At McBride bay, South Hero, Vt., these shells are smaller than at places farther south, except Crown Point and Chimney Point. This may be due to lack of extensive collecting, or perhaps an environment unfavorable to a better development of the shells. The largest shell found measures only 17.5 mm x 14 mm; medium-sized shells measure from 13 mm x 10.5 mm up to 14.3 mm x 12 mm; the majority of the shells have the following measurements or are smaller: 11.5 mm x 10.2 mm up to 13 mm x 10.7 mm. Near Burlington, Vt., and vicinity very few of the large shells were found and these measured from 18.7 mm x 16.5 mm to 22 mm x 17.7 mm. The medium-sized shells running from 17 mm x

14.8 mm to 17.7 mm x 14.6 mm are not abundant; the majority of the shells have the following measurements or are smaller: 14.7 mm x 12.8 mm up to 16.8 mm x 15 mm. Macoma groenlandica is not very abundant at Valcour island. The specimens collected here, in general, run smaller than those of the previous locality, but the predominating sizes at Valcour island run somewhat larger than the predominating sizes at Burlington and vicinity. The largest shells are few in number measuring 18.4 mm x 15.8 mm up to 18.8 mm x 16.3 mm and 19 mm x 15.1 mm. The medium-sized shells, 16 mm x 13.3 mm to 17.5 mm x 14 mm are fairly abundant; but the most numerous shells are smaller than this, giving the measurements 15 mm x 13 mm to 15.5 mm x 13.7 mm and 15.8 mm x 13.2 mm. At Lapham Corners, while the shells average about the same, the largest-sized shells are more abundant: 18 mm x 14.7 mm and 19 mm x 15 mm up to 22 mm x 19.3 mm; the medium-sized shells vary from 16.2 mm x 14 mm to 17.5 mm x 15.3 m; but the majority of the shells collected at this locality run as follows and smaller: 14 mm x 12.7 mm to 15.7 mm x 13 mm. M. groenlandica was found at Port Kent in much larger numbers than at any other locality, the largest proportion of the shells varying from 12.4 mm x 10.4 mm to 13.7 mm x 11.5 mm and 14.7 mm x 11 mm. The medium-sized shells measure from 15.2 mm x 13.7 mm to 17 mm x 14.7 mm; while the largest shells reach the size of 18 mm x 15 mm to 22 mm x 19.4 mm. At Willsboro, a short distance south, the shells were very abundant, but no shells were found so large as the largest size found at Port Kent; but the medium and average-sized shells run about the same. The largest shells vary from 17.2 mm x 13.7 mm up to 19 mm x 16.6 mm and 19.2 mm x 15.8 mm; the medium-sized shells vary from 14 mm x 11.3 mm to 15.7 mm x 13.5 mm and 16.7 mm x 13 mm; the majority of the shells average smaller than this and give the measurements: 12 mm x 9.5 mm to 14 mm x 10 mm. Although Essex is only a few miles south of Willsboro, from this point for several miles southward along the lake shore the shells average smaller and thinner, if anything. The majority of the shells vary from 13 mm x 11.8 mm to 15 mm x 12.5 mm; the medium-sized shells, which are much fewer in number, vary from 14.5 mm x 13 mm to 16 mm x 13 mm; while the few largest-sized shells show the measurements: 16.7 mm x 14.2 mm to 18.8 mm x 16.5 mm. The shells found a few miles north of Port Henry and just north of Chimney Point, Vt., while very small for the species, still run markedly larger than the Crown Point specimens. At the locality north of Port Henry only a very few (six) of the largest-sized shells were found and these vary from 18.2 mm x 13.7 mm to 21 mm x

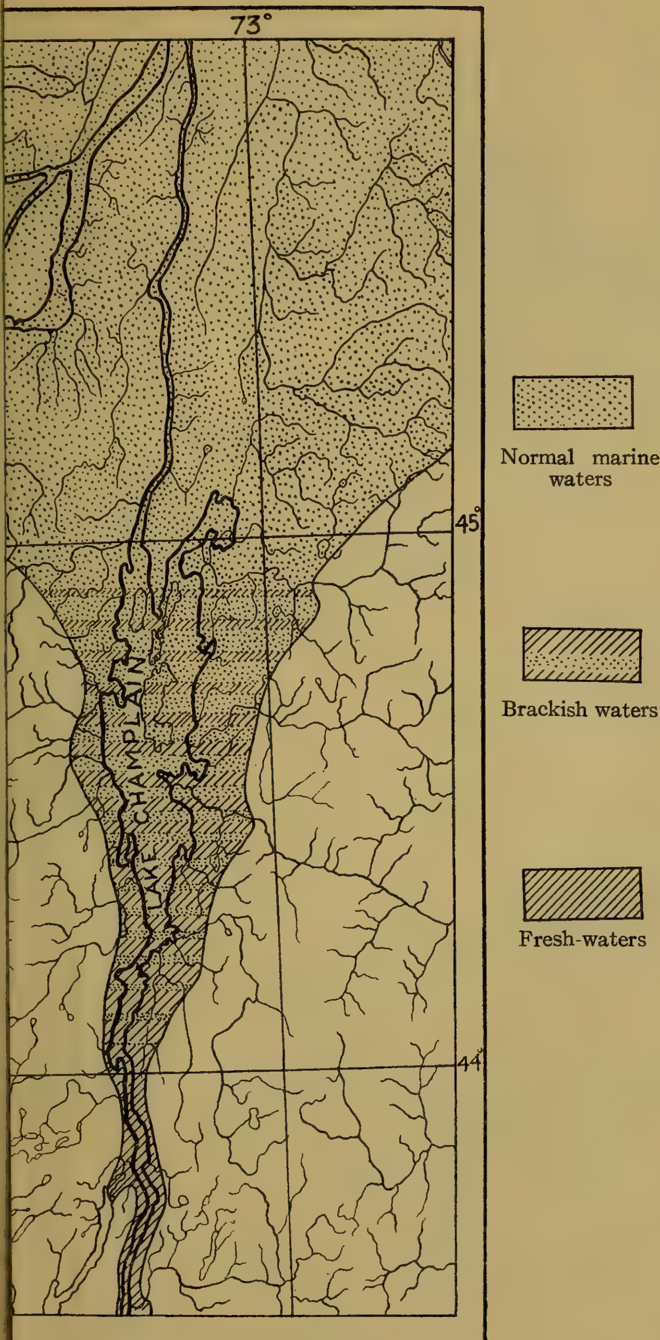
17.8 mm. Here there are two sizes about equally abundant: one size varying from 16 mm x 12.4 mm to 17.5 mm x 13.8 mm and the other, from 13.4 mm x 10.8 mm to 15.8 mm x 12.5 mm. None of the very large specimens was found in the vicinity of Chimney Point. One specimen was found measuring 17.2 mm x 14 mm. The large specimens found vary from 14 mm x 10.8 mm to 14.7 mm x 11.6 mm and 14.8 mm x 11.3 mm; average specimens vary from 12.1 mm x 10 mm to 13.5 mm x 10.8 mm and 13.7 mm x 10.1 mm; but the majority of the shells run smaller, measuring 10 mm x 8.2 mm to 11.6 mm x 9.2 mm.

Yoldia arctica has been found almost as far south as Macoma groenlandica. It has been collected at fewer localities and in smaller numbers than the latter; but it nevertheless shows the same gradual decrease in size southward. Just north of Chimney Point, the most southern locality for the species, the occurrence is very rare, so that few specimens were collected; seven fragmentary shells (four of them half shells) were found and pieces of five other half shells. So far as measurements can be made these shells vary from 8.7 mm x 5.5 mm to 9.5 mm x 6.1 mm and 9 mm x 6.4 mm. Comparison of shells from this locality with recent shells and those from the Montreal section can be made only approximately because of the small number to judge from. All the shells found run small, and since those found farther north run as small or smaller, the small size of the Chimney Point shells I think may be accepted without question. I am rather inclined to believe that a larger series of shells from this place would show that those in our possession are an expression of the larger sizes of the shell and that the average individual runs smaller. Typical adult recent forms of Yoldia arctica vary from 19.5 mm x 12 mm to 20.7 mm x 14 mm; at Montreal typical adult shells were found varying from 17.2 mm x 11.2 mm to 19.3 mm x 11.8 mm and 19.2 mm x 11.9 mm. Approximately, then, the Chimney Point shells are less than one-half the size of the recent shells and about one-half the size of the Montreal specimens. (*See* plate 2, figures 4, 5, 6.)

Yoldia arctica was collected in largest numbers at Ottawa and Port Kent, N. Y., and is apparently more abundant at the latter place. At Willsboro this species was rare in occurrence, though not so infrequent as at Chimney Point. The largest individuals here vary from 9 mm x 5.6 mm to 9.8 mm x 6.3 mm, while the average specimens measure from 7.1 mm x 4.6 mm to 8.8 mm x 5.7 mm. The average specimens vary from a little over one-third to less than one-half the size of the recent specimens and from one-half (or more) to less than one-half the size of the Montreal specimens. The Port Kent and Burlington localities are the most northerly ones at which Yoldia arctica has been collected in the Champlain area. The largest specimens at Port Kent vary from 10 mm x 7 mm to 12 mm x 8 mm; the averaged-sized specimens vary from 6. 7 mm x 4.5 mm to 8.5 mm x 5.4 mm and 8 mm x 6 mm. The majority of the specimens are included in the smaller sizes measuring 7 mm in length and slightly under. The largest specimens then are a little above one-half to three-fifths or more the size of the recent and Montreal specimens, while the average-sized specimens are well under one-half, and even one-third, their size. Of the specimens found at Burlington and vicinity, the largest number were found around Mallett's Bay, but the species was not found to be very abundant anywhere in this area. A larger number of specimens would be necessary to make any more than an approximate comparison with the Port Kent material; but so far as observations go the average specimens of this material run as small as, and perhaps smaller than, those from Port Kent. The large-sized specimens are few in number and vary from 9.8 mm x 6 mm to 13.9 mm x 8 mm. The average-sized specimens (the majority) vary from 5.8 mm x 4 mm to 8.2 mm x 5 mm, but only a few reach the upper limit of size. In the vicinity of Ottawa the specimens in general run smaller than at Montreal, the largest having been collected at Ottawa. The largest specimens here attain the size of 16.4 mm x 9 mm to 19 mm x 11 mm, but the majority of the specimens vary in length from 13 mm to 15 mm and in width from 8 mm to 9 mm. At Green's creek along the Ottawa river, several miles below Ottawa, and at Britannia, a few miles above, all the specimens found were much smaller; but specimens were not found in these localities in sufficient numbers to permit comparisons.

Saxicava rugosa and Mytilus edulis were both found just a few miles north of Port Henry, but Mytilus only in small fragments and these very infrequent, so it is rather impossible to make any conjectures as to the size of the individuals of that species at this locality. Recent specimens of Saxicava rugosa from Barden bay, Greenland, range from a size of 34.6 mm x 18.8 mm to 41 mm x 20 mm. Macoma groenlandica was found to be by far the most abundant species in the Port Henry area; while S. rugosa was found to be rare. Less than twenty specimens were collected here, the largest found measuring 22 mm x 11.5 mm and the others ranging from 18.4 mm x 10 mm to 21 mm x 10.3 mm. The Port Henry area was very carefully searched; and, while the number of specimens collected is not sufficient to make hard and fast comparisons, I believe they may be regarded as typical of the area. They are a little over one-half the size of the recent specimens, and are very considerably smaller than the average Montreal shells, which in addition are very much thicker. The largest Montreal specimen measured 37 mm x 17.1 mm; average large specimens range from 31 mm x 16 mm to 34 mm x 21 mm; a large proportion of the material shows measurements from 22 mm x 14 mm to 27 mm x 16 mm. The Port Henry material therefore runs about the size of the smaller Montreal specimens, though even the very small specimens from the Montreal area have very heavy shells. (*See* plate 1, figures 1–5.)

Localities in the Champlain valley between these two areas show intermediate-sized specimens. At Willsboro the specimens tend to be chunky, short and broad. Only a few are at all large and the majority run rather small. Out of about three hundred specimens only four of the largest sizes were found and these range from only 25.5 mm x 12.8 mm to 28 mm x 13.5 mm. Average large specimens, about ten out of the whole number, vary from 22 mm x 10.8 mm to 23 mm x 12.8 mm; but the majority of the specimens measure as follows and smaller: 17.8 mm x 10 mm to 19.5 mm x 11.6 mm and 20.5 mm x 11.4 mm. At Port Kent, in about the same number of specimens, the shells run slightly larger. The largest sizes, though few in number, are more numerous than in the Port Henry area and range from 25 mm x 12 mm or 13 mm to 29 mm x 14.5 mm. The average large specimens vary from 22 mm x 13.7 mm and 22.6 mm x 11.6 mm to 23 mm x 12.6 mm and 24.8 mm x 11 mm; but the majority of the shells run smaller: 18.4 mm x 11.7 mm to 21.7 mm x 11.6 mm. In this last group belong also shells which run longer, but are much narrower. This variation in the shape of the shells in the same locality will be discussed later. At Valcour island the larger sizes are more abundant and the shells are much heavier again, approaching the condition found in the Montreal area. The species is more abundant here than in any of the other localities and the specimens collected are the largest found in the Champlain valley. The largest specimens range from 28 mm x 17 mm and 29.5 mm x 14 mm to 34.5 mm x 15.5 mm; the average specimens, and the most abundant, measure 22 mm x 11.2 mm to 27.8 mm x 14.3 mm and 28 mm x 13.5 mm. A large portion of the specimens are under 25 mm in length, varying from 20 mm to 25 mm. In the vicinity of Burlington fragments of a few specimens were found, insufficient for comparison; at McBride Bay, South Hero, only three small specimens were found. Valcour island, therefore, is the most northern locality in the Champlain area at which specimens were found in numbers



'oodworth and Fairchild for New York (see
tely 15 miles to the inch.

Map 2 Map of the Champlain sea showing the relative salinity of the different parts. Based upon maps by Coleman and Mather for Canada, Woodworth and Fairchild for New York (see bibliography). Boundaries in Canada more or less generalized and only approximately correct. Scale $\frac{1}{950400}$; approximately 15 miles to the inch.

sufficient for making comparisons. In the Canadian area, in addition to the Montreal material, specimens were collected at Ottawa and vicinity. At Ottawa only a few small specimens were found, decidedly not typical; but at Green's creek, along the Ottawa river, 8 miles below Ottawa, more typical material was found, though not in great abundance. The shells found range from average-sized specimens with a length of 15 mm and width of 7 mm to the largest-sized specimen with a length of 25 mm and width of 13.8 mm, giving measurements well under those for Montreal.

Mytilus edulis was found only in small numbers south of Lapham Corners; and this is the most northern locality in the Champlain area from which the writer has shells for comparison. Specimens collected here number up to several hundreds. The largest specimens range from 38 mm x 20 mm to 45 mm x 20 mm and 43 mm x 25 mm. Sizes varying from 33 mm x 17 mm to 41 mm x 18 mm are abundant, but a large part are smaller. The larger specimens in the case of this species are used for comparison, because I have only the larger, representative recent forms and in some localities only enough specimens have been found to make such a comparison. Recent forms from the New York coast range from 68 mm x 32.1 mm to 77.5 mm x 35.2 mm; from Cape May, 68 mm x 29.7 mm to 76.4 mm x 35.3 mm. Specimens from Gay Head, of "average adult size for the locality and station" run somewhat smaller than those from the two preceding localities. The largest specimen at hand measures 68.3 mm x 30.7 mm. The larger Lapham Corners specimens run one-half to three-fifths and less the size of the largest recent specimens. No specimens have been obtained from the Montreal area. A specimen figured in "Geology of Canada" for 1863 (page 963) measures 40 mm x 20.5 mm, but I should regard this as small for the area. (*See* plate 2, figures 1–3.)

Farther south, at Port Kent, only about a dozen specimens at all complete were found. The largest specimens measure 52 (?) mm x 27 mm and 46 mm x 22 mm; the rest of the specimens range from 32.5 mm x 18.5 mm to 43.7 mm x 27 mm. The largest specimens run about three-fifths the size of the largest recent specimens; most of the other specimens run one-half, and less, that size. At Willsboro, a short distance farther south, the shells are heavier than at Port Kent and, particularly, Lapham Corners. I think this is due to the fact that the limy layer has been dissolved away to a large extent in the specimens from the last-named places. As noted above, at Port Henry only small fragments were found, and these of rare occurrence. At Willsboro, compared with Saxicava rugosa and Macoma groenlandica, this species is relatively rare. Only a few shells are anywhere near perfect, and the larger shells are so broken that measurements can be only approximate or not taken at all. The largest specimens must have had a length of 45 mm to 52 mm and greatest width of 23 mm to 26 mm. The rest of the specimens (not more than twenty-five collected in all, besides the fragments) range from 31.8 mm x 19.5 mm to 43 mm x 23 mm, the majority running under 40 mm in length. The specimens in general run from under one-half to about three-fifths the size of the recent specimens, with the exception of the two or three largest specimens. With the small number of specimens from this locality, it is difficult to make comparisons; but the material seems in general to run about the same as that from Port Kent and Lapham Corners.

Mya arenaria, like Mytilus edulis, has been found in only a few localities, but the Pleistocene specimens from the Champlain area are so pronouncedly smaller and thinner than the recent and Montreal Pleistocene specimens that they deserve consideration here. Recent specimens from the New York coast and Portland, Maine, range from 76 mm x 45.2 mm to 89 mm x 51.2 mm. Specimens from the shore of the bay at Ocean City run considerably smaller, those used in comparison ranging from 64.2 mm x 39.5 mm to 69.6 mm x 42.2 mm. A large number of fragments were found at Montreal, but no whole specimens. The fragments show that the specimens were fully as heavy and must have been comparable in size to the typical, adult recent specimens. In "Geology of Canada" for 1863 (page 963) is figured a specimen from the Montreal area measuring 85 mm x 50 mm, almost the size of the largest recent specimen here used (*see* plate 3).

Pleistocene specimens of this species were collected at Cumberland Head (near Plattsburg); McBride bay, South Hero; and Valcour island. The two largest specimens out of a collection of several hundred specimens from Cumberland Head, measure 52 mm x 35 mm and 50 mm x 31 mm. Other specimens range from 37 mm x 25 mm to 44 mm x 30 mm. The majority of specimens have a length of 40 mm or less, though quite a number range between 40 mm and 44 mm in length. The South Hero specimens are smaller, if anything, than those from Cumberland Head. The largest specimen in the collection of several hundred from this area measures 52 mm x 33 mm. Typical specimens range from 31.3 mm x 18 mm to 44 mm x 29 mm, the larger number measuring less than 40 mm in length. This species is much less abundant at Valcour island. Much of the material collected is fragmentary and comparisons can be made on only about twenty-five specimens. The largest found measures 42 mm x 27.5 mm. One fragmentary specimen, if complete, might be a little larger than this specimen, but there is not enough difference to count in the general run. Other specimens measured range from 33 mm x 20.3 mm to 41 mm x 34.8 mm; and the fragmentary specimens seem to run about the same size. I should say that in general the Valcour island material runs about the same as the South Hero material, with perhaps a smaller representation of the larger-sized specimens. From the above measurements it is seen that the Valcour specimens run one-half, and less, the size of the recent specimens; in the South Hero material, the largest specimen is about three-fifths the size of the largest recent specimen, and a large part of the average material is about one-half the size of recent specimens. At Cumberland Head the relations stand much the same, though the larger specimens here are more abundant.

There is one other species, Cylichna alba, which occurs in a dwarfed form in the Champlain valley. This species has been found only at Port Kent, and even there is relatively infrequent. About 115 specimens were found during the course of several days' collecting, all running much smaller than the Canadian specimens. The largest Port Kent shells are about one-half the size of those from Canada, the majority, however, are much smaller, ranging from two-fifths down to one-third the size of Canadian forms. (*See* plate 2, figures 8, 9.)

Just as it is found in the Baltic, so here, together with the dwarfing of species goes a decreasing thickness of shell. The little Cylichna alba, just discussed, has a very thin shell, so thin that even in working the specimens out of the sand with the point of a small knife-blade many were broken. Of the other shells, Yoldia arctica, Macoma groenlandica and Mya arenaria perhaps show the most noticeable changes. Yoldia arctica, through the Champlain area, from Port Kent southward, shows the same characteristics as Cylichna alba. The shells are of a paperlike thickness and very easily broken in collecting. For this reason most of those collected at Chimney Point, Vt., the most southern locality, are in a fragmentary condition. Even the smaller specimens of Macoma groenlandica from the Montreal area are stoutly built and not easily crushed. Though there are slight variations in some localities, in general there is a gradual decrease in thickness of the shells of this species going southward, until at Crown Point even the largest shells are very easily crushed into numerous pieces between the fingers. At Cumberland Head and South Hero the shells of Mya arenaria particularly were found in quantity and suggested a mass of broken eggshells, a resemblance which is further carried out by their extreme thinness and brittle character. The thinness of the shells of this species at these localities is in striking contrast to the specimens from Montreal and recent specimens. The Montreal specimens are somewhat heavier even than the recent individuals and are three or four times as heavy as the specimens from the Champlain area, measuring even up to 2.6 mm, 3.5 mm, or even 4 mm, in thickness at the thickest part of the shell. Saxicava rugosa shows extremely heavy shells, even among the smaller sizes, from the Montreal area (*see* plate 1, figures 4, 5). Some of them are much heavier than the recent forms from Barden bay, Greenland, but in general this species seems to have been less affected than the others as regards thickness of shell. Saxicava rugosa near Pebble Beach, south shore of Valcour island, is so abundant that shells can be collected by the hundreds in a very short time. Here the shells tend to run rather heavy, the largest ones approaching the Montreal specimens, which in their heaviest expression have a thickness of 2 mm to 2.5 mm and almost 3 mm in the thickest part of the shell. At Port Kent and southward the shells run thinner again, having their thinnest expression in the few specimens found a few miles north of Port Henry. Here the thickness of the largest specimens is no more than .5 mm. There is not sufficient data to make similar comparisons for the specimens of Mytilus edulis found in the various localities.

Walther (1920, p. 210) points out that brackish-water conditions are indicated also by insignificant constancy of form. This is shown to some degree by Macoma groenlandica and Saxicava rugosa, where the shells may be longer and narrower, or shorter and wider than normal or show gradations between these two forms. In Yoldia arctica from the Champlain area the modified form of the shell is very noticeable, as shown by figure 7, plate 2. In the recent forms and those from the Montreal and Ottawa areas, there is a pronounced posterior extension or wing, with subacute tip. The specimens from the Champlain area, Port Kent and southward, possess this posterior wing, but it is shorter and blunter, giving a squarish appearance to the posterior end of the shell; in a large proportion of the shells, the wing is so blunted at the tip that it is hardly recognizable as such. There are all gradations between these two types of forms, and except for these gradations the extreme forms of the Champlain area are so different from the typical form from the vicinity of Montreal and Ottawa that one would be inclined to regard them as belonging to another species.

Pleistocene Fauna of the Hudson Valley and its Significance

No fossils have been reported from the Pleistocene deposits of the Hudson valley south of Croton Point, either from the New York or New Jersey shores. The clays of the Hackensack region, New Jersey, might be attributed either to marine or lacustrine origin (Salisbury, p. 195, 200). The absence of fossils seems to be against the hypothesis of a bay of salt water. However, it is thought probable (ibid., p. 198) that such connections as the bay had with the ocean were perhaps outlets rather than inlets and the discharge of fresh water into the bay after the ice had left New Jersey must have been great. Under these conditions the waters of the bay may not have been salt, or at least not normally salt, which would account for the absence of marine life.

The most northern point at which Pleistocene fossils have been reported from the Hudson valley is at Storm King, 50 miles above New York (Shimer, p. 488, 489). The specimens were found in drilling a series of holes across the Hudson bed and belong to only two species, Mulinia lateralis (Say), of which hundreds of specimens were collected, and Trivia trivittata Say, of which there were but few specimens collected. The fossils were found 620 feet out in the river from the Storm King shore, 40 feet below the bed of the river, which is about 120 feet below the present river or sea level at that point. Shimer describes this as a dwarf fauna which in the abundance of Mulinia lateralis suggests Pleistoceen age. He points out that the Hudson today is brackish at Storm King and as far north as Poughkeepsie and that heavier sea water might still come up in sufficient amount to furnish a marine habitat even under quite fresh surface conditions; but that it was not ascertained whether there are any marine forms in the present bed of the stream. Fairchild (1919, p. 16) states that salt-water organisms pass up the Hudson only to the Highlands.

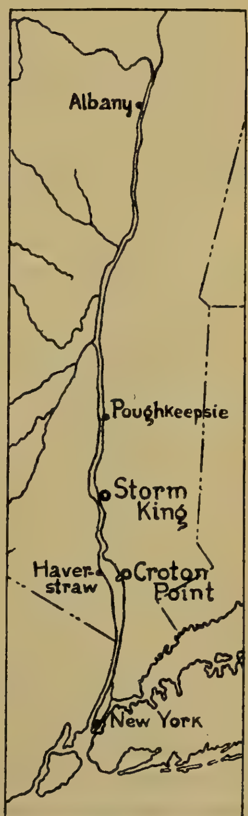


Fig. 2 Sketch map of Hudson river valley showing localities [o] where marine Pleistocene fossils were found.

The two species found at Storm King live at present off the New England and New Jersey coasts, in normal marine or but slightly freshened water; and in these localities are considerably larger than the Pleistocene specimens. An average size for specimens of Trivia trivittata off the Massachusetts coast is two-thirds of an inch long by one-third of an inch greatest diameter; an average-sized fossil specimen is three-eighths of an inch long by a greatest diameter of three sixteenth of an inch. An average specimen of Mulinia lateralis from the New England coast has a length of nine-tenths of an inch and a width of six-tenths of an inch. One of the larger of the fossil specimens measured five-sixteenths of an inch by one-fourth of an inch. Shimer further points out: "The young shells off the coast are small, thin, with margins subequally rounded and beaks inconspicuous and nearly touching each other; this description applies to all of the Hudson River specimens. It does not seem probable, however, though possible, that so many shells could be gathered at random as was done by the drill without getting some adults. The more probable explanations seems to be that these fossil individuals were living in an unfavorable environment, a water less than normally saline, and through a constant sapping of vitality, were not able to attain large size" (p. 489). Recently a few specimens of Mulinia lateralis were collected at Croton Point about 20 miles south of Storm King. The largest one measured 11.9 mm x 8.5 mm (i. e. about seven and one-half sixteenths of an inch long); a smaller specimen measured 7.1 mm x 5.3 mm (i. e. about four and one-half sixteenths of an inch long). The larger specimens from Storm King run somewhat smaller than the largest specimen from Croton Point, as one might expect in waters of decreasing salinity; but the latter is still only about one-half the size of average recent forms, under normal conditions.

In the sandy layers at Croton Point, a few feet above the water's edge, occurs a bed of oysters (Ostrea virginiana Lister), similar to the thick Saxicava beds found in some localities in the Champlain area and Canada. In one place the bed reaches a thickness of about 30 inches, but it quickly thins out and varies from 12 and 14 inches to about 6 inches; following around the point to the shore on the north side only a thin line of shells is found. It has been popularly assumed that this bed of oysters represents an Indian shell heap. Prof. A. W. Grabau, I understand, some years ago, in a paper which I have not been able to locate, describes this occurrence of oyster shells as an oyster bed rather than a shell heap[1]; and the evidence which I have collected seems to indicate the

[1] Woodworth (p. 187) after an examination of this oyster bed concluded that the shells were in a talus and derived from an old shell heap at the top of the bluff.

same thing. Some of the oysters in this bed are of very large size, but the majority of the shells belong to young forms, and there are a large number of very young forms, "baby" oysters. Also associated with the oyster shells are a number of other marine species of shells: Mya arenaria Linn., Modiola demissus (Dill.), Mulinia lateralis (Say), and Alectrion (Nassa) obsoleta (Say). Balanus crenatus Brug. was collected here; but as that form occurs on the oyster shells, it is of no importance in this connection. I have discussed this bed of shells found at Croton Point with the State Archeologist, Arthur C. Parker, and he believes that the conditions found there warrant the assumption that the occurrence is an oyster bed.

Of the marine forms collected at Croton Point, all but the oysters are in too small numbers or too fragmentary to make comparisons as to size with typical marine forms. Mulinia lateralis we have discussed above as larger than the specimens from Storm King and smaller than the recent shore forms. The oysters occur in very large sizes and the largest specimens are quite massive; but this is a euryhaline form which thrives in water with diminished salt content (Walther, 1920, p. 210).

A number of fresh-water gastropods were found to be of rather frequent occurrence in the oyster beds. They are Polygyra hirsuta (Say), Polygyra fraudulenta (Pilsbry), Eyrgomphala alternata (Say) and Planorbis sp?. These species undoubtedly were carried in by streams.

Ries (p. 594, pl. 14) reports sponge spicules from Croton Point; also five species of fresh-water diatoms. At Croton landing a number of impressions were found in the blue clay which were identified as worm tracks by Professor Hall.

The Pleistocene fauna of the Hudson valley, as far as present knowledge goes, is very small; but I am of the belief that, with this problem in mind, more information can be obtained through further work along these lines. The present evidence, however, seems to lead to the same conclusions as were drawn for the Champlain area. The waters of the Pleistocene Hudson estuary were so freshened in going northward that (1) only a few marine forms were able to advance into these waters at all; (2) so far as present knowledge goes, only two species reached as far up as Storm King, 50 miles above New York, and none has been reported north of this locality; (3) the two species found at Storm King represent a dwarf fauna, one of them, Mulinia lateralis, occurring in a dwarfed condition (less so, however) at Croton Point about 20 miles farther south.

Experiment in the laboratory and observation in the field (information of Dr Raynor Lidén and Dr Ernest Anters) have shown that clay deposited in fresh water shows a laminated character that is not found in similar deposits laid down in very brackish or salt water. The Pleistocene clays in the vicinity of Albany and northward show this laminated character very beautifully, and it has been found in the clays of the Hudson valley extending as far south as Haverstraw (Ries, p. 577). This condition of the clays verifies what has already been indicated by the absence of marine fossils: that the Pleistocene waters of the Hudson valley were fresh or practically fresh north of Storm King. In contrast to this, nowhere in the Champlain area where marine fossils were found was this peculiar laminated character noted, which fact, together with the distribution and character of the fossils of this area, indicates that the Champlain sea extended in a brackish condition, gradually freshened, to the vicinity of Crown Point station and that south of this area its waters were practically fresh.

Summary

This study of collections made in the Champlain and St Lawrence valleys has led to the conclusion that the character of the Champlain Pleistocene fauna is due in large part at least to decreasing salinity southward in the waters of that time.

The first part of this paper is given up to a discussion of conditions found in the Baltic sea and other freshened bodies of water. The Baltic sea shows a very striking decrease in salinity eastward and in a large way the responses of the fauna to it. As the salinity of the water decreases from that normal for sea water, the fauna changes from one typically marine to one in which only a few marine groups are represented and finally to a fresh-water fauna. Each phylum is affected. The decrease in number of species eastward is very rapid; the Baltic has been described as being faunistically divided into two basins, a western and an eastern, the former marked by a rich fauna, the latter by a strikingly impoverished one. Another striking change in the Baltic fauna is the dwarfing of the euryhaline forms. This has been noted among the worms, crustaceans, fishes, but the best examples are found among the mollusks, notably Mytilus edulis and Cardium edule. In addition to being dwarfed the shells become poor in lime, as exemplified by Mytilus edulis and Macoma balthica (groenlandica). Examples of dwarfing and decrease in thickness of the shells (in the case of mollusks) due to freshening of sea water have also been noted in the British estuaries, and in the Black and Caspian seas.

A careful list, with localities, has been compiled of the Pleistocene invertebrate species collected and reported and these have been tabulated to show the distribution of the species from the sea (Labrador) to the southernmost locality (Crown Point station) from which they have been collected in the Champlain area. The total number of Pleistocene species reported from all localities is 183. Of this number, 89 have been collected from the vicinity of Montreal and 25 from Ottawa and vicinity. So far as reported, only 32 of the total number of species entered the Champlain area, and of this number 7 are listed without localities. At Port Kent, about 40 miles north of the Crown Point area, only 13 species occur; from Burlington and vicinity, on the Vermont side, are reported 17 (—) species. There is a rapid decrease in species from this point southward: at Willsboro only 5 species occur (Saxicava rugosa, Macoma groenlandica, Mytilus edulis, Yoldia arctica, Balanus crenatus); a few miles north of Port Henry, 3 species (Macoma groenlandica, Saxicava rugosa, Mytilus edulis); just north of Chimney Point, Vt, 2 species (Macoma groenlandica, Yoldia arctica); at Crown Point, 1 species (Macoma groenlandica).

By comparison of specimens of the Pleistocene species of the Champlain area and Canada with recent representatives it has been found that the Champlain fauna is a dwarf fauna, the dwarfed character being well shown by 5 species: Macoma groenlandica, Saxicava rugosa, Mytilus edulis, Mya arenaria and Yoldia arctica. In general, representatives of all these species show a gradual decrease in size southward. For example, in the case of Macoma groenlandica, which extends farther south in the Champlain area than any other species the largest shells from Crown Point are less than half the size of the largest recent ones and less than three-fifths the size of the largest shells from the Montreal area. The average Crown Point shells are half, or less, the size of average recent shells and three-fifths, or slightly over, the size of average Montreal specimens. Another species, Cylichna alba, occurs in a dwarfed form in the Champlain valley, but has only been found at Port Kent and is there relatively infrequent.

Just as it is found in the Baltic, so here, along with the dwarfing of species goes a decreasing thickness of shell. This is seen best in Cylichna alba, Yoldia arctica, Macoma groenlandica and Mya arenaria, but is also well shown in Mytilus edulis and Saxicava rugosa.

The variability in form noted by Walther as characteristic of a fauna living under brackish-water conditions is shown in the various Champlain localities to some degree by Macoma groenlandica and Saxicava rugosa; very strikingly by Yoldia arctica.

The Pleistocene fauna of the Hudson valley is briefly considered, but the data are meager. The evidence obtained, however, seems to lead to conclusions similar to those arrived at for the Champlain area. The waters of the Pleistocene Hudson estuary were so freshened going northward that (1) only a few marine forms were able to advance into these waters at all; (2) so far as present knowledge goes only two species reached as far up as Storm King, 50 miles above New York, and none has been reported north of this locality; (3) the two species found at Storm King represent a dwarf fauna, one of them, Mulinia lateralis, occurring in a dwarfed condition (less so, however) at Croton Point about 20 miles farther south.

It is recognized that clay deposited in fresh water shows a laminated character not found in similar deposits in very brackish or salt water. The laminated character of the Hudson Valley clays, seen as far south as Haverstraw, and the absence of this peculiar laminated character in any of the localities in the Champlain area where marine fossils were found, verifies what has already been indicated by the distribution and character of the faunas of these areas: (1) that the Pleistocene waters of the Hudson valley were fresh, or practically fresh, north of Storm King; (2) that the Champlain sea extended in a brackish condition to Crown Point and that south of this area its waters were fresh or practically fresh.

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EXPLANATION OF PLATES

PLATE I

Saxicava rugosa Lam. (= *arctica* L.)

Fig. 1 Recent specimen (right valve) from Barden bay, Greenland.

Fig. 2 Outlines of right valves showing comparison in size of the largest Pleistocene specimens from various localities in Canada and New York with one of the largest recent specimens. *a*, recent, Barden bay; *b*, Montreal; *c*, Valcour island; *d*, Port Kent; *e*, Willsboro; *f*, Ottawa vicinity; *g*, few miles north of Port Henry.

Fig. 3 Similar outlines of average-sized specimens showing comparison with a medium-sized recent form. *a*, recent, Barden bay; *b*, Montreal; *c*, Valcour island; *d*, Port Kent (Ottawa and vicinity about the same); *e*, Willsboro.

Fig. 4, 5 Two specimens from Montreal showing the remarkable thickness of the shells. Both valves are weathered.

Macoma groenlandica Beck (= *balthica* L.)

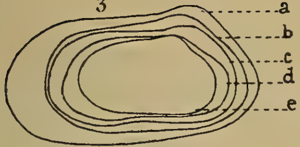
Fig. 6 Recent specimen (left valve) from the New York coast.

Fig. 7 Outlines of left valves showing comparison in size of the largest Pleistocene specimens from various localities in Canada and New York with one of the largest recent specimens. *a*, recent, South Amboy, N. J.; *b*, Montreal; *c*, Port Kent (Burlington vicinity and Lapham Corners practically the same); *d*, Cumberland Head (Port Henry practically the same); *e*, Willsboro (Valcour island and Essex practically the same); *f*, Chimney Point; *g*, Crown Point.

Fig. 8 Similar outlines of average-sized specimens. *a*, recent, Cape May, N. J.; *b*, Montreal; *c*, Valcour island (Burlington and Lapham Corners about the same); *d*, Cumberland Head; *e*, Port Kent (Willsboro, Essex, Port Henry practically the same); *f*, Chimney Point; *g*, Crown Point.

PLATE I

3



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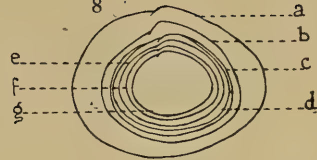

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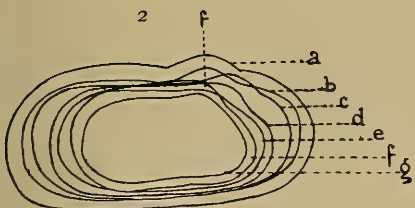

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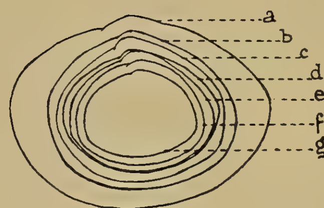

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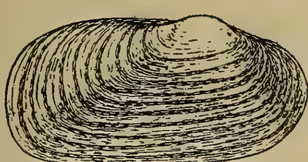

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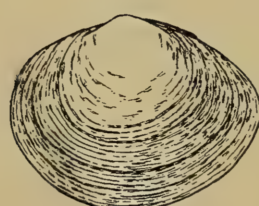

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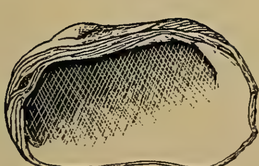

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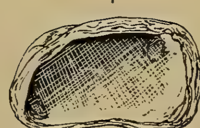

W. Goldring, del.

PLATE 2

Mytilus edulis Linn.

Fig. 1 Recent specimen (left valve) from Cape May, N. J.

Fig. 2 Outlines of left valves showing comparison in size of the largest Pleistocene specimens from localities in New York with one of the largest recent specimens. *a*, recent, Cape May, N. J.; *b*, Lapham Corners; *c*, Port Kent.

Fig. 3 Similar outlines of average-sized specimens. *a*, recent New York coast; *b*, recent, Gay Head, Martha's Vineyard, Mass.; *c*, Lapham Corners; *d*, Port Kent (Willsboro about the same).

Yoldia arctica Gray

Fig. 4 Right valve of a large-sized recent specimen.

Fig. 5 Outlines of right valves showing comparison in size of the largest Pleistocene specimens from localities in Canada and New York with one of the largest recent specimens. *a*, recent; *b*, Montreal; *c*, Ottawa; *d*, Burlington; *e*, Port Kent; *f*, Willsboro; *g*, Chimney Point.

Fig. 6 Similar outlines of medium-sized valves. *a*, recent; *b*, Canada (Montreal); *c*, Port Kent; *d*, Port Kent (majority of specimens). Port Kent material is taken as typical of the Champlain specimens, because there are larger numbers to judge from.

Fig. 7 Outline of right valves showing variation in shape of Pleistocene specimens. *a*, Ottawa; *b*, *c*, *d*, Port Kent. *a* and *d* represent the two extremes.

Cylichna alba Brown

Fig. 8 Pleistocene specimen from Canada (Dawson, Can. Ice Age, p. 244).

Fig. 9 Outlines showing comparison in size of Canadian and Port Kent specimens. *a*, Canadian specimen; *b*, one of the largest Port Kent specimens; *c*, specimen representing the size of the majority of Port Kent forms.

PLATE 2

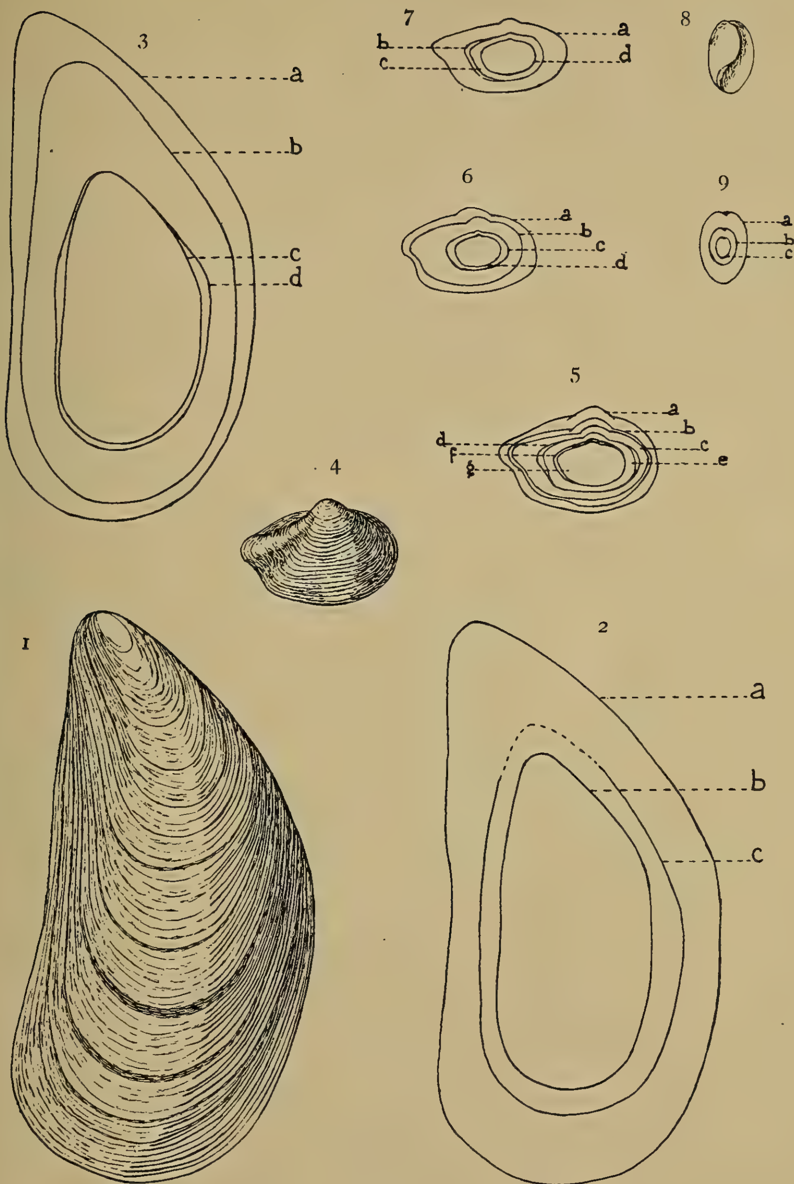

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PLATE 3

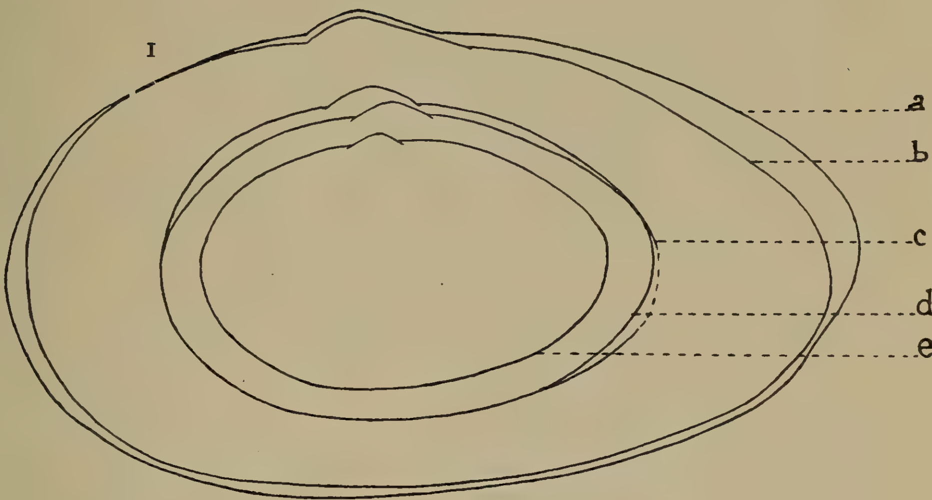
Mya arenaria Linn.

Fig. 1 Recent specimen (left valve) from the New York coast.

Fig. 2 Outlines of left valves showing comparison in size of the largest Pleistocene specimens from localities in Canada and New York with one of the largest recent specimens. *a*, recent, New York coast; *b*, Canada (Geol. Can. 1863, p. 963); *c*, Cumberland Head; *d*, McBride bay; *e*, Valcour island.

PLATE 3

I



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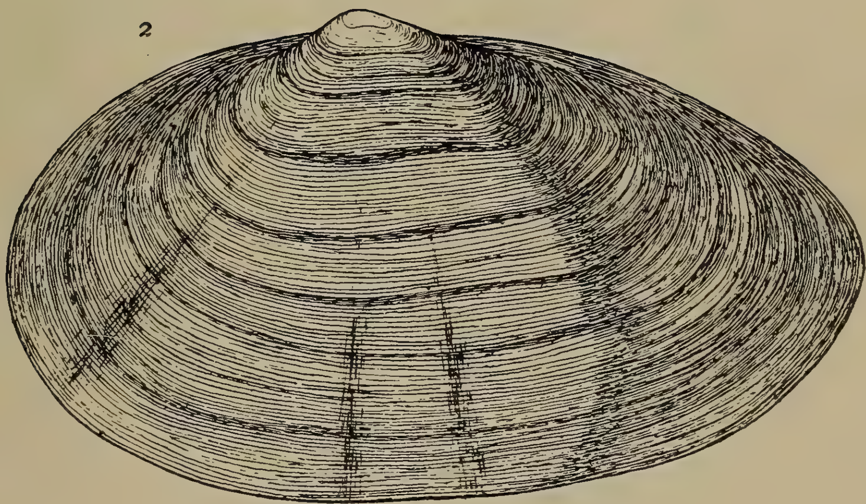

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New York State Museum

JOHN M. CLARKE, DIRECTOR

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Museum annual reports 1847–date. *All in print to* 1894, 50c *a volume,* 75c *in cloth;* 1894–*date, sold in sets only;* 75c *each for octavo volumes; price of quarto volumes on application.*

These reports are made up of the reports of the Director, Geologist, Paleontologist, Botanist and Entomologist, and museum bulletins and memoirs, issued as advance sections of the reports.

Director's annual reports 1904–date.

1904. 138p. 20c.
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1906. 186p. 41pl. 25c.
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1908. (Bul. 133) 234p. 39pl. map. 40c.
1909. (Bul. 140) 230p. 41pl. 2 maps, 4 charts. *Out of print*
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1918. (Bul. 219, 220) 309 p. il. 43 pl. 75c.
1919. (Bul. 227, 228) 146p. il. maps.

These reports cover the reports of the State Geologist and of the State Paleontologist. Bound also with the museum reports of which they form a part.

Geologist's annual reports 1881–date. Rep'ts 1, 3–13, 17–date, 8vo; 2, 14–16, 4to.

In 1898 the paleontologic work of the State was made distinct from the geologic and was reported separately from 1899–1903. The two departments were reunited in 1904, and are now reported in the Director's report.

The annual reports of the original Natural History Survey, 1837–41, are out of print.

Reports 1–4, 1881–84, were published only in separate form. Of the 5th report 4 pages were reprinted in the 39th museum report, and a supplement to the 6th report was included in the 40th museum report. The 7th and subsequent reports are included in the 41st and following museum reports, except that certain lithographic plates in the 11th report (1891) and 13th (1893) are omitted from the 45th and 47th museum reports.

Separate volumes of the following only are available.

Report	*Price*	*Report*	*Price*	*Report*	*Price*
12 (1892)	$.50	17	$.75	21	$.40
14	.75	18	.75	22	.40
15, 2v.	2	19	.40	23	.45
16	1	20	.50	[*See* Director's annual reports]	

Paleontologist's annual reports 1899–date.

See first note under Geologist's annual reports.

Bound also with museum reports of which they form a part. Reports for 1899 and 1900 may be had for 20c each. Those for 1901–3 were issued as bulletins. In 1904 combined with the Director's report.

Entomologist's annual reports on the injurious and other insects of the State of New York 1882–date.

Reports 3–20 bound also with museum reports 40–46, 48–58 of which they form a part. Since 1898 these reports have been issued as bulletins. Reports 3–4, 17 are out of print, other reports with prices are:

Report	*Price*	*Report*	*Price*	*Report*	*Price*
1	$1	13	*Out of print*	24 (Bul. 134)	$.35
2	.30	14 (Bul. 23)	$.20	25 (" 141)	.35
5	.25	15 (" 31)	.15	26 (" 147)	.35
6	.15	16 (" 36)	.25	27 (" 155)	.40
7	.20	18 (" 64)	.20	28 (" 165)	.40
8	.25	19 (" 76)	.15	29 (" 175)	.45
9	.25	20 (" 97)	.40	30 (" 180)	.50
10	.35	21 (" 104)	.25	31 (" 186)	.35
11	.25	22 (" 110)	.25	32 (" 198)	.40
12	.25	23 (" 124)	.75	33 (" 202)	.35

Reports 2, 8–12 may also be obtained bound in cloth at 25c each in addition to the price given above.

Botanist's annual reports 1867–date.

Bound also with museum reports 21–date of which they form a part; the first Botanist's report appeared in the 21st museum report and is numbered 21. Reports 21–24, 29, 31–41 were not published separately.

Separate reports for 1871–74, 1876, 1888–98 are out of print. Report for 1899 may be had for 20c; 1900 for 50c. Since 1901 these reports have been issued as bulletins.

Descriptions and illustrations of edible, poisonous and unwholesome fungi of New York have also been published in volumes 1 and 3 of the 48th (1894) museum report and in volume 1 of the 49th (1895), 51st (1897), 52d (1898), 54th (1900), 55th (1901), in volume 4 of the 56th (1902), in volume 2 of the 57th (1903), in volume 4 of the 58th (1904), in volume 2 of the 59th (1905), in volume 1 of the 60th (1906), in volume 2 of the 61st (1907), 62d (1908), 63d (1909), 64th (1910), 65th (1911), v. 2 of the 66th (1912) reports. The descriptions and illustrations of edible and unwholesome species contained in the 49th, 51st and 52d reports have been revised and rearranged, and, combined with others more recently prepared, constitute Museum Memoir 4.

Museum bulletins 1887–date. 8vo. (1) *geology, economic geology, paleontology, mineralogy;* (2) *general zoology, archeology, miscellaneous;* (3) *botany;* (4) *entomology.*

Bulletins are grouped in the list on the following pages according to divisions.
The divisions to which bulletins belong are as follows:

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2 Botany
3 Economic Geology
4 Mineralogy
5 Entomology
6 "
7 Economic Geology
8 Botany
9 Zoology
10 Economic Geology
11 " "
12 " "
13 Entomology
14 Geology
15 Economic Geology
16 Archeology
17 Economic Geology
18 Archeology
19 Geology
20 Entomology
21 Geology
22 Archeology
23 Entomology
24 "
25 Botany
26 Entomology
27 "
28 Botany
29 Zoology
30 Economic Geology
31 Entomology
32 Archeology
33 Zoology
34 Geology
35 Economic Geology
36 Entomology
37 "
38 Zoology
39 Paleontology
40 Zoology
41 Archeology
42 Geology
43 Zoology
44 Economic Geology
45 Geology and Paleontology
46 Entomology
47 "
48 Geology
49 Paleontology
50 Archeology
51 Zoology
52 Paleontology
53 Entomology
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57 Entomology
58 Mineralogy
59 Entomology
60 Zoology
61 Economic Geology
62 Miscellaneous
63 Geology
64 Entomology
65 Paleontology
66 Miscellaneous
67 Botany
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98 Mineralogy
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120 " "
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173 Director's report for 1913
174 Economic Geology

175 Entomology
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213–214 "
215–216 "
217–218 "
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223–224 Economic Geology
225–226 Geology
227–228 Director's report for 1919
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233–234 Botany
235–236 Archeology
237–238 "

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65	56, v. 2	111	60, v. 2	164	66, v. 1	7	57, v. 4
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68	56, v. 3	113	60, v. 3	168–70	66, v. 1	8, pt 2	59, v. 4
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73	57, v. 2	117	60, v. 3	182, 183	69, v. 1	11	61, v. 3
74	57, v. 1, pt 2	118	60, v. 1	184	69, v. 2	12, pt 1	63, v. 3
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77	57, v. 1, pt 1	123	61, v. 1	187	69, v. 1	14, v. 1	65, v. 3
78	57, v. 2	124	61, v. 2	188	69, v. 2	14, v. 2	65, v. 4
79	57, v. 1, pt 2	125	62, v. 3	189	69, v. 1	15, v. 1	72, v. 2
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81, 82	58, v. 3	129	62, v. 2	191	70, v. 1		
83, 84	58, v. 1	130	62, v. 3	192	70, v. 1		

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39 Clarke, J. M.; Simpson, G. B. & Loomis, F. B. Paleontologic Papers 1. 72p. il. 16pl. Oct. 1900. 15c.

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—— Dictyonine Hexactinellid Sponges from the Upper Devonic of New York.
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Simpson, G. B. Preliminary Descriptions of New Genera of Paleozoic Rugose Corals.
Loomis, F. B. Siluric Fungi from Western New York.

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45 Grabau, A. W. Geology and Paleontology of Niagara Falls and Vicinity. 286p. il. 18pl. map. Apr. 1901. 65c; *cloth*, 90c.
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Clarke, J. M. New Agelacrinites.
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DIVISION 3 MINERALOGY. Beck, Lewis C. Mineralogy of New York; comprising detailed descriptions of the minerals hitherto found in the State of New York, and notices of their uses in the arts and agriculture. il. pl. sq. 4to. Albany 1842. *Out of print.*

v. 1 pt 1 Economical Mineralogy. pt 2 Descriptive Mineralogy. 24 + 536p. 1842.

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Outlines history and work of the museum with list of staff 1902.

Paleontology. 12p. 1899. *Out of print.*

Brief outline of State Museum work in paleontology under heads: Definition; Relation to biology; Relation to stratigraphy; History of paleontology in New York.

Guide to Excursions in the Fossiliferous Rocks of New York. 124p. 1899. *Out of print.*

Itineraries of 32 trips covering nearly the entire series of Paleozoic rocks, prepared specially for the use of teachers and students desiring to acquaint themselves more intimately with the classic rocks of this State.

Entomology. 16p. 1899. *Out of print.*

Economic Geology. 44p. 1904. *Out of print.*

Insecticides and Fungicides. 20p. 1909. *Out of print.*

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Guide to the Mineral Collections, prepared by Herbert P. Whitlock. p. 45. 1916. *Out of print.*

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Geologic maps. Merrill, F. J. H. Economic and Geologic Map of the State of New York; issued as part of Museum Bulletin 15 and 48th Museum Report, v. 1. 59 x 67 cm. 1894. Scale 14 miles to 1 inch. 15c.

—— Map of the State of New York Showing the Location of Quarries of Stone Used for Building and Road Metal. 1897. *Out of print.*

—— Map of the State of New York Showing the Distribution of the Rocks Most Useful for Road Metal. 1897. *Out of print.*

—— Geologic Map of New York. 1901. Scale 5 miles to 1 inch. *In atlas form,* $2. *Lower Hudson sheet,* 50c.

Separate sheets of this map are available at 50c each, as follows:

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Niagara	Long Island	Adirondack
South Western	St Lawrence	Hudson Mohawk
Ontario East	Central	Lower Hudson

(Note) The Ontario West and Ontario East are not colored as they have no surface geology.

The lower Hudson sheet, geologically colored, comprises Rockland, Orange, Dutchess, Putnam, Westchester, New York, Richmond, Kings, Queens and Nassau counties, and parts of Sullivan, Ulster and Suffolk counties; also northeastern New Jersey and part of western Connecticut.

—— Map of New York Showing the Surface Configuration and Water Sheds. 1901. Scale 12 miles to 1 inch. 15c.

—— Map of the State of New York Showing the Location of Its Economic Deposits. 1904. Scale 12 miles to 1 inch. 15c.

Geologic maps on the United States Geological Survey topographic base. Scale 1 in. = 1 m. Those marked with an asterisk have also been published separately.

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Canton quadrangle. 1920.
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Mount Marcy quadrangle. 1921.

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New York State Museum Bulletin

Entered as second-class matter November 27, 1915, at the Post Office at Albany, N. Y. under the act of August 24, 1912. Acceptance for mailing at special rate of postage provided for in section 1103, act of October 3, 1917, authorized July 19, 1918

Published monthly by The University of the State of New York

Nos. 241-242 ALBANY, N. Y. January-February 1921

The University of the State of New York

New York State Museum

JOHN M. CLARKE, Director

THE MASTODONS, MAMMOTHS AND OTHER PLEISTOCENE MAMMALS OF NEW YORK STATE

BEING A DESCRIPTIVE RECORD OF ALL KNOWN OCCURRENCES

By

C. A. HARTNAGEL AND SHERMAN C. BISHOP

ALBANY

THE UNIVERSITY OF THE STATE OF NEW YORK

1922

M169r-N22-1800

PREFACE

The elephants and mastodons of the New York fauna which disappeared with the waning of the Postglacial waters, are a subject of constant interest to our citizens, for the bones of these creatures are still being uncovered in the normal processes of agriculture and industry. The first discovery of these extinct proboscideans in America was made in this State and so extensive have the records of their occurrence now become that they picture a time, not far behind us, when the highlands of the State, and the watersheds of the Hudson valley, were traversed by these great beasts, particularly the mastodons, in vast numbers. Twenty years ago the writer, who had then some experience in excavating these remains, compiled and published a list of all known occurrences of these creatures in this State, but since then additional early records have come to light, new discoveries have been made and many specimens added to the State Museum, and it has seemed wise to reconsider the whole subject. This work has now been admirably done by my associates, Messrs. C. A. Hartnagel and Sherman C. Bishop, who have extended the record to cover all occurrences of mammalian remains in the Glacial and Postglacial soils of New York.

John M. Clarke
Director

September 1922

Plate 1

The Cohoes mastodon as restored by N. T. Clarke and C. P. Heidenrich 1922; in the State Museum.

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INTRODUCTION

The preservation of any land mammal as a fossil is an accident; its subsequent discovery frequently one. The many elements contending in the destruction of organisms make preservation of such remains the exception rather than the rule. Regions that are richly populated with fossil remains preserve but a remnant of the legions that formerly existed; regions devoid of remains of any kind may have supported an immense living world.

Fossil remains of carnivorous land mammals in New York are exceedingly rare. Only the discovery of a fox and two species of bears have been reported. Records of mastodons and mammoths are more numerous not only because the bones are larger and resist decay longer but because their very size calls attention to them, as something unusual. Remains of many smaller Pleistocene mammals which did not differ materially from those now living, have doubtless been found but not reported.

De Kay (*New York Fauna,* pt 1, Mammalia, 1842) noticed at some length occurrences of the mammoth and the mastodon, which will be referred to again in their proper places; also a "stag" termed Elaphus americanus, and a supposedly fossil horse. Prof. James Hall, in the Boston Journal of Natural History (1846, 5:390), mentioned without discussion the mastodon, mammoth, *Castoroides,* deer and elk. C. Hart Merriam's list of the Mammals of the Adirondack Region, (1886) included records of a horse and mastodon or mammoth. Joseph Leidy's "Synopsis of the Mammalian Remains of North America" (1869) gave accounts of several New York specimens including remains of elk, deer, caribou, horse and *Castoroides.* More recently, Gerrit S. Miller ("Preliminary List of New York Mammals," N. Y. State Mus. Bul. 29. 1899) included the fossil beaver (*Castoroides*), peccary, horse, mastodon and mammoth. In New York State Museum, Bulletin 19 (1898), F. J. H. Merrill mentioned the mastodon, *Cas-*

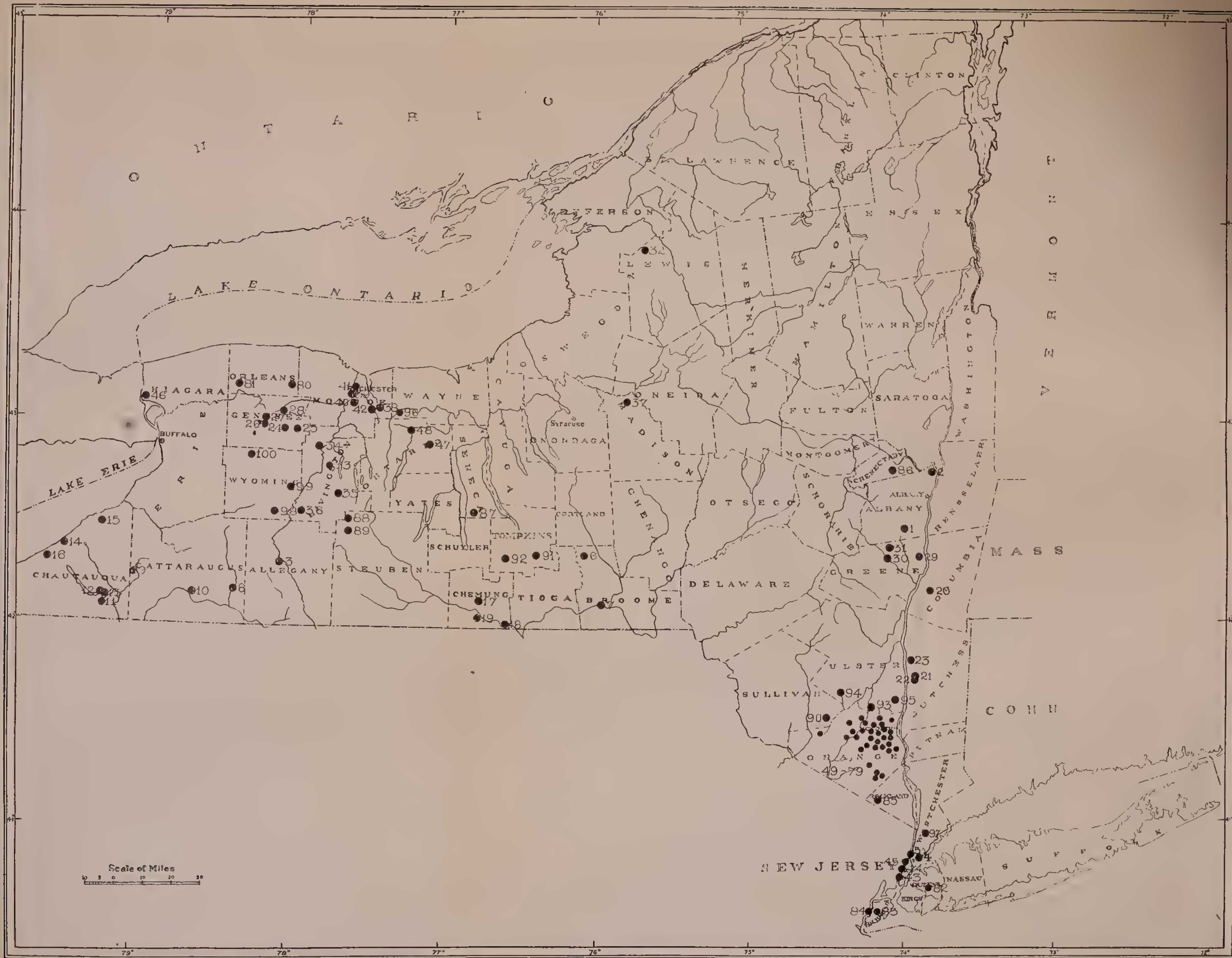
toroides and reindeer. The most complete record of mastodon occurrences thus far printed is that by John M. Clarke (N. Y. State Museum Bul. 69, 1903) in which there are about sixty distinct entries with ten or more in later publications. Rock caves have been a source of vertebrate remains, but exploration of New York caves has not resulted in the finding of numerous species such as have been discovered in Pennsylvania and elsewhere; from the great abundance and variety of species discovered in these neighboring states it would be reasonable to suppose that New York supported a similar fauna. The discovery of open caves or crevices and the accident of entombment and preservation must be depended on for any great extension of the list of fossil species in New York.

New York has proved to be particularly rich in remains of *Mastodon* and *Elephas* and in here summarizing these discoveries, they have been recorded chronologically by counties, numbered consecutively in the text and indicated on key maps, plates 2, 6, 13, showing distribution. Of the several factors contributing to the localization of mastodon remains in southeastern New York, where over one-third of the recorded specimens have been found, the early physical development of the country is doubtless the most important. Here were thousands of acres of swampy upland, freed by the recession of the great ice sheet and offering food to invading animals from the south. The land to the northwest held fewer inducements for there is nothing in the makeup of a mastodon to fit it for mountain climbing. Eastward the ancient Hudson may have acted as a partial barrier, for comparatively few remains of these animals have been recorded from New England. The largest of the existing swampy areas in Orange county, the so-called "drowned lands," cover about 17,000 acres, but it is not here that remains have been found, probably because the change from open lake to swamp has been too recent. Peat bogs and marl ponds outside the area of the "drowned lands," and the beds of extinct ponds now being used for agricultural purposes are the regions that have contributed most largely of mastodon remains.

Muck and marl deposits are natural traps in which the animals mired; and this is every year evidenced by the "bogging down" of domestic cattle. If further proof were needed it is only necessary to recall the many instances where remains have been found in positions which would admit no other explanation. In several cases too, the stomach contents have been found between the ribs, further evidence of sudden death.

This record is believed to be reasonably correct and complete but the writers would be grateful for additional data and for corrections to errors existing in the list herewith presented.

Map showing distribu



Map showing distribution of mastodon remains in New York State.

RECORDS OF MASTODON * REMAINS

ARRANGED BY COUNTIES

Albany County

1 1835? *Coeymans.* Mastodon or mammoth. This specimen was found previous to 1842, but the exact date is not known. W. W. Mather,[1] after mentioning the discovery of supposed fossil elephant bones in Green county, states: "Another was found on the Helderberg mountain, in a bed of shell or lake marl, where it appeared to have been mired in this material, on the bank of a small pond-hole or marsh. This was found on the farm of Mr. Shear, 4 or 5 miles west of the Hudson, in the township of Coeymans, Albany county. A tusk of the animal was brought to Albany. Most of the skeleton is supposed to be still at the locality where the tusk was found. The tusk was small for one of these animals." Professor James Hall,[2] who also visited the Coeymans locality, states that "the bones were imbedded in a fresh-water marl, or rested upon the clay beneath the marl. There is here no possibility of their having been transported; and the inference of Doctor DeKay,[3] that these animals perished while in search of food in swamps, seems substantiated by the position of their bones."

The find above reported is probably the same as that recorded from the town of Coeymans, in French's Gazetteer (1860) which states, "The fossil remains of a mastodon were found on the farm of Mr P. Gidney, 6 miles west of the river."

Sir Charles Lyell's[4] reference of this occurrence follows:

"Albany and Greene counties.— Mr Lyell examined, in company with Mr Hall, two swamps west of the Hudson river, where the

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* *Mammut* (Blumenbach, Naturges, ed. 6, 1799, p. 698), is the earliest name given to the fossil probascidean commonly called the American mastodon. The specific name "*americanum*" was supplied by Kerr.

[1] Geology of New York, pt 1, 1843, p. 44.

[2] Geology of New York, pt 4, 1843, p. 367.

[3] Zoology of New York, pt 1, 1842, p. 104.

[4] In Amer. Jour. Sci. 1844. v. 46, p. 322. From article by Sir Charles Lyell originally printed in Proc. London Geol. Soc. v. 4, no. 92. See also Lyell's Travels in North America, v. 1, 1845, p. 54. Sir Charles Lyell travelled in America in 1841 and with Professor Hall visited several localities where mastodons had been found, including the one in the town of Coeymans. Further references to his visits to mastodon localities will be noted under the counties of Livingston, Monroe and Niagara.

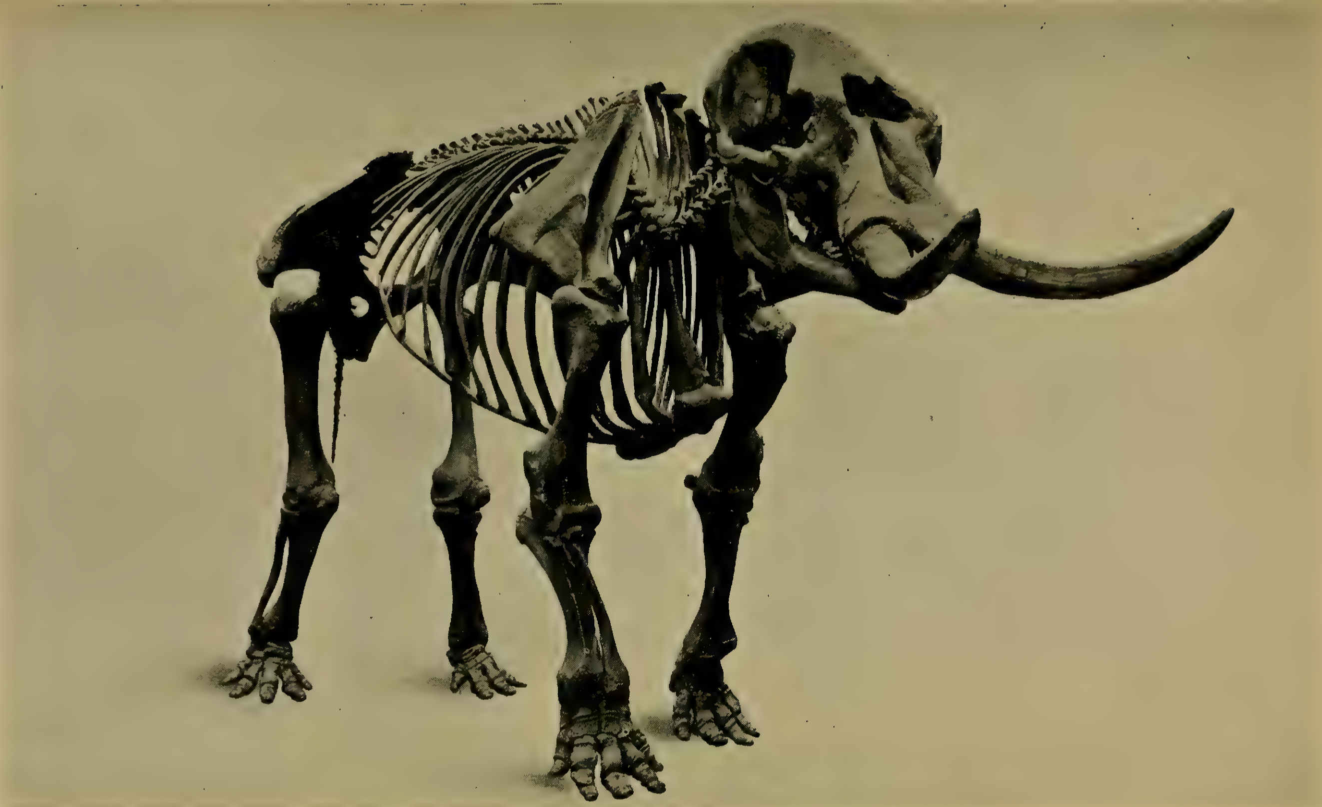
remains of mastodon occurred in both places at a depth of 4 or 5 feet, precisely in such situation as would yield shell marl, and peat, with remains of existing animals in Scotland. Cattle have recently been mired in these swamps."

The date of this find is given by Clarke as 1835? (New York State Mus. Bul. 69, 1903, p. 929). None of the bones of this find are believed to have been preserved and there are no records showing that they were ever received in the State Museum or the Albany Institute. There is thus no direct evidence to determine whether the animal was a mastodon or a mammoth. On the basis of other known finds in this section of the State the chances are that it was a mastodon.

2 1866. *Cohoes* (plates 1, 3, 4). The peculiar circumstances under which the skeleton of the Cohoes mastodon was discovered, have given the specimen wide publicity. The lower jaw and a single foot bone were found on a ledge of rock, on the side of a pot hole, by workmen excavating for the foundations of the Harmony Mills at Cohoes, N. Y., in September 1866. Continued excavations revealed the principal parts of the skeleton at a lower level of the same pothole; and in February of the year following, a few other bones (those of the right fore leg and foot) in a smaller pothole about 60 feet to the southwest of the larger one. Most of the bones were lying on a bed of clay and broken slate above a layer of water-worn pebbles. Above the bones there was an accumulation of muck, peaty soil with fragments of limbs and rotten, beaver-gnawed wood and artificial fill, almost 60 feet in thickness.

The surface of the rock in which the potholes were excavated lies at a level almost 100 feet above the present surface of the river bed below the Cohoes falls. Hall[5] thought the potholes had been formed by the action of surface waters falling through crevasses in the ice sheet to the rock beneath but this interpretation has been generally abandoned in favor of the theory that they are of a post-glacial origin. Quoting H. L. Fairchild, O. P. Hay[6] states that at the time of the withdrawal of the ice sheet, the site of Cohoes was depressed about 350 feet below the present level and covered with a thick deposit of sand and clay laid down in the bed of Lake Albany. With the elevation of the land, Lake Albany was drained and the ancient Mohawk (Iromohawk) cut through the deposited sands and clays, reached bedrock and drilled the potholes.

[5] N. Y. State Cab. Nat. Hist. 21st Annual Rep't, 1871, p. 105.
[6] Science 1919, 49:379.



The Cohoes mastodon. Skeleton in New York State Museum.

Plate 4

Deformed lower jaw of Cohoes mastodon. Note absence of the ultimate molar of right side of jaw and the distortion due to disease (pyorrhea) in the remaining tooth.

Various theories have been advanced to account for the presence of the skeleton in the potholes. Hall not only provided a glacial origin for the holes but for the mastodon itself which he believed to have been entombed in the glacier, dismembered by action of the ice and dropped, part in one pothole and part in another.

Clarke[7] was of the opinion that the skeleton belonged to the period of swamps which covered the area after the fall of the postglacial waters. O. P. Hay[8] stated his opinion as follows: "We may fairly assume that it [the mastodon] had only recently died and was lying on the flood plain not far above the potholes. No disarticulated bones could have been distributed as this skeleton was. The bones must, perhaps without exception, have been held together by ligaments and probably much of the flesh remained. At this moment the river rose and swept the flood plain carrying the cadaver over the potholes."

It is certain that the skeleton was deposited long after the potholes had been drilled, for the majority of the bones rested on a bed of clay and broken slate above a layer of water-worn pebbles and gravel at least 10 feet thick. Above the bones the muck and peat deposit was at least 50 feet thick. It would seem therefore that the bones were deposited while in the flesh in potholes which were abandoned except at periods of high water, and subsequently covered by the accumulated debris of years.

Allegany County

3 1903. *Belvidere.* The only find of a mastodon in Allegany county of which we have knowledge is the one mentioned as a news item in the American Geologist (Jan. 1904: 33:60). "Remains of a large mastodon were discovered recently in the village of Belvidere, N. Y. They were unearthed by Dr James Johnson of Bradford and Mr Alban Stewart of the Smithsonian Institution. The remains consist of three ribs and four vertebrae, each of the latter being 6 inches in width, indicating a very large individual."

Bronx County

4 1880. *Morrisania.* Mastodon or mammoth. Dr N. L. Britton[9] has given the following account of this find: "A mastodon's tusk was recently found at Morrisania, N. Y., by Mr R. Stoker, in

[7] N. Y. State Mus. Bul. 69, 1903, p. 930.
[8] Science 1919, 49:379.
[9] School of Mines Quarterly, May 1880, p. 198–99. *See also* N. Y. Acad. Sci., Trans. 1885, 5:15.

an excavation for a cellar. It was obtained from a stratum of drifted material about 4 feet in thickness, underlain by gneiss rock, and covered with 6 feet of artificial filling. The specimen was taken from one corner of the excavation, about 6 feet from each wall, and 1 foot above the floor. No other parts of the animal were found, nor is it likely that there would be by further exploration as the material consists of drifted dirt and pebbles, and the tusk was probably brought there from a distance. The specimen has been donated to the School of Mines by Mr Stoker."

5 1887? *Harlem.* Prof. J. F. Kemp[10] states that, "in the Columbia College collection there is a mastodon tooth from that [the drift] of Westchester Co., just across the Harlem river." The exact locality or the date of this find has not been ascertained but the locality can not be far from Morrisania where a portion of a mastodon's tusk was found. The part of Westchester county above referred to is now a part of Bronx county.

Broome County

6 1875. *Center Lisle.* There are in the museum of Cornell University, a humerus and a rib, identified as belonging to a mastodon found a few hundred yards north of Center Lisle[11] at 1100 feet elevation. According to Professor Tarr,[12] the remains were found in a boggy place where a spring emerges from the base of a gravel terrace. The remains occurred in such a situation as to warrant the inference that the animal may have mired there after the valley was cut down to its present level. He states too that it is equally possible to infer that the remains were washed out of the gravels and concentrated in this swampy area, but with present information it is not possible to decide between these alternatives.

7 1887? *Binghamton.* Mastodon or mammoth. In 1887 there was presented to the State Museum by H. L. Griffis, the "waterworn extremity of tusk of mastodon, found in drift while excavating for a sewer at Binghamton, N. Y." (N. Y. State Mus. Nat. Hist., 41st Annual Rep't, 1888, p. 30).

Binghamton is situated at the junction of the Chenango and Susquehanna rivers at an elevation of 845 feet. No direct evidence presents itself which determines whether the tusk belonged to a mastodon or an elephant.

[10] N. Y. Acad. Sci. Trans., 1887, 7:52.
[11] The locality is given as *Lisle,* in Am. Jour. Sci., 1875, 10:390.
[12] Geol. Atlas U. S., Folio 169 (Field ed.), 1909, p. 201.

In this connection it may be worthy of remark that Binghamton lies in a valley where during glacial retreat there flowed a great river, whose waters were supplied from the melting ice to the north. It is, of course, possible that the tusk was brought down by this river from the glacial ice, in which case the tusk is probably that of a mammoth. On the other hand, the animal may have lived later and the tusk been buried in the river drift; if so, the chances favor its belonging to a mastodon.

Cattaraugus County

8 1843? *Hinsdale.* Mastodon or mammoth. At Hinsdale, Hall[13] reports in his list of mastodons, "a tusk, with some horns of deer, was found 16 feet beneath the surface in gravel and sand." Nothing further is known of the character of the remains and it is not known whether the tusk was taken out and preserved. This find is at present interesting chiefly for the association of the deer horns found with it. Hinsdale is at an elevation of 1484 feet.

9 1906. *Conewango Valley.* Mastodon or mammoth. In September 1906, C. N. and W. H. Hoard reported to the State Geologist the finding of parts of a skeleton represented by 40 to 50 bones, mostly vertebrae and foot bones. The largest bone found was a femur a little over 2 feet in length and 13 inches in circumference midway between the ends; after seasoning 10 years it weighed a little over 20 pounds. The remains were uncovered by a steam dredge in excavating for the state ditch along the Conewango creek in a shelf of blue clay 10 or 12 feet high. The bones were found imbedded in the blue clay overlaid by about 3 feet of black muck and about 6 feet below the natural surface of the ground. At present writing these bones are in possession of William T. Fenton, Conewango, N. Y. This locality is close to the boundary of Cattaraugus and Chautauqua counties. The remains are very probably those of the mastodon but they have not been identified by anyone capable of close discrimination of their generic characters. (See Clarke, N. Y. State Mus. Annual Rep't Director for 1906, p. 60).

10 1908. *Kill Buck.* "A single tusk has been reported as found at this date near the banks of the Great Valley creek. Details are wanting." The above brief account quoted from Clarke (N. Y. State Mus. Bul. 140, p. 46) has not been supplemented by later information, and so the generic character of the tusk still remains in doubt. The elevation of the creek at Kill Buck is 1400 feet. The

[13] Geology Fourth Dist., 1843, p. 364.

creek empties into the Allegany river less than a mile from Kill Buck, which is nearly 3 miles east from the great northern bend of the Allegany. The locality is nearly midway between Hinsdale and Conewango, the other two localities where fossil bones have been found in the county.

Chautauqua County

11 1843? *Jamestown.* In 1843 Hall reported that a tooth of a mastodon had been found at Jamestown, several feet below the surface, in gravel.

Fossil teeth from the same neighborhood, at first thought to belong to the mastodon, were described as early as 1835, but these have proved to be teeth of the buffalo. Jamestown is located near the outlet of Chautauqua lake at an elevation of 1300 feet and is 24 miles distant from Lake Erie. (See Amer. Jour. Sci., 1835, 27:166.

12 1871. *Jamestown.* Large mastodon. Two skeletons were found in this year at the same locality. The larger one[14] has been rather fully described by the late Hon. Obed Edson in his "History of Chautauqua County" (1894, p. 34-36). His account follows:

"In August 1871, portions of a gigantic mastodon were found 1 mile north of Jamestown near the summit of the low hills dividing the valley of Chautauqua lake from that of the Cassadaga. This important discovery within our county, of relics of life in the Champlain period (perhaps of the Recent period), demands a full description. The exhumation and preservation of the bones were fortunately intrusted to the late Prof. Samuel G. Love, assisted by Professors Burns and Albro, and are now in the museum of the Jamestown High School. The following is from an article written by Prof. S. G. Love, published in the Jamestown Journal:

On the east side of the Fredonia road, about 1 mile north of Jamestown, is the farm of Joel I. Hoyt. About 500 yards from the road is a sink or slough covering about an acre, possibly more in extent, and varying from 2 to 8 feet in depth, and fed by several living springs. Cattle have been mired and lost there since the farm was first occupied. Mr Hoyt drained the sink and left the muck to dry, and later commenced an excavation there. The work of excavating had continued a little more than a week, when the workmen began to find (as they supposed) a peculiar kind of wood and roots, imbedded some 6 feet beneath the surface. For several days they continued to carry the small pieces into an adjoining field with the muck, and to pile the larger ones with pine roots and stumps to be burned. But Mr Hoyt discovered unmistakable evidences of the remains of some huge animal. At once there was a change

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[14] Another description of this skeleton and that of a smaller one found nearby is given by T. A. Cheney under date of November 13, 1871, in the American Naturalist 1872, 6:178–79. See description, p. 16.

in the procedure, in order to secure specimens and determine their character. It was difficult to determine the precise position of the remains, as they were much disturbed and partially removed before any special notice was taken of them. From the best information I could get, I conclude that the body lay with the head to the east, from 4 to 6 feet beneath the surface, and in a partially natural position. Many of the bones were, however, out of place. The lower jaw was about 5 feet from the head, and lay on the side crushed together so that the rows of teeth were very near each other. The tusks extended eastwardly in nearly a natural position, and, judging from the statements of Mr Hoyt and the workmen, they must have been from 10 to 12 feet in length. After digging into the gravel and clay about 10 inches I found traces of a rib, decayed, but distinctly marked, over 5 feet in length. Where the body must have lain were found large quantities of vegetable matter (evidently the contents of the stomach) mostly decayed, in which were innumerable small twigs varying from one-half inch to 2 inches in length. The remains were all in a very forward state of decay; and when I reached the ground I found it impossible to do little more than had already been done to preserve them. Many of them were picked up in the field, whither they had been drawn with the muck, and from piles of roots and stumps. Specimens secured: (1) Tip of one of the tusks; length, 3 feet, 7½ inches; diameter, 6½ inches. (2) Middle section of the other tusk; length, 2 feet, 5 inches; diameter, 7½ inches. (3) Six teeth; length of longer ones on the crown, 7½ inches; weight, 5½ pounds; length of shorter ones, 4½ inches; weight, 2½ pounds. (4) Left side of under jaw containing two teeth in situ; length preserved, 2 feet, 1 inch; depth from the crown of the teeth, 10½ inches; thickness, 6 inches. (5) Pieces of scapula (shoulder blade) from 10 to 13 inches long and 4 to 7 wide. (6) Sections of ribs; 12 to 18 inches long. (7) Head of the femur (thigh bone). (8) Portions of the vertebrae of the neck. (9) Fragments of the cranium (skull). (10) Various other pieces not yet identified. The animal was undoubtedly the American mastodon (Mastodon Maximus, or Mastodon Americanus of some authors). A single tooth is sufficient to distinguish it from the elephant. The grinding surface of a mastodon's tooth is covered with conical projections (whence the name of the animal) while that of the elephant is flat. The size of the living animal must have been, in height, from 10 to 15 feet, and in length to the base of the tail, from 15 to 20 feet. (I ought perhaps to say that although I am quite satisfied with the above estimate of size, I have been told by very good authority that it is an underestimate.)

The following is from a paper read by Professor Love before the Chautauqua Society of History and Natural Science, July 16, 1885. Referring to the article in the Journal he says:

" When we arrived at the farm we found the rain of the previous night had filled the excavated portion of the sink with water to the deph of 2 or 3 feet. At the limit of the digging on the eastern side stood a bank or wall of the muck about 4½ feet high. After reopening the ditch and draining off a part of the water, we commenced an examination of this bank, in which the lower jaw was soon found. It was nearly 3 feet from the surface; the sides were crushed together, the right side of the jaw being uppermost. It was removed with great care in a blanket, but the upper (right) half crumbled into small pieces as soon as it was exposed to the air for a few minutes. I am of opinion that the animal died in his tracks from some natural cause. He may have been drowned or mired, but if so the sink must have been at that time much deeper than at present, and, judging from the make of the land around the sink, I should say it may have been deeper by many feet. The slight dislocation or disturbance of the remains I have no doubt were due to causes which would naturally operate in a slough, into which large trees would be liable to fall and finally sink to the bottom. In any event the remains must have been buried much deeper in the muck and water for many, many years in order to escape complete destruction, and the fact that the bones of those animals were permeated with large proportions of fatty matter would help greatly to preserve them.

"The twigs found in such large quantities where the stomach would naturally be were found, upon a miscroscopical examination and camparison, to be the same kind (genera and species,) as the cone-bearing trees (pine and spruce) of the present day. Mingled with the twigs was a mass of yellowish fetid matter, probably the remains of some vegetation which did not possess the staying qualities of the balsamic cone-bearers."

13 1871. *Jamestown.* Small mastoden. In the preceding account of the large mastodon found at Jamestown mention is made of another description of this skeleton by T. A. Cheney. In the body of his account such expressions as *larger skeleton, smaller animal* are found, and the concluding paragraph of his article is as follows: "The smaller skeleton (found at a short distance from the larger one) was probably 7 feet in height; tusks 4 feet long, 4 inches wide, teeth 3½ inches in length; sections of jaw and rib bones were also found." Although no mention is made of the smaller mastodon by Obed Edson in his original account of the larger skeleton, a letter received from him in 1919 stated that the skeletons of four mastodons had been found in Chautauqua county. Mr Edson also stated in his letter that some teeth of other mastodons and elephants had been found in the county but was unable to give any definite data regarding the other finds. The measurements given of the smaller skeleton at Jamestown indicate the smallest mastodon of which we have definite knowledge in New York State.

14 1871. *Portland (?).* Mastodon or mammoth. We are indebted to William L. Bryant of the Buffalo Society of Natural Sciences for the following memorandum relating to a fragment of a tusk in the Buffalo museum: "From G. W. Brud, Silver Creek, N. Y., a fragment of a tusk of a mastodon [the tusk measured 13 feet long] dug out of a gravel bank in Portland (?), Chautauqua county."

15 1894. *Sheridan.* This specimen was discovered by Robert Dahlman in April 1894, on his farm, which is in the town of

Sheridan, one-half mile west of the Hanover town line, and 2½ miles from Lake Erie. The farm is along the main highway, running from Buffalo to Erie, Pa., and here follows the beach of glacial Lake Warren for several miles. The beach is at an elevation of 755 feet, or 183 above the level of Lake Erie. A second or higher beach of Lake Warren is here well developed, lying parallel to it one-half of a mile to the southeast and 30 feet higher. At the south, beyond this higher Warren lake beach at a little more than a mile distant is the still older beach of glacial Lake Whittlesey, 40 feet above the highest Warren beach. At the place where the bones were found, the lower Warren beach is not over 300 feet wide with a narrow strip of muck land on both sides, and it was in this muck 150 feet south of the highway (landward side of the beach) that the bones were found. The muck at the locality is about 2 feet thick, and below that 3 feet of quicksand, underneath which is a hard bed of sand on which all the bones were found, except the skull. The tusks were driven into the sand a couple of feet. From the position in which the bones lay, it would seem as if the mastodon had come up over the old lake beach and plunged headfirst into the quicksand.

The remains found consisted of the skull fairly well preserved, one tusk with the tip broken off measuring 7½ feet long and 7 inches in diameter. The other tusk had the tip preserved, but the base was broken off and measured about 4 feet in length. Other bones found were a number of vertebrae, part of the leg and shoulder bones. Twelve teeth were found, some of which were 4 inches across and weighed 4 pounds each.

16 1902. *Westfield.* Mastodon or mammoth. We are indebted to Doctor Clarke, who visited this locality, for the details of this find. He states[15] that the bones were found "on property of Mrs Alice Peacock, alongside the Nickel Plate Railroad. The bones lay on pavement of heavy boulders and under several feet of black clayey muck. They consisted of one tusk (6 feet, 2 inches, and highly curved), seventeen ribs, eight pelvic and lumbar vertebrae, patella and parts of scapula and pelvis." No direct evidence is at hand to determine whether the remains were those of a mastodon or mammoth. The highly curved character of the tusk mentioned does not warrant any generic determination such as might be possible if the tusk were double curved. It is not known what disposition has been made of Westfield remains. The locality where

[15] N. Y. State Mus. Bul. 69, 1903, p. 863, 933.

the bones and tusk were found is a little more than a mile from, and 140 feet higher than Lake Erie.

Chemung County

17 Before 1757. *Chemung.* Chemung is an Indian name meaning big horn or great horn, and it is evident from the following account by Beauchamp[16] that at least one tusk of a mammoth or mastodon had been found in this country before the coming of the early white settlers. "Chemung has various forms, as that of Skeemonk in 1777, and Shimango in 1779. In 1757 the French spoke of the 'Loups of Chaamonaqué or Theoga,' meaning the Delawares living at Tioga. It was written Shamunk in 1767, but usually Chemung. The river and an Indian village bore this name, which meant big horn. The village was burned in 1779. Zeisberger has wschummo for horn, and the locative may be added. Spafford said: 'Chemung is said to mean big horn, or great horn, in the dialect of the Indian tribes that anciently possessed this country. And that a very large horn was found in the Tioga or Chemung river is well ascertained.' This was a Delaware name, and the river had another of similar meaning. In Schoolcraft's larger work[17] (5:669) is a communication from Thomas Maxwell, who gave the usual definition and said that the name came from a large horn or tusk found in the river. Of course this must have been in colonial times to have originated the Delaware name. The early settlers found a similar one in the stream in 1799. It was sent to England, and an eminent scientist called it the tusk of an elephant or some animal." In the communication referred to above, Maxwell also states that the tusk was found embedded in sand, and the year given is "about 1794" instead of 1799.

According to Thomas Maxwell, the tusk from which Chemung derived its name, had been preserved by the Indians, as shown in the following paragraph[18]: "The name of the river is given in the journal of Col. Gansevoort as the Tioga. It has since been called the Chemung — and it is said it was so called from a large horn having been found in the river near Bydelman's, by the Indians — Chemung meaning great horn. The Muncies and Delawares called it Conongue, which in their language means horn in

[16] N. Y. State Mus. Bul. 108, 1907, p. 42.

[17] Information respecting the History, Condition and Prospects of the Indian Tribes of the United States by Henry R. Schoolcraft, Philadelphia, 1855.

[18] Brigham's Elmira Directory for 1863 and 1864. Elmira 1863, p. 16, 17.

the water. A similar horn was found in the water at the lower end of the Upper Narrows, by some of the early settlers. Captain Daniel McDowell, a former resident of Chemung was captured at Shawanee on the 12th of September, 1782, by the Indians, and carried to Niagara, and thence to Quebec. While a captive among the Indians he saw (it is believed at Quebec,) the identical horn which gave the name of Chemung to the river theretofore called Tioga. He stated to the writer in his life time that it was a counterpart of the one found at the Upper Narrows, about the year 1791. Captain McDowell had seen both, and was well calculated to give an opinion in the matter. The river is still called Tioga above its junction with the Cohocton, at Painted Post, and to its head, in the neighborhood of Blossburgh, Pennsylvania."

18 1788. *Chemung river* (upper narrows). Mastodon or mammoth. In the preceding account, the early find with date given as about 1794, should probably be 1788 in which case the occurrence would be the same as the one of which the account follows:

"A Description of a Horn or Bone, lately found in the River Chemung, or Tyoga, a western Branch of the Susquehanna, about 12 miles from Tyoga Point: Communicated by the Hon. TIMOTHY EDWARDS, of Stockbridge, Esq.; in a Letter to the Rev. Joseph Willard, D. D.

January, 1788.

"It is 6 feet 9 inches long, 21 inches round, at the large end, and 15 inches, at the small end. In the large end is a cavity, 2½ inches in diameter, much like the hollow which is filled with the pith of the horn of the ox: This is only 6 inches deep. Every other part is, or appears to have been solid. The exteriour part, where entire or not perished, is smooth; and in one spot of a dark colour. The interiour parts are of a clear white, and have the resemblance of well burnt, unslacked lime stone; but these can be seen only where it is perished, tender, and broken. From one end to the other, it appears to have been nearly round; and on it there have been no prongs or branches. It is incurvated nearly into an arch of a large circle. By the present state of both the ends, much of it must have perished; probably 2 or 3 feet from each end. From a general view of it, there is reason to believe, that in its natural state, it was nearly a semicircle of 10 or 12 feet. The undecayed parts, particularly the outside, send forth a stench, like a burning horn or bone. Of what animal this is the horn or bone, and what has become of this animal, are questions worthy of the curious and learned."[19]

[19] From Memoirs of the American Academy of Arts and Sciences, v. 2.

Another brief account of the tusk is given by Mitchill[20] who states that the tusk was found, " at Chanango, in New York, near the point where the Susquehannah passes into Pennsylvania." DeKay[21] refers to a tooth found on the banks of the Susquehannah, near Tioga, March, 1786, and states that the tooth was figured in the Columbian Magazine. Although the date of publication of the magazine is not given by DeKay, it is believed that he had reference to the figure in the November number of 1786 (1:103), where figures are given of a thigh bone, a tusk and a tooth, which are supposed to have been brought by Major Craig from Ohio. Concerning this, Mitchill states, " Of this species appears to be the animal, whose remains were brought by Major Craig from the banks of the Ohio, in 1786. They consisted of a thigh bone, part of a tusk, and a portion of the jaw with the grinders. They were figured by Colonel DeBrahm, and published in the Columbian Magazine, at Philadelphia, vol. 1, p. 103-107."

19 1853. *Elmira.* Mastodon or mammoth. The following account by Maxwell relates to a tusk, " found on an island in the river below Elmira, a few weeks since, and it is now here. I have recently examined it. It is about 4 feet in length, of the crescent form, perhaps 3 to 4 inches in diameter. Capt. Eastman saw it yesterday, and with others who have seen it, pronounces it to be ivory, and a tusk of some large animal, probably now extinct. This is the third horn or tusk which has been found in the Chemung so that the name is likely to be perpetual."

Columbia County

20 1705. *Claverack.* Cotton Mather, of witchcraft ill-fame, has been generally credited, but incorrectly, with the authorship of the earliest printed account of the discovery of mastodon remains. In a letter to Doctor Woodward of England, dated November 17, 1712 and published in the Philosophical Transactions of the Royal Society of London for 1714, 29:62 Mather described briefly, " . . . bones and teeth of some large animals found lately in New England " and, giving a literal interpretation of the biblical

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pt 1, p. 164 (1793). See also article by George Turner in Trans. Amer. Phil. Soc, 1799, 4: 514. Brief account of the tusk above described and refers to publication above cited.

[20] Geology of North America, in Cuvier, Theory of the Earth, 1818, p. 3[illegible]3, New York.

[21] DeKay, Nat. Hist. N. Y. Zool. pt. 1, 1842, p. 101.

statement, "there were giants in the earth in those days," judged the remains to be of antediluvial giant men. But Mather's information was derived from a letter he had received from Governor Joseph Dudley, dated Roxbury, July 10, 1706, and from an item published July 30, 1705 in the Boston News Letter.

B. Green, editor and printer of the Boston News Letter, gives the following account: "New York, July 23. There is a prodigious Tooth brought here, supposed by the shape of it to be one of the far great Teeth of a man; it weighs four pound and three quarters, the top of it as sound and white as a Tooth can be, but the Root is much decayed, yet one of the fangs of it holds half a pint of Liquor; it was lately dug up, a great way under ground in the side of a Bank or Hill 30 or 40 Foot above it, at or near a place call'd Claverack, about 30 miles on this side of Albany, and is looked upon here as a mighty wonder, whither the Tooth be of Man or Beast: They also dug up several Bones, which as they came to the Air crumbled away: They say one of them which is thought to be a Thigh-bone was 17 Foot long. There is since another Tooth taken up in the same place, which is a Fore Tooth flat and broad, and is as broad as mans Four Fingers, which I have not yet seen; but the other I did see, and t'was brought here by a Gentleman of the Assembly: They dug up several Trees in the same place of great bigness."

A short extract from the above account, without reference to the source, is given in Dunlap's History of the New Netherlands (1840). DeKay (1842) incorrectly credited Dunlap's account to the Phil. Trans. Roy. Soc. of London for 1705.

Governor Dudley's letter to Mather, which is concerned particularly with an account of specimens found some miles south of Albany, states concerning the teeth from Claverack: ". . . one of the same growth, but not of equal weight, was last year presented to my Lord Cornbury, and one of the same figures exactly was shown at Hartford of near a pound weight more than this."

As an interesting commentary on the thought and learning of the time in matters pertaining to natural science, Cotton Mather's communication taken from the Transactions of the Royal Society, is quoted in full: "The first letter directed to Doctor Woodward, is dated at Boston, in New England, Nov. 17, 1712. In this the Writer gives an Account of a large Work in Manuscript, in two Volumes in Folio, but does not name the Author. This, according to the account of it, is a large Commentary upon some Passages in the Bible interspers'd with large Philosophical Remarks taken out of Natural Historians, and the Observations of himself and others, more particularly as to Matters observ'd in America, whence he entitles the Work Biblia Americana. This Work Dr. Mather recommends to the Patronage of some generous Mecaenas, to promote the publication of. As a specimen of it, he transcribes a Passage out of it, being a Note on that Passage in Gen. Chap. 6. V. 4 relating to Giants; and confirms the Opinion of there having been in the Antediluvian World, Men of very large and prodigious Statures, by the Bones and Teeth of Some large Animals, found lately in Albany in New England, which for some Reasons, he judges to be Human; particularly a Tooth brought from the Place where it was found to New York, 1705, being a very large grinder, weighing 4 pounds and three-quarters, with a Bone, suppos'd to be a Thigh-bone, 17 Foot long. He also mentions another Tooth, broad and flat like a Fore-Tooth, four fingers broad: the Bones crumble to pieces in the air after they are dug up; they were found near a place call'd Claverack, about 30 miles on this side of Albany. He then gives the Description of one, which he resembles to the Eye-Tooth of a Man; he says it has four Prongs, or Roots, flat, and something worn on the top; it was six inches high, lacking one eighth, as it stood upright on its Root, and almost Thirteen Inches in circumference; it weighed two pounds four ounces Troy weight: There was another near a pound heavier, found under the Bank of Hudson's River, about fifty leagues from the Sea, a great way below the Surface of the Earth, where the Ground is of a different colour and Substance for seventy five Foot long, which they suppose to be from the rotting of the Body, to which the Bones and Teeth did, as he supposes, once belong. It were to be wished the Writer had given an exact Figure of these Teeth and Bones."

It may be pointed out that the tooth mentioned by Mather in the above account as resembling "the Eye-Tooth of a man," came from the west bank of the Hudson, the locality as given by Dudley being "some miles below the city of Albany, about fifty leagues from the sea." The tooth, "near a pound heavier," the specimen mentioned by Dudley as being shown at Hartford, was doubtless the Claverack fore tooth, "flat and broad . . . as a man's four fingers."

In 1713, English ministers and governors stationed abroad were instructed to promote the welfare of the Royal Society of London by contributing specimens and by replying to any inquiries addressed to them, concerning the countries to which they were delegated. As a result of these instructions, Lord Cornbury sent to the secretary of the Royal Society one of the teeth and some of the bones found at Claverack in 1705. A letter from Lord Cornbury, dated at New York and addressed to the secretary, gives further details of the discovery of the specimens and an account of the excavations carried on under his (Cornbury's) direction.

"I did, by the Virginia fleet, send you a Tooth, which, on the outside of the box, was called the tooth of a Giant, and I desired it might be given to Gresham College: I now send you some of his bones, and I am able to give you this account. The tooth I sent was found near the side of Hudson's river, rolled down from a high bank by a Dutch country-fellow, about twenty miles on this side of Albany, and sold to one Van Bruggen for a gill of rum. Van Bruggen being a member of the Assembly, and coming down to New York to the Assembly, brought the tooth with him, and show'd it to several people here. I was told of it, and sent for it to see, and ask'd if he would dispose of it; he said it was worth nothing, but if I had a mind to it, 'twas at my service. Thus I came by it. Some said 'twas the tooth of a human creature; others, of some beast or fish; but nobody could tell what beast or fish had such a tooth. I was of opinion it was the tooth of a giant, which gave me the curiosity to enquire farther. One Mr. Abeel, Recorder of Albany, was then in town, so I directed him to send some person to dig near the place where the tooth was found; which he did, and that you may see the account he gives me of it, I send you the original letter he sent me: you must allow for the bad English. I desire these bones may be sent to the tooth, if you think fit. When I go to Albany next, I intend to go to the place myself, to see if I can discover anything more concerning the monstrous creature, for so I think I may call it."

Mr Abeel's letter runs thus:

"According to you Excellency's order, I sent to Klaverak to make a further discovery about the bones of that creature, where the great tooth of it was found. They have dug on the top of the bank where the tooth was roll'd down from, and they found, fifteen feet underground, the bones of a corpse that was thirty feet long, but was almost all decayed; so soon as they handled them they broke in pieces; they took up some of the firm pieces, and sent them to me, and I have ordered them to be delivered to your Excellency."[22]

[22] Weld, Hist. of Royal Soc., London, 1848.

Dutchess County

22, 23 1854 *Poughkeepsie.* Two skeletons, presumably of mastodons, have been found in the vicinity of Poughkeepsie, one in 1854, the other previous to that date. Concerning these finds Doctor Clarke states,[23] " 'A skeleton of a mastodon has been recently discovered buried, in a marsh about 2 miles from Poughkeepsie, New York. Its state of perfection is not known, as it is yet but partly exhumed. This is the second skeleton obtained from the vicinity of this city'. (Am. Jour. Sci., ser. 2, 1854, 18:447.)

" This seems to me to be the same find recently described to me by Prof. W. B. Dwight, who writes: 'The chief find of mastodon bones here occurred 40 or perhaps 45 years ago in a small circular pond (in an unusually dry season I believe) on what is called the Creek road, and from 2 to 3 miles northeasterly from the city. The bones were of large size and were, I think, put into the hands of a library association called the Lyceum. What became of them nobody knows.'

"A vertebra from Poughkeepsie is in the State Museum."

A brief account of the mastodon remains found in 1854 is contained in a letter dated Sing Sing, N. Y., September 22, 1854, written by Spencer F. Baird, former secretary of the Smithsonian Institution, to James Hall. Regarding this occurrence Professor Baird says, " When at Poughkeepsie yesterday morning, I learned that some large bones, supposed to be mastodon, had been discovered in digging marl near the city." A memorandum accompanying the letter states, " that the bones found appear to have been a large vertebra and some splinters of other bones lying in the shelly marl bed. The locality was visited by Professor Baird."

24 1899. *Hyde Park road.* The following account from Poughkeepsie of the remains of a mastodon or mammoth was printed in the New York Herald, of November 20, 1899: " Portions of a mastodon have been found in Dutchess county, in a swamp on the old Macpherson place, in the Hyde Park road, near the country homes of Frederick W. Vanderbilt and other prominent New York persons. Workmen digging a drain found several fragments of heavy bone 15 feet below the surface, and some feet deeper part of a mammoth tusk.

" Mr Edward Storrs Atwater, a wealthy resident of this city, has obtained the bone and will present it to Vassar College. The college officials are desirous of making further excavations in the

[23] N. Y. State Mus. Bul. 69, 1903, p. 927.

hope of unearthing the entire skeleton. They also believe other skeletons may be found there."

The printed article also includes a brief account of the mastodon, found on the Schaeffer farm near Newburg on the opposite side of the Hudson river. The latter find is described under Orange county in this paper.

Genesee County

24 1835? *Stafford.* A mastodon tooth from this place is reported by Hall[24] who states, "In a small muck swamp in Stafford, Genesee county, a small molar tooth was found several years since. Its situation was beneath the muck, and upon a deposit of clay and sand."

25 1841. *LeRoy.* Concerning this find we have only the brief account given by Hall,[25] "In 1841, a molar tooth, weighing 2 pounds, was found in a bed of marl 3 miles south of LeRoy."

26 1897. *Batavia.* In September of this year, some remains of a mastodon were found on the Baker farm about a mile south of Batavia. Accounts of the discovery were published in the Buffalo Express of September 10 and 11th. The animal was identified as the mastodon by Prof. H. L. Ward of Rochester, who visited the locality and saw the parts of the skeleton that were recovered.

One of the tusks of the mastodon was first encountered at a depth of 3 feet in making an excavation which was said to have been in a soil of the nature of quicksand saturated with water. This indicates that the locality was not a true peat bog. The published account also states that "the tusk and rib were found on high land," probably near the margin of a swamp as indicated by the saturated condition of the soil.

Among the other parts recorded as being found was a second tusk of pure cream color found at a depth of about 4 feet. This tusk, probably broken, was about 3¼ feet long and weighed about 32 pounds. It was shorter than the first tusk, which had a length of 5 feet, with a diameter of 5 inches at its larger end and 2½ inches at the point. A portion of a jaw with two teeth, one of which weighed 4½ pounds, was obtained. Some vertebrae, a rib and larger bones, probably leg bones, and part of skull were also uncovered. See Clarke N. Y. State Mus. Bul. 69, 1903, p. 932.

27 1908. *Batavia.* This find is reported by Clarke,[26] who states,

[24] Nat. Hist. N. Y., Geol. 4th Dist. 1843, p. 364.
[25] Nat. Hist. N. Y., Geol. 4th Dist. 1843, p. 364.
[26] N. Y. State Mus. Bul. 140, 1910, p. 46.

"Discovery of a part of a skeleton on Willow street in this village has been reported. The bones found consisted of a few ribs, vertebrae and leg bones and it is stated that a jaw bearing teeth was also uncovered." Most of the remains are in a splendid state of preservation and are now in the Holland Land Office Museum at Batavia.

28 1916. *South Byron.* About 1916 a molar of a mastodon was found on the farm of Mrs E. H. Miller. The location is a short distance south of the village at an altitude near 700 feet, and 8 miles northeast from the mastodon locality in Batavia village. At the present writing the tooth is in the possession of Mrs Miller.

Greene County

29 1706. *Coxsackie.* This mastodon, whose remains were found some miles below Albany, probably in the town of Coxsackie, was the second found in America. The year before, in 1705, the first specimen found by white settlers had been uncovered at Claverack. It is no wonder then that great curiosity and doubt was expressed as to the kind of animal to which the remains belonged.

Among the manuscripts of Cotton Mather, deposited at one time with the American Antiquarian Society at Worcester, was a letter to him from Governor Joseph Dudley in which an account is given of these mastodon remains from the vicinity of Albany, N. Y. The letter was first printed in the Collections of the Massachusetts Historical Society[27] and later in Eager's History of Orange County. As an early record of mastodon remains from this locality, it is herewith presented in its entirety:

"Roxbury, 10 July, 1706.

"Sir, I was surprised a few days since with a present laid before me from Albany, by two honest Dutchmen, inhabitants of that city, which was a certain tooth accompanied with some other pieces of bone, which being but fragments, without any points whereby they might be determined to what animals they did belong, I could make nothing of them; but the tooth was of the perfect form of the eye tooth of a man, with four prongs or roots, and six distinct faces or flats on the top, a little worn, and all perfectly smoothed with grinding. I suppose all the surgeons in town have seen it, and I am perfectly of opinion it was a human tooth. I measured it, and as it stood upright it was six inches high lacking one-eighth, and

[27] Second ser. 1814: 2:263–64. See also Phil. Trans. Royal Soc. Lond., 1814, 29:62.

round 13 inches, lacking one-eighth, And its weight in the scale was 2 pounds, and four ounces, Troy weight. One[28] of the same growth, but not of equal weight was last year presented to my lord Cornbury, and one of the same figure exactly was shewed at Hartford, of near a pound weight more than this.

"Upon examination of the two Dutchmen they tell me the said tooth and bones were taken up under the bank of the Hudson's river, some miles below the city of Albany, about 50 leagues from the sea, about —— foot below the surface of the earth, in a place where the freshet does every year rake and waste the bank, and that there is a plain discoloration of the ground, for seventy five foot long at least, different from the earth in colour and substance, where is judged by every body that see it, to be the ruins and dust of the body that bore those teeth and bones.

"I am perfectly of opinion that the tooth will agree only to a human body, for whom the flood only could prepare a funeral; and without doubt he waded as long as he could to keep his head above the clouds, but must at length be confounded with all other creatures and the new sediment after the flood gave him the depth we now find.

"I remember to have read somewhere a tradition of the Jewish rabbins, that the issues of those unequal matches between heaven and earth at the beginning were such whose heads reached the clouds, who are, therefore called Nephelim, and their issue were Geborim, who shrunk away to the Raphaim, who were then found not to be invincible, but fell before less men, the sons of the east in several places besides Canaan. I am not perfectly satisfied of what rank or classis this fellow was, but I am sure not of the last, for Goliah was not half so many feet as this was ells long.

"The distance from the sea takes away all pretension of its being a whale or animal of the sea, as well as the figure of the tooth, nor can it be any remains of the elephant, the shape of the tooth and admeasurement of the body in the ground will not allow that.

"There is nothing left but to repair to those antique doctors for his origin, and to allow Dr. Burnet and Dr. Whiston to bury him at the deluge, and, if he were what he shows, he will be seen again at or after the conflagration further to be examined.

"I am, Sir, your humble servant,

"J. DUDLEY."

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[28] This refers to the Claverack specimen.

30 1838? *Greenville.* Both Hall and Mather record in their 1843 reports[29] the finding of bones at Greenville, which were probably those of a mastodon, although Mather remarks that they were "the bones of a fossil elephant, as is supposed." Hall states that "the bones were imbedded in a freshwater marl, or rested upon the clay beneath the marl. There is here no possibility of their having been transported." This locality, which is about 2 miles west of Greenville, was also visited by Sir Charles Lyell[30] in company with Professor Hall in 1841. Lyell states that the remains of a mastodon occurred, "at a depth of 4 or 5 feet, in shell-marl, with recent species of shells. These deposits of marl covered with peat are newer than the boulder (drift) formation." No information is available as to the exact date when the bones were found. According to Mather, "Two of the vertebrae were brought to Albany, one of them, *the dentatus,* is still in the possession of Prof. E. Emmons. The articulating surface of this is 9 inches in diameter." Greenville is at an elevation of around 700 feet, about 12 miles west of the Hudson and 8 miles north of the higher points of the northern Catskills.

31 1840. *Freehold.* From a small swampy depression on the farm of Charles Coonley, located on the road between Freehold and Greenville, bones of a mastodon have been obtained at various times. Doctor Clarke[31] records an atlas found in 1840, and within the last 15 years a few other bones, including one vertebra, have been obtained. A vertebra from this locality is in the American Museum of Natural History, having been presented by Charles Snyder of Freehold. Information given the writers by residents of Freehold and Greenville is to the effect that most of the bones of the mastodon are still in the swampy depression, their presence having been determined, it is said, by sounding. The Freehold locality is about 3 miles from the mastodon find recorded from west of Greenville.

Lewis County

32 1877. *Copenhagen.* Mastodon or mammoth (plate 5, upper figure). Franklin B. Hough of Lowville in a letter, now in the Museum files, to Dr S. B. Woodworth, Secretary of the Regents, under date of September 29, 1877, writes as follows: "Mr P. H.

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[29] Hall, Geology of New York, pt 4, p. 367; Mather, Geology of New York, pt 1, p. 44.

[30] Lyell's Travels in North America, 1845, 1:54. See also Amer. Journal Sci. 1844, 46: 322.

[31] N. Y. State Mus. Bul. 69, 1903, p. 927.

Upper figure. Slender tusk found at Copenhagen, Lewis co., N. Y. Believed to be a tusk of a female mastodon, but may possibly be that of a mammoth. *Lower figure.* Well-preserved tusk of a young mastodon from Harriman, N. Y.

Sage of Copenhagen, Lewis Co., has just brought to me a tusk of a Mammoth or Elephant[32] found about a mile west of that village on Thursday of last week (Sept. 20th). It is 5 feet 9 inches long on the lower side, 8¾ inches around at the base and 10¾ at the largest part, and weighs 25 pounds. It was found in digging muck from a low place in a field that had no drainage but was on somewhat elevated ground. Its base was uppermost in the muck and it passed obliquely down through a kind of marl into a bed of blue gravel. The tip was broken off in getting out but has been mended on again. The tusk is quite sound and has a socket at the base. . . . The tusk is much more slender than any I have seen, and must have belonged to a young animal." In a letter to Professor Hall, dated October 11, 1877, Doctor Hough tells of a personal visit to the locality. He wrote, "The place where the tusk was found being 12 miles from this place, I did not find an opportunity of seeing it until today. The spot is a narrow swamp timbered with black ash, soft maple and elm, and was evidently once a shallow pond. The limestone rock is not over 10 or 12 feet below the surface, and is covered with a foot or more of gravel. Over this is a stratum of marl, still showing occasionally delicate but distinct shells of existing species but mostly a finely comminuted greyish white mass of the consistence of putty. Above this and varying in depth from 1 to 6 feet or more, is muck, full of the remains of the recent vegetation of the swamp. The place where the tusk was found, was near the bottom of the muck, and in the marl, about 5 feet below the surface. No excavatioins have since been made and the hole is now in the condition of a mortar bed from recent rains.

"I think there is no doubt but that the animal lost its life there as both the marl and muck have been formed where they are. There is no appearance of any materials having been transported by currents or otherwise."

This swamp is on the divide between the North Sandy creek and the Deer river at an elevation of 1190 feet above sea. A slight difference in level would turn the waters into the Deer river, but the natural overflow is into the extreme source of the North Sandy creek. This find is the most northerly thus far recorded in the State. The tusk as shown in the plate is a slender one and it has not been determined definitely whether it belonged to a mastodon or mammoth. While the tusk resembles in some respects that of

[32] A brief account of this find is given by C. H. Merriam in "The Mammals of the Adirondack Region," 1886, p. 145. The same account is also given in Tran. Linnaean Soc. of N. Y., 1884, 2:47.

the mammoth it is quite likely that it belonged to a female mastodon. The character of the tusk and the nature of the deposits in which it was found are quite similar to those of the Mount Holly, Vermont, mammoth[33] (E. primigenius), which was found on the divide between the Champlain and Connecticut valleys, beneath muck and lying on a bed of gravel at an elevation of 1415 feet. One of the Mount Holly tusks had the following measurements: along curve on outer surface 80 inches, greatest circumference 12 inches, cord from base to point 60 inches, longest perpendicular from cord to inner curve 19 inches. In the Copenhagen specimen the corresponding last two measurements are 50 and 13 inches respectively. The measurements show that the Mount Holly specimen is larger than the Copenhagen, and that the proportions are nearly the same. It is not known whether the curve of the Mount Holly tusk is in a single plane. The Copenhagen specimen clearly shows a spiral curve.

Livingston County

33 1825. *Geneseo.* In 1825, the remains of a mastodon were found about one-half mile east of the court house at Geneseo in a small marsh. An account of the find was published in the Livingston Register of August 17, 1825, and 2 years later the following article was written by Jeremiah Van Rensselaer:[34] "The tusks were first seen, and then the head, but these, as indeed the whole skeleton, were in such a state of almost total decomposition, as to defy all attempts at preservation. The skeleton lay in the direction so frequently observed in the remains of this animal, South West and North East. The head rested upon the lower jaw. The tusks were much decayed; their points were five feet apart, and curved at least a foot from the center. They were four feet and two inches in length; the largest diameter could not be ascertained on account of their decay — but it was preserved a considerable distance and then gradually diminished, so that at five inches from the point, the diameter was three inches. The laminated structure of the tusk was rendered evident by decomposition, which had in a measure separated the laminae, and the whole was supposed to be phosphate of lime.

"Of the two (superior) incisors, no trace could be discovered, but the eight molars were in situ. The length of the largest tooth

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[33] Appendix to Thompson's Vermont, 1853, p. 15.
[34] Amer. Jour. Sci., 1827, 12:330-81.

was six and a quarter inches; of the smallest three and a half; the crown of the tooth was two and a half; and the breadth of the enamel from one-eighth to three-eighths of an inch, as was rendered visible by wearing away of the surface. The roots were all broken and decayed. The animal could not have been old, as eight molar teeth were found; old animals have only one molar on either side of each jaw.

"The pelvis was twenty two inches in its transverse diameter, between the acetabula at the inferior opening. The epiphyses of the large bones, and the patellae were found nearly perfect, not having suffered from decay."

This find is mentioned by DeKay,[35] who states that the skeleton was found resting upon a bed of fine white gravel, but as DeKay refers to the Rensselaer account, which is apparently the source of his information, the word marl should have been used instead of gravel.

One of the teeth of the Geneseo mastodon is figured by Hall[36] whose brief account is here given:

"At Geneseo in Livingston county, several years since, a large number of bones and three teeth were found in a swamp beneath a deposit of muck, intermingled with a sandy calcareous marl. A single tooth, in the possession of C. H. Bryan, Esq. of Geneseo, is the only known remaining specimen of this collection. The figure at the head of the chapter is from this fossil."

Hall further states (p. 366), "In the case at Geneseo, where the bones were said to be imbedded in gravel, it is proved to have been a shell marl."

A footnote on the same page reads; "While Mr. Lyell was in this part of the country, being desirous to ascertain the truth among conflicting statements, he procured an excavation to be made at the spot where the bones were originally found. Some fragments of bones were obtained, mixed with marl and freshwater shells, leaving no doubt of the position of the animal, which doubtless perished on the spot where these remains occur."

Sir Charles Lyell's account of his visit to the Geneseo locality is given in his "Travels in North America" (1845, 1:45):

"I was desirous of knowing whether any shells accompanied the bones, and whether they were recent species. Mr. Hall and I there-

[35] Nat. Hist. N. Y. Zool., pt 1, 1842, p. 104.
[36] Nat. Hist. N. Y., Geol. pt 4, 1843, p. 364; fig. 173, p. 363: tables; no. 68, fig. 74. See also Amer. Jour. Agr. & Sci., 1847, 6:35, fig. 2.

fore procured workmen, who were soon joined by several amateurs of Geneseo, and a pit was dug to the depth of about five feet from the surface. Here we came down upon a bed of white shell-marl and sand, in which lay portions of the skull, ivory tusk, and vertebrae, of the extinct quadruped. The shells proved to be all of existing freshwater and land species now common in this district. I had been told that the Mastodon's teeth were taken out of *muck,* or the black superficial peaty earth of this bog. I was therefore glad to ascertain that it was really buried in the shell-marl below the peat, and therefore agreed in situation with the large fossil elks of Ireland, which, though often said to occur in peat, are in fact met with in subjacent beds of marl."

Another account by Lyell,[37] published previously to the one above given states that at Geneseo (printed Genesee), "Remains of the Mastodon giganteum were found with existing shells in a small swamp, in a cavity of the boulder formation, so that the animal must have sunk after the period of the drift, when a shallow pond fed by springs was inhabited by the same species of fresh-water Mollusca as now live on the spot."

A somewhat extended account of the Geneseo mastodon is given in "A History of Livingston county."[38] From this history the following statements are derived: "The tusks were of spiral form, one measured 5 feet in length and 7 inches in diameter at its base, gradually diminishing in size to an obtuse point. They were found about 3 feet apart, their points lying in opposite directions. The teeth were marked upon their grinding surface by four rows of studded, blunt points elevated an inch. The processes of the teeth that enter the jaw were destroyed in all of them. The bones were so badly decayed that it was impossible to collect any of the important ones. Measurements showed that the lower bone of the hind leg was 3 feet in length from the knee joint to the ankle. The thigh bone was 3 feet in length from joint to neck. The length of the animal from the center between the base of the two tusks to the exterior point of the pelvis was estimated at 20 feet and the height at 12 feet. The bones were placed in the cabinet of the Buffalo Natural Historical Society."

This society is now the Buffalo Society of Natural Sciences. Its

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[37] Am. Jour. Sci., 1844, 46:322. This article is from the Proceedings of the London Geological Society, 1843, v. 4, no. 92.

[38] By Lockwood L. Doty, Geneseo, 1876, p. 379–81. On page 528 is the statement that the Mammoth spring at Geneseo is so called from the fact that several bones and teeth of a mastodon were exhumed here in 1825.

museum contains five molar teeth and parts of tusks from western New York and probably belong to the Geneseo specimen. The molar from Geneseo figured by Hall, shows the root processes. It is not known whether this specimen has been preserved. It may have represented the best of the molars or the processes may have been added when making the drawing. The early accounts stated that the root processes were all broken and decayed.

34 1886. *Fowlerville.* Some remains of a mastodon were found in an excavation on the bank of the Genesee river, 80 feet above the water. Three or four teeth, tusks and some badly broken bones were found.[39] Some of the teeth are said to be in a private collection in Rochester.

35 1835. *Scottsburg.* An account of the finding of this specimen is given in "A History of Livingston County" (1876, p. 380). The account states that the " discovery was made about the year 1835, in straightening the road from Scottsburgh to Conesus lake. In digging the ditch on the east side of the road, where it ran through a swamp of five or six acres, near the inlet of the lake and about thirty rods to the west, the remains of a mastodon were found, about three feet below the surface. Eight teeth were found, four of which had blunt points, and weighing about two pounds each. The shoulder blades, pieces of the ribs and some joints of the backbone were also found. Some of these bones are now in the Le Roy Female Seminary." Clarke[40] states on the authority of C. E. Beecher that twenty bones and fragments were collected by F. H. Bradley and H. A. Green, which were presented to Yale University Museum by R. S. Fellows. There is a possibility that the record presented above may actually represent two finds in the vicinity of Scottsburg. Data to determine this point are not available.

36 1900? *Nunda.* It is not known whether this find represents a mastodon or mammoth. The only account we have of the bones is the brief statement of Clarke[41] which reads, " Ten bones and fragments, collected by Rev. Milton Waldo and presented by R. S. Fellows to Yale University Museum, *C. E. Beecher.*" As no account of the find is given in the History of Livingston County published in 1876, the bones were probably collected between that date and 1900.

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[39] N. Y. State Mus. Bul. 69, 1903, p. 932.
[40] N. Y. State Mus. Bul. 69, 1903, p. 932.
[41] N. Y. State Mus. Bul. 69, 1903, p. 932.

Madison County

37 1917. *Canastota.* The discovery of these remains was reported by Dr Burnett Smith, of Syracuse University, and a brief account of the find was published by Doctor Clarke (N. Y. State Mus. Bul. 196, p. 46, 1918). The bones were found in 1917 at an elevation of 420 feet while a drainage ditch was being dug in muck on the farm then owned by Mrs J. B. Fuller, 4 miles north from Canastota and 2½ miles south from Lewis point on the south shore of Oneida lake, which is 123 feet above the level of Lake Ontario and within the limits of glacial Lake Iroquois. The parts found consisted of femur, ulna, radius, tibia, patella and three ribs. A photograph of the larger leg bones was shown to Dr W. D. Matthew and by him identified as those of a mastodon. The bones were all found close together, in muck at a depth not exceeding 3 feet from the surface. Efforts to obtain the bones for the Museum were unavailing as the owners hoped to procure the remaining ones for assembling a complete skeleton. Difficulties encountered with water gave but little encouragement to hopes for final success of the enterprise. The locality for this mastodon is less than 3 miles from the place, and at nearly the same elevation, where an incisor of the giant beaver[42] was found. This mastodon find is of special interest because the remains occurred well within the basin of glacial Lake Iroquois, thus indicating the presence of the living mastodon in this section after the withdrawal of glacial waters and the extinction of Lake Iroquois. At this time the glacier also had retreated far enough to the north to again establish the St Lawrence drainage.

Monroe County

38 1813?, 1830, 1833. *Perinton.* In a letter, to the editor of the American Journal of Science and Arts, dated Pittsford, October 26, 1830, J. A. Guernsey states:

> I have just procured a piece of a tusk found 3 weeks since in the bank of the Irondequoit creek, 2½ miles from this place; a boy struck a spade against the point of the tusk and broke it off, he then dug parallel to the surface of the earth, about 5 feet below the sod, but he broke it into five pieces. The entire length of all the pieces was 7½ feet, and the whole tusk must have measured 9 feet The exposure to the air causing it to slack and crumble, I advised the possessor to lay it in a box of sand where it now remains.
>
> The root or butt of the tusk is hollow for 18 inches. The longest piece measures 22 inches in length, and 16½ inches in circumference, weighing

[42] See article by Burnett Smith (Am. Jour. Sci., Nov. 1914) for detailed account of the incisor and descriptions of the Pleistocene formations of the region.

22 pounds. The weight of the whole was, when I first saw it, 57 pounds and 8 ounces.

P. S. One of the vertebrae of the neck was also found, weighing 2 pounds 2 ounces; it was apparently very much decayed. The owner of the lands intends digging for the remainder of the skeleton. A. J. S., 1830 (1831) 19:358.

With the above published description there is a sketch of the tusk and the statement is made that it was drawn from memory.

Six years after the publication of the above account, an article, written at Rochester, describing another find was published[43] under the title, " Fossil Remains of the Elephant, Elephas primigeneus." The locality is undoubtedly the same as that of the 1830 find since both are at the Irondequoit creek and the same distance from Pittsford. Fullam's Basin, the locality for the later find, is just west of Fairport near the place where the West Shore Railroad crosses Irondequoit creek. The 1837 account includes these statements:

These fossil remains were dug up from a sand bank in the Irondiquot creek in the town of Perinton, about 10 miles east of this city. They consist of a *tusk* and *two teeth* of the fossil elephant. The teeth are well preserved. The tusk had decayed for some distance at each end. As it lay in the sand, curved somewhat, it measured 10 *feet* in length, and *7 feet* of it were removed, but a portion of this length broke into many pieces. The longest piece is *2½ feet long,* and 5 inches in diameter, and as it belonged near the middle part of the tusk, the whole was of great size and near the root was probably 8 inches in diameter. The large piece and many fragments are now in the possession of Mr Butler,[43a] the enterprising proprietor of the museum in this city.

These fossils were found April 2, 1833, in excavating the earth for the passage of water at a saw-mill. It is said that there was no indications of other bones or teeth. About *20* years before, a *thigh bone* of some huge animal was found in removing the earth a few rods below in the same bank. The whole probably belonged to the same animal, and more may yet be discovered on further removal of the earth. The *thigh bone* is said to be in the possession of a gentleman in an adjoining town to Perinton, but I have not been able to discover it. The tusk lay about *4 feet* below the surface, and partly under the stump of a large forest tree. The place was covered with forest a few years ago; I have conversed with several individuals who were at the place, and knew the circumstances, and have examined the remains in the museum. There can be no doubt about the character of these remains and that they had been buried for centuries in the earth. The place is in the road, at the Irondiquot creek, a little distance from the place called *Fullum's Basin,* perhaps 10 miles from Lake Ontario.

The thigh bone mentioned as having been found about 20 years before, which would make the date about 1813, seems not to have been known to Mr Guernsey, and no mention is made of Guernsey's letter in the 1837 article.

In a footnote in the American Journal of Science (1838, 33:123) Prof. C. Dewey states, " The remains of the elephant in the museum

[43] Am. Jour. Sci., 1837, 32:377.
[43a] Should probably read " Mr Bishop."

of Mr. Bishop, noticed in the last number of this Journal, belong to one species of the mastodon. The teeth of the elephant were from some place, it is said, in Ohio. Those of the mastodon were found with the tusk in Perinton, as described."

It is evident from Dewey's statement that the remains at Perinton were those of a mastodon, and his statement finds substantiation in " Sketches of Rochester " by Henry O'Reilly, published at Rochester in 1838, which has the following account of the Rochester Museum (p. 381), " The proprietor is J. R. Bishop. Some small remains of the mastodon, found in Perinton, in Rochester, and on the western prairies, may be seen in this collection."

The Perinton fossil remains are also described by O'Reilly as follows:

It was on the bank of this stream [Irondequoit], near Fullam's Basin, in the town of Perrinton, that the thigh bone, one large tusk, and two teeth of the fossil elephant, mastodon, were found in the diluvium, over which stood the aged trees of an ancient forest. A part of these remains are now to be seen in the Rochester Museum kept by Mr Bishop. The discovery was made by Mr Wm. Mann while digging up a stump. The teeth were deposited about 4 feet below the surface of the earth. These were in a tolerably good state of preservation; the roots began to crumple a little on exposure, but the enamel of the teeth was in almost a perfect state.

Under the heading "American Elephant," DeKay[44] in 1842, described what he considered to be a new species of fossil elephant (Elephas americanus). He states that the specimens " were found in a diluvial formation near the Irondiquoit river in Monroe county, 10 miles east of the city of Rochester. According to a writer in the American Journal [of Science], volume 32, page 377, these remains consisted of a tusk and two molars, one of which is in the Cabinet of the Lyceum (New York) and is that figured in the plate." On the basis of Dewey's statement, it seems reasonable to assume that the tooth figured by DeKay, may represent a find from without the State, or if from the State it was not from the Perinton locality. Possibly the tooth may have been obtained from Bishop's Museum at Rochester, which had mammoth teeth among its collections. At least it is not clear how the tooth figured by DeKay, came to be recorded from Perinton. Further reference to this tooth will be given under mammoths (page 70). It may be here remarked that among the mastodon localities given by DeKay, he lists (page 104) " Perrinton, near Rochester, Monroe county." Hall[45] throws no further light on the character of these remains

[44] Nat. Hist. N. Y.; Zool. 1842, pt 1, p. 101; pl. 32, fig. 2.
[45] Nat. Hist. N. Y., Geol., pt 4, 1843, p. 364.

and apparently no mammoths from New York were known to him at the time of the publication of his report in 1843. Among the list of Fossil Bones of Quadrupeds he cites one (page 364): "in the town of Perrinton, in the bank of a small stream, in gravel and sand, a tusk and several teeth were found at this place, which are now in the Rochester Museum."

The evidence as to the age of the deposits in which the remains were found is not such as to justify any definite conclusion. Whether the animal became imbedded in these deposits while Iroquois waters were still present or at a much later period can not be determined from present known facts. Hall states that "the deposit of gravel and sand is a recent one, made by the stream on which it occurs" (page 366). It is possible that the remains may have been washed out of an earlier deposit by later waters and some of the parts reinterred. The scattering of the remains suggests that such might have been the case. The bulk of deposits are of glacial delta formation and the locality is not only within the southern area of glacial Lake Iroquois but also in the area of the preceding water, glacial Lake Dawson.

39 1837. *Genesee Valley Canal.* Mastodon or mammoth. A letter apparently written by Prof. Chester Dewey and dated Rochester August 19, 1837 states[46]:

A part of a mammoth has this day (Aug. 19th) been uncovered in excavating the Genesee Valley Canal, where it crosses Sophia[47] street, in this city. Two ribs, a part of the skull, and of a bone of a leg, and an enormous tusk, have been found. The last, which must have been 8 or 10 feet long, was chiefly picked to pieces by the Irish laborers, who supposed it to be a log, as it had lost its gelatine; about a foot of the smaller end is entire, and there can be no doubt what it once was. It must have been 8 inches in diameter in the middle. One rib, which seems to have been a short rib, is in a fine state of preservation. Whether the animal was an elephant or a mastodon is uncertain. These remains were found about 4 feet below the surface in a hollow or water-course, lying on and in a very hard body of blue clay, and about 2 feet above the polished limestone, which underlies so great a portion of this city.

The upper surface of the limestone, which is covered with soil and earth from 2 to 6 and sometimes to 12 and 20 feet deep under Rochester, is not merely smoothed, but actually polished, making a very good transition marble.

This find is also recorded by Hall in Assembly Document 200, February 20, 1838, page 347, and more fully described by him in the Natural History of New York (Geol. pt 4, 1843, p. 364). Hall states, "In 1838 [should be 1837], . . . some bones

[46] Amer. Jour. Sci., 1838, 33:201.
[47] This is now Plymouth avenue and the locality is near its intersection with Caledonia avenue.

of the head, several ribs, parts of two vertebrae, and some portion of the pelvis were found, intermingled with gravel and covered by clay and loam, and above these a deposit of shell marl. These bones are now in the state collection. The tusk is said to have been nine feet long, but was nearly destroyed by the workmen before removing it from the clay. A portion of a tibia was also found, which is in the Rochester Museum."

Sir Charles Lyell[48] during his travels in America in 1841, visited the above locality. He writes, " In the suburbs of Rochester, Mr Hall and I visited a spot where the remains of the great mastodon had been dug up from a bed of white shell-marl. I found fragments of the fossil teeth and ivory of one tusk, and ascertained that the accompanying shells were of recent species of the genera Limnea, Planorbis, Valvata, Cyclas, etc."

In the report of DeKay (1842), no mention is made by name of the Sophia street (Rochester) find. The following, however, occurs on page 103: " In the same year (meaning 1817), remains were found in the city of Rochester, 4 feet below the surface, in a hollow or watercourse." It is evident on comparing the above sentence with the August 19th letter of Professor Dewey, that DeKay's statement refers to the Sophia street discovery and that the date should have been 1837 instead of 1817. On the basis of DeKay's published statement, Hall in 1843 (page 364) lists finds for the two years 1817 and 1838, which are here combined under the date 1837.

40 1866? *Mt Hope cemetery.* "A few remains at Mount Hope cemetery, H. L. Ward."[49] This is all the information we have concerning this find, and it is not known whether any of these bones were ever collected. It is possible that the bones were too fragmentary and probably not well preserved as only a few were found and it is not known whether the bones belonged to a mastodon or a mammoth. The locality is on the east side of the Genesee river, the cemetery being in line with the southwestern extension of the Pinnacle hills and apparently having a similar glacial origin, the deposits being composed of sand and gravel. The site is less than a mile from the Genesee Valley canal find of 1837.

41 1913. *Charlotte Boulevard, Rochester.* In the geological museum of the University of Rochester there is a rib of a mastodon

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[48] Travels in North America, 1:18, 1845. See also Lyell's article in Proceedings of the London Geological Society, v. 4, no. 92. This article is also printed in Amer. Jour. Sci. v. 46, 1844; see p. 322 for reference to the Rochester locality.

[49] Clarke, N. Y. State Mus. Bul. 69, 1903, p. 931.

or mammoth found 12 feet below the surface of the ground in gravel at the corner of Charlotte boulevard and Miller street, Rochester. The specimen was presented by Sigurd Bo in January, 1913, having been found but a short time previously. No other remains are believed to have been present in the immediate vicinity, at least no others were found, and we are with no clue for the generic determination of the specimen. The above information was given by Prof. G. H. Chadwick to one of the writers when he visited the Rochester Museum a few years ago.

42 1918. *Pittsford.* Prof. H. L. Fairchild has recently reported the discovery of the foot bones of a mastodon or mammoth in a small swamp near Pittsford in which there is marl overlaid by muck. It is intended to carry on excavations in hopes of obtaining other parts of the animal.

New York County

43 1840? *Manhattan.* The following account of a find, supposedly that of a mastodon, in New York City is quoted from Issachar Cozzens, in "A Geological History of the New York or Manhattan Island," published in 1843 (page 75): "The cellular part of a large bone, probably of the mastodon, was found in digging the cellar of J. M. Bradhurst's house about 10 feet below the present surface, in Broadway near Franklin street."

44 1885. *Inwood.* Mastodon or mammoth. Of this tusk Prof. R. P. Whitfield[50] writes as follows: "In April 1885, Elisha A. Howland, then principal of grammar school No. 68, at 128th street, between Sixth and Seventh avenues, brought and donated to the museum the lower extremity of a mastodon tusk, nearly 15 inches long by 4 in its greatest diameter, which had been found shortly before at Inwood, N. Y., while cutting a ditch through a peat bed near the Presbyterian Church at that place. This fragment shows fresh breaking at the upper end, and was undoubtedly much longer when first found."

45 1885. *Dyckman's creek.* Mastodon or mammoth. In 1885 a tusk was found in excavating for the Harlem ship canal. An account of this find as communicated to Science[51] by R. P. Whitfield of the American Museum of Natural History includes the following statements:

> The specimen was found at a depth of 16 feet below mean low water, at the eastern end of Dyckman's creek, at its junction with the Harlem river.
> The portion of the tusk preserved and received at the museum is nearly

[50] Science, v. 18, Dec. 18, 1891.
[51] V. 18, Dec. 18, 1891.

3 feet long, and has a diameter of 7½ inches full, at its largest part; being the upper or socket end of the tusk, and is well preserved, although much shattered by drying and rough handling by the workmen before it came to the attention of the engineers in charge of the work.

The excavation at this point is through the salt meadow of the Harlem river, showing from 4 to 6 feet of meadow sod and silt filled with the roots of the meadow grass; below this there is a deep bed of incipient peat, of which, at the spot where the tusk was found, there was fully 12 feet; next below comes a bed of sandy clay of very variable thickness, but at the spot in question measuring only 18 or 20 inches in thickness. This clay rests immediately on the submerged slope of the dolomitic limestone ridge which forms the upper end of Manhattan island, and extends northward beyond the Spuyten Duyvil creek.

The tusk was found imbedded in the peat with the socket or "butt" end down, and slightly entering the sand, the shaft being in the peat and at an angle of about 70 degrees to the horizontal, showing that it had settled through the peat until it came in contact with the sand.

From the indications furnished by the conditions of its occurrence I should conclude that the tusk had not been transported from any other locality after the death of the animal, as there is no abrasion shown on its surface. Moreover, the peat in which it was imbedded is in the condition of its original formation, is clean and unmixed with any foreign matter, being entirely of vegetable origin: and contains quantities of seeds, apparently of Carices, or sedges, and grasses, as well as a few nutlets of some bush or shrub not yet determined, and examples of the elytra of beetles. At the top of the peat occur numbers of the stumps and roots of forest trees and fragments of wood. No evidence whatever is found of any marine substance below the roots of marsh grass, not a vestige of any kind of mollusks, marine or fresh water, can be detected, although now living and abundant in the salt waters at the surface. The sandy clay between the peat and the surface of the limestone appears to me to be the result, principally, of the decomposition of the limestone in place, and not transported sand. Glacial markings are discoverable on the surface of the limestone a short distance south of the locality, where the soil has protected it from the action of the weather, but where the ledge has been uncovered by the removal of the peat and sand, it shows a deeply rotted surface covered by the sand.

Dyckman's creek was an artificially excavated channel, made about 1818, for the purposes of a tide mill, through a natural depression at that point, and not a natural stream; consequently, it could have had no agency in the transportation of the tusk; and it seems probable that the animal to which the tusk once belonged either died near the spot, or by some accidental injury had it broken from its socket near where it was found.

The exact location of its occurrence is in the canal, about 15 feet from its northern side, and about 10 feet west of the center of Broadway.

Niagara County

46 1840? *Niagara Falls.* Both Hall and Lyell mention the finding of mastodon remains at Niagara Falls. Hall[51a] states: "A molar tooth was found in digging a mill-race at Niagara falls, several feet below the surface. The deposit in which it occurs is a fine gravel and loam containing fresh-water shells, and is evidently a fluviatile deposit." Hall further adds (page 396) that the place was "upon the east side of the river, of the same elevation as Goat Island. It was at this place, and in the same deposit, that a mas-

[51a] Nat. Hist. N. Y. Geology, pt 4, 1843, p. 364, 396.

todon's tooth was found 11 feet below the surface." Lyell,[52] who visited the locality in company with Hall, gives a more extended account and has a figure which indicates the place where the remains were found on the mainland opposite Goat island.[53] Lyell's account follows:

We began by collecting in Goat island shells[54] of the genera Unio, Cyclas, Melania, Valvata, Limnea, Planorbis, and Helix, all of recent species, in the superficial deposit. They form regular beds, and numerous individuals of the unio and Cyclas have both their valves united. We then found the same formation exactly opposite to the falls on the top of the cliff on the American side, where two river terraces, one 12 and the other 24 feet above the Niagara, have been cut in the modern deposits. In these we observed the same fossil shells as in Goat Island, and learnt that the teeth and other remains of a mastodon, some of which were shown us, had been found 13 feet below the surface of the soil. We were then taken by our guide to a spot farther north, where similar gravel and sand with fluviatile shells occurred near the edge of the cliff overhanging the ravine, resting on the solid limestone. It was about half a mile below the principal fall, and extended at some points 300 yards inland, but no farther, for it was then bounded by the bank of more ancient drift. This deposit previsely occupies the place which the ancient bed and alluvial plain of the Niagara would naturally have filled, if the river once extended farther northwards, at a level sufficiently high to cover the greater part of Goat island. At that period the ravine could not have existed, and there must have been a barrier, several miles lower down, at or near the whirlpool.

A more recent account of the gravels at Niagara Falls and their age, together with many interesting observations relative to the wearing back of the Niagara gorge since the gravels were deposited, is given by Kindle and Taylor in the Niagara Folio (U. S. G. S. no. 190, 1913). Brief extracts from this folio follow: "While the falls were still below the whirlpool the river above that point was flowing in a shallow bed, like that in which it now flows from Buffalo to Chippewa. This bed was cut mainly in drift, and in the cutting process the fine material was washed out and carried away and the gravel was formed into bars. There are not many such formations in the old bed of the river, but some very small ones are well known through the fossil shells that have been found in them. . . . Much the largest of the gravel deposits connected with Niagara river are those on Goat island and in Prospect Park and the city of Niagara Falls, N. Y. (page 14). . . . Until the falls had cut the gorge back to the vicinity of Swift Drift point, about 1000 feet north of Hubbard point (nearly 2 miles below Goat

[52] Travels in North America, 1845, 1:29, fig. p. 30.
[53] This find is apparently the one to which DeKay refers when he states, "A tooth was found in digging a mill-race on Goat island, Niagara county, 12 or 13 feet below the surface." Nat. Hist. N. Y. Zool., pt 1, p. 104, 1842.
[54] See "Post-Pliocene Fossils of the Niagara River Gravels," by Elizabeth J. Letson, N. Y. State Mus. Bul. 45, 1901, p. 238–52.

island) the bed of the river south of that place remained at the level of the gravel on Goat island (page 22.)"

The evidence presented above shows that the gravels in which the mastodon remains were found were deposited when the falls were nearly 2 miles farther down stream. The time required for excavating this upper section of Niagara gorge gives some basis for estimation of the time since the bones were imbedded in the gravels. The estimate for the time required to cut the Upper Great gorge (about 2¼ miles) has been given as a minimum of 3000 years and a maximum of more than 20,000 years, so that it may not be an exaggeration to say that the mastodon whose tooth was found at Niagara Falls lived 15,000 years ago.

Ontario County

47 1885. *Seneca.* These remains were found at Seneca Castle in the town of Seneca, 6 miles northwest from Geneva. The exact elevation at which the bones were found is not available, but Seneca Castle is at an elevation of 762 feet and the bones must have been obtained somewhere near this altitude. An account of the discovery of these bones was communicated to Science by Prof. E. Hitchcock[55] in 1885. A later account by Clarke[56] is as follows: "Excavated by Henry J. Peck on farm of Charles Gregory, where the bones had been discovered about 1882. Found beneath marl and diatom earth, about 3 feet from the surface. Sixty-five bones were obtained, mostly ribs and vertebrae with one tusk, 9 feet on outer curve, and styloid 1 inch longer than in the Warren mastodon. The antler of an elk was also found. The bones are now in the collection of Amherst College. *H. J. Peck*"

Accompanying the above account by Clarke, is a plate with scale showing the distribution of the bones and a section of the bedded deposits of the swamp.

48 1908. *Manchester.* All the knowledge that we have concerning this find is that a tooth[57] was found on the property of Leonard S. Lyke in the year given.

Orange County

49 1780. *Montgomery* (3 miles south). The earliest definite record of Orange county mastodon remains is given by the Rev. Robert Annan[58] in an article entitled, "Account of a Skeleton of a

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[55] Science, 1885, 6:450.
[56] N. Y. State Mus. Bul. 69, 1903, p. 931.
[57] Clarke, N. Y. State Mus. Bul. 140, 1910, p. 46.
[58] Amer. Acad. Arts and Sci. Mem. 1793, 2:160-64.

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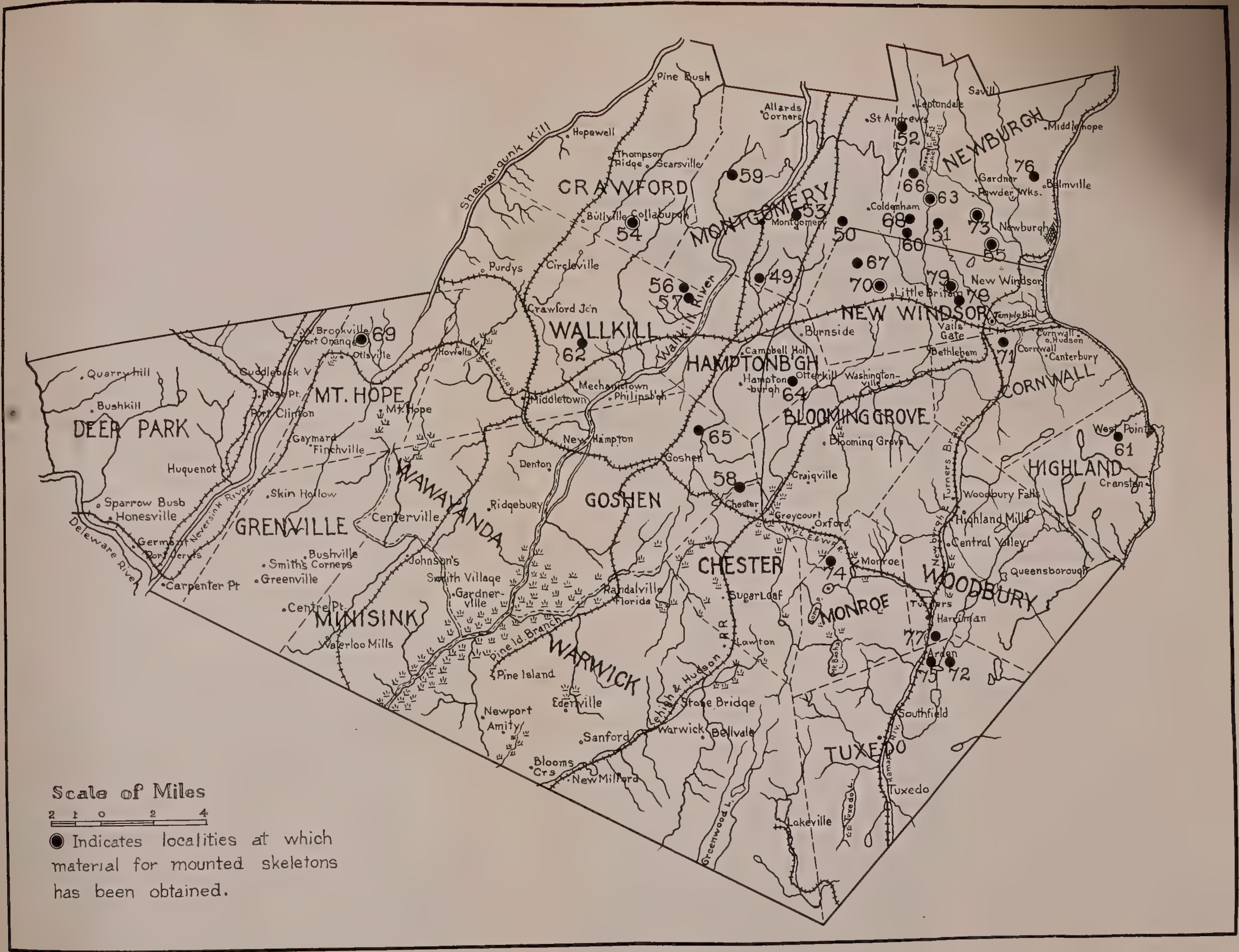

Map of Orange county showing distribution of mastodon remains.

Large Animal, found near Hudson's River." Bones and teeth were found in the fall of 1780 during ditching operations intended to drain a deep swamp on the Annan farm, located on the banks of the Wallkill river about 15 miles west of the Hudson.

A considerable part of the skeleton was unearthed, including vertebrae, leg bones and four teeth, the descriptions of which give undoubted evidence of the identity of the animal. The remains were examined by Gen. George Washington while he was encamped at Newburgh in 1782-83 after which some of the bones were carried to Germany by Doctor Michaelis, physician general of the Hessian troops; other bones were sent to a museum in Philadelphia.

The locality of the Annan farm has been given more definitely by other writers as being 3 miles south of Ward's Bridge[59] in the town of Montgomery.

Dr Johann David Schoepf,[60] writing of travels made in America during 1783–84, mentions a tooth from Ulster county. This very likely came from the Annan farm, then probably in Ulster county but annexed to Orange in 1798 when five towns were added.

Under the date of September 10, 1800, Dr James G. Graham, writing to Doctor Mitchill, proprietor of the Medical Repository, said the bones were found in 1782, and later writers have perpetuated the error[61].

Graham (ibid) listed additional Orange county remains, found between 1782 and 1794, giving the localities of them in terms of miles from Ward's Bridge (Montgomery) as follows:

50 *Montgomery* (3 miles east). "About 3 miles east of Ward's Bridge, some other bones were found."

51 *Montgomery* (7 miles east). "About 7 miles east of said bridge, a tooth (one of the grinders), and some hair, about 3 inches long, of a dark dun color, were found by Mr Alexander Colden, 4 or 5 foot below the surface." Sylvanus Miller, in a letter addressed to De Witt Clinton in 1814, mentions specimens of mastodons from Ulster and Orange counties with which were found, "locks and tufts of hair, in tolerable preservation."[62] It is probable that Miller referred to the remains above noticed.

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[59] The village of Montgomery, which was incorporated in 1810, was, prior to that date, known as Ward's Bridge.

[60] Reise durch einige der mittlern und südlichen vereinigten nordamerikanischen Staaten, 1788, 1:413.

[61] Medical Repository, 1801, 4:213–14.

[62] De Witt Clinton, An Introductory Discourse Delivered before the Literary and Philosophical Society of New York, on the Fourth of May 1814. New York, 1815.

52 *Montgomery* (7 miles northeast). "About 7 miles northeasterly from Ward's Bridge, a vertebra was found."

The Peale Skeletons

53 1793-1801. *Montgomery* (1 mile east). Graham (ibid) stated that in 1793, three or four ribs of the mastodon were found 1 mile east of Ward's Bridge at a depth of 8 feet below the surface. This was one of three localities to be exploited in 1801 by Charles Wilson Peale, who succeeded in recovering sufficient material to partially restore two skeletons.

Rembrandt Peale,[63] in the account of the exertions of his father, gives this locality as being 11 miles from Newburgh on the farm of Captain J. Barber: "Almost an entire set of ribs were found, lying nearly together, and very entire; but as none of the back bones were found near them (a sufficient proof of their having been scattered) our latitude for search was extended to very uncertain limits. . . ." Excavations carried on for 2 weeks resulted in finding " . . . two rotten tusks, three or four small grinders, a few vertebrae of the back and tail, a broken scapula, some toe-bones, and the ribs, found between 4 and 7 feet deep." Eager[64] states incorrectly that the Peale excavations were carried on in 1805 or 1806.

Peale's Baltimore Skeleton

54 1794-1798-1801. *Montgomery* (5 miles west). Five miles westerly from Ward's Bridge a number of bones were taken up in 1794 and sent by Graham to New York where they were said to have been deposited in Columbia college (Graham, ibid). In 1798 other bones were found in the same locality and secured by Peter Millspaw, on whose farm the bog was situated. Peale carried on further excavations in 1801 and secured the first specimen of a complete under jaw. Altogether Peale succeeded in unearthing some ribs, toe and leg bones, the right scapula, the atlas and part of the head; to these were added bones that had been in the possession of Doctor Graham and Doctor Post, consisting of a rib, the sternum, a femur, tibia and fibula, and a patella. Another rib was found in a farm house some 10 miles distant (Peale, ibid).

These remains, together with restorations made from bones discovered in other localities, were assembled and exhibited for a num-

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[63] Godman's Amer. Nat. Hist., 3d ed. 1846, 2:55–63. U. Hunt & Son. Phil.
[64] Hist. of Orange County, 1847, p. 73.

ber of years in the Baltimore Anatomical Museum.[65] The skeleton was disarticulated and purchased in 1848 by Warren who used the bones in his studies of the osteology of the mastodon.[66]

Peale's Philadelphia Skeleton

55 1799-1801. *Near Newburgh.* On the farm of John Masten, bones of the mastodon were found in 1799 and sold to Peale in 1801. The bones recovered at this time consisted of the vertebrae of the neck and most of those of the back and tail; most of the ribs, both scapulae, both humeri with the radii and ulnae; one femur, a tibia of one leg and a fibula of the other; some fragments of the head and many of the fore and hind foot bones; the pelvis somewhat broken and a large piece of a tusk about 5 feet long. Peale's exertions at this locality, which lasted for several weeks, added but a few bones and teeth (Peale, ibid).

This skeleton was exhibited in London about 1802 but later returned to the United States where it remained in Peale's Philadelphia Museum for about 50 years. Warren[67] states that this specimen disappeared about 1849 or 1850 and that there is no authentic record of its later history. Lucas[68] says it was destroyed by fire together with other material in Peale's museum.

Two pieces of tusk from Orange county were in the possession of Doctor Mitchill in 1801. Mitchill, one of the proprietors of the Medical Repository, commented editorially on the discovery of the perforation in the upper jaw to receive the tusk and pointed out that this structure evidenced relationship with the elephants.[69]

56-57 1800-1809. *Montgomery* (4 miles south). Remains were found between 1800 and 1809 in two localities on the farm of Thomas Booth in the town of Wallkill, 4 miles south of Ward's Bridge. These bones were recovered from a depth of 6 feet below the surface of soil said to consist of (1) black and rich earth, (2) a stratum of blue clay, (3) a layer of white marl and (4) a layer of gray marl.[70]

58 1807-1817. *Chester.* Remains of the mastodon on the farm of Mr. Yelverton at Chester, near Goshen, were first noticed in 1807 or 1808. On May 28, 1817, Samuel L. Mitchill visited the spot and with the help of several friends succeeded in getting out

[65] The Mastodon Giganteus of North America, 1852, p 253, pl. 1.
[66] See also Tran. Amer. Phil. Soc. n. s., 1834, 4:321.
[67] The Mastodon Giganteus of N. Amer. 1852, p. 252, pl. 1.
[68] Animals of the Past, 4th ed., 1916, p. 206.
[69] Medical Repository, 1801, 4:308.
[70] Arnell, Medical Repository, 1809, 6:315-16.

a considerable number of bones, including parts of the legs, feet, shoulder blades, vertebrae and pelvic bones. Both the upper and lower jaws with the teeth and two tusks, 7 and 9 feet long, were found.

The bones were recovered from a layer of peat and were nowhere in contact with the marl that underlaid this formation at a depth of about 6 feet. Beneath and immediately around the bones was a mass of coarse vegetable fibers said to resemble chopped straw — perhaps the remains of the last meal.[71]

59 1829. *Montgomery* (vicinity). In 1829 remains of a young specimen were disinterred by Archibald Crawford in the vicinity of Montgomery and said to have been placed in the museum of Peale of New York. Besides many bones of the trunk and limbs, both tusks and jaws were found. Dr John Godman directed attention[72] to the presence of sockets and a fragment of tusk in the right side of the lower jaw, and upon this evidence attempted to establish a new genus and species under the name Tetracaulodon mastodontoideum. The specimen is of particular interest, however, because of the retention of sixteen teeth in the jaws, there being two teeth on each side, above and below, in addition to the permanent complement.

60 1838. *Near Newburgh.* In 1838 a tooth was found by Daniel Embler of Newburgh, on or near the farm of Samuel Dixon of that city.[73]

61 1843. *West Point.* Issachar Cozzens[74] in 1843, records mastodon remains from a bog at West Point. This is perhaps the discovery to which Mather,[75] referred in the following terms: "Bones of this animal (mastodon) are now (September 16, 1843) being disinterred from the marl underlying peat in a marsh in Orange Co."

The Shawangunk Head

64 1844. *Scotchtown.* "In 1844, [remains were] found 8 miles southwest from Montgomery, on the farm of Mr Conner near Scotchtown, in Wallkill."[76]

The remains in this case consisted of one of the largest and best preserved heads ever found, but only a few other bones. Warren[77]

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[71] Mitchill in Cuvier, Theory of the Earth, 1818, p. 376, pl. 7, fig. 1–4, pl. 8, figs. 1–3. Hovey, N. Y. Acad. Sci. Ann., 1908, 18:147, pl. 5.
[72] Amer. Phil. Soc. Tran., 1830, 3:478–85.
[73] Eager, Hist. of Orange Co., 1847, p. 73.
[74] History of Manhattan or New York Island," New York 1843, p. 103.
[75] Nat. Hist. N. Y. Geol. pt 1, 1843, p. 636.
[76] Eager, Hist. of Orange Co., 1847, p. 73.
[77] The Mastodon Giganteus of North America, 1852, p. 125–32, pl. 16.

has figured and described this specimen, which is now in the American Museum, New York City. The jaws retained ten teeth; three each on the right side above and below and two on the left. The tusks of the upper jaw, said to have been perfect when found, disintegrated soon after exposure to the air. Traces of the sockets for tusks in the lower jaw are present, more pronounced on the right side. The head and other fragments were covered first by a layer of gravel, second by marl, third a layer of peat.

The Warren Mastodon

63 1845, August 12. *Newburgh.* This skeleton, first described by A. J. Prime,[78] came from the farm of Nathaniel Brewster, near Newburgh. It is the finest and most complete specimen ever collected and the subject of an elaborate account by Dr John C. Warren,[79] its one time owner. With the exception of a few toe bones and vertebrae of the tail, the skeleton is complete. Both upper tusks and the lower tusk of the right side are present, the former measuring 8 feet 6 inches in length.

The soil at the bottom of the small pond or bog in which the bones were found, was composed of the following materials: (1) a layer of peat about 2 feet thick; (2) a layer of moss described as red, about 1 foot thick; (3) a layer of shell marl in which most of the bones were embedded. Some of the bones of the limbs extended below the layer of marl and were embedded in mud. The Warren mastodon is mounted and on exhibition in the American Museum of Natural History, New York.

64 1845. *Hamptonburg.* Remains were found, " . . . on the farm of Jesse C. Cleve, Esq., in Hamptonburgh, about 12 miles southeast of Montgomery."[80]

65 Date? *Goshen.* Mastodon remains were found in the town of Goshen sometime before 1846 but the exact locality and circumstances of the discovery are not known.[80]

66 Before 1850. *Near Newburgh.* A large tooth from Newburgh about 3 miles from the Warren mastodon locality was described and figured by Warren (ibid. pl. 10).

67 Date? *Near Newburgh.* Warren also mentions (page 173), "a specimen of silicified os femoris, 3½ feet long. It was found in Orange county, New York, not far from Newburgh. It is almost

[78] Amer Quar. Jour. Agr. and Sci., 1845, 2:203–12, pl. 4.
[79] Warren, The Mastodon Giganteus of North America, 1852.
[80] Eager, p. 73.

as dark as ebony, has a brilliant exterior, and requires the full strength of a laboring man to lift it."

68 1873. *Near Newburgh.* Among the specimens in the collections of the State Museum are parts of two ribs and a sternal bone from the vicinity of Newburgh. These bones form part of a collection made during 1873; the entire lot consists of seven sternal bones, five foot bones, four vertebrae and two rib fragments.[81]

The Marsh Skeleton

69 1872. *Otisville.* This skeleton, complete except for the bones of the hind legs, was exhumed by Mr A. Mitchell in February 1872 on his grounds at Otisville. It was later secured by Prof. O. C. Marsh and mounted for the Peabody Museum of Yale University. The following note is from an unsigned editorial:[82] "The bones were found on and in clay beneath a deep bed of muck, and are in an excellent state of preservation." The skeleton was restored, described and figured by O. C. Marsh.[83] The bones are those of an adult animal with the epiphyses of the vertebrae and limbs firmly ossified, in some cases to the extent of obliterating the sutures. Eight teeth are present in the jaws, well preserved though some, particularly the penultimate molars, are considerably worn. Both tusks of the upper jaw were found but no evidence of the lower ones.

The Whitfield Skeleton

70 1879. *Little Britain.* Before the better preserved and more complete Warren skeleton was purchased for the American Museum of Natural History, a composite skeleton, restored from remains of several individuals but chiefly from the bones found at Little Britain, was exhibited for many years. R. P. Whitfield,[84] onetime curator of geology and palaeontology in the American Museum, gives the following account of the recovery of this specimen: "The bones of the skeleton . . . were found embedded in peaty material on the edge of what was, less than 50 years before, an open pond of considerable size, subsequently drained and brought under cultivation, situated in the town of Little Britain, about 9 miles southwest of Newburgh, N. Y., and at the time of their discovery, cultivated as a potato field." A leg bone was found at a depth of 14 inches below the surface by a farmer engaged in ditching. The

[81] N. Y. State Mus. 27th Annual Rept, 1875, p. 24.
[82] American Jour. Sci., 3d ser., 1875, 9:483.
[83] Amer. Jour. Sci. 3d ser., 1892, 44:350.
[84] Guide to Geol. and Paleontological Collections in Amer. Mus. 1892.

discovery induced greater efforts and within a few days almost one-third of the skeleton, including the head, was unearthed.

In the restoration, the tusks and lower jaw were from a specimen from Hoopeston, Ill., the pelvic bones and three ribs from another individual from Hangman's creek, Oregon. Some of the vertebrae of the neck and back and most of those of the tail, were modeled. A part of the right scapula was also restored. The Whitfield skeleton was disarticulated and sold to the Senckenburg Museum, Frankfort, Germany, in 1910.

71 1895. *Cornwall.* Heinrich Ries (N. Y. State Mus. Bul. 12, 1895, p. 109) records, without giving definite information, the bones of a mastodon from the vicinity of Cornwall. "Clay was observed in a meadow opposite the Roman Catholic church; it was exposed in digging drainage trenches. Near this locality, but a little nearer the river, were found several mastodon bones." See also, N. Y. State Mus. Bul. 35, 1900, p. 583.

72 1899. *Arden.* "Parts of a skeleton were exhumed near the village of Arden on lands of Mr E. H. Harriman. Efforts made to secure all the bones resulted in uncovering only a few portions of the scapula or pelvis, leg, ribs, and two teeth. The soil was peat or vegetable mold." [85]

The Schaeffer Skeleton

73 1899. *Newburgh* (3 miles west). Almost an entire skeleton, now restored and on exhibit in the Brooklyn Museum, was found in 1899 on the farm of F. W. Schaeffer about 3 miles west of Newburgh. The skeleton lacked the bones of the legs and feet (except about twenty phalanges), one scapula and a number of the vertebrae and ribs. H. F. Osborn, who examined the locality, made the following observations: "The deposition is in three levels, the two upper being separated by a smooth, clearly defined surface, and by slight differences in the character of the soil, which is largely dark and thoroughly decomposed vegetable matter, intermingled with a few stones and very numerous remains of trees of various sizes. Examination of the latter gives abundant evidence of the existence of beaver in this hollow in the period of the mastodon, and we can easily imagine that the different soil levels were due to the building of successive beaver dams." [86]

74 1888–1901. *Monroe* (plate 7). During a period of drouth in 1888, some bones and tusks of the mastodon were recovered from

[85] J. M. Clarke, N. Y. State Mus. 3d Rep't of Director, 1907, p. 60.
[86] Osborn, H. F., Science n. s., 1899, 10:539.

the bottom of a small pond on the lands of Martin Konnight near Monroe, N. Y. Both tusks of the upper and lower jaws, several ribs, a scapula, foot bones, a tibia and other leg bones were found at this time and kept intact by Mr Konnight. Excavations carried on in 1901 by Jacob Van Deloo, under the direction of Dr John M. Clarke, brought to light many additional parts of the skeleton and a few fragments of bones of a horse thought to be of the same age as the mastodon. Here also was found the proximal half of the femur of a large bear comparable in size to the existing grizzly.

The remains of the Monroe mastodon are of particular interest not only because of the presence of the lower jaw tusks but on account of the great size of the bones.[87]

75 1901. *Arden.* In 1901 a tusk and a few bones were found near the village of Arden.[88]

76 1902. *Balmville.* From the grounds of the George Gorden estate near Balmville, there were recovered in 1902, part of a cranium, lower jaw, one 7-foot tusk, eighteen ribs, fourteen vertebrae, and some foot bones. The soil consisted of muck and marl, the latter resting on a boulder pavement. The bones were buried at depths varying from 2 to 8 feet and were recovered both from the muck and marl.[89]

77 1913. *Harriman* (plate 5, lower figure). While taking muck from the bottom of a pond during the summer of 1913, W. J. Post of Harriman found and presented to the State Museum a very well-preserved tusk of a mastodon. The pond from which the specimen was recovered lies about 2 miles south of Harriman Station on the line of the Erie Railroad. The tusk was buried at a depth of 6 feet in the muck of the pond bottom and has the appearance of being that of a young animal. It is about 6 feet long with the tip unworn and sharp and where the surface is unbroken, the grain resembles ebony both in color and texture. Mention of this specimen was made in the 13th Report of the Director of the State Museum, 1918, pages 46-47.

78 1917. *Temple Hill.* "During the summer of 1917, remains of a mastodon were found on the muck land of Antonio Fisher, one-half of a mile west of Temple Hill monument and 1 mile north of Vails Gate Junction. The find consists of a few scattering bones together with a well-preserved lower jaw containing four

[87] Clarke, N. Y. State Mus Bul. 52, 1902, p. 439.
[88] Clarke, N. Y. State Mus. Bul. 69, 1903, p. 926.
[89] Gordon, Science, n. s. 1902, 16:594; Clarke, N. Y. S. Mus. Bul. 69, 1903, p 926.

Plate 7

Tusks of the lower jaw of the Monroe (Orange co.) mastodon. Lower tusks are rarely developed in the American mastodon.

teeth. These remains were found in a shallow excavation 2 feet below the surface. In size the jaw is slightly larger than that of the Cohoes mastodon." [90] The specimen remains in the possession of the finder.

The Temple Hill Skeleton

(Also named the McMillin Mastodon as a memorial of the late Emerson McMillin who defrayed the cost of acquisition.)

79 1921. *Temple Hill* (plates 8–9). This skeleton, exceeded in size by no mounted specimen except the Warren mastodon and second only to it in completeness, came from the muck lands near Temple Hill only a few hundred feet from the site of the excavation that produced a lower jaw and other bone fragments of another individual in 1917. A part of the cranium was noticed in the fall of 1920 during construction of a drainage ditch but condition of soil and weather prevented excavation. Following a protracted drouth in the spring of 1921 the work of exhuming the skeleton commenced and within a few days all the large bones were recovered. Some of the ribs, back and tail vertebrae, a part of the cranium and a few toe bones are lacking. The many free epiphyses and the condition of the teeth show that the bones belonged to a young but nearly full-grown animal.

The topography of the land in the vicinity and the disposition of muck and marl reveal the former existence of a pond of considerable extent; the area is now partly drained and under cultivation. The position in which the bones were found gives support to the theory that the mastodon mired while foraging along the boggy margin of the pond, for head and tusks were nearest the present surface of the ground, as if thrown back in an effort to keep them above water. The muck at the site of the excavation varies from 1 to 3 feet in thickness and covers marl of unknown depth. Most of the bones were recovered from the marl but all were within 5 feet of the surface.

In view of the great size and relative completeness of the skeleton and its extraordinary preservation, attention may be directed to some of its interesting features.

Dentition. Twelve teeth are preserved in the jaws, three on each side above and below; the so-called intermediate molars show considerable wear and are retained anteriorly by a thin shell of bone. The worn surface of the ultimate molars involves only two anterior crests.

[90] Clarke, N. Y. State Mus. Bul. 196, 1918, p. 47.

Tusks. Exact measurements are impossible owing to the destruction of the basal portions, but the tusks as recovered are each over 7 feet in length and so curved that the points overlap about 10 inches. Apparently worn by contact when under strain, the upper and inner side of the point of the right tusk is beveled and fits a similar area on the lower, outer side of the left.

Styloid process. The left styloid process of the temporal bone was found, but a careful search failed to recover the right. It measures 9¾ inches in length, is perfectly preserved and of very dense texture.

Food. Most of the large bones had been taken from the excavation before the attention of the museum authorities was called to the discovery. In removing the bones great masses of broken twigs and plant remains were brought into view and their position in relation to the ribs and other bones gives considerable support to the theory of postprandial death by miring. The stomach contents were scattered and lost by the truck farmer who discovered the bones.

In opposite columns the measurements of the Temple Hill skeleton are given for comparison with those of the Warren mastodon.[91]

	Warren	*Temple Hill*
Length, base of tusks to drop of tail......	14 ft. 11 in.	15 ft. 1 in.
Height to top of spines of back at the shoulders	9 ft. 2 in.	9 ft.
Tusks: length of right tusk, on outside curve	8 ft. 6 in.	7 ft. 5¼ in. (base lost)
length of left tusk, on outside curve	....	7 ft. 4½ in.
Thigh bones: length of right............	3 ft. 5 in.	3 ft. 6½ in.
length of left..............	3 ft. 6½ in.	3 ft. 6 in.
Pelvis, or innominate bones, width of.....	6 ft.	5 ft. 7¼ in.

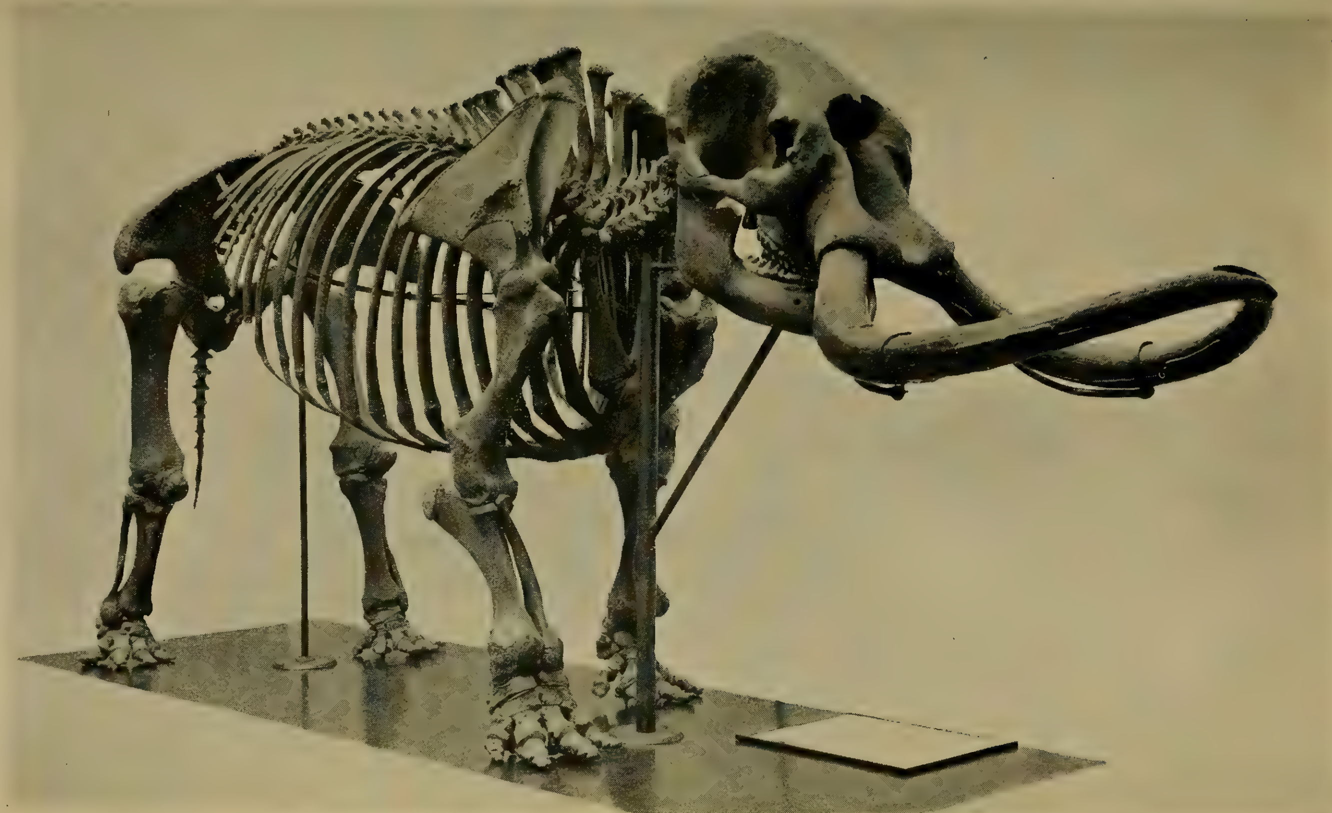
The Temple Hill skeleton stands in the Hall of Fossil Vertebrates, New York State Museum.[92]

Orleans County

80 1825. *Holley.* During the excavation of the Erie canal, which was completed in 1825, a large molar tooth was found in a swamp near the village of Holley.[93] An account of this find is given in the " Pioneer History of Orleans County " [94] which states,

[91] Data on Warren mastodon taken from Amer. Mus. Jour., 1907, 7:92.
[92] See also Science, n. s. 1921, 54:170.
[93] Hall, Nat. Hist. N. Y., Geol. pt 4, 1843, p. 364.
[94] By Arad Thomas, 1871, p. 307.

Plate 8

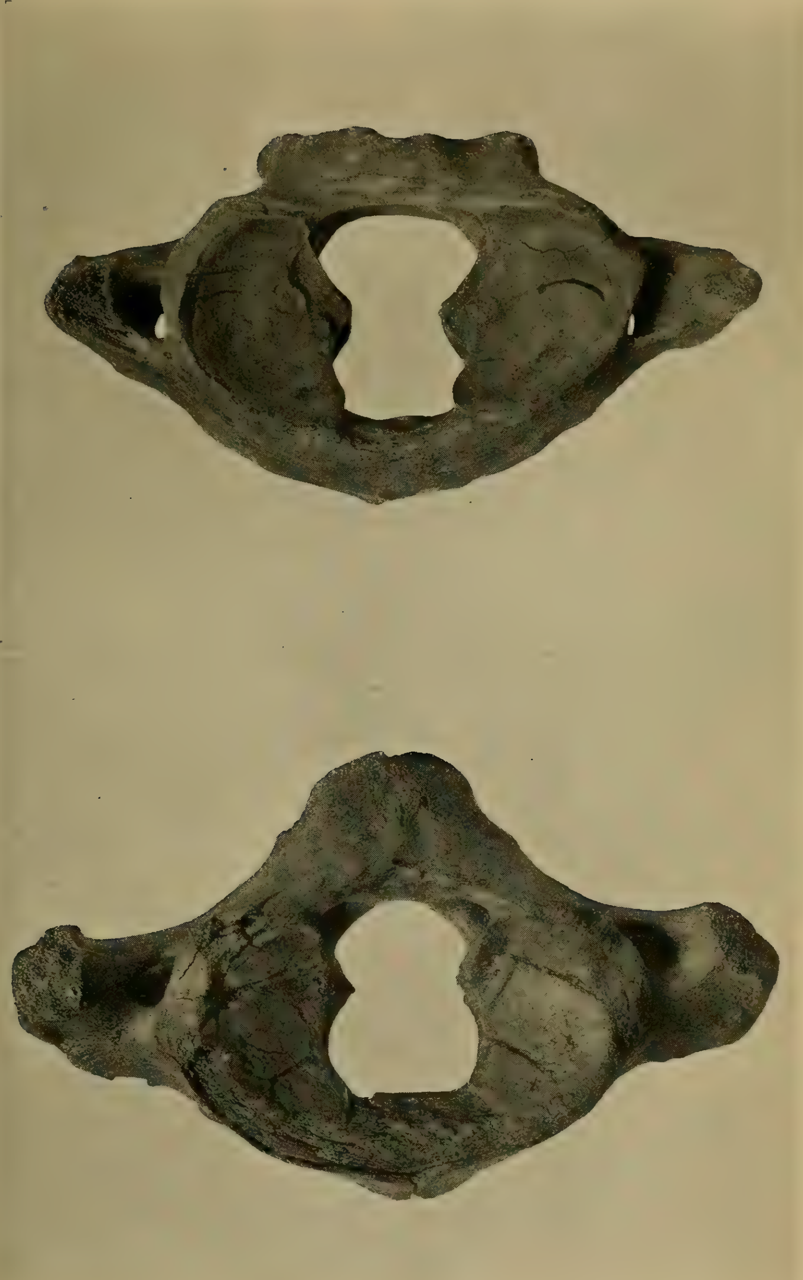


The Temple Hill skeleton as mounted in the New York State Museum.

Plate 9

Lower jaw of the Temple Hill mastodon. Twelve teeth are retained in the jaws, three on each side, above and below.

Plate 10



Upper figure. Atlas of *Elephas primigenius* from gravels at Lewiston, N. Y.
Lower figure. Atlas of a mastodon from Orange county, N. Y.

"When laborers were excavating and building the canal embankment, a tooth of some huge animal, a mammoth, perhaps, was dug up. The tooth was a grinder, and weighed 2 pounds and 2 ounces. No other bones of such a creature have been found, and it has been conjectured this tooth must have been shed there by the animal to which it belonged, when it came after salt. It is now in the State collection in Albany." The tooth above described may be the one referred to by DeKay[95] when he says, "There is, however, in the museum of the Albany Institute, a portion of the tooth of an elephant said to have been found on the line of the Erie canal, but the precise locality is not known." During the construction of the Erie canal a true mammoth was found at Chittenango, and it is possible that DeKay's reference is to one of the teeth of the Chittenango specimen. DeKay does not state whether or not he saw the tooth, and because it can not be found among the collections of the Albany Institute, there is some doubt as to whether it belonged to a mammoth or mastodon. The Erie canal passes through Holley at an elevation of 500 feet. The beach of glacial Lake Iroquois is within 3 miles to the northeast of Holley so that the tooth was found outside of the province of this glacial lake. We have thus no evidence that the tooth was deposited through the agency of glacial waters, unless it was by the higher waters of glacial Lake Tonawanda, which had one of its outlets at Holley and whose waters poured into Lake Iroquois.[96]

81 1894. *Medina.* Among the collections of the Buffalo Society of Natural Sciences is a lower jaw with teeth of a mastodon. It was found in a swamp about 4 miles from Medina by W. S. Slodge, and through the efforts of Prof. F. K. Mixer was presented to the Buffalo museum by John Moore.

Queens County

82 1858. *Jamaica.* The following is the account of the Jamaica specimen, as given by J. C. Brevoort:[97]

Five molar teeth and a few fragments of bones belonging to the American Mastodon were found on Long Island toward the end of last March, by the workmen engaged in removing the pond muck at the head of Baiseley's pond near Jamaica. This pond is an artificial one, covering some 40 acres in a shallow valley, and is one of the series of five similar ponds which are now being prepared and cleaned out for the purpose of affording a water supply to the city of Brooklyn. In Baiseley's pond a

[95] Nat. Hist. N. Y., Zool. pt 1, 1842, p. 101.
[96] U. S. G. S. Niagara Folio, 190, p. 19, fig. 10.
[97] A. A. A. S.Proc. 12th meeting, May 1858 (1859) p. 232–33.

deposit of mud, in some places 6 feet in depth, has to be removed before exposing the gravel bottom. This deposit is continued for some distance up the valley and beyond the flow line of the water, thus proving that most of this deposit has been the result of vegetable growth in the open air. In this last locality the boggy surface is covered with a thick carpet of moss interspersed with a few trees which are able to flourish in such a soil.

The remains in question were discovered in this last-mentioned spot, about 20 yards from the channel of the stream which runs into the pond, and resting on the gravel, covered by about 4 feet of the muck or peat.

The bones and a few fragments of an ivory tusk are much broken up, and crumble on exposure to the air. The top of the lower jaw is very distinct. Two of the pieces of bone show articulating surfaces, but their exact position in the skeleton has not been determined. They appear to belong to the fore leg. The five molar teeth were in excellent preservation, the enamel being colored black, but perfect, while the roots were less complete, but nearly whole.

According to Owen's Odontography, where the series of teeth is figured, it would appear that the present molars were those of a young adult mastodon. The anterior ones are worn on every cusp, while the large posterior molar is only slightly worn on two of the anterior cusps.

From the fact that so few bones were found, it would seem that the animal (as in some other localities has been supposed to be the case), was not mired in the spot where the fragments were found. Neither could they have been washed by floods into their position, for the Long Island streams are not subject to freshets, their course being too short and the soil too porous to allow the accumulation of waters overflowing their banks. It is, however, probable that the creature died not far from the spot where these remains were found, and that they were gradually covered up by the vegetable growth of centuries.

The Jamaica specimen is probably the one referred to by Prof. D. S. Martin[98] when he stated that a mastodon was exhumed in excavating for the Ridgewood, L. I., reservoirs. Ridgewood is west of Jamaica and its reservoirs, like the one near Jamaica mentioned by Brevoort, supply water to Brooklyn.

Richmond County

83 1899. *New Dorp.* In the museum of the Staten Island Institute of Arts and Sciences are fragments of a tooth which were found in a swamp at the Moravian cemetery at New Dorp, Staten Island. An account of this find was given by Dr Arthur Hollick and was published in the Annals of the New York Academy of Sciences, volume 14, 1901, pages 67-68. The following description is from the above publication:

The surface deposit was found to consist of a fine moss peat and a coarse peat composed of all kinds of swamp vegetation, extending out to the margin of the pool, while below this and forming the bottom of the pool was a black organic mud, such as may be seen in almost any swamp where decaying vegetation has accumulated. Below this the deposit was a fine sandy silt, distinctly stratified, the layers following the general contour of the depression, thicker towards the middle and thinning out at

[98] N. Y. Acad. Sci. Trans. 1885, 5:15.

the edges. The general shape of the depression is roughly pyramidal, with steeper sides on the north and east than on the south and west. The deepest part is in the northeast angle, where the entire deposit was about 25 feet in thickness. All this deposit has been taken out and the sides and bottom of the depression are now exposed to view.

The first thing which attracted my attention was a number of logs and branches in the upper part of the silt, beginning at a depth of about 5 feet from the surface. There was nothing in connection with these to indicate that they were anything more than the remains of a comparatively recent forest growth. Below this, however, at a depth of about 8 feet, were a number of layers, aggregating about 2 feet in thickness, containing a large number of small cones and twigs. There are no coniferous trees now growing in the vicinity and no record of any in recent years so that these were manifestly the remains of a forest growth which antedated the one now growing there and a subsequent careful examination and comparison of the cones showed them to belong to the white spruce (Picea canadensis (Mill) B. S. P.) — a tree of northern range, which does not now extend farther south than northern New England and the Adirondacks — and this fact naturally led to the conclusion that at least the lower portion of the deposit was of Quaternary age.

On inquiry of the superintendent of the cemetery, Mr N. J. Ostrander, information was subsequently obtained to the effect that "some bones" had been dug out by one of the workmen, at a depth of about 23 feet, and these were very kindly turned over to me. They proved to be the broken pieces of a mastodon's molar and the Quaternary age of the deposit was established beyond question and inasmuch as it was in morainal basin it must all have been post-morainal in age.

The indications are that a pond was formed in the depression immediately after the recession of the ice sheet and that this pond was a receptacle for silt, dust and decayed vegetation ever since; the accumulations finally filling it up and converting it into a swamp, with a little pool of casual water remaining in the middle.

Incidentally it may also be worth recording, that a considerable amount of charcoal and charred wood was found in connection with the cones, near the northeastern side, which fact might indicate the presence of man at the time this portion of the deposit was laid down.

Another account of this find is published in the Proceedings of the Natural Science Association of Staten Island, volume 7, no. 10, pages 24 and 25. This description is also by Doctor Hollick and is a similar account to the one above quoted. Further notes on this locality are given in the "Proceedings of the Natural Science Association for February 10, 1900." This records a piece of well-lignitized wood in this deposit. The specimen was apparently coniferous. See also Plant World, December 1900, page 184, for further description of the deposits found in the swamp and its geological history.

84 1894. *Staten Island sound.* The following brief notes relating to this find have been published:[99] "Mr L. W. Freeman presented a mastodon's tooth, obtained from Staten Island sound by Mr Seeley Van Pelt, while tonging for oysters. Its value was not understood by the finder, who allowed it to be thrown away, with

[99] Nat. Sci. Assoc. Staten Island, Proc. 1894, 4:18, 32.

the refuse oyster shells, into Old Place creek, from whence it was recovered by Mr Freeman." (Page 18).

"Mr Arthur Hollick stated that the mastodon's tooth, shown at the March meeting, has been submitted to Prof. R. P. Whitfield, of the American Museum of Natural History, who had kindly identified it as a sixth molar of Mastodon gigantea Americanus. It contains the second, third and fourth crests. The first crest and heel on fifth crest are broken off." (Page 32).

Rockland County

85 1817. *New Antrim* (now Suffern). The first account of this find was in a letter written shortly after the discovery of the mastodon, by Edward Suffern to the Hon. Samuel L. Mitchill and printed in the American Monthly Magazine[1]. The text of the letter is as follows:

On Saturday last, a man in the employ of my father, in digging a drain or ditch through a miry swamp, discovered, about 3 feet from the surface of the earth, several pieces of teeth of enormous size: — from their appearance, shape, and the manner they are worn away, the animal must have lived I suppose to a great age, and belonged to the Granivorous species; who have probably inhabited this region, and become extinct previous to the discovery, or at least the settlement of this country by the Europeans. The largest piece appears to belong to the extreme back tooth of the under jaw, and is 8 inches in length, 4 inches in breadth, and 3 inches in height, from where it has rested on the jaw bone to the head or top of the tooth, (though it evidently appears that one-half of its original size is worn away by mastication), weighing 3 pounds 6 ounces, Avoirdupois weight. The enamel is the principal part of the tooth that is preserved; the root or periostium is chiefly decayed and, upon being exposed to the air, moulders away. The ditcher, before he discovered the teeth, broke them while digging with the spade: these are full of marrow resembling lard. If you should deem a further discovery necessary to aid you in your scientific pursuits, I shall be happy to see you at my residence, or I will carefully preserve the pieces, and bring them with me to New-York for your inspection and examination.

The mastodon remains were presented to Mitchill and by him donated to the New York Lyceum of Natural History. Mitchill states[2] that the bones were found on "E. Suffern's farm, 32 miles from New York City, and 11 miles west of the Hudson river, in New Antrim, Hemstead town" (now Ramapo). The locality is near the west border of the Triassic area (Newark formation) of Rockland county and within a mile of the New Jersey state line.

[1] 1817, 2:46. See also p. 56, 57.

[2] Catalogue of Organic Remains presented to the New York Lyceum of Natural History by Samuel L. Mitchill, New York, 1826. Cat. no. 3, p. 11.

Another account of this mastodon is given by Mitchill[3] and he states that the fatty substance contained in the cavities of the teeth, mentioned by Suffern, no longer remained when the teeth reached him. Two figures of one of the teeth are also given by Mitchill.

Schenectady County

86 1914. *South Schenectady.* In this year Richard Ribley found and brought to the State Museum for identification, a fairly well-preserved, medium-sized tooth of a mastodon which he had obtained from the extensive gravel deposits at South Schenectady. The gravel deposits at that place are of delta origin and were laid down near the western margin of glacial Lake Albany by the flood of waters, which coursed eastward through the Mohawk valley and carried all the outflow waters of glacial Lake Dawson and its successor early Iroquois. This was before the latter lake had reached its maximum extent and before the greater Mohawk had carved the many potholes in the rocks at Cohoes,[4] in one of which the Cohoes mastodon was found.

Seneca County

87 *Lodi.* Among the collections of the American Museum of Natural History, there is a tooth which carries this label, "Tooth of Mastodon (5th and 6th) found at Lodi, Seneca Co., N. Y. Presented by Wm. Nevius, N. Y." No information is available as to date, character of deposits or the depth at which the tooth was found. The town of Lodi borders Seneca lake and Lodi village is 2½ miles east of the lake at an elevation of 1045 feet, and a mile or more from the divide between Seneca and Cayuga lakes.

Steuben County

88 1874. *Wayland.* The following account, relating to the contents of a mastodon's stomach, is printed in the Proceedings of the Boston Society of Natural History for 1874 (page 91):

"Mr Charles Stodder exhibited, with the microscope, a slide showing some of the contents of a mastodon's stomach. The ma-

[3] Observations on the Geology of North America. p. 390; in Essay on the Theory of the Earth by M. Cuvier, New York, 1826. In the text Mitchill states that the illustrations of the tooth are on plate 2, figures 1 and 2. The copy examined by the writers has three press-numbered plates, VI, VII and VIII, and the tooth is illustrated on plate VI, figures 1 and 4. The remains are also described in Godman's American Natural History, 1836, 2: 77.

[4] See Stoller, "Glacial Geology of Schenectady Quadrangle," N. Y. State Mus. Bul. 154, 1911, p. 16, 34.

terial from which the slide was prepared, received through the kindness of Mr Morehouse, was obtained in Wayland, N. Y., and he had sent it to Dr J. G. Hunt, of Philadelphia, for determination and preparation. Respecting this material Doctor Hunt reports as follows:

The remains, both of cryptogams and flowering species, were in abundance. Stems and leaves of mosses, wonderfully distinct in structure, so much so that I could draw every cell. I even readily detected confervoid filaments, with cells arranged in linear series, resembling species now found in our waters. Numerous small black bodies, probable spores of the mosses, were found in abundance. Not a fragment of sphagnum was seen in the deposit. I found, however, one fragment of a water plant, possibly a rush, an inch long, every cell of which was as distinct as though growing but yesterday. Pieces of woody tissue and of bark of herbaceous plants, spiral vessels, etc., were abundant. Carapaces of Entomostraca were present, but no trace of coniferous plants could be detected. It hence appears that the animal ate his last meal from the tender mosses and boughs of flowering plants growing on the banks of the streams and margins of the swamps, rather than fed on submerged plants; and it is probable, moreover, that the pines and cedars, and their allies, formed no part of the mastodon's diet.

The above account does not give any information concerning the find, but in a footnote in "A History of Livingston County, New York "[5] the following is printed: " Within the last 2 years several bones of a mastodon were discovered on the borders of the county near Dansville, some 8 feet below the surface, a portion of which are now in the possession of Professor Allen of the State Normal School at Geneseo."

Dansville is 5 miles west of Wayland, and the county line passes between them less than 2 miles from Dansville. The dates given in the above brief accounts show that the year was 1874, and therefore both undoubtedly relate to the same find in the town of Wayland, Steuben county.

89 1907. *Perkinsville* (plate 11). The remains of the Perkinsville mastodon are in the State Museum and an account of this find has been given by Clarke,[6] who states:

This skeleton was found in August last by John Morsch on his farm near the west end of Perkinsville swamp and three-fourths of a mile north of the railroad station of Portway. This swamp is a nearly equilateral triangle about 1½ miles on the side. It occupies a shallow depression in a mass of morainic drift of unknown depth at the head of the Cohocton valley and is adjacent to the west side of a low ridge that separates the drainage area of the Cohocton river from that of the Canaseraga creek. It has an altitude of 1360 A. T. The surface layer of the swamp is black muck to a depth of 6″ — 1′, beneath which is a bed of nearly white marl 6″ — 6′ in thickness. The bones were found about 26 rods from the highway and 4 or 5 rods from the north edge of the black soil or border of the swamp. In digging about a small boulder Mr. Morsch came upon one of the

[5] By Lockwood A. Doty, Geneseo, 1876, p. 381.
[6] N. Y. State Mus. Bul. 121, 1908, p. 44, 45.

Plate 11

Complement of permanent molars, from right side of jaw of the Perkinsville mastodon.

larger leg bones and proceeded to take out the remains of the skeleton. These bones lay largely in their natural position and while perhaps the numerical two-thirds of the skeleton were preserved, the more conspicuous bones were fragmentary or wanting. At the conclusion of the excavation it was found that all four legs and feet, a large number of ribs and vertebrae, parts of the shoulder girdle and one ramus of the lower jaw with teeth had been recovered. The skull with tusks, greater parts of pelvis and scapulae were gone. It would seem that the animal in sinking into the mire had been left with the more protuberant portions of the body, the head probably thrown up and back, exposed to the air and inviting the attack of rodents. The absence of these parts when all the other bones had so compactly kept together, left little likelihood of their being found in any other part of the swamp. The preservation of the bones recovered was excellent for mounting and it is to be regretted that the specimen just missed being a desirable acquisition to a scientific museum.

Suffolk County (?)

1823. *Riverhead or Southold.* In 1823, according to DeKay,[7] there was found " more than one-half of a lower jaw, with the teeth, on the shore of Long Island, between high and low water mark, about 4 miles east of the county court house at Riverhead, Suffolk county." The specimen is mentioned by DeKay as being in the Cabinet of the Lyceum of Natural History, New York. It was probably the same specimen recorded by Mitchill[8] which he states was found at Southhold on the north side of Long Island, between high and low water mark. Mitchill adds that the specimen had been satisfactorily traced to Kentucky. In view of the fact that Riverhead and Southhold are but 15 miles apart, there seems no doubt but that the finds recorded from these two places are one and the same. Moreover, since Mitchill once owned the specimen and it was presented by him to the New York Lyceum, it is believed as stated by him, that it was not originally found on Long Island and so the find is referred to here, without number, simply as a matter of record.

Sullivan County

90 1827. *Wurtsboro.* A brief account of this mastodon is given in a letter written in December 1827 by Jeremiah Van Rensselaer to Professor Silliman. The letter states[9] " That the fossil remains of *a mastodon giganteum* were discovered last autumn, by the workmen, while digging the Delaware and Hudson Canal. A considerable portion of the skeleton has arrived in this city, and I have enjoyed an opportunity of examining it. The bones which I saw,

[7] Nat. Hist. N. Y.; Zool. 1842. pt 1, p. 103. See also record of this find in A. A. A. S. Proc. for 1858 (1859), p. 233.
[8] Catalogue of the Organic Remains, presented to the New York Lyceum of Natural History, New York, 1826. Cat. no. 1, page 5.
[9] Amer. Jour. Sci., 1828, 14:33.

are in good preservation, and seem to justify the wishes of the proprietors to set up the entire skeleton. The teeth are in perfect order. One of the tusks has arrived; it is a beautiful and perfect specimen, 9 feet long." The locality is given by Mather[10] who states that the bones "were found in digging the Delaware and Hudson canal, in a peat bog between Red bridge and Wurtsboro in Sullivan county."

Tompkins County

91 1871. *Brookton.* Mastodon remains were found in Tompkins county in 1871 and Professor Hartt of Ithaca, writing to Professor Hall under date of May 28, 1871, briefly refers to the find as follows: "We have lately found mastodon remains, good teeth but broken bones in a bog at Motts Corners (Brookton), Six-mile creek." The printed account by Professor Hartt[11] includes the following:

> At the mastodon locality the stream met with a little knob of Chemung rocks which appears to have formed at one time an island, but the creek afterward cut its way through the rock to a lower level on the left side and the channel on the opposite side was deserted. Springs, one of which is said to be salt, have kept this deserted channel wet and a bed of peat has formed which once supported some large trees. The layer of peat varies from a few inches to 2 feet or more and is full of sticks, pine knots, bark, etc., more or less decayed. Beneath this is a layer of variable thickness, rarely more than a few inches, composed of clay mixed with pebbles and pieces of shale. In this were found small fragments of bones and teeth, the former in a very decayed condition showing that the skeleton had been completely broken up and scattered. The whole rests on a bed of blue arenaceous clay with large pebbles and fragments of rock of all kinds, in fact, a modified drift. In most cases the bones were merely scattered over the surface of this bed between it and the peat. The teeth are in very good condition and not at all waterworn. The animal probably became mired near the spot. The skeleton, exposed to the action of the elements, went to pieces, and the fragments were scattered, partly by water action and partly through the agency of wild animals.

A communication to the American Journal of Science (1871, 2:58) by Prof. B. G. Wilder of Cornell, relates to the Brookton specimen. Wilder states: "Five teeth and many bones and fragments of the mastodon have been discovered in a deposit of modified drift near Ithaca, New York, and placed in the museum of Cornell University. Many more remains will doubtless be obtained, as the teeth already indicate the existence of two or more individuals; little hope is entertained, however, of finding a perfect skeleton."

The above specimen is also the one referred to by Professor Tarr[12] as having been found in a swamp in the valley bottom at Brookton.

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[10] Nat. Hist. N. Y., Geol. pt 1, 1842, p. 233.
[11] Amer. Naturalist, 1871, 5:315.
[12] U. S. Geol. Sur. Folio 169, 1909, p. 200, Field ed.

He states that the animal may have mired there after the valley was cut down to its present level or that it was washed out of the gravels and concentrated in the swampy area; it is not now possible with the information at hand, to decide between these alternatives.

92 1914. *Pony Hollow.* The account of this find as given by Pearl Sheldon[13] is as follows:

A tusk of a proboscidean, probably Mastodon americanus, was found recently in a gravel pit in Pony Hollow, 12 miles southwest of Ithaca, N. Y., on the property of Mr Bert Drake. Unlike most mastodon finds from this region this is not postglacial. It was found in place 24 feet below the surface in stratified sand and gravel which was being used in good roads work. The pit is in the base of an extensive terrace whose top follows the valley wall high above the outwash gravel plain which occupies the floor of the valley. The exact origin of this Pleistocene terrace is obscure but it is certainly not later than the end of the ice occupation of the valley and may be earlier.

The tusk was broken in removing the gravel. Two pieces, each about a foot long, from 10 to 13 inches in circumference, were presented to the paleontological museum of Cornell by E. A. Dahmen, the road engineer. Three approximate measurements of the curvature of the tusk gave from 2 feet 1 inch to 2 feet 11 inches as the radius of curvature.

Ulster County

93 1800. *Town of Shawangunk.* The first mastodon remains found in Ulster county as at present constituted was in this year. Earlier records from Ulster county were from that portion which was annexed to Orange in 1798 and are recorded under Orange county.

An excellent account of the 1800[14] find is given in a letter written by Dr James G. Graham under date of September 10, 1800 to Doctor Mitchill. In his letter Graham[15] mentions a number of localities where fossil bones had been found and at one locality some hair, about 3 inches long, of a dark dun color. The letter continued:

And last week another skeleton has been discovered, about 3 miles east of my house, in the town of Shawangunk, about 10 miles northeast of said bridge (=Ward's Bridge). These last discovered bones lie about 10 feet from the surface, and are in a very sound state. Many of them have been raised, but some much broken, especially the bones of the head, which, I am persuaded, lie entire, and in their natural order.

I have procured two bones of this last discovered skeleton, and sent them to New-York, by Edward W. Laight, Esq. for the purpose of having them examined by yourself, and other well-informed naturalists in the city. One of these I take to be a metacarpal or metatarsal bone, which indicates the animal to have been claw-footed and, from the forms of the astragalus and os calcis which were among the bones sent to Dr Bayley, to have resembled the foot of the bear. With respect to the other bone,

[13] Science, n. s., 1915, 41:98, 99.

[14] These remains should not be confused with the well-known "Shawangunk head" which was found in Orange county at Scotchtown in 1844.

[15] Medical Repository. New York, 1801, 4:213-14.

I am at a loss where to assign it a station among those of the skeleton. . . . I have been particular in stating the relative situations and distances of those places in which bones have been discovered, from a certain point, to show, from the small district in which many discoveries have been made, the great probability that these animals must have been very numerous in this part of the country, for if we compare the small proportion that swamps, in which only they are found, bear to the rest of the surface, and the very small proportion that those parts of such swamps as have yet been explored, bear to the whole of such swamps, the probable conclusion is, that they must once have existed here in great numbers. And why Providence should have destroyed an animal or species it once thought proper to create, is a matter of curious inquiry and difficult solution. If, however, they were voracious, it must appear happy for the human race that they are extinct, by whatever means.

The hair above mentioned seems to prove that it was not the elephant, or, if it was, that it must have been of a species or variety widely different from any known at present.

A letter by Sylvanus Miller relating to this mastodon, which was written 10 days later than Graham's, was also addressed to Doctor Mitchill and published in the same volume of the Medical Repository (page 211-12). In his letter Miller says:

On my arrival at Newburgh, I was informed, that about 12 miles to the westward of that place had lately been discovered the skeleton of an animal of uncommon magnitude, and decidedly larger than that of any of which we have at this time any knowledge. . . . The bones here discovered lay buried about 10 feet under this marle and earth, which generally consists of five different strata — the first is the common earth found in low meadows; the second a very black and rich earth, and is deemed good for manure; the third a small stratum of blue clay; the fourth a stratum of white marl; and the fifth a stratum of grey or black marl; at or near the bottom of which these bones are discovered, and some of them sunk into the earth some inches below the marl. . . . The bones which were lately discovered appear of the same species, though I think larger, with those found some time since in the same vicinity, and afford a spectacle truly astonishing; they appear little decayed by the lapse of time and their proper places, and names of the several parts of the skeleton, could, I presume, easily be discovered by a person possessing your knowledge in anatomical science.— They are, however, not as yet entirely procured, though great exertions have been made, and are still making, to effect so desirable an object — the difficulty is made much greater by the influx of the water, continually rushing in from the bottom and sides to the hollow already made — there are among the bones found, several of the legs, some of the back bones, several ribs, and the upper part of the head,[16] etc.— one bone of the thigh measures more than 40 inches in circumference round the joint, and 36 inches on the cylindrical part of the bone, and is nearly 5 feet long; the teeth are nearly 7 inches long, and 4 broad — they are found white, and fast in the jaw, without appearance of decay; the holes in the skull where appear to have been the nostrils, measure nearly 8 inches in diameter; the orifice occasioned by the decay of marrow is, in the back bones, 3½ inches diameter; there are several others of like magnitude, and some bones of the foot which shows evident marks that it once had claws.

The concluding quotations from both Graham's and Miller's letters indicate much doubt on the part of these early writers as to

[16] The head is thought, by Doctor Graham, to have been as large as an ordinary hogshead.

the character of the animal to which the bones belonged. This matter, however, is cleared on a later page (308) of the Repository where we find this statement, " Since the publication of the communications of Mr Miller and Dr Graham . . . other discoveries have been made. We have been informed that the upper jawbone is perforated to receive a tusk, like that of the elephant. . . . This structure of the head leads towards a belief that the animal was a species of elephant."

The widespread interest created by the discovery of these mastodon remains in the town of Shawangunk is shown by the fact that less than 6 months after their discovery, Thomas Jefferson, then Vice President of the United States, but President a month later, was endeavoring to obtain specimens, which he succeeded in doing. The great interest taken by Jefferson in this mastodon is shown in the article by Frederic N. Luther[17] on " Jefferson as a Naturalist," which states: " Thus, during those exciting weeks in February, 1801, when Congress was vainly trying to untangle the difficulties arising from the tie vote between Jefferson and Burr, when every politician at the capital was busy with schemes and counterschemes, this man, whose political fate was balanced on a razor's edge, was corresponding with Dr. Wistar in regard to some bones of the mammoth which he had just procured from Shawangunk, Ulster County."

That Jefferson did actually obtain the lower and upper jaws, both with teeth, of the mastodon from the town of Shawangunk, is shown by the figured specimens of a plate accompanying an article by John S. Patton[18] on " Thomas Jefferson's Contributions to Natural History." The label, photographed with the jaws, carries this inscription, " The above remains of MASTODON were collected by THOMAS JEFFERSON and by him presented to the UNIVERSITY of VIRGINIA."

94 1859? *Ellenville* (plate 12). In 1860 there was received by the State Museum[19] one tusk, 7 feet long, parts of a skull, jaws with teeth, a pelvic and thigh bone of a mastodon found at Ellenville. The remains indicate an old individual, and of special interest is the worn condition of the teeth. These, as shown by the plate, have been worn down through the dentine to the pulp cavities,

[17] Magazine of American History, April, 1885:13:387.

[18] Natural History (Journal of the American Museum) 1919, 19: 407 (plate); see also p. 496.

[19] N. Y. State Cab. Nat. Hist., 14th Annual Rep't, 1861, p. 7, 15 and 21st Annual Rep't, 1871, p. 128.

which are exposed and open. The remains were found in a swamp of several acres extent, and the bones were recovered near its outlet. The swamp section showed 2 feet of peat and 3 of marl, the latter resting on a bed of clay. The bones were found in the marl. Some comparative measurements with the Cohoes mastodon are given in the last of the two references cited.

95 1890. *Milton.* About this year a very small tooth of a mastodon[20] was found near Milton by Charles Kniffen on what is now known as the Bray farm. The tooth is probably still in possession of the finder.

Wayne County

96 1888? *Macedon.* The remains of the mastodon from the town or village of Macedon are represented by two teeth, which are in the museum of the University of Rochester. They have been identified by Dr O. P. Hay as right and left upper last molars. These teeth were in the musuem, according to a statement of Professor Fairchild, previous to 1888 but the actual date when they were received and other data relating to the find are lacking. The teeth are of average size, well preserved and very white, apparently from clean sands or gravels. Macedon is the southwestern township of Wayne county 9 miles east of the Perinton locality in Monroe county, and 11 miles south of Lake Iroquois beach. Extensive sand and gravel deposits are found in the vicinity of Macedon. They are in the Fairport-Lyons glacial channel, which carried eastward the waters of glacial Lake Dawson and early Lake Iroquois. Not all the delta deposits of ice border drainage have been plotted but the more important of them are shown on Fairchild's[21] glacial maps. The chances that these teeth were found in these glacial gravels are excellent for numerous excavations have been made in them for commercial supplies and also they have been cut through by the New York Central and the West Shore railroads and the Erie (now Barge) canal. The Rochester, Syracuse and Eastern, an electric line, also passes through this glacial channel, but this was constructed subsequent to the finding of the mastodon teeth. While it can not be proved that the teeth have definite relations to glacial waters on account of the uncertainty as to the exact spot where they were found, yet it is believed, on account of their color, that they did come from these glacial gravels and in point of age these mastodon teeth are among the oldest found in the State.

[20] N. Y. State Mus. Bul. 196, 1918, 47.
[21] N. Y. State Mus. Bul. 127, 1909, pl. 3 and Rochester Acad. Sci., 1919, v. 6, pl. 2.

Mastodon americanus. Palatal view of specimen from Ellenville, showing worn teeth of a very old animal. Note reduction of teeth to one on each side of jaw.

Westchester County

97 1906. *Hartsdale.* "A tooth[22] and some small fragments of bone were found at Hartsdale on the property of W. H. Fish." This is the only authentic record from Westchester county. A reported discovery of mastodon bones near White Plains in June 1920 is here mentioned on account of the publicity it received. The so-called bones proved to be weathered blocks of "Calciferous" sandstone.

Wyoming County

98 1876. *Pike.* A brief statement concerning this find was published by Clarke[23] in 1903 and a fuller account in 1908.[24] His later account is as follows: "I append here some additional data concerning the Pike skull taken from a recently published account (Guide to the Genesee Valley Museum, Letchworth Park, by Henry R. Howland, 1907, p. 5):

> These remains of a mastodon were found in the summer of 1876 in cutting a farm land ditch on the farm of Charles Dennis, on the outskirts of the village of Pike, which is about 7 miles from Glen Iris, and through which flows the Wiscoy creek, one of the tributaries of the Genesee river. The tusks were fortunately quite perfect and with them were found a part of the skull, some vertebrae and some foot bones. In order that these remains should be properly preserved they were at once purchased by Mr Letchworth who caused them to be mounted at the natural history establishment of Prof. Henry A. Ward in Rochester, N. Y. The prompt action taken in the matter resulted in the preservation of this valuable relic which was returned to Pike and allowed to remain on exhibition at the Pike Seminary until the completion of the Genesee Valley Museum Building in 1898. In 1904 the seminary building was destroyed by fire. The measurements of the pike Mastodon are as follows:

Length of skull, measured in a straight line from back to front	43½ inches
Length of tusks, measured along lower curve	96½ inches
Greatest circumference of the tusks	23 inches

The following additional information concerning the Pike mastodon is from a letter in the State Museum files written by C. B. Rieler to James Hall, dated Pike, N. Y., July 17, 1876: "Nearly all the bones found are more or less decomposed. None of the leg bones found have as yet been seen nor have any of the rib bones been found. The bones lay much scattered at the depth of 2 to 6 feet in a small peat bog so that digging is difficult. The result thus far is seven teeth, ten vertebrae one with a 'spine' 17 inches in length, two clavicles, one scapula, two small bones of the foot, two tusks 9 and 6 feet long respectively, and each 6¾ inches in diameter at base, and several other bones large and small, including portions of the skull."

[22] Clarke, N. Y. State Mus., 3d Rep't of the Director, 1907, p. 60.
[23] N. Y. State Mus. Bul. 69, 1903, p. 932.
[24] N. Y. State Mus. Bul. 121, 1908, p. 45.

99 1884. *Perry.* "The Museum of the Wyoming Pioneer and Historical Association at the Silver Lake Assembly, contains two teeth [of the mastodon] found on the farm of William Olin, town of Perry, in the year indicated."[25]

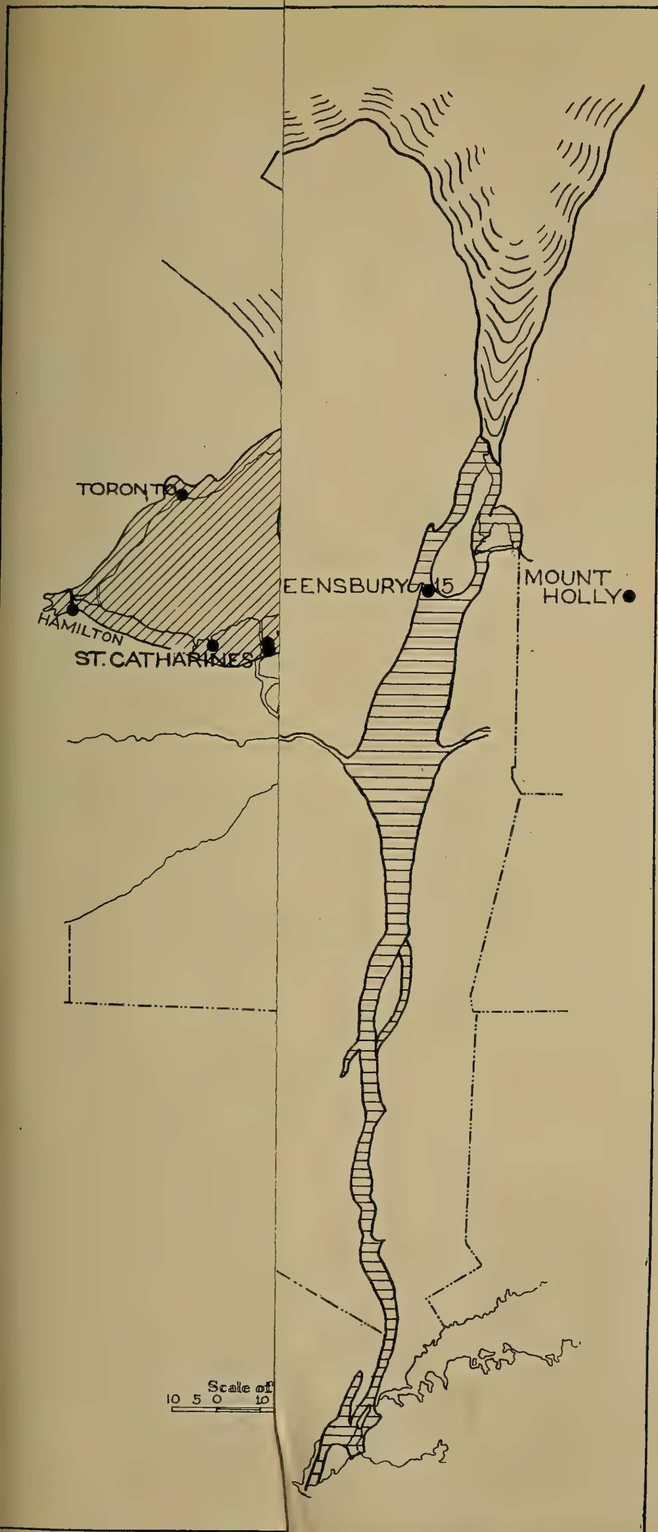
100 1886. *Attica.* The following summary with references to the Attica mastodon or mammoth has been published by Clarke.[26] "Small tusk, ribs and other bones found in digging trench on Genesee street, in unlaminated clay at a depth of 2 to 3 feet, overlaid by clayey muck and loam. Beneath these bones were found several pieces of charcoal.[26a] In another part of the same swamp, under 4 feet of muck and 1 foot below level of the bones, was found a considerable quantity of charcoal with broken pottery. *Clarke. N. Y. State Geol. 6th An. Rep't, 1887, p. 34; 7th An. Rep't in N. Y. State Mus. 41st An. Rep't, 1888, p. 388.*" See also Geological Magazine (3) 1889, 6:192. Of the above references, the 41st Museum Report is best as it contains a cut showing ground plan and vertical section of the locality.

MAMMOTHS

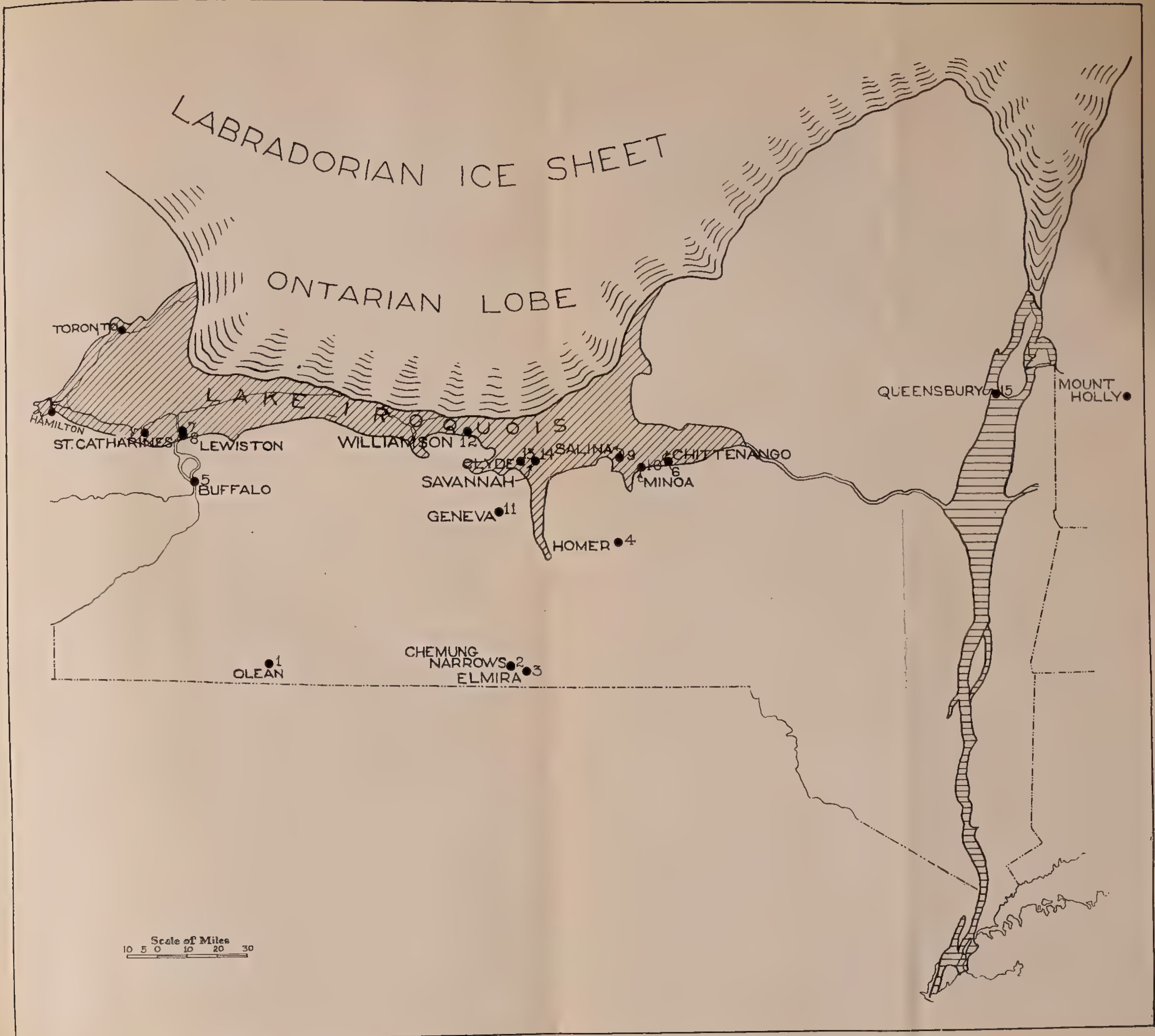
Of the one hundred and fifteen mastodon and mammoth remains listed from New York State, fifteen have been definitely determined as those of the mammoth. With the exception of the Queensbury, Warren county, tooth, all the mammoth remains have been found in central New York and westward. The fifteen mammoth finds recorded in the list that follows are all represented by teeth, and thus generic determination is positively established. In six of the fifteen finds the teeth were accompanied by bones, thus indicating the possible presence of the whole animal.

Among the list of one hundred specimens recorded under mastodons, about thirty lack positive generic determination. Twenty of these are from southeastern New York, which thus far has revealed no mammoth remains. It is then reasonable to assume that nearly all, if actually not all, of the generically undetermined specimens from southeastern New York belong to the mastodon. It is to be regretted that the terms "elephant," "mastodon" and "mammoth" have often been used and are still used in a sense that tends to confusion. Both mastodons and mammoths are "elephant like," and moreover the word "mammoth" may be used either as an

[25] Clarke, N. Y. State Mus. Bul. 140, 1910, p. 46.
[26] N. Y. State Mus. Bul. 69, 1903, p. 932.
[26a] See account of charcoal and charred wood found with cones of trees now extinct on Staten Island, under description of the New Dorp, Richmond county, mastodon.



Map sh[...]uois waters.



Map showing the preponderance of mammoth remains in New York State, in the area covered by Lake Iroquois waters.

adjective or a noun. As an adjective it denotes large or huge size and was so used in America even before the word became used as an adjective in England. It is recorded that an English writer wondered why the Mammoth Cave of Kentucky was so called since no remains of the mammoth had been found there. Although the fossil elephant has been recorded from southeastern New York, it is believed that this record was due to the use of an indefinite term and that the animal was really a mastodon. In western New York about ten specimens which lack generic determination are recorded with the mastodons. In the latter section only two of the fourteen mammoth remains can be credited, and these doubtfully as having been found in swamp deposits. On the other hand, nearly all the mastodon remains have been found in swamps. The chances then greatly favor the inference that the generically undetermined proboscidian remains from swamps are of the mastodon rather than of the mammoth. Of the doubtful specimens included under the mastodons, the tusk from Pony Hollow (no. 92 Tompkins county) could, it is believed, have been placed with equal propriety with the mammoths. This was not done because only such remains as have been positively identified as mammoths are included in the list. Another doubtful specimen described with the mastodons is the Copenhagen tusk from Lewis county. If this slender tusk could be proved to belong to a mammoth, it would go far to indicate the presence of the mammoth in New York in Postglacial times. Such evidence, although eagerly sought for, has not been forthcoming. Further studies and discoveries may prove definitely the presence of the mammoth in New York since the glacial period. Such discoveries of a late mammoth may be expected since they have been found in some of the nearby states.

There is no doubt that mammoth remains were imbedded in sand and gravels laid down during recession of the ice sheet. Examples of these are best seen in the Lewiston specimens of teeth and bones which were found deeply buried in the spit formed in Lake Iroquois. The Savannah specimen is another good example, where the gravel beds in which the teeth and bones were found was formed during the period when Lake Iroquois was at a high level. The Clyde mammoth tooth was deeply buried at a still earlier time in a delta of Lake Montezuma — a lake earlier than Iroquois and in point of time corresponding more nearly to glacial Lake Warren. These three occurrences as described in the pages following are comparatively recent finds, and the data relating to them have been carefully investigated by the writers and are thoroughly reliable.

Deeply buried specimens of bones and teeth of the mammoth have also been found in the Iroquois beach in Canada[27]. At Hamilton, Ont., there is an excellent beach and bar of Iroquois age. In this bar and nearby beach are found bones, ivory and teeth of mammoths which occur at various levels from 33 feet to 70 or 80 feet above Lake Ontario. Mammoth bones with remains of trees were found in an old soil 30 feet below the gravel bar in the city of Hamilton, indicating a lower and earlier stage of Lake Iroquois before the final higher beach level was reached.

Interglacial periods have also been recognized in Canada in the vicinity of Toronto. In some of these interglacial deposits, bones of the mammoth or mastodon have been found as well as bones of the bison and Cervalces borealis.[28] It is unfortunate that the proboscidian remains have not been identified as either mammoth or mastodon, but in either case the occurrence is of interest in showing antiquity as well as the association of the bones of the bison.

Fossil mammoth teeth have also been found in the Pleistocene deposits of Ontario, at St Catharines. A number of mastodon remains are also recorded from the gravel deposits at St Catharines. Definite data regarding the finds here are lacking, and it is not known whether the mammoth and mastodon remains were associated in the same deposits or whether they were found at different levels. The figures and descriptions of some of the remains from St Catharines are contained in Ward's "Catalogue of Casts of Fossils," published in 1866.

As shown on the accompanying map, the more frequent finds of mammoth remains along the south shore of Lake Iroquois are not without significance and may have interesting bearing on the Pleistocene history.[29] The presence of these along Lake Iroquois shore can not be fully explained as the effect of more favorable burial and preservation within the belt of the rising level of Iroquois waters. Neither can it be regarded as merely fortuitous or accidental. Some causal relation must be sought. The explanation is probably found in the mechanics of the ice sheet in relation to the Ontario basin and Lake Iroquois history.

Assuming that the Canadian elephants were forced southward and some remains inclosed in the glacier while advancing over a land surface of moderate irregularity, such of the skeletal parts as survived transportation should be irregularly distributed over the

[27] A. P. Coleman in Guide Book 4, 12th International Geological Congress, 1913, p. 73, 74.

[28] Coleman, in The Natural History of the Toronto Region, 1913, p. 72.

[29] Prof. H. L. Fairchild has generously given the writers valuable suggestions relating to the mechanics of ice movement.

glaciated territory, in this case reaching to central Pennsylvania. But the deep Ontarian valley (present Ontario basin) lying athwart the trend of ice movement introduced important modifying factors, and but few of the mammoths were carried far to the south of Lake Iroquois by the glacier.

The remains of most of the Canadian animals that were overwhelmed by the glacial snows were incorporated in the lower, or ground-contact ice of the southward-moving sector of the Quebec (Labradorian) ice cap. This deepest portion of the ice sheet was pushed into the deep Ontarian valley and becoming stagnant because of its position and also of its load of detritus, it served during all the duration of the Quebec glacier as a bridge over which the upper ice, by a shearing flow, passed on south over New York. This element of glacier mechanics is fundamental to the present explanation of the peculiar distribution of the Elephas remains and is believed to describe the behavior of the continental glacier toward deep and capacious valleys, not only those transverse to the ice flow but also longitudinal valleys, especially when these decline toward the transgressing ice sheet, like the Finger Lakes valleys.

During the life of the Quebec glacier, the captured mammoth remains lay in refrigeration in the Ontarian valley, until, with the waning of the glacier, the frontal melting reached their position. Then some of them were lifted in floating ice on the waters of Lake Iroquois and were rafted to the south shore. Of these, some were buried and preserved in the deposits laid in the rising waters on the south shore, and of these a few have been discovered.

The above explanation and glacial history assumes only a single ice invasion, which is thought to be true for New York and New England. If dual glaciation is claimed, as is the case in the Toronto region where proboscidian remains are found in interglacial deposits, the mechanical conditions would be duplicated in essential factors, but it would be necessary to repopulate southern Canada with the Elephas fauna, as the second ice advance would remove the fossils left by the first ice recession.

The history need not be complicated by postulating deep-ponded waters in the Ontarian valley during the earliest transgression by the ice (a "preglacial Iroquois") because the latter found a great river valley of free drainage southward.

The entrapping of the mammoth remains in the deep valley of the lower ice, their release by flotation in the ice rafts of the frontal waters and the rafting of the fossils to the south shore of Lake Iroquois, appear to afford a reasonable explanation of the peculiar relation of the discovered fossils.

The Type Specimen of Elephas americanus *DeKay*

In 1842 DeKay[30] described and figured a tooth of a mammoth, which he called the American elephant, Elephas americanus. His description follows: "It is with some hesitation that I venture to designate, under a new name, a species founded on specimens of teeth, which appear to differ widely from any hitherto met in this country. The tooth found on the banks of the Susquehannah, near Tioga, March 1786, and figured in the Columbian Magazine, approaches it somewhat, but can scarcely be referred to the same species. The specimens above alluded to were found in a diluvial formation near the Irondiquoit river in Monroe county, 10 miles east of the city of Rochester. According to a writer in the American Journal, vol. 32, p. 377, these remains consisted of a tusk and two molars, one of which is in the Cabinet of the Lyceum, and is that figured in the plate. This is 6 inches in its greatest depth; and, as nearly as can be conjectured from the part which remains, it must have been about 8 inches long, and 3 in breadth on its grinding surface, which is, however, too much injured to exhibit the ends of the enamel. There are thirteen plates in a space of 5 inches, and they are more compressed than in any fossil species with which I am acquainted, being almost in contact, with very little interstitial substance. It is altogether different from any fossil elephant hitherto described, and merits the distinct appellation of E. americanus."

In the account of the Perinton, Monroe county, mastodon it has been pointed out that the remains from Perinton described in 1837, as "Fossil Remains of the Elephant, Elephas primigeneus," were actually those of the mastodon and that the specimen described by DeKay possibly came from without the State, or at least it was not one of the two teeth found at Perinton, because they belonged to the mastodon. The teeth found at Perinton are described as "well preserved," but both the figure and description of the elephant tooth as given by DeKay show that it was more or less decayed and a part actually missing. DeKay's type is no longer in existence, having been destroyed by fire.[31] According to the figure and measurements given by DeKay the tooth may be regarded as a synonym of Elephas primigenius.

In view of the facts above stated the Perinton locality in Monroe county is not included in the list of mammoths which follow.

[30] Nat. Hist. N. Y.; Zool., 1842, pt 1, p. 101; pl. 32, fig. 2.
[31] Am. Mus. Novitates No. 41, July 1922, p. 1.

RECORDS OF MAMMOTH REMAINS FOUND IN NEW YORK STATE ARRANGED BY COUNTIES

Cattaraugus County

1 1889. *Olean.* About the year 1889 a molar tooth was found, with a light covering of soil over it, on the edge of a swamp near Olean creek, a short distance above its junction with the Allegany river. The junction of the two streams is at the city of Olean and the tooth was found at an elevation of 1430 feet. Measurements of the tooth show that it is about 3 inches wide, 9 inches long, about 7½ inches in height and weighs 5 pounds. The writers are indebted to Mrs Katherine E. Bradley of Olean for the above information, and mention is made of the tooth in her *historic* sketches of "The Olean Rock City" (1920, p. 20). Only a photograph of this tooth has been seen by the writers and it is provisionally identified as E. primigenius. Further study may show that it is *E. boreus* = E. jeffersonii, since the width of the ridge plates appear to agree quite closely with that species.

Chemung County

2 1872. *Chemung narrows.* In a letter dated December 30, 1872, Prof. J. Dorman Steele, noted teacher and author of Steele's Natural Science series of textbooks, wrote to Dr James Hall as follows:

> A man at the Chemung Narrows has found a tooth of the mammoth (not mastodon), very fine, weighing over 7 pounds and 13 inches in length. I have had a talk with him today. A neighbor has one also about the same size. . . . It is probable that there are more to be found in the same spot as they have already picked up pieces of the jaw-bone.

A portion of a tooth from Chemung Narrows is among the collections of the State Museum and is recorded as an accession in the 37th Report of the State Museum for 1883 (1884), page 28. It is not known whether this specimen represents an additional find to that mentioned in Steele's letter or whether it is a broken part of one of the two teeth mentioned.

3 Date? *Elmira.* A catalogue in the American Museum of Natural History has the following entry: "E. primigenius. River gravels, Elmira, N. Y. Presented by D. W. Payn. Part of a molar." Further details concerning the finding of this specimen are lacking. Dr O. P. Hay[32] recorded this tooth under the name

[32] Science, 1919, 49:378.

E. columbi, but according to the definition of the species by Prof. H. F. Osborn,[33] it belongs to his recently described E. jeffersonii.

Cortland County

4 1847. *Homer.* According to the original description by Woodworth,[34] the tooth (plates 14, 15), was "found in the bank of a small stream, about 2 miles north-west of the village of Homer. The stream had washed away a portion of the bank, and left a part of the tooth exposed, lying about 20 inches below the surface, in an alluvial formation, resting on a base of gravel."

In the Report of the North Carolina Geological Survey (1848, page 200), E. Emmons gives a figure of the Homer tooth. He states: "But to those who have marl beds, to identify its remains a tooth (fig. 24) of this interesting animal is given in the margin. It is a reduced figure of one found in the superficial deposits of New York." The Homer tooth, which is in the State Museum, has been identified by Dr O. P. Hay as E. columbi.

Erie County

5 1921. *Buffalo.* (E. primigenius.) In November 1921, a large tooth of a mammoth was obtained at a depth of 50 feet while dredging for sand in the middle of the Niagara river opposite Black Rock, Buffalo. The tooth is in the Museum of the Buffalo Society of Natural Sciences, and Director William L. Bryant writes that the tooth belonged to the northern mammoth. Three or four other teeth were observed by the workmen of the sand dredge, but only one was saved by one of the laborers, whose curiosity was aroused and who took the tooth to the museum.

Madison County

6 1825. *Chittenango.* (E. primigenius.) Some remains of a mammoth were discovered during the excavation of the Erie canal, which was completed in 1825, or possibly they were found

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[33] Am. Mus. Novitates, no. 41, July 1922, p. 11.

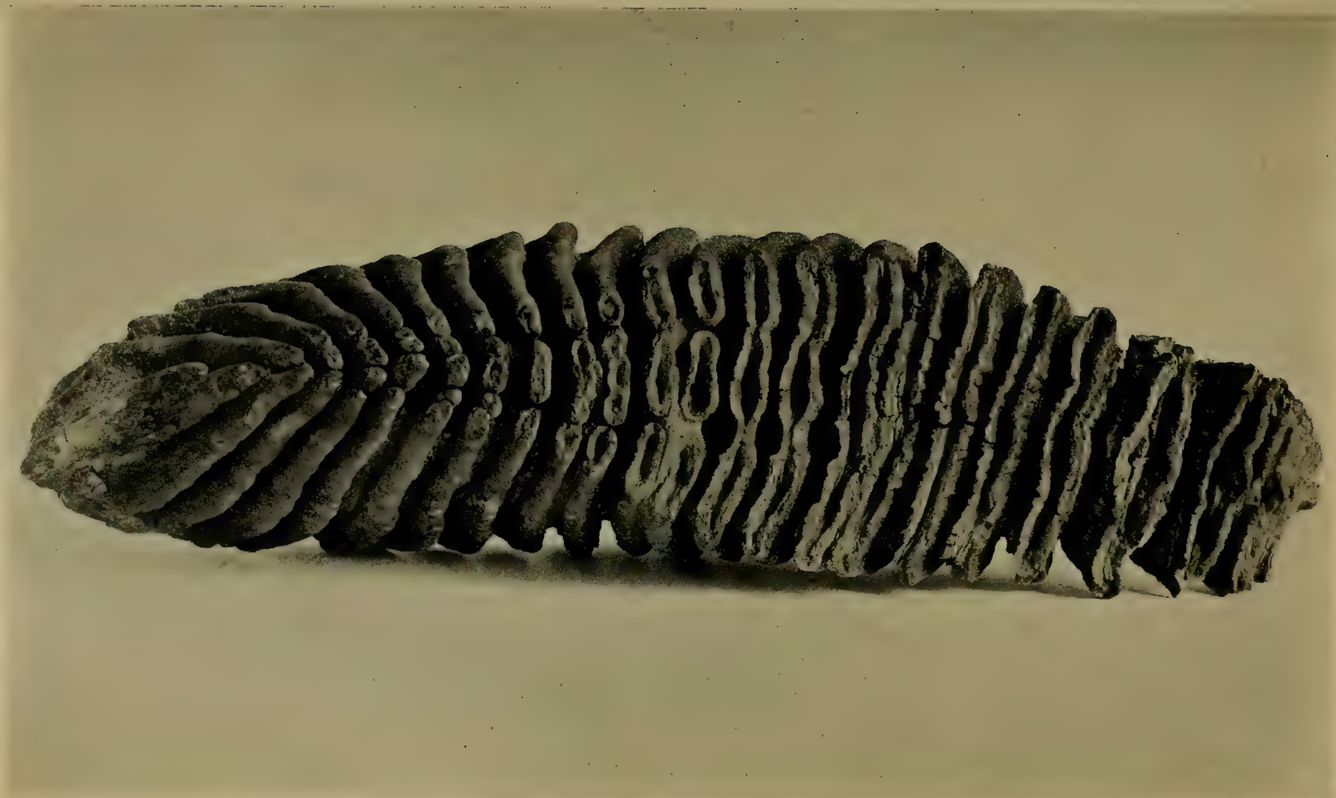
[34] Samuel Woodworth, Amer. Jour. of Agri. and Sci., 1847, 6:31–37, fig. 1. Description of a Tooth of the Elephas Americanus. See also the following:

1854. Caleb Green, 7th Annual Rep't, State Cabinet Nat. Hist., appendix A, p. 16; letter to John Gebhard jr, states tooth was found in summer of 1847.

1859. Twelfth Annual Rep't, State Cabinet Nat. Hist., p. 109. Records gift of the tooth to the State Museum from trustees of Homer Academy.

1918. J. M. Clarke, N. Y. State Mus. Bul. 196, p. 47. Of the two teeth mentioned by Clarke, only the one figured by Woodworth can be identified with certainty.

Plate 14



Top view of molar of mammoth found in 1847 at Homer, N. Y.

Side view of the Homer mammoth tooth.

Plate 16

Tooth of the African elephant. Compare with plates showing mammoth tooth.

during the enlargement of the canal at a somewhat later date. It is not known how many of the remains were found for the various parts were carried away by collectors. Some of these are now in the State Museum and were acquired through efforts to bring together in one place as many of the remains as possible. The following statement with list shows the parts that were brought together for the museum.

The Regents are indebted to the following gentlemen for their assistance in procuring the remains of a fossil elephant, exhumed near Chittenango, in excavating the canal:

To James Stewart, Esq., of Amsterdam, for a tusk, tooth, vertebrae, ribs, and bones of the foot.
To H. C. Merrick, Esq., Civil Engineer of Cortland, for a tusk and ribs.
To Prof. A. K. Eaton, of Clinton, for ribs, etc.
To Charles Van Eppes, Esq., of Sullivan, for a tooth.
To James Coleman, of Sullivan, for a tooth and ribs.
To Mr Robert Wilson, of Chittenango, for a part of the underjaw.[35]

Unfortunately we do not possess detailed information of the circumstances attending the find or a section showing the character of the material in which the remains were embedded. The portion of the jaw is excellently preserved. So are the parts of the tusks, the missing portions having been cut and sawed away. The jaw is clean and not discolored. It shows little sign of decay and has the appearance of having been found in sand or gravel, although the blue clay, still attached to the rough broken part and in the nerve channels, indicates that the specimen was found either in blue clay or else came in contact with it after excavation.

The elevation of the Erie canal in the vicinity of Chittenango is about 420 feet, and it lies within the province of glacial Lake Iroquois. Nearly the whole of the region north to Oneida lake is a low flat country, with here and there some drift material appearing above the general level of the country, and near the line of the canal there are glacial channels showing the Vernon red shales of the Salina beds.

The drift material and the Pre-Iroquois channel through which the canal passes near Chittenango have been described by Fairchild,[36] and as the mammoth remains seem likely not to have been found outside of the limits of the drift and channel his description of them is here incorporated:

In the midst of the embayment at Chittenango is a great mass of morainal drift overlying rock which has a very prominent bank on the

[35] Tenth Annual Rep't, State Cabinet Nat. Hist. for 1855 (1857), p. 188, 190.

[36] 21st Rep't State Geol. for 1901 (1903), p. r42. See also topographic map, pl. 9, for location of drift area and glacial channel. Also N. Y. State Mus. Bul. 127, 1909, pl. 4.

northwest flank (see pl. 24). South of, or behind, this islandlike mass is a large river channel about the dimensions of the Syracuse channel. Whether the floor is rock or alluvium has not been determined, but in either case the form and surface are due to the sweeping by a great river before the ice had opened a passage north of the outlying hill. The canal follows the north side of the broad channel.

Niagara County

7 and 8 1912. *Lewiston.* (E. primigenius.) Plate 10, upper figure. In 1912, parts of the remains of two mammoths were found in a large sand and gravel pit of a terrace not more than 40 rods north of the New York Central Railroad station at Lewiston. The finding of two nearly perfect atlases indicates that the bones represent at least two animals. Altogether about 35 pieces of bones were found, many of which are too badly broken or crumbled to be identified. Some of the bones show the effect of being moved about with the sand and gravel as they are water-woven. Among the bones that can be recognized are the pelvis, two or three broken ribs, one vertebra, some foot bones and the beach-worn joints of some of the larger leg bones. Of the teeth, one complete molar (plate 17) and parts of two other molars were found. According to Frank Lonsdale, pit foreman, who collected the remains and from whom they were obtained for the State Museum, the bones were found in several layers of sand and gravel aggregating 6 to 10 feet in thickness and 20 to 40 feet below the original flat top of the terrace, but the actual depth below the surface at the point where found was not less than 20 feet. The filling of the place where the bones were found made the exact determination of depth impossible when the gravel pit was later visited. As the surface of the filled hole was 20 feet below the top of the pit, actual depth at which the higher bones were found must have been at least 20 feet; and as they were scattered in layers 6 to 10 feet thick some of the bones must have come from a depth of at least 26 feet and possibly from a depth of 30 feet. On account of the bearing which the age of the gravels in which the bones were found has to the age in which the mammoths lived, the following geological history of the sand and gravel deposits at Lewiston is given:[37]

Spits.— The larger gravel pits just north of the landing at Lewiston show one of the most remarkable sections of Pleistocene gravel to be seen in the region. The beds are of clean gravel and include some coarse layers con-

[37] Kindle and Taylor. U. S. G. S., Niagara Folio, no. 190 (1913), p. 13. See also Geol. Sur. Can. Guide Book No. 4, 12th International Congress, 1913, p. 65-68.

A mammoth tooth from gravels of glacial lake Iroquois, Lewiston, N. Y.

sisting of large pebbles with no filling between them. Fine and coarse layers alternate in sharply defined beds. Some of the stones are 8 to 12 inches in diameter. Most of the material is well rounded, but some of the larger stones are not, their edges and angles retaining some prominence. The gravel is bedded, the beds dipping steeply southeastward, in some places nearly south, in others nearly east, and there is almost no evidence of ordinary cross-bedding. Only in one or two places has even the slightest discordance of bedding been observed. The most remarkable aspect of the deposit is the depth of the gravel and the depth to which the inclined beds go without break or change. At times the exposure has shown individual beds running to a depth of 40 feet and the bottom was not then exposed. A considerable part of the gravel is cemented into a hard conglomerate. The deposit appears to be thickest at the pits, but it extends northward along the bank of the river for half a mile or more, thinning out in that direction. On the surface the beds give no evidence of their presence except that the ground is stony and sandy; their surface is merely a part of the surf-worn plain lying in front of the Iroquois beach. . . . The ridge of the Iroquois beach or spit that runs west through the village of Lewiston comes to the bank of the river at the gravel pits and unconformably overlies the coarse, steeply inclined beds. The beach is composed of fine gravel or coarse sand, entirely unlike the material of the inclined beds.

Some of the characteristics of the coarse gravel suggested at first that it may be a bar of initial Lewiston torrent, but excavations have gone on more rapidly in the last 5 years and the new exposures, coupled with the finding of the bones of a mastodon at a depth of 18 to 20 feet in the gravel, seem to show that it is of Iroquois age. Gravel was drifted along shore from the east and was built into a large spit that pushed out into the deep water of Niagara river and at its west end hooked around to the south. The inclined beds shown in the pits appear to have been built off the south end of the hook or on the rear side of a subaqueous bar. The work was done mainly soon after the level of Lake Iroquois was raised from the Newfane level and probably in part during the transition, the spit during that time migrating up the slope. As the shore line was cut farther into the land the upper part of the older gravel was cut off.

The location of the deposits of sand and gravel of the Lewiston spit is well shown on the map (Niagara gorge) of the folio above cited, and under the legend is the statement "Coarse spit gravel (deposited as spits by waves and currents when lake was rising from Newfane to Iroquois beach level, 20 to 40 feet thick)."

Onondaga County

9 1867. *Salina.* (E. primigenius.) In 1867 the State Museum received as a donation from Ira A. Gilchrist[38] of Salina "part of a fossil elephant's tooth, from the gravel of Salina. The section showed a depth of 15 feet above the point where two elephant's teeth are said to have been taken out." The tooth in the Museum is light in color. We have no information relative to the two teeth said to have been obtained 15 feet deeper. Part of another tooth in the Museum may have come from this locality but we have no positive evidence as the label is old and may have been misplaced.

[38] N. Y. State Cabinet Nat. Hist., 21st Annual Rep't, 1871, p. 16.

The origin of the deposits of Salina, which are on the east side of Onondaga lake, has been given by Fairchild[39] as follows: "The delta sand plain on which stands the city of Syracuse and the plains east and west of Onondaga lake were probably mostly laid in the early Iroquois waters, and at about 110 feet above the sea."

10 1883. *Minoa.* (E. primigenius). About 1883, during the construction of the West Shore Railroad, some remains of a mammoth were unearthed at Manlius Station (now Minoa). According to a statement of the late Prof. John D. Wilson of Syracuse, some bones, broken pieces of tusks and a molar were found. The bones were so fragile that none was collected, but the molar and portions of a tusk or tusks were obtained. The parts collected were obtained by Mr John Cunningham and are now in the geological department of Syracuse University and have been described by Dr Burnett Smith,[40] who writes:

The molar is of interest on account of its approach to that of the southern mammoth (Elephas columbi Falconer). In the number and character of its enamel ridges it undoubtedly presents some resemblance to the teeth of E. columbi but it is nevertheless probably referable to the northern form.[41] The tusk possesses a diameter of about 180 mm near the base, while the molar, which is from the left side of the lower jaw, measures 250 mm on a grinding surface which is incomplete through breakage.

The specimens indicate a large individual and it is indeed unfortunate that we have only meager records of its horizon and of the material in which it was found. Mr. Cunningham has assured the writer that the position of these remains was quite superficial. An inspection of the locality leads to the belief that the specimens could not have been unearthed much, if at all, above the 400 foot contour. A few fragments of vegetable matter are still adherent on the tusk but the unstained condition of all the specimens makes it unlikely that true peat was the inclosing deposit.

Both tusk and molar are now in a very friable condition but this, by itself, can hardly be advanced as a certain sign of great antiquity. We are dealing with an extinct animal, it is true, yet no evidence has so far appeared to prove indubitably its reference to any system of deposits differing materially in age from those which included the other mammalian remains considered in this paper.

From the above account it is evident that the remains did not come from a peat bog and so it is very probable that they were obtained from sand or gravel. The locality is just within the province of glacial Lake Iroquois and nearby are several earlier glacial channels,[42] indicating that the remains may have been found in deposits laid down by glacial waters.

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[39] Rochester Acad. Sci. Proc., 1919, 6:40.

[40] N. Y. State Mus. Bul. 171, 1914, p. 68.

[41] Dr O. P. Hay and Dr W. K. Gregory have both examined photographs of this specimen and have very generously given the author the benefit of their opinions on its specific position.

[42] N. Y. State Mus. Bul. 127, 1909, pl. 4 (pocket) and N. Y. State Geol. 21st Annual Rep't, 1903, pls. 8, 9.

Ontario County

11 1847. *Geneva.* (Species?) In the account of the Homer mammoth tooth by Samuel Woodworth,[43] Principal of Homer Academy, he states, "we possess a tooth or cast of a tooth of the elephant from Seneca lake near Geneva." As Geneva is on Seneca lake, the above tooth is undoubtedly the one referred to 11 years later by E. Emmons,[44] who states that "a tooth belonging to the elephant was taken from the beach upon Seneca lake, New York." The figure given by Emmons agrees with the Homer specimen, and as we have not seen the Geneva specimen or a figure of it we are unable to place it specifically.

Wayne County

12 1908. *Williamson.* (E. primigenius.) The mammoth tooth from the town of Williamson, in the museum of the University of Rochester, has been identified by Dr O. P. Hay as the lower left last molar. The tooth is practically complete and dark in color, having the appearance of having been found in swamp or muck material. The specimen was received at the museum about 1908. The town of Williamson lies northeast of Macedon, where mastodon teeth were found, and the higher and closing level of the Iroquois beach passes through the town in an east and west direction. Prof. H. L. Fairchild has informed the writers that the locality is northeast from the village of Williamson and that the tooth came from the province of glacial Lake Iroquois, a short distance north of the beach of this glacial lake.

13 1910. *Clyde.* (E. primigenius). During the construction of the state Barge canal, a tooth of a mammoth was found near Clyde in October 1910. The tooth was on exhibition for a short time in one of the store windows at Lyons and was presented to the Museum by William B. Landreth, deputy state engineer. A letter from B. F. Failing, resident engineer at Lyons, written shortly after the tooth was found, states, "The mammoth tooth was found while excavating for lock 26, Barge canal, 2½ miles east of Clyde, N. Y. It was found about 100 feet from the Clyde river and 22 feet underground in a layer of sand and clay, on top of gravel which

[43] Amer. Jour. of Agri. and Sci., 1847, 6:35.
[44] Rep't of North Carolina Geol. Sur., 1858, p. 200.

appears to have been the old river bottom." The elevation of the surface of these deposits are 400 feet, and as the tooth was obtained 22 feet below the surface it was found at an elevation of 378 feet.

These sand and gravel deposits, which are really to the southeast of Clyde, are of delta formation and were formed by the escaping waters of glacial Lake Dawson, which poured through the Fairport channel and built its delta near Clyde in the waters of glacial Lake Montezuma, an initial body of water, which later became a part of and belonged to the province of the larger glacial Lake Iroquois. The depth, the known character and the history of the deposits in which the Clyde specimen was found, stamp its age, the tooth having been imbedded during Lake Dawson time and while Lake Iroquois was still in its infancy, the latter lake at this time extending only over the Syracuse-Rome area.

The Clyde delta was formed by the same waters flowing from glacial Lake Dawson as were the glacial deposits in which the mastodon teeth were probably found at Macedon, 24 miles farther west from the mouth of this glacial river which terminated near Clyde. The Clyde delta is well shown on[45] Fairchild's maps as are also the deposits at Macedon and those at Perinton where mastodon remains were found.

14 1916. *Savannah.* (E. primigenius). The remains of this mammoth were dug from a gravel pit on the west side of a drumlin 1 mile northwest of Savannah. The parts recovered include two teeth, shoulder blade, fragments of the leg bones and foot bones. Fragments of a tusk were also observed but these were not collected. The drumlin is an isolated one upon which the waters of glacial Lake Iroquois built a spit in which the gravel bed was opened. The elevation of the gravel bed is about 30 feet above the surrounding marshes. The nearest drumlin is more than one-fourth of a mile away. Chadwick[46] states, "There is every reason to believe, nevertheless, that the bones were buried in these beach gravels by the waves themselves, and at the time when Lake Iroquois was at its full height. In no other way could they have become so interstratified with the beach shingle." The evidence presented gives us

[45] N. Y. State Mus. Bul. 127, 1909, pl. 3, and also Rochester Acad. Sci. 1919, Proc. v. 6, pls. 2, 3.

[46] More complete details of this find are given by Prof. G. H. Chadwick in N. Y. State Mus. Bul. 196, 1918, p. 44-46. The account is accompanied with detailed maps and sketches.

very clearly the geological time when the remains were embedded, but it does not tell us whether the mammoth was living in New York at that time or whether the remains belonged to an earlier period and were rafted to the drumlin frozen in the ice. The latter view appears the more plausible.

Warren County

15 1860. *Queensbury.* Since 1911, when the Holden collection was presented to the State, there has been in possession of the Museum a single molar (plate 18) of a mammoth from this county. The tooth had long been in the geological collection of Dr A. W. Holden of Glens Falls. The date of the finding of the tooth has not been definitely determined but it was probably sometime previous to 1860. In a letter from the late Dr J. A. Holden written in 1918, he states: "The tooth which during the days of my youth reposed carefully under a glass case in my father's office at Glens Falls, was found on the farm of one John Harris in Upper Queensbury, N. Y., during, as I now remember it although I will not be absolutely certain, an excavation for a well or cellar." Upper Queensbury is the northern part of Queensbury township, and borders Lake George at the lake's southern tip and for a few miles along its eastern shore.

Unfortunately we do not possess exact information concerning the character of the deposits or the depth at which the tooth was found. If the tooth was found in an excavation for a cellar or a well, it is quite evident that it was not obtained from a peat bog or swampy ground. If it was obtained from a cellar excavation, the depth at which it was found was probably less than 6 feet, but if found in a well excavation, it may have occurred at a much greater depth. The Queensbury mammoth tooth is of special interest on account of being the only proboscidian relic thus far found in northeastern New York. This tooth has been identified by Dr O. P. Hay as E. primigenius. It has thin enamel but in distance between ridge plates approaches *E. boreus* Hay = E. jeffersonii Osborn.

Both sides of the valley in which the Queensbury tooth was found are bordered by rather steep ridges of Precambrian gneisses of the southeastern Adirondacks, although the valley floor is made up of Ordovician rocks. The elevation of the valley does not rise much above 400 feet, and in its lower reaches it is near the level of Lake George, which has an elevation of 323 feet. This valley, which now has a northern drainage into Lake George, in Pleistocene time (Lakes Dawson and Iroquois age) was occupied by southward-flowing glacial waters derived from the melting Labradorian ice lobe, which projected into this region. These waters were carried over the present divide between Lake George and the Hudson river at Glens Falls and into the Hudson valley drainage. Above Albany the waters were met by the waters from the melting ice of western New York and beyond. After the establishment of the divide west of Little Falls, all the waters of glacial Lake Iroquois were carried north of the Adirondacks and into the Hudson river valley by way of the Champlain valley. At a still later time the region where the mammoth tooth was found was covered by the waters of the Gilbert gulf age, known as the Champlain sea which was at ocean level. Whether the mammoth tooth was buried in the deposits laid down by glacial waters or possibly in deposits in the later Gilbert gulf can not be definitely stated. In light of other mammoth finds in New York State, it seems more probable that the tooth was derived from glacial ice and buried in glacial deposits, but if it was derived from Gilbert gulf sediments, it stamps its age as more recent, and as the only trace of the mammoth found in the Champlain deposits. It is to be regretted that more definite details of this isolated find are lacking since with our present knowledge it is impossible to determine between the alternatives above given as to the age of the deposits in which the tooth was found imbedded.

In this connection it may be well to note that in Vermont,[47] in the township of Mount Holly, 45 miles east of Queensbury, some remains of a fossil elephant were found resting on a bed of gravel which was covered with 9 feet of muck. The place was close to the divide between the Champlain and Connecticut valleys, and at an elevation of 1360 feet, or nearly 1000 feet higher than the place where the Queensbury specimen was found. The Vermont specimen has been identified by Doctor Leidy[48] as E. americanus (E. primigenius). This find seems to show clearly that this animal was postglacial, but no such conclusive evidence has thus far been found in any of the New York records.

[47] Appendix to Thompson's Vermont, 1853, p. 14–15.
[48] Acad. Nat. Sci. Phil., Proc., 1885, 7:392.

Plate 18

The mammoth tooth from Queensbury, Warren county, N. Y.

OTHER MAMMALIAN REMAINS

Vulpes sp. **Fox**

W. C. Redfield[49] in a brief account of mammal remains from Broome county, New York, mentioned the discovery of bones which he ascribed to the genus Vulpes. They were said to have been found in clay beneath drift, on the Delaware-Susquehanna divide near the New York-Pennsylvania state line.

> In the autumn of 1848 . . . [W. C. Redfield] received from Major Brown, engineer in chief of the New York and Erie Railroad, the lower jaw and other bones of this mammal, partly inclosed in a matrix of fine clay, in which material the whole had evidently been embedded. These bones had been obtained by Mr Jonathan Case, in excavating for the line of railway at the Gulf Summit, in Broome county, N. Y., at a depth of 40 feet below the natural surface, at an elevation of 1375 feet above tide. The incumbent materials consisted, mainly, of gravelly clay and fragments of the native rock which belongs to the Hamilton group of the New York geologists, and are such as constitute the greater portion of the drift in that region.

The account states that a careful examination of the ground in the vicinity gave no evidence that the bones had been buried by a slide of surface materials; that the remains were of a true fossil character was further evidenced by finding in the incumbent materials, a fragment of Corniferous (Onondaga) limestone, the outcrop of which was 70 miles distant from the locality where the bones were discovered.

Ursus sp. **Fossil Bear**

Excavations at Monroe, Orange county, in 1901 for the purpose of recovering remains of a mastodon discovered first in 1888, brought to light the proximal half of a femur of a large bear comparable in size and conformation to that of a grizzly. Specific determination is impossible owing to the fragmentary condition of the remains, but the size of the bone excludes the possibility of its having belonged to the common black bear. It was found deep in the muck of the pond bottom associated with remains of a mastodon and a horse.[50]

Ursus americanius Pallas **Black Bear** (Plate 19)

W. M. Smallwood[51] reported briefly on the discovery in 1903 of the remains of five or more bears with bones of deer from the

[49] Amer. Assn. Adv. Sci., 1850, p. 255–56.
[50] Clarke and Matthew, Bul. Geol. Soc. Amer., 1920, 31:204.
[51] Science, n. s. 1903, 18:26–27.

vicinity of Onondaga lake. Smallwood was of the opinion that these remains were of comparatively recent origin but Burnett Smith[52] in giving an account of the same specimens expressed the belief that they were of considerable antiquity. Smith states, ". . . all the bones were secured during excavations which reached from the surface through the peaty layers into the marl below. The specimens were found immediately above the marl at a depth of about 10 feet. Even allowing for the sinking of heavy carcasses through soft material, one is justified in assuming a considerable antiquity for remains found in such deposits at that depth." Plate 19 is reproduced from Museum Bulletin 171.

The bones recovered consisted of "two skulls, three mandibles, two left mandibular rami, three left humeri, two right humeri, one left tibia, one right tibia and one right fibula."

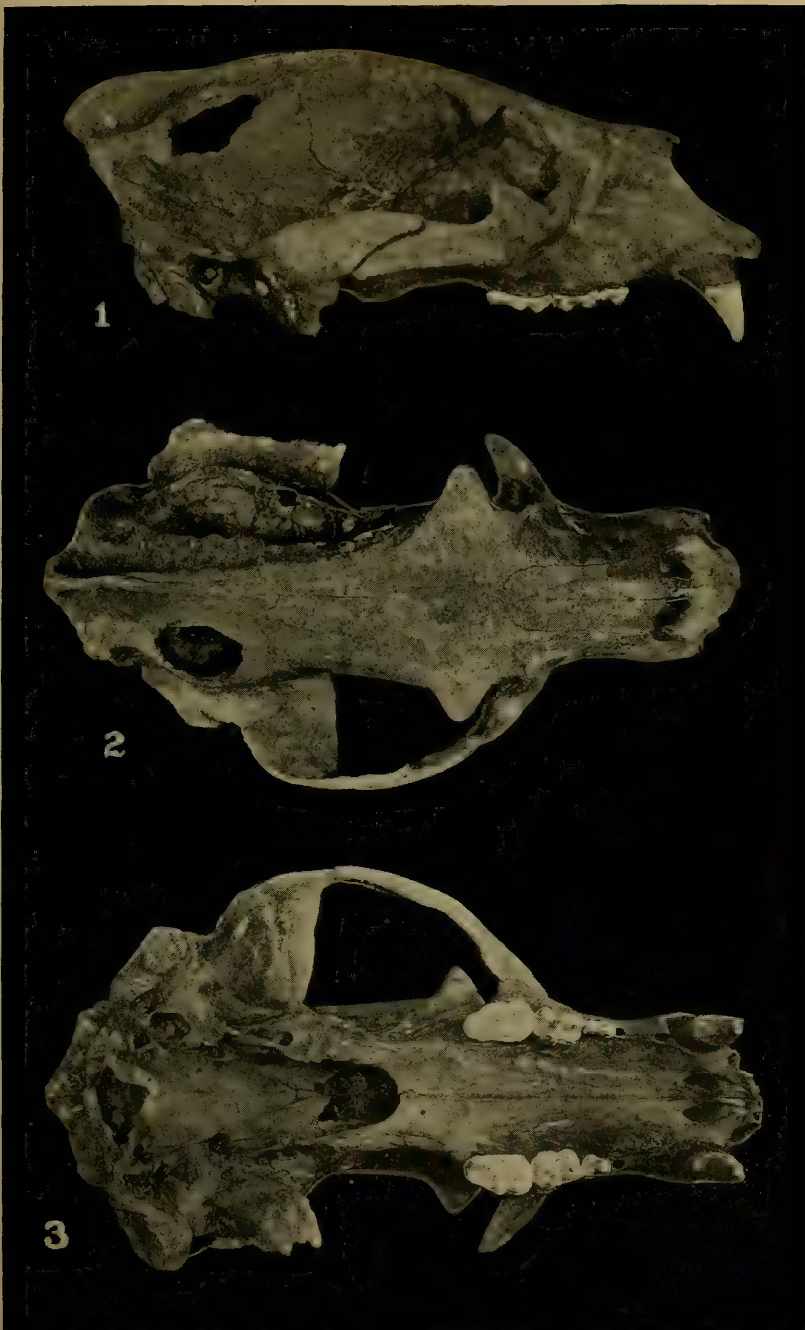
Cystophora cristata Erxleben **Seal**

"In 1901 the New York State Museum received from Dr D. S. Kellogg, Plattsburg, New York, the tibia of a seal which had been recovered in October of that year from the postglacial clays within the city limits. The bone was found at a depth of 11 feet below the surface during the construction of a sewer trench on Bailey avenue. The soil at this locality was said to consist of a layer of sand 4 or 5 feet thick overlying fine clay. Fossil marine shells, Macoma greenlandica (*Beck*), were abundant in the upper part of the layer of clay but none were found at the depth of the imbedded bone.

"The specimen has been examined by Mr Remington Kellogg of the Biological Survey and the following statements quoted from a recent letter will indicate its affinities. A young individual of Cystophora cristata (no. 14013, U. S. N. M.) from Newfoundland . . . shows a very close approach to the fossil tibia. The lower extremity is approximately the same, including the facet for the fibula. The curvature of shaft and angle formed by the suture for the epiphysis of head, same as in C. cristata. The shaft of the tibia of the fossil specimen is a little thicker in the median region than is the condition in C. cristata. Although similar in essential characteristics to the recent specimen with which it was compared, it is perhaps best, on account of the fragmentary condition of the remains, to record the bone as the left

[52] N. Y. State Mus. Bul. 171, 1914, p. 65, 2 pl.

Plate 19



Three views of cranium of black bear (*Ursus americanus*) from Ley creek, Onondaga Lake, near Syracuse, N. Y. (After Burnett Smith.)

tibia of a fossil phocid near Cystophora cristata *Erxleb.*"[53]

This fossil had its origin in the Pleistocene sea which overspread the area now occupied by Lake Champlain and the adjacent parts of New York and Vermont and is doubtless of the same age as the remains of the fossil cetacean unearthed in August 1849 on the Vermont side of the lake, 12 miles south of Burlington and about 1 mile east of the lake shore.[54]

Castoroides ohioensis Foster **Fossil Giant Beaver**

The remains of this giant rodent were first discovered in Ohio associated with the bones and teeth of *Mastodon, Elephas, Ovis* and other mammals. S. R. Hildreth[55] presented the earliest account of the species but failed to give it a name; this was later supplied by the geologist, J. W. Foster.[56]

In New York State remains have been found in two localities. The first were discovered (1845) in a swamp on the farm of Gen. W. H. Adams of Clyde, during the construction of a canal extending from Sodus bay, Lake Ontario, to the Erie canal about 1 mile west of the village. The well-preserved cranium is now in the New York State Museum (plates 20, 21).

The geological position of the fossil was fully discussed by James Hall,[57] who stated in part: "The situation in which it was found is an elevated plateau or level tract of land . . . the whole surface [of which] is covered by a peaty soil. . . . This elevated ground is the summit level, from which the waters flow in opposite directions, into Lake Ontario on the north, and into the Clyde river, and thence into Cayuga and Seneca lake outlets on the south. The precise locality of the fossil was near the termination of a shallow ravine, or the bed of a small stream, which flows into Lake Ontario, in a northeasterly direction."

A section at the locality presented the following characters from the top down:

"1st. Muck, or vegetable soil . . . 2 feet or more in thickness.

"2d. Fine sand, with occasional thin bands of clay, often consisting of alternating layers of sand, twigs, leaves and other fragments of vegetable matter; . . . 2 to 3 feet thick.

[53] S. C. Bishop, Jour. of Mammalogy, 1921, 2:170.
[54] Zadock Thompson, Amer. Jour. Sci., 2d ser., 1850, 9:257.
[55] Amer. Jour. Sci., 1837, 31:80–81, figs. 15–18.
[56] Geol. Surv. Ohio, 2d Annual Rep't, 1838, p. 80–81.
[57] Bost. Jour. Nat. Hist. 1846, 5:385–91, 3 pl.

"3d. Muck or peaty soil, . . . inclosing trunks of trees of large size, about 4 feet thick."

The cranium of Castoroides rested on a layer of fine sand 2 or 3 feet thick, beneath which occurred drift containing boulders and fragments of sand and limestones from a locality a few miles farther north.

Among the fragments of fossil wood, in the layer above that on which the cranium rested, were found pieces showing plainly the marks of beaver teeth but whether these were of the recent species or of Castoroides was not determined. The Rev. Benjamin Hale of Geneva, N. Y., from whom the specimen was received, stated in a letter dated November 1845, that specimens of charred wood and charcoal were also discovered in the layer above the cranium. An anatomical description of the specimen by Jeffries Wyman follows Hall's account in the same journal.

In Ohio, as before mentioned, and in Indiana, Louisiana and Tennessee, Castoroides bones were found mingled with those of mastodons, elephants and other animals. Mastodons or elephants have not been recorded from the precise localities of New York specimens of the giant beaver but they have been found in deposits of like character and at practically the same level. Remains of the recent beaver have also been found with those of the extinct one.[58]

An account of the discovery of a lower left incisor tooth of Castoroides in the town of Lenox, Madison county, has been given by Burnett Smith.[59] In this instance the tooth was embedded in a layer of bluish clay overlain by the following materials:

1. The surface materials consisting of about 2 feet of sandy soil and artificial fill.
2. About 6 inches of muck.
3. Marl, 2 to 6 inches.
4. One to 1½ feet of clay with peaty bands.

Castoroides is distinctly an American species with the general proportions of the recent beaver and bulk of the black bear. Its grinding teeth, however, resemble those of the South American Capybara (Hydrochoerus) and more remotely, those of Chinchilla.

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[58] Proc. Bost. Soc. Nat. Hist, 1848, 2:138.
[59] Amer. Jour. Sci. 1914, 38:463–66.

Giant beaver (*Castoroides ohioensis*). Side view of cranium from Clyde, N. Y.

Plate 21

Giant beaver (*Castoroides ohioensis*). Palatal view of cranium from Clyde, N. Y.

Platygonus compressus LeConte **Fossil Peccary**

An account of the first discovery of remains of Platygonus compressus is given by John L. Le Conte,[60] who described the species from portions of a skeleton found in the lead regions of Illinois. In New York State parts of four individuals have been found, two from a gravel bank a few miles from Rochester, the others from a gravel bed on the farm of James Russell near Gainesville, Wyoming county, in 1912.

The Rochester remains are in the possession of the Academy of Natural Sciences of Philadelphia and the following account is taken from that of Leidy:[61] "Recently the writer procured through purchase for the Academy of Nat. Sci. of Philadelphia . . . a collection of remarkably well-preserved remains of two adult individuals of Platygonus compressus which were found in making a railway excavation in a gravel bank a few miles from Rochester. Of one individual there is the greater part of the skeleton, consisting of the nearly perfect skull with the teeth . . . 21 vertebrae, the sacrum, the long bones of both pairs of limbs, the imperfect scapulae, an innominatum, and part of a second, both pairs of principal metacarpals, one pair of principal metatarsals, an astragalus, a calcaneum, portions of a sternum and fragments of three ribs. Of the second individual there is a less perfect skull with the upper teeth but without the mandible." The above account is also quoted by G. S. Miller.[62]

"The material from Gainesville belongs to two individuals, and consists of two skulls, remains of five ribs, five vertebrae, two scapulae, one left and one right, two metacarpals, one innominate, one ilium, one radius, and ulna and two tibias. Of the two skulls, one is complete; in the other the lower jaw is missing. The complete one belongs to an older individual, and the incomplete one to a younger, though grown specimen, which still has the temporary molar teeth" [63] (plates 22, 23).

The remains were purchased for the State Museum in 1914 from F. P. Barrett of Gainesville.

The position of the hill or drumlin from which the bones were obtained, is shown on the Portage topographic map by a small contour circle one-third of a mile northwest of Gainesville. The larger features of the hill are shown on the sketch map (plate 24).

[60] Amer. Jour. Sci., ser. 2, 1848, 5:102-3.
[61] Wagner Free Inst. of Phila., Tran. 1889, 2:41-50, pl. 8, fig. 1.
[62] N. Y. State Mus. Bul. 29, 1899, p. 372.
[63] Clarke, N. Y. State Mus. Bul. 187, 1916, p. 34.

At the gravel bed where the bones were found in a pocket of sand, besides sand and gravel, pebbles of all sizes occur up to 1 foot in diameter, those of 3 to 4 inches in diameter being most abundant. They include granite and granitic schist, Medina sandstone, Clinton limestone, Onondaga limestone and chert, some light colored quartzite, local Portage rock and some pieces of shale, usually concretion-like in shape, from which the outer shell readily scales off. A rock with small vertical fucoids is also found, probably " Calciferous " limestone. There is no indication of stratification or assortment by water, although the pebbles are often well rounded and water-worn.

The form of the hill is that of a drumlin, which may have been slightly modified by later glacial waters. The west and north slopes are the steepest with the highest point near the north end. The south slope is less steep than the north and the east is a gentle decline. To the south as far as East Koy creek the plain is almost level. This is not regarded as a lake bottom, although floods from melting glacial ice may have surrounded the hill and reworked some of the material which was redeposited as a sand and gravel bar at the south end of the hill. The present shape of the hill suggests that some modifications have taken place since it was built by the ice, and the presence of the sand pocket in which the bones were said to have been found, may be due to this modification, or more likely, a readvance of the ice built the major part of the drumlin above the deposit in which the bones had already become embedded. In other words the remains of the peccaries may be interglacial. The bones were buried to a depth of at least 10 feet and near the level of the plain. One letter received states that the " bones were found at a depth of perhaps 30 feet below the surface."

The peccaries are indigenous to America and have as relatives several living species which range from Texas through Mexico to Central and South America.

Odocoileus sp. **Deer**

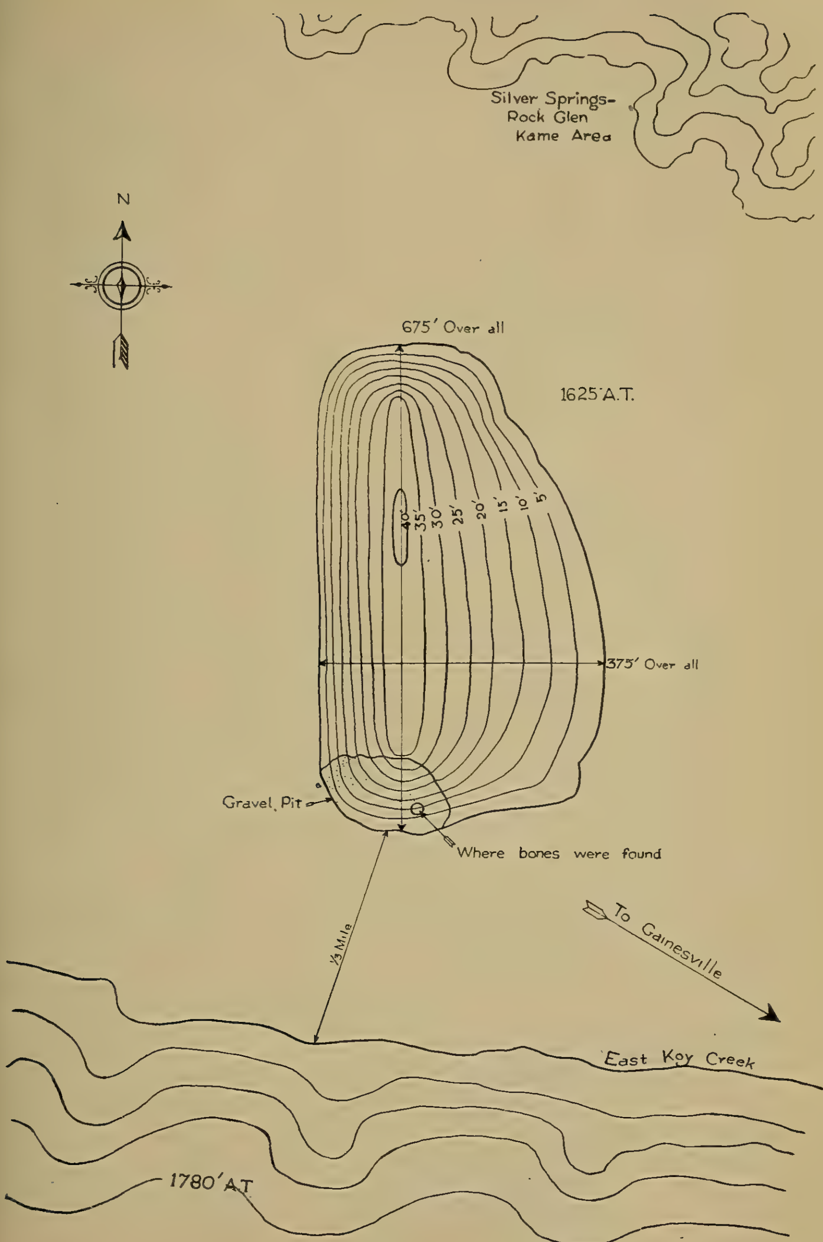
Remains of deer have been recovered from peat bogs, muck and marl deposits in many parts of the State, and while in some instances the situations have been such as to preclude the possibility of recent origin, in many cases the material has had every indication of being newly buried. The finds here recorded are regarded as being of true fossil character.

Cranium and lower jaw of peccary (*Platygonus compressus*) from Gainesville, N. Y.

Plate 23

Cranium of peccary (*Platygonus compressus*) from Gainesville. Found in same excavation as the one shown in preceding plate.

Plate 24



Sketch map of hill (drumlin) at Gainesville, N. Y., showing location of sand and gravel pit where remains of peccaries (*Platygonus*) were found.

A part of the upper jaw of a deer with the premolars and molars of one side well preserved, was recovered in 1908 from the muck of a swamp at Cedar Hill, Albany county. The specimen was found by J. H. Baumer in a position well below the present surface of the swamp and the condition of the bone and teeth give evidence of its being long interred.

"At Hinsdale, Cattaraugus county . . . some horns of deer, were found 16 feet beneath the surface, in gravel and sand."[64]

James Hall[65] in his account of Castoroides, mentions the finding of the jaw and teeth of a deer in a swamp, with the bones of a mastodon, in Greenville, Greene county; and in the same account (page 391) states that, "several deers' horns and the horn of an elk were found 12 feet below the surface, in a muck deposit" at New Hudson, 4 miles from Cuba, N. Y. Hall,[66] also records deer remains from Cattaraugus county, found in a sand and gravel deposit and associated with mastodon bones.

The antlers of two deer were found in marl at the cement plant at Caledonia in 1902. The antlers came into the plant with marl for the drier so that their exact position in the deposit is not known.

Remains of three or more individuals were found on the north side of Ley creek, east shore of Onondaga lake, and briefly described by W. M. Smallwood.[67] A more extended account was given by Burnett Smith[68]: "The bones were secured during excavations which reached from the surface through the peaty layers into the marl below. The specimens were found immediately above the marl at a depth of about 10 feet." Some of the specimens had shell particles adhering to them and perhaps came from the marl itself. The remains consisted of "two large humeri each accompanied by its corresponding radius and ulna, two small humeri, one metacarpus, six ribs, one lumbar vertebra, one thoracic vertebra and one atlas."

At another locality, Harbor brook, Syracuse, fragments of deer bones were discovered during sewer construction in 1912. "A sewer excavation in the Harbor Brook valley cut down through the swamp deposits to a depth of from 10 to 15 feet. The layers of different materials exhibited a variable and irregular structure but in general the normal sequence of such deposits could be observed. That is, a bluish clay occurred below, followed by marly bands which in

[64] Hall. Nat. Hist. N. Y., Geol., pt 4, 1843, p. 364.
[65] Bost. Jour. Nat Hist., 1846, 5:390.
[66] Nat. Hist. N. Y. Geol., pt 4, 1843, p. 366.
[67] Science, n. s. 1908, 18:26.
[68] N. Y. State Mus. Bul. 171, 1914, p. 65.

turn were overlaid by peaty layers." One left metacarpus, one right metacarpus and antler fragments with adhering particles of shells were found." Burnett Smith, ibid.

Mitchill[69] records the finding of fragments of two deers' horns a short distance below the surface of the ground in Stuyvesant street, New York city.

Cervus canadensis (Erxleben) **Elk**

Under the name Elaphus americans, "Fossil stag," DeKay[70] gave a description and measurements of "a portion of a pair of horns attached to a fragment of skull, dug up near the mouth of Raquet river in this State." Joseph Leidy,[71] in 1869, pointed out the identity of this specimen with the common elk and later, C. Hart Merriam[72] expressed the same opinion, basing his conclusion on the comparative measurements given by DeKay. A horn of the second year's growth from Grand Isle, Vermont, which was also referred by DeKay to his fossil species, has since been shown to belong to the elk.[73] A single tooth from Chautauqua county, mentioned and figured by DeKay and placed provisionally under this species, will be discussed under Cervalces.

Merriam (ibid) noted specimens of antlers from Steel's Corners, St Lawrence county, and two sections of horns, "ploughed up in an old beaver meadow in Diana, Lewis Co."

Hall[74] records the discovery of an elk horn in a muck deposit at the summit level of the Genesee Valley canal near New Hudson, 4 miles from Cuba, N. Y. These, with several deer's horns, were found at a depth of 12 feet below the surface.

In 1886, about two-thirds of the entire skeleton of an elk was taken from the muck of a swamp in the northern part of the town of Farmington, Ontario county.[75]

In the account of the mastodon from Seneca, Ontario county, mention is made of the discovery in 1885, of part of an antler of an elk at a depth of 3 feet below the surface and beneath a deposit of marl and diatomaceous earth.[76]

G. S. Miller, quoting from a letter of Dr Fred F. Drury, gives

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[69] Cat. Organic Remains, New York, 1826.
[70] DeKay, Nat. Hist. N. Y., Zool. pt 1, 1842, p. 120.
[71] Acad. Nat. Sci. Phil. Jour., 1869, 7:377.
[72] Mammals of Adirondacks, 1886, p. 144.
[73] Letter of G. H. Perkins, dated Jan. 17, 1898.
[74] Hall, Nat. Hist. N. Y., Geol. pt 4, 1843, p. 367.
[75] Clarke, 6th Annual Rep't, State Geol. N. Y. 1887, p. 39.
[76] N. Y. State Mus. Bul. 69, 1903, p. 931.

an account of a pair of elk horns dug up on a farm about 4 miles from Gouverneur, St Lawrence county, in 1898. " They were accidentally discovered while digging out a spring hole in a pasture to provide water for cattle during the dry season. One horn is in perfect state of preservation, the other has been influenced somewhat by exposure, but not enough to in any way destroy the symmetry. The perfect one measures from root to tip 39 inches, and biggest circumference 8¼ inches. They each have five prongs, and when placed in approximate apposition have at widest point a spread of 34 inches opposite biggest prong." [77]

A single horn dug from a bog at Cananderago, Otsego county, is recorded by Mitchill.[78]

In the muck, above the clay in which the Attica, Wyoming county, mastodon remains were resting, the ankle bones of a large ruminant, probably an elk, were found in 1887.[79]

Near the outlet of Cassadaga lake, Chautauqua county, about 20 miles south of Dunkirk, a skeleton of an elk was found in marl overlaid by muck. The exact circumstances of the discovery are not known but the bones were found sometime before 1907 and were for a time in the possession of Mr Obed Edson.

The basal portions of a pair of large shed antlers from a swamp near Beekmantown Corners, Clinton county, were found by Joseph Ouimette in 1887 and recently loaned to the State Museum for study by Prof. George H. Hudson of Plattsburg. These horns give no indication of having been water-worn and the tines, except one, are roughly broken at the tips. An interesting abnormality, evidently the result of fracture while in the velvet, is presented in one of the brow tines which is almost twice the diameter of the corresponding member.

These horns may be regarded as fossil only in the sense that they were dug from the ground and belonged to animals now extinct within the State. It is likely that they were dropped where found within the last century.

Rangifer sp. **Caribou**

The earliest notice of the discovery of remains of caribou in New York that has come to our attention, is given in an article by Ebenezer Emmons, entitled "The Lost Races." [80] After a dissertation

[77] N. Y. State Mus. Bul. 29, 1899, p. 302.
[78] Mitchill, Cat. Organic Remains, N. Y. 1826.
[79] Clarke, N. Y. State Mus. 41st Annual Rep't, 1888, p. 389.
[80] Amer. Jour. of Agr. and Sci., 1845, 2:201.

of some length on the extermination of animals in general, the writer continues: "We have been led into the foregoing train of thought, by the discovery of the remains of a species of deer in the freshwater marl beds of Orange and Greene counties in this State. We first obtained the jaw of this extinct species from a marl pit of Mr. Stewart in the latter county, and afterwards one of the horns from a similar pit in Scotchtown in Orange. This deer was about the size of the reindeer of the north, and like that animal, was provided with a flattened (though more slender) horn; but it differs specifically from the reindeer, in the possession of two brow antlers instead of one, on a single shaft, and quite near its base. No other bones have yet been found, and hence the height and bulk of the animal have not been accurately determined; but that in this country the genus Cervus contained a species which is now extinct, is by this discovery placed beyond a doubt." The antlers found were probably those of the barren ground species, Rangifer arcticus (Richardson).

The deciduous horns of all the deer family are subject to great individual variation due in part to the age and condition of the animal during the period of growth of the horns and, to a less extent, caused by injuries received while in the velvet. The anomalous development of two brow tines on a single shaft has therefore no more significance than other abnormalities of like character and could scarcely be considered sufficient grounds for the erection of a species.[81]

An account of the finding of an antler of a caribou at Sing Sing is given in the Proceedings of the Academy of Natural Sciences of Philadelphia for 1860, 11:194 under the date of August 23d. It is as follows: "Dr Leidy read a letter from Dr G. J. Fisher, dated at Sing Sing, N. Y., giving an account of an antler of the reindeer, which had been found in the vicinity of the place mentioned. The specimen was discovered in excavating a peat bed, at a depth of 6 feet from the surface. The peat bed is almost an acre in extent, surrounded by high ground, and looks as if it had been the site of an ancient lake. Dr Leidy observed that there is a similar specimen of an antler of the reindeer in the museum of the academy which had been found near Vincentown, New Jersey, at a depth of 4 feet. . . ."

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[81] Rep't North Carolina Geol. Surv., 1858, p. 200.

Alces americanus Jardine **Moose**

Bones of the moose were recovered from a buried pothole of the greater Mohawk channel near West Waterford in December 1909 and deposited in the State Museum. The exact locality of this pothole, one of twenty-five or thirty encountered during excavation of the barge canal between locks 5 and 6, is recorded on blue-prints at the State Engineer's office, at a point 200 feet east of the end of lock 6 between guide piers 19 and 24. Two to 4 feet of soil and residual clay cover the rock surface at this point.

The largest of the potholes measured 16 by 20 feet at the surface and was excavated to a depth of 14 feet. At this point the bones were recovered and with them cones of the white spruce (*Picea canadensis*), Sphagnum moss, pieces of wood and shells belonging to the genus *Planorbis*. This find was recorded by Clarke,[82] who regarded the potholes as being similar in origin and date to those on the Mohawk at Cohoes in one of which the Cohoes mastodon was found.

The bones recovered consist of the entire set of cervical and six dorsal vertebrae and portions of six ribs of one side; their occurrence in the pothole presupposes deposition in the flesh or at least while held together by ligaments; other bones, fragments of ribs about a foot long, were said to have been found in several of the potholes excavated.

Cervalces scotti? Lydekker

Remains that can be positively assigned to this species have not been recorded from New York localities. Emmons,[83] however, described a tooth from a clay deposit in Chautauqua county, that may belong here. DeKay[84] figured this tooth and gave an account under his discussion of the "fossil stag," *Elaphus americanus*. The figure and measurements given by DeKay indicate a tooth somewhat larger than the corresponding member of a large bull elk, and differing otherwise in the absence of the column which, in the tooth of the elk, is usually well developed between the two lobes on the inner side.

References to the literature of *Cervalces* in O. P. Hay's catalogue[85] include DeKay's *Elaphus* (in part) and doubtless refer to this tooth.

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[82] N. Y. State Mus. Bul. 140, 1909, p. 46.
[83] Rep't on the Quadrupeds of Mass. 1840, p. 82–83.
[84] Nat. Hist. N. Y., Zool. pt 1, 1842, p. 120–21, pl. 29, fig. 1.
[85] U. S. Geol. Surv. Bul. 179, 1902, p. 685.

The fourth edition of Dana's Manual of Geology[86] describes and figures the almost complete skeleton of Cervalces found in New Jersey, but incorrectly records the specimen from Warren county, New York.

Bison bison (Linnaeus) **American bison**

J. A. Allen[87] carefully examined the historical evidence of the former occurrence of the bison in northeastern North America and stated that he " failed to find a single mention of the occurrence of this animal within the present limits of New York, New England, Canada . . . that will bear a critical examination." Allen also pointed out that bison remains had not been found in the Indian shell-mounds of the Atlantic coast. The statement quoted is somewhat modified in a later paragraph by the remark that there was fair evidence of the buffalo having ranged as far east as western New York. Several earlier writers asserted, apparently without a careful examination of the evidence, that bison were formerly to be found along the entire Atlantic seaboard from New York to Florida. Although the historical accounts are, at best, misleading and indefinite, the more recent discovery of remains of bison in postglacial deposits and in the graves and refuse pits of the Indians prove conclusively that the former range of this animal extended not only to western New York but occasionally through the central counties to the Hudson river.

As early as 1835 mention is made of fossil teeth and bones found 10 feet below the surface, in muck overlaid with gravel, at Jamestown near the outlet of Chautauqua lake. The teeth were submitted to Professor Knight of Yale who identified them as probably belonging to the buffalo; and his conclusion is substantiated by the measurements and descriptions given, and by the fact that they were too deeply buried to belong to a domestic animal.[88]

A brief notice of the discovery of a bison skull at Syracuse was given by Underwood.[89] It was said to have been found at a depth of 10 feet below the surface of the ground at the junction of deposits of black swamp muck and clay. Burnett Smith,[90] referring to this specimen (plate 25) and quoting its owner, Mr John Cunningham of Syracuse, " Places the depth at 17 feet and the position

[86] Manual of Geol., 4th ed., 1895, p. 999.
[87] Mem. Mus. Comp. Zool., 1876, 4:1–246.
[88] Amer. Jour. Sci., 1835, 27:167–68.
[89] Amer. Nat., 1890, 24:953–54.
[90] N. Y. State Mus. Bul. 171, 1914, p. 67–68.

Buffalo (*Bison bison*) skull from Syracuse, N. Y. Views at right show horn-cores without horns. (After Burnett Smith.)

as below the muck, and adds that fragments of shells were found adhering to the horn cores."

Smith (ibid) also quotes part of the story related by Thomas Ashe[91] as evidence of the former abundance of the bison at Syracuse. Ashe says, in part: "The native animals of the country too, as the buffalo, elk, deer etc. are well known to pay periodical visits to saline springs and lakes, bathing and washing in them, and drinking the water till they are hardly able to remove from the vicinity. The best roads to the Onondaga from all parts, are the buffalo tracks; so called from having been observed to be made by the buffalos in their annual visitations to the lake from their pasture grounds." But as Allen (ibid) has pointed out, the region about Onondaga was well known as early as 1670, and settlements made and a fort erected prior to 1705. Had the buffalo been a periodical visitor to that region in the numbers stated by Ashe, they could have hardly escaped the attention of the earlier writers. That bison formerly visited the central and even eastern New York can not be doubted but they were probably small companies outside their normal range.

Concerning three teeth of the bison found near Albany, N. Y., J. M. Clarke[92] remarked: "Some teeth obtained in the postglacial clays of the Hudson valley a few miles below Albany, in deposits commonly regarded as laid down during that stage of the Mohawk drainage of the Great Lakes, termed Lake Albany, have been identified by Dr O. P. Hay as those of the bison. Although entirely exact data concerning the date and location of this discovery are wanting, these teeth have come into the museum within the writer's recollection and have been kept in association with a series of other mammal relics from this vicinity." These teeth are the second and third left upper molars and the second right lower molar. When compared with teeth of the recent bison they exhibit no marked difference except in size, the fossil specimens being somewhat larger.

Interesting as evidence of the former wide distribution of the bison in New York, but of less importance to the paleontologist, are the remains found in graves and refuse pits of the Indians. Bryant[93] records the discovery of a perfect skull on an Erie Indian village site, on Cattaraugus creek, 7 miles from Lake Erie. The skull was that of a female and buried to a depth of 2 feet. A portion of the upper jaw of a bison was taken from an Indian grave

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[91] Travels in America, London, 1809, p. 39–41.
[92] N. Y. State Mus. Bul. 140, p. 46, 1910.
[93] Interesting Archeological Studies in and about Buffalo. Buffalo, N. Y. 1890.

at Irving, N. Y., in 1914 and brought to the State Museum by the collector, E. R. Burmaster. The fragment was identified by W. D. Matthew of the American Museum who said it belonged to an old individual whose teeth were worn down to the roots and whose premolars had dropped during life. The bone gives no indication of having been used as an implement and it may be inferred that the animal was killed in the vicinity. In August 1919, bison bones were found by Alanson Skinner in the ash-beds of a prehistoric Onondaga village site near Watertown in Jefferson county. The remains in this case consisted of hoof and toe bones and some teeth.

Equus sp. **Horse**

It has not been generally conceded that a native species of Equus persisted in eastern North America after the last (Wisconsin) glaciation. Attention has been directed, however, to the discovery of fragments of horse bones associated with remains of the mastodon and a large bear, in a postglacial peat bog, at Monroe, Orange county, in 1901.[94] The bones recovered consist of the right ramus of the lower mandible containing four teeth, and the right femur. They were found buried in the muck of the pond bottom and their state of preservation indicates that they are of the same age as the mastodon.

W. B. Marshall,[95] in a report on a deposit of peat and marl in the town of New Baltimore, Greene county, mentions the finding of supposedly fossil horse teeth and states the circumstances as follows: "In the collections of the State Museum are nine teeth of a fossil horse which were found in 1889 by Mr Bronk Van Slyke, embedded in the peat in the southern lot. Dr Charles E. Beecher, of Yale University, has identified them with Equus fraternus Leidy." No horse teeth have been found in the collections of the State Museum which are distinguishable from Equus caballus although this circumstance alone does not prove them to be recent. Many horse teeth which are unquestionably early Pleistocene, do not differ materially from those of the recent horse, and their specific determination when the teeth alone are found, is often impossible.

In 1902, Mr Bronk Van Slyke sent to the New York State Museum remains that are recorded as belonging to a supposed Quaternary horse. The catalogue record of the specimens states that

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[94] Clarke and Matthew, Bul. Geol. Soc. Amer., 1920, 31:204.
[95] N. Y. State Mus. 45th Annual Rep't 1891, p. 46–52.

they were found in the peat of a swamp at Aquetuck, Albany county, July 16, 1902. The single tooth in the collection of the State Museum which can be referred to this locality, can not be distinguished from Equus caballus and although discolored does not appear to have undergone any other change.[96]

Teeth of a horse from Troy, N. Y., which were regarded as fossil, were presented to the New York State Cabinet of Natural History[97] in 1859 and mentioned in the report for that year and in the Proceedings of the Boston Society of Natural History for 1859, 6:303-4. There is no account of the circumstances of the discovery nor are the specimens to be found in the museum's collections.

C. Hart Merriam[98] in his account of the Adirondack mammals, mentions a fossil horse under the name Equus major. "It is also worthy of remark that wild horses, larger than our domesticated stock, once roamed the borders of this region. Dr C. C. Benton, of Ogdensburg, has shown me several fossil molar teeth of Equus major that were exhumed at Keenes Station near the Oswegatchie Ox Bow in Jefferson county. I have compared them with the corresponding teeth in an immense dray-horse, and find them much larger." DeKay (ibid) applied the name, Equus major to remains of a horse found near Neversink Hills in New Jersey but as Gidley[99] has pointed out, the name is practically a *nomen nudum* as no figures or measurements were given and the original specimens lost.

In the absence of more conclusive evidence than is offered by the records presented above, the conservative view is to regard the existence of a late Pleistocene horse in New York as yet unproved.

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[96] N. Y. State Mus., 56th Annual Rep't 1904, p. r. 158.
[97] N. Y. State Cab. Nat. Hist., 12th Annual Rep't 1859, p. 109.
[98] The Mammals of the Adirondack Region, 1886, p. 145.
[99] Amer. Mus. Nat. Hist. Bul. 1906, 14:91–141.

ADDENDA

The following records, received too late to be incorporated in the body of the report, have been taken from Dr O. P. Hay's account of " The Pleistocene of North America, and Its Vertebrated Animals from the States East of the Mississippi River and from the Canadian Provinces East of Longitude 95°," published February 1923, by the Carnegie Institution of Washington. Publication No. 322.

Page 63. *Mastodon:* Erie county. A tooth found near the mouth of Buffalo creek, and recorded by Barton (Phil. Med. & Phys. Jour. v. 2, 1806, p. 157) is believed by Hay to belong to a mastodon.

Page 62. *Mastodon:* Niagara county. "At the museum of Davis Brothers, at Niagara Falls, Mr B. U. Davis told the writer that he owned two mastodon teeth which had been found in digging for the foundations of the Tower Hotel, which faces the Falls park." On later personal inquiry these specimens were not to be found.

Page 52. *Mastodon:* Orange county. " Dr F. A. Lucas, of the American Museum of Natural History, New York, stated in 1902 (Sci., 16: 169) that there is in Vassar College a skeleton of a mastodon which is supposed to have been found at Newburgh." The mastodon at Vassar was mounted by Messrs A. P. Wilbur and E. H. Eaton. Professor Eaton informs the writers that most of this skeleton came from Circleville, Ohio; 1 femur and one-half of the pelvis from Indiana, and the tusks from southern Ontario.

Page 55. *Mastodon:* Ulster county. " In Rutgers College, New Brunswick, New Jersey, the writer has seen a tusk about 10 feet long, with a considerably spiral form, which is said to have been found at Ellenville. It may, however, be the tusk of an elephant."

Page 236. *Cervus canadensis:* " Livingston county. In the collection at Princeton University is a calvarium of an elk labeled as found in Livingston county. The finder had, with a tool, chopped off the antlers and otherwise hacked the skull. One can not be certain as to the geological age of the specimen."

Page 183. *Equus:* A brief account of a horse tooth said to have been found 18 feet below the surface at Fort Schuyler, Throg's Neck, New York, is given by Charles Whittlesey in Smithson. Contr. Knowl. 1866, Art. 3, 15:16. The tooth came from a deposit described as, " compact marine drift."

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New York State Museum Bulletin

Entered as second-class matter November 27, 1915 at the Post Office at Albany, N. Y., under the act of August 24, 1912. Acceptance for mailing at special rate of postage provided for in section 1103, act of October 3, 1917, authorized July 19, 1918

Published monthly by The University of the State of New York

Nos. 243-244 ALBANY, N. Y. MARCH-APRIL 1921

The University of the State of New York

New York State Museum

JOHN M. CLARKE, *Director*

HOMER D. HOUSE, *State Botanist*

REPORT OF THE STATE BOTANIST FOR 1921

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THE UNIVERSITY OF THE STATE OF NEW YORK

1923

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REPORT OF THE STATE BOTANIST FOR 1921

Scientific investigations. The investigative work of the State Botanist has been largely devoted to a study of the native vegetation, and its ecological relations, in several localities. The three principal localities selected for these studies are the eastern end of Lake Ontario, the region around Oneida lake in central New York, and the township of Newcomb in the Adirondack mountains. At the latter locality it is proposed to continue the study of the vegetation of this area as a supplement to the "Plants of North Elba," by the late Doctor Peck, published as Bulletin 28. North Elba is located northeast of Newcomb and separated from it by Mount Marcy, Mount McIntyre and other high mountains. The distance between the two sections is not great, but Newcomb is drained largely by the Hudson river, while North Elba is drained by the Ausable and Saranac rivers, and hence lies north of the divide between the Atlantic (Hudson) and St Lawrence basins. While both sections possess in general the typical Adirondack vegetation there are many minor differences in the character of plant life which will be more fully elaborated through future investigations.

The eastern shore of Lake Ontario is characterized chiefly by the numerous sand bars and sand dunes which separate the lake proper from many partially inclosed shallow bays. These bays are largely bordered by extensive marshes which with the bays afford an unusually rich flora of marsh and water-loving plants.

A report has already been made upon the vegetation of the eastern end of Oneida lake. Investigations there are directed mainly toward the working out of a more exact knowledge of the ecological relations of the plant life of that region.

In all the areas studied extensive collections were made for the purpose of record in the state herbarium. Considerable time has been spent in the study of various groups of small fungi, both parasitic and saprophytic. The large number of plants submitted to this office for information regarding the control of such diseases makes it imperative that as much time as is available be spent upon such investigations.

While routine matters occupy much time, opportunity was found to prepare a numbered check list of the ferns and flowering plants of the State, which may serve as a basis for a more complete flora of the State to be published at some future time.

Investigations upon the flora of New York State during the past few years have involved not only the necessary field work, and study of herbarium material, but have also necessitated a careful review of all the literature dealing with the botany of the State either wholly or in part.

Largely as a matter of curiosity, and partly because it has been suggested in certain quarters that the field of natural history research in this State was an "unoccupied field," the Botanist has brought together a brief summary of the work in botany which has been done in this State since the earliest available record. The total number of pages of printed matter on the plant life of the State is doubtless a poor indication of the relative value of such pages, but for lack of a more precise method of comparison it may serve as a sort of indicator as to the relative amount of such work performed by the State Museum.

The total number of pages of printed matter on the flora of New York State, since the beginning of the nineteenth century, to January 1920 (excluding experiment station bulletins and forestry reports, where such are not exclusively botanical), is 10845

(Approximately 200 authors)

The total number of pages of printed matter on the flora of New York State, printed under the auspices of the Regents, and later as publications of the New York State Museum, to January 1920, is 5265

These are distributed as follows:

a Annual Reports, State Botanist, 1867 (1871) to 1917 (1920), exclusive of pages of wholly extralimital matter, but including contributions on botany of the State by others than the State Botanist, pages, 3851

b Other bulletins on the botany of the State by the State Botanist, pages, 195

c Botanical papers in the Regents Reports, prior to 1870, by others than the official State Botanist, including Torrey's Flora of the State (part 2, of the Natural History Survey of New York, 1843), and Peck's Memoir 4, on Fungi, pages, 1676

d Botanical articles by Peck on the state flora published in reports other than those of this Department, pages, 133

e Wild Flowers of New York, pages, 323

It will be seen from this inadequate summary that the Regents and the State Education Department have had the supervision of the publication of 48.5 per cent of all the botanical literature dealing with the botany and plant life of the State.

It is also worth noting that nearly 39 per cent of all this literature was produced by one man, the late Doctor Peck, former State Botanist, between 1867 and 1912, with less than 5 per cent of contributed matter and with the aid of an assistant during only a few years.

This brief review does not take into account any comparison of illustrations or plates, although the record indicates that over 80 per cent of the plates, illustrative of the plant life of the State, have been published under the supervision of the Regents and the State Education Department.

Investigations of a cooperative nature have been carried on with Prof. John Dearness of London, Canada, upon certain parasitic and saprophytic forms of fungi. The results of these investigations are presented in another part of this report as a joint paper. Extensive collections of seed of the evening primrose (Oenothera biennis L.) were secured from several sections of the State and submitted to Dr H. H. Bartlett, director of the botanic gardens, University of Michigan, where the seeds are being grown and a study made of the various mutants which may result.

Noteworthy contributions. The chief additions to the state herbarium during the year in the form of contributions and exchanges, are presented in the following list of contributors, which indicates the number of specimens received from each.

The most important contribution was the herbarium of the late F. E. Fenno, of Earlville, donated by Mrs Fenno, acknowledged in the preceding report, but only arranged and added to the herbarium during the past year. Mr Fenno had for many years, in addition to his duties as a teacher and school principal in the schools of this State, devoted much of his spare time to the study of botany, and has contributed valuable papers for publication upon the plant life of the Upper Susquehanna valley (State Museum Bulletins 67, 75, and 217–218). His untimely death by drowning early in 1920 is a distinct loss to the large group of amateur botanists in this State.

Contributions to the State Herbarium

New York Botanical Garden (exchange)	415
Ira Clokey, State Museum, Denver, Col. (exchange)	354
J. C. Nelson, Salem, Ore. (exchange)	310
Percy Wilson, New York, (exchange)	180
J. M. Grant, Langeley, Wash. (exchange)	100
Miss Helen LaForce, Deland, Fla	80
M. S. Baxter, Rochester	76
Dr A. H. W. Povah, Syracuse (exchange)	55

Mrs D. E. House, Pasadena, Cal	55
Dr James S. Wier, Spokane, Wash. (exchange)	32
Dr Anne E. Perkins, Collins	20
Gray Herbarium, Harvard University (exchange)	14
Dr H. M. Denslow, New York	10
Dr David Sumstine, Pittsburgh, Pa	8
Roy G. Pierce, Washington, D. C	7
Dr H. S. Jackson, Lafayette, Ind	5
Dr Emmaline Moore, Conservation Commission	4
Mrs Orra Parker Phelps, Wilton	4
Dr J. J. Davis, Madison, Wis	3
Bureau of Plant Industry, Washington, D. C	2
Mable Martin, Broadalbin; Charlotte Borgardus, Coxsackie; C. E. Chandon, Ithaca; Dr E. P. Felt, Albany; Dr G. G. Atwood, Albany; Dr L. O. Overholts, State College, Pa.; Florence Beckwith, Rochester; Dr W. A. Murrill, New York, one each	8
Total	1742

The total number of specimens which have been added to the state herbarium from all sources is 2542, of which 1742 were received either in exchange or as contributions, as indicated above. The other 800 specimens were collected by the State Botanist in the following counties:

Albany	Madison	Saratoga
Essex	Oneida	Ulster
Greene	Oswego	Warren
Jefferson	Rensselaer	Onondaga
Lewis		

In addition to the 1070 specimens reserved from the current collections for the state herbarium, approximately 1600 specimens were collected to be used in exchange with other institutions.

Identifications. The State Botanist's office has been called upon to identify 395 specimens of plants, including many edible and poisonous kinds of mushrooms and various parasitic or disease-causing fungi. These identifications were asked for by 155 different persons. This is a marked increase over the plant identification service rendered during the preceding year (1920), when 260 specimens were identified for 140 different persons.

Chestnut blight (Endothia parasitica). During 1921 observations were made at various localities on the spread and extent of the chestnut blight. Northward the disease has spread to the northern limits of the distribution of the host in Rensselaer, Albany and Saratoga counties, although owing to the scattered distribution of the chestnut northward, not all the trees are as yet infected. In the lower Mohawk valley, owing to the scattered distribution of the host tree, the disease is as yet somewhat sporadic. While there is a rather thin and uneven natural distribution of the chestnut up the Mohawk valley and on over into the Ontario lowlands where it becomes common, the chestnut blight apparently has not as yet penetrated to this region.

In the Hudson valley and the foothills of the Catskill mountains the destruction of the chestnut has been most complete. Practically all chestnut trees have been killed at least in part. Most of the diseased trees sprout again from the trunk or around the base of the trunk. These shoots live a year or two, sometimes longer, and are in turn infected by the disease and die. This persistency of sprout growth on the blight-killed chestnut causes a constant recurrence of the disease and renders distant and perhaps hopeless a time when, the disease having run its course, new chestnut trees may be planted.

In most sections where any care is taken of the woodlands the dead chestnut trees are cut down and used for timber or firewood. In consequence there is left in the woods a large void, since in many places the forests and woodlands formerly contained from 15 to 20 per cent of chestnut, especially below 1000 feet altitude.

Other trees have not been slow to take advantage of this change and almost everywhere there is a vigorous growth of young oaks (white, chestnut, red, scarlet and black). Left to nature the forests of this region in the future will be quite unlike those of former days.

Some owners are planting white pine where the chestnut has been killed and removed, which would be an excellent idea if we could be sure that it in turn would not fall a prey to the white pine blister rust. There is an abundance of wild gooseberry and currant in this region to act as alternate hosts for the white pine blister rust.

Scotch pine is apt to prove a more acceptable conifer for planting in the region, and has many points of excellence to recommend its use. It is free from any serious rust similar to that of the white pine, it is less sensitive to ground fires which are numerous and very destructive to white pine in the Hudson valley and Catskill region and it will produce a better growth in mixtures with the hardwoods than will white pine.

Lectures. During 1921 the State Botanist has delivered twelve lectures upon wild flowers and wild flower protection in various parts of the State.

Publications. The following articles on botany have been published by the State Botanist, in journals devoted chiefly to botany:

The Genus Aetopteron, Ehrhart. American Fern Journal, 10: 88–89. 1920

A Consideration of Certain Genera Proposed by Ehrhart. American Midland Naturalist, 6: 200–7. 1920

The Wild Flower Preservation Idea is one of Practical Value. Torreya, 21: 17–22. 1921

Conservation of Wild Flowers. Conservationist, 3: 119–21. 1920

Nomenclatorial Notes on Certain American Plants. I. American Midland Naturalist, 7: 126–35. 1921

Florida plants collected by Miss LaForce. During the winter months of 1920–21, Helen LaForce, temporary assistant in the Botanist's office, made a small collection of plants chiefly in the vicinity of Deland, Fla. This collection was limited by the time available for the work and by the fact that most of the specimens had to be gathered during a short period in the early spring of 1921. About 80 specimens were made and of them the following have been incorporated into the state herbarium:

Aster concolor *L.*
Berlandiera pumila (*Michx.*) *Nutt.*
Bradburya virginiana (*L.*) *Kuntze*
Cassia fasciculata *Michx.*
" nictitans *L.*
Chrysopsis graminifolia (*Michx.*) *Nutt.*
Commelina communis *L.*
Cuthbertia rosea (*Vent.*) *Small*
Clitoria mariana *L.*
Cracca purpurea *L.*
Eupatorium mikanioides *Chapm.*
Eriogonum tomentosum *Michx.*
Gerardia divaricata *Chapm.*
" tenuifolia *L.*
" fasciculata *Ell.*
Gelsemium sempervirens (*L.*) *Ait. f.*
Leptilon canadense (*L.*) *Britton*
Lespedeza virginica (*L.*) *Britton*
" repens (*L.*) *Barton*
Lacinaria Smallii *Britton*
" elegans (*Walt.*) *Kuntze*
" pauciflora (*Pursh*) *Kuntze*
Lobelia glandulosa *Walt.*
Lygodesmia aphylla (*Nutt.*) *DC.*
Petalostemon corymbosus *Michx.*
Polygonella gracilis (*Nutt.*) *Meissn.*
" polygama (*Vent.*) *A. Gray*
Polygala grandiflora *Walt.*
Phlox floridana *Benth.*
Pieris nitida (*Bartr.*) *B. & H.*
Pinguicula edatior *Michx.*
" lutea *Walt.*
" pumila *Michx.*
Piaropus crassipes (*Mart.*) *Britton*
Rhexia alifanus *Walt.*
Raimannia humifusa (*Nutt.*) *Rose*
Rhynchosia simplicifolia (*Walt.*) *Wood*
Ruellia humilis *Nutt.*
Solanum carolinense *L.*
Syngonanthus flavidulus (*Michx.*) *Ruhl*
Trilisa paniculata (*Walt.*) *Cass.*
Trichostema dichotoma *L.*
Tradescantia reflexa *Raf.*
Verbena carolinensis (*Walt.*) *J. F. Gmel.*

PLANTS NEW TO THE STATE HERBARIUM

A Ferns and Flowering Plants

A number of the plants here reported for the first time have not been collected during 1921, but the description or the reports of them have not been previously published.

Actaea alba f. rubrocarpa *Killip*
Agastache Foeniculum (*Pursh*) *Kuntze*
" urticifolia (*Benth.*) *Kuntze*
Aquilegia canadensis f. albiflora *House*
Anemone virginiana f. rubrosepala *House*
Arabis viridis *Harger*
Aster linariifolius f. lateralis *House*
" " f. monocephalus *House*
Aster novae-angliae f. geneseensis *House*
" " f. rosarius *House*
" Pringlei (*Gray*) *Britton*
Betula coerulea *Blanchard*
Blephariglottis psycodes f. albispicata *House*
Blephilia hirsuta f. albiflora *House*
Calluna vulgaris (*L.*) *Salisb.*
Carex interior incomperta x interior
" scoparia var. tessellata *Fernald & Wiegand*
Chaetochloa viridis var. Weinmanni (*R. & S.*) *House*
Cirsium arvense f. albiflorum *House*
Cypripedium acaule f. albiflorum *House*
" arietinum f. albiflorum *House*
Dentaria diphylla x maxima *Haberer*
" laciniata x maxima *Haberer*
" laciniata x diphylla *House*
Doellingeria umbellata var. oneidica *House*
" " var. pubens (*A. Gray*) *House*
Euphorbia dentata *Michx.*
Galeorchis spectabilis f. Gordinierii *House*
Hibiscus Moscheutos f. Peckii *House*
Hypopitys lanuginosa var. rosea (*Torrey*) *House*
Juncus inflexus *L.*
Lathyrus palustris var. pilosus (*Cham.*) *Ledeb.*
Lepidium perfoliatum *L.*
Lilium philadelphicum f. flaviflorum *E. F. Williams*
Limodorum tuberosum f. latifolium (*St John*) *House*
" " f. linariifolium *House*
Limonium trichogonum f. albiflorum (*Raf.*) *House*
Linnaea americana f. candicans *House*
Lycopodium clavatum f. sterilis *House*
Lysimachia terrestris x thrysiflora *Fernald & Wiegand*
Malva sylvestris var. mauretiana (*L.*) *Boiss.*
Meibomia nudiflora f. Dudleyi *House*
Mimulus alatus f. albiflorus *House*
" ringens f. Peckii *House*
Nepeta hederacea var. parviflora (*Benth.*) *House*
Onobrynchis Onobrynchis (*L.*) *Rydberg*
Origanum vulgare f. albiflorum *House*
Oxalis oneidica *House*
Polygala polygama f. albiflora *House*
" viridescens f. albiflora (*Millsp.*) *House*
Polygonum pennsylvanicum var. nesophilum *Fernald*

Pontedera cordata f. Angustifolia *(Pursh) House*
" " f. latifolia *(Raf.) House*
Ranunculus Boraeanus *Jordan*
" sicaeformis *Mackenzie & Bush*
Rhus copallina var. nesophila *House*
Rosa serrulata *Raf.*
Rubus odoratus f. albiflorus *House*
" strigosus var. canadensis *(Richards.) House*
" " var. heterolasius *(Fernald) House*
Senecio aureus x pauperculus *House*
" aureus x Robbinsii *House*
Solidago graminifolia var. galetora *(Greene) House*
Spartina juncea var. caespitosa *(A. A. Eaton) Hitchc.*
Trientalis latifolia *Hook.*
Verbascum Blattaria f. albiflorum *(G. Don) House*
" Lychnitis f. album *(Mill.) House*
Viola eriocarpa var. leiocarpa *Fernald*
" lanceolata x pallens *House*
" palmata x sororia *House*
" pedata lineariloba f. rosea *(Sanders) House*
" pubescens var. Peckii *House*
" rostrata f. Phelpsiae *House*
" rugulosa *Greene*
" sororia f. Beckwithii *House*
Washingtonia longistylis var. villicaulis *(Fernald) House*

B Fungi

This list includes only collections made in New York State and which are new to the fungus flora of the State. Specimens received in exchange or by contribution representing species new to the state herbarium are not included if they have been collected outside the State.

Aecidium Dicentrae *Trelease*
Cercospora galli *E. & H.*
" menispermi *E. & E.*
" sagittariae *E. & K.*
Cintractia Taubertiana *(P. Henn.) Clinton*
Cladosporium gloeosporioides *Atk.*
Coccomyces coronatus *(Schum.) DeNot.*
Cylindrosporium clematidis *E. & E.*
Dinemasporium hispidulum *(Schrad.) Sacc.*
Entyloma lineatum *(Cooke) Davis*
Glenospora melioloides *Curt.*
Gloeosporium polygoni *Dearn. & House*
Gnomonia papillostoma *Dearn. & House*
Haplosporella dulcamara *Dearn. & House*
Harknessia Foeda *Sacc. & Dearn.*
Melampsora Euphorbiae *(Schreb.) Cast.*
Melampsoropsis chiogenis *(Diet.) Arth.*
Microdiplodia populi *Dearn. & House*
" spiraeocola *Dearn. & House*
Micropuccinia conglomerata *(Schum.) Arth. & Jackson*
" recedens *(Sydow) Arth. & Jackson*
Mollisia iridis *(Rehm.) Sacc.*
Mycosphaerella oxycocci *Dean. & House*
Myxosporium Ellisii *Sacc.*
Odontia candidissima *(B. & R.) Burt*

Pestalozzia monochaetoidea var. parasitica *Dearn. & House*
Poria flavidans *Karst.*
Phyllachora agrostidis *Orton*
" elymi *Orton*
" vulgata *Theiss. & Sydow*
" luteomaculata (*Schw.*) *Orton*
" puncta (*Schw.*) *Orton*
Phyllosticta guttulata *Hals.*
" iridis *E. & M.*
Septoria aquilegiae *Penz. & Sacc.*
" pallidula *Dearn. & House*
Spegazzinea rubra *Dearn. & House*
Sphaeropsis betulae var. lutea *Dearn. & House*
Sphaerulina acori *Dearn. & House*
Trametes Morgani *Lloyd*
" protracta *Fries*
Urocystis carcinoides (*B. & C.*) *F. de W.*

LOCAL FLORA NOTES VIII

Albany County

Andropogon scoparius Michx.

On the sand plains west of Albany, this is one of the most abundant of the grasses. Three forms are easily distinguished in the field, but when dried and mounted they lose much of their distinctiveness.

The literature at hand does not indicate that they have been formally recognized as varieties, nor is it my intention to do so here, but merely to call attention to the characters which are most marked in the field.

a The most abundant form. Nearly or quite glabrous, the culms purplish, sheaths green, sometimes with a rather sparse and spreading soft white pubescence toward the top of the sheath. Culms strictly erect.

b Culms strictly erect, averaging from 4 to 12 inches taller than *a*, when growing with it, purplish and conspicuously glaucous beneath the nodes; leaves relatively shorter and broader than *a*, the lower and middle ones one-fourth of an inch wide and from 5 to 7 inches long, light green above, conspicuously glaucous beneath and on the sheaths, somewhat more noticeably scabrous on the margins and on the midvein beneath than in *a*; sheaths copiously pubescent with soft white spreading hairs, especially toward the top of the sheath; pubescence of the inflorescence more copious than in *a*, but not longer.

c Stems quite markedly decumbent at the base, and averaging from a few inches to nearly a foot shorter than those of *a*, when growing with it; leaves about as narrow as *a*, but the sheaths very copiously pubescent, especially toward the top of the sheaths with conspicuously spreading white hairs which are somewhat stiffer than those of the same parts on either *a* or *b*. Color of the culms and leaves practically the same as *a*; no glaucous tint noticeable.

Arabis viridis Harger

(Rhodora, 13:38. 1911)

Rocky woods, Glenmont. *House 7872,* May 24, 1921.

A rather conspicuously distinct plant which seems to have passed unnoticed until recently, or which has been included in A. laevigata, from which it differs by being bright green and more leafy, the white flowers with conspicuous petals and the pedicels noticeably erect.

Asclepias intermedia Vail

Sandy soil west of Albany, in open fields. *House 7159,* July 4, 1920.

The plant here recorded consisted of a single root with three flowering branches. The flowers possessed the clovelike odor of A. obtusifolius, which is common here, and the character of the leaves also indicated that A. obtusifolius was one of the parents of this hybrid. The hoods were pointed or acute as in A. syriaca, but the rather darkish purple color of the flowers would seem to indicate that the other parent species is A. purpurascens, which is not uncommon here, although less so than A. syriaca.

Aster persaliens Burgess

In dense woods of mixed hardwood and hemlock, near Clarksville. *House 6831,* October 15, 1919.

A very distinct member of the group of species usually included in Aster divaricatus L. and which should at least be regarded as of varietal rank.

Aster linariifolius L.

This beautiful aster is very common on the sand plains west of Albany, and presents numerous variations with respect to the inflorescence. The common form here as elsewhere in the State has the heads of the inflorescence numerous and terminating short peduncles, the peduncles provided with small appressed leaflike scales. These peduncles vary in length from 4 to 10 cm and in number from three or four to a stem to large congested inflorescences of thirty or forty heads. Two extremes, however, merit definite record, namely:

Forma **monocephalus** forma nova. Stems branched near or below the middle; heads solitary and terminal on each branch, the peduncle portion of which is 6 to 10 cm long, and with its reduced leaves presents a marked contrast to the larger leaves below and resembles somewhat in appearance single-headed forms of Aster nemoralis. Karner, Albany county. *C. H. Peck.*

Forma **lateralis** forma nova. Stems normal as regards size and foliage, the flowering heads scattered and borne upon short axillary peduncles (1–2 cm long) in the axils of the leaves above the middle of the stem, the peduncles shorter than the subtending leaves, sometimes also one of the short-peduncled heads terminal on the stem. Karner, Albany county. *C. H. Peck.*

Aster laevis L., var. **concinnus** (Willd.) comb. nov.

Aster concinnus Willd. Enum. 884. 1809

The typical form of this variety has extremely long and correspondingly narrow leaves, and appears quite distinct, but intermediate forms between it and the typical Aster laevis are not rare in the highlands adjacent to the Hudson valley in Albany county.

Clarksville. *House 7661,* September 18. Green's lake, Catskill, Greene county. *House 5970,* August 17, 1915 (photographed for the "Wild Flowers of New York"). Whitehall, Washington county, *Peck.* Intermediate form: Sandy woods west of Albany. *House,* September 14, 1916 (photographed for A. laevis, in the Wild Flowers of New York). The extremely broad-leaved form, var. **amplifolius** Porter, occurs at Lake Mohonk, Ulster county, *Peck.*

Betula coerulea Blanchard

On dry rocky, partially wooded hillside near Glenmont. *House 6794,* August 26, 1919.

Blephariglottis lacera (Michx.) Farwell, forma **elongata** (Peck) comb. nov.

Habenaria lacera var. elongata Peck, 46th Rep't N. Y. State Mus. 49. 1893

Selkirk. *Dr C. H. Peck.*

The inflorescence greatly elongated, the flowers rather distant and subtended by large foliaceous or leaflike bracts.

Botrychium obliquum var. **oneidense** Gilbert

Sandy woods west of Albany. *House 8721,* October 18, 1921.

Carex Bicknellii Britton

Rocky ledges under shade of cedars and pines, near Glenmont. *House 7875,* May 24, 1921. Dutchess and Tompkins counties are the only other recorded localities for this sedge in New York.

Carex conoidea Schk.

Woods near Glenmont. *House 6988,* June 8.

Carex glaucoides Tuckerm.

Woods near Selkirk. *House 7018,* June 11.

Carex laxiflora var. **gracillima** Boott

Woods near Selkirk. *House 7017,* June 11.

Carex leptonervia Fernald

Woods near Glenmont. *House 6989,* June 8; and *7125,* June 28.

Carex normalis Mackenzie

Wooded hillsides near Glenmont. *House 6998,* June 8, 1920; *7123,* June 28.

Carex radiata (Wahl.) Small

Moist woods near Glenmont. *House 6994,* June 8.

Carex retroflexa Muhl.

Open woods near Glenmont. *House 6991,* June 8.

Carex tonsa (Fernald) Bicknell

Common on the sandy plains west of Albany. *House 7712,* April 15 to May 1, 1921.

Elymus hirsutiglumis Scribner

On sand bars along the Hudson river near Wemple. *House 7514,* August 23.

Eupatorium trifoliatum L.

In dry woods, near Wemple. *House 7560,* September 8.

Easily distinguished from any related species by its green stems, purple at the nodes only, the flowers few to a head and those much longer than in E. purpureum, and nearly white or at most a pale pink or flesh-colored when first opening, the styles very long and conspicuous, the flowers turning to a dingy pinkish color with age; leaves varying from two to six, but usually two or three, and quite often four to a whorl; leaves narrowed from below the middle to an attenuate base, the margins on each side of this base being concave. Described by Michaux as E. falcatum.

Lupinus perennis L.

The form with rose-colored or pink flowers, forma **rosea** Britton, and the form with pure white flowers, forma **albiracemus** Moore, were both observed at Karner, June 7.

Lilium philadelphicum L.

The form of this species with yellow flowers, forma **flaviflorum** E. F. Williams, was collected at Karner (*no. 7154*), in July 1921.

Mimulus alatus Soland.

Several years ago Doctor Peck collected near Albany, a form of this species with pure white corollas (34th Rep't N. Y. State Mus. 54), preserved in the state herbarium, and which may be designated as forma **albiflorus**, forma nova.

Mimulus ringens L.

A specimen of this species with pure white corollas was also collected by Doctor Peck, near Albany and likewise reported along with the preceding form. It is preserved in the state herbarium and may be designated as forma **Peckii**, forma nova.

Oxalis rufa Small

Sandy thickets, Karner. *House 7856*, May 23, 1921.

Polygala paucifolia Willd., forma **alba** Wheelock.

P. paucifolia var. *albiflora* Raf. Med. Bot., 2:64. 1830
P. paucifolia var. *alba* Eights, in T. & G. Fl. N. Am., 1:132. 1838
P. paucifolia var. *albiflora* Knight, Rhodora, 8:66. 1906
P. paucifolia forma *alba* Wheelock, Torr. Club Mem., 2:142. 1891; House, N. Y. State Mus. Bul. 205–206:27. 1917

A conspicuous and beautiful form of the species growing at Glenmont, Albany county, and also reported from several other localities throughout the State. The plants spread and propagate largely by means of the underground stems, so that large colonies of the white-flowered form are occasionally developed.

Prunus americana Marsh., forma **rosea** (Peck) comb. nov.

Prunus americana var. *rosea* Peck, 47th Rep't N. Y. State Mus. 27. 1894

Petals pink or rosy in color. Meadowdale. *Dr C. H. Peck* (state herbarium), also collected by Doctor Peck at Westport, Essex county.

Raimannia laciniata (Hill) Rose

Along railroad tracks at Selkirk. *House 7027*, June 11.

A native of the western states, and apparently introduced here with shipments of grain and hay, several of which upon inquiry, were said to have been received from the west during the past few seasons.

Rosa serrulata Raf.

Common in the dry sandy plains west of Albany and about Karner. *House 6367*, June 26, 1919.

Senecio obovatus Muhl.

Open woods near Glenmont. *House 7003,* June 8.

Scirpus microcarpus Presl., var. **Bissellii** (Fernald) comb. nov.
S. Sylvaticus var. *Bissellii* Fernald, Rhodora, 2:21. 1900

Marsh near Albany, *Wibbe* (state herbarium).

I can not find that this curious variety was ever reported by Doctor Peck. The plants are stout; spikelets 8–14 mm long; scales much darker than in either S. sylvaticus or in S. microcarpus; styles mostly two-divided, but occasionally three-divided in the same spikelet; sheaths with a marked reddish tinge. While combining certain characteristics of both S. sylvaticus and S. microcarpus (S. rubrotinctus Fernald), the preponderance of characters seems to indicate that it is more properly a variety of the latter.

Viola affinis LeConte

In low woods near Selkirk. *House 7020,* June 11.

Hybrid violets also noted here at the same time are: V. affinis x cucullata; V. affinis x sororia, and V. cucullata x sororia.

Viola pedata L., var. **lineariloba** DC.

Sandy thickets near Karner. *House 6980,* June 7.

This variety of the bird's-foot violet, with uniformly colored petals was first observed near Karner several years ago by Doctor Peck, and it is interesting to note that in spite of numerous destructive grass fires in this section, the species has persisted. It is rare outside of the coastal region in this State.

Zizia cordata (Walt.) DC.

Dry woods near Glenmont. *House 7868,* May 24, 1921.

Cayuga County

Gentiana clausa Raf.

Fernald (Rhodora, 19:147–149. 1917) maintains G. Saponaria L., G. clausa Raf., and G. Andrewsii Griseb. as three distinct species. Material available from all parts of New York State has not served to convince the writer that we have more than the two species of closed gentians, usually recognized, namely, G. Saponaria L., chiefly southern in distribution in this State, and G. clausa Raf., an older name for G. Andrewsii Griseb., of general distribution across the State.

The white-flowered form (G. Andrewsii var. albiflora A. Gray; G. Andrewsii forma albiflora Britton), has been collected at Auburn, Holzer (state herbarium), and may be designated now as **G. clausa**, forma **albiflora** (A. Gray) comb. nov. The same form has also been collected at Salamanca, Cattaraugus county, by *G. W. Clinton.*

Broome County

Blepharigottis psycodes (L.) Rydb., former **albispicata,** forma nova

Divisions of the corolla pure white. Reported from Broome county by *C. F. Millspaugh* (Torr. Club Bul., 12:101. 1885).

Columbia County

Lycopodium clavatum L.

There are two sheets of this species (five specimens) in the state herbarium, collected by Arthur K. Harrison, at Lebanon Springs, August 18, 1893, in which all the peduncles are greatly elongated, 20–50 cm long, and sterile (devoid of any terminal strobili). These might appear like sterile forms of the var. megastachyum, except that of the sixteen elongated peduncles on the five specimens, two are branched below the middle, and one above the middle.

This form may be designated as **L. clavatum** L., forma **sterilis,** forma nova.

Delaware County

During the summer season of 1920, the following plants were collected near Arkville, by Dr H. M. Denslow, and in 1921 deposited in the state herbarium:

Botrychium neglectum *Wood*
" angustisegmentum (*Pease & Moore*) *Fernald*
" obliquum *Muhl.*
" obliquum var. oneidense *Gilbert*
Camptosorus rhizophyllus (*L.*) *Link*
Cryptogramma Stelleri (*Gmel.*) *Prantl.*
Malaxis unifolia *Michx.*
Cypripedium acaule *Ait.*
Corallorrhiza trifida *Chat.*
" maculata *Raf.*
Liparis Loesellii (*L.*) *Richard*
Lysias Hookeriana (*A. Gray*) *Rydb.*
" orbiculata (*Pursh*) *Rydb.*
" macrophylla (*Goldie*) *House*
Monotropa Hypopitys *L.*

Erie County

Ophrys australis (Lindl.) House

This small member of the orchid family has recently been found at Concord by Edward A. Eames on May 29th. This is the first record for the species west of Wayne county in this State.

Carex Hassei Bailey

Moist meadow near Collins. *Dr Anne E. Perkins,* June 15, 1920 and May 15, 1921.

This is an interesting addition to the already large number of carices for New York State. Presque Isle, Pa., is the most easterly station for the species previously known.

Onobrynchis Onobrynchis (L.) Rydberg

(*O. sativa* Lam.)

A native of the Old World and apparently well established near Collins, where collected by Dorothy Raymond in 1919 and 1920, and also by Dr Anne E. Perkins, who forwarded flowering and fruiting specimens in 1921. In full bloom on May 30th.

Erythronium albidum Nutt.

Collins. *Dr Anne E. Perkins,* April 15–20, 1921.

This was reported from Erie county by *Clinton* (19th Regents Rep't, 205. 1866) and was apparently once a fairly common meadow plant near Albany (see *Wright & Hall,* Pl. Vic. Troy 17, 1836), and several collections are in existence made by *Beck, Eights, Eaton, Torrey, Hall* and others. It is now a rare plant about Albany, although collected there in 1910 by *J. C. Smock.*

For the purpose of definite record it is desirable that the following plants collected by Dr Anne E. Perkins in the vicinity of Collins, should be listed with the dates of their collection. These specimens are preserved in the state herbarium.

1920

Polycodium stamineum (*L.*) *Greene*	June 3, August 2
Chamaelirium luteum *L.*	June 3
Cubelium concolor (*Forst.*) *Raf*	June 3
Cypripedium pubescens *Willd*	June 3
Ibidium plantagineum (*Raf.*) *House*	June 3
Phlox divaricata *L.*	June 3
Geranium pusillum *L.*	June 4
Pentstemon pallidus *Small*	June 6
Carex Shriveri *Britton*	June 18
Bromus inermis *Leyss*	June 19
Sherardia arvensis *L.*	June 22
Evonymus atropurpureus *Jacq*	June 22, September 10
Polanisia graveolens *Raf*	August 1
Teucrium canadense *L.*	August 1
Lycopodium lucidulum *Michx*	August 2
Thaspium barbinode *Michx*	August 10
Cheirinia cheiranthoides (*L.*) *Link*	August 15
Lespedeza frutescens (*L.*) *Britton*	August 15
Stachys palustris *L.*	August 15
Cimicifuga racemosa (*L.*) *Nutt*	August 17
Monarda clinopodia *L.*	August 17
" mollis *L.*	August 17
Agastache nepetoides (*L.*) *Kuntze*	August 17
" scrophulariaefolia (*Willd.*) *Kuntze*	August 17
Cassia marilandica *L.*	August 19
Gaura biennis *L.*	August 21
Nicotina rustica *L.*	August 22
Parnassia caroliniana *L.*	August 26
Epilobium hirsutum *L.*	August 26
Corallorrhiza maculata *Raf*	September 1
Disporum lanuginosum (*Michx.*) *Nichols*	September 10
Solidago squarrosa *Muhl*	October 1

1921

Mertensia virginica (*L.*) *Link*	April 15, May 16
Erythronium albidum *Nutt*	April 15
Polemonium repens *L.*	April 20
Phlox divaricata *L.*	April 20
Carex Hassei *Bailey*	May 15
Houstonia canadensis *Willd*	May 15
Cardamine rotundifolia *Michx*	May 16
Disporum lanuginosum (*Michx.*) *Nichols*	May 16
Cassia marilandica *L.*	August 5
Solidago squarrosa *Muhl*	September 4

Essex County

Actaea rubra (Ait.) Willd., forma **neglecta** (Gillman) B. L. Robinson

A not infrequent form of the red baneberry about Newcomb, possessing the slender pedicels of the typical species, but the mature fruit pure white in color. As the white baneberry (*A. alba*) does not occur in this section of the State, the form can not be suspected to be of hybrid origin.

Aster roscidus Burgess

Dry woods near Schroon Lake. *House 7654,* September 16.

Agastache Foeniculum (Pursh) Kuntze

Roadside thickets near Newcomb. *House 8478,* August 4, 1921.

Well established and conspicuous by its purple bracts, calyces and flowers. How this western species came to be so well established here is not apparent, as the spot is not near any habitations.

Botrychium simplex E. Hitchc.

Moist sandy hillside among grasses, sedges and various herbs, shrubs and small evergreens near Newcomb. *House 8012,* June 8, 1921.

Campanula rotundifolia L., forma **albiflora** (G. Don) comb. nov.

C. rotundifolia var. *albiflora* G. Don, Gen. Syst. 3: 758. 1838.

Indian Pass, *Dr C. H. Peck* (state herbarium), also collected by *Doctor Peck* at Lansingburg, Rensselaer county.

Carex tenuiflora Wahl.

Frequent in swamps and bogs near Newcomb. *House 7431,* July 15–30, 1920, and June 3–10, 1921.

Carex lenticularis Michx.

Common on the moist shores of Lake Harris. *House 7428,* July 15–30, 1920; *8083,* June 12, 1921.

Carex Kneiskernii Dewey

(*C. castanea* x *arctata*)

Along the edge of woodland near Newcomb. *House 7421,* July 15–30, 1920; *7944,* June 6, 1921.

Carex viridula Michx.

Common on the shores of Lake Harris. *House 7391,* July 15–30. Nearly as abundant here is C. cryptolepis Mackenzie (*no. 7392*), and rarely also C. irregularis Schw. (*no. 7394*), which seems to be a proliferous variety of C. cryptolepis. **Carex flava** L. also is not rare here.

A more detailed account of the flora of the township of Newcomb is hoped to result from further studies during succeeding seasons. The region is particularly rich in members of the genus Carex, and the list below indicates those collected up to the end of the present season (1921):

Carex abacta *Bailey*
exilis *Dewey*
tenuiflora *Wahl.*
lenticularis *Michx.*
castanea *Wahl.*
Kneiskernii *Dewey*
Deweyana *Schw.*
Buxbaumii *Wahl.*
viridula *Michx.*
cryptolepis *Mackenzie*
irregularis *Schw.*
flava *L.*
aenea *Fernald*
novae-angliae *Schw.*
annectans *Bicknell*
leptonervia *Fernald*
Baileyi *Britton*
aurea *Nutt.*
angustior *Mackenzie*
Bebbii *Olney*
pauciflora *Lightf.*
intumescens var. Fernaldii *Bailey*
lasiocarpa *Ehrh.*
interior *Bailey*
cephalantha (*Bailey*) *Bickn.*
trisperma *Dewey*
Carex vulpinoidea *Michx.*
disperma *Dewey*
scoparia *Schk.*
scoparia var. condensa *Fernald*
comosa *Boott*
brunnescens *Poir.*
communis *Bailey*
stipata *Muhl.*
gynandra *Schw.*
gracillima *Schw.*
hystricina *Muhl.*
flexuosa *Muhl.*
digitalis *Willd.*
pallescens *L.*
vesicaria *L.*
vesicaria var. jejuna *Fernald*
scabrata *Schw.*
oligosperma *Michx.*
limosa *L.*
paupercula *Michx.*
lurida *Wahl.*
retrorsa *Schw.*
strictior *Dewey*
plantaginea *Lam.*
projecta *Mackenzie*
Peckii *E. C. Howe*

Cirsium arvense (L.) Scop.

Along a roadside near Newcomb occurs a colony of plants of this species, doubtless formed from the growth of underground stems, in which all the flowers are pure white. It is quite possible that this has received a name. If so, I have not been able to locate it and for the purpose of record it may be designated as forma **albiflorum,** forma nova.

Comandra livida Richards.

Near the summit of Mount Marcy. *A. B. Brooks,* June 23.

This is not only an interesting addition to the list of arctic-alpine plants of the summit of Mount Marcy, but is also new to the state flora.

Cornus canadensis L., forma **elongata** (Peck) comb. nov.

Cornus canadensis var. *elongata* Peck, N. Y. State Mus. Bul. 150: 44. 1911

Averyville marsh, near North Elba. *Dr C. H. Peck,* September 14, 1911. Also collected by Doctor Peck at Sandlake, Rensselaer county, July 14, 1910 (type).

Doellingeria umbellata (Mill.) Nees
var. **pubens** (A. Gray) comb. nov.

Aster umbellatus var. *pubens* Gray, Syn. Fl., 1^2: 107. 1884

The lower surfaces of the oblong-lanceolate leaves tomentulose-pubescent. Ausable river. *Dr C. H. Peck* (state herbarium). More common west of our borders.

Aster nemoralis Ait. f.

Frequent in a sphagnum bog on the border of Woodruff pond, Newcomb. *House 7530,* September 6.

This has been regarded by Hill (Vascular Flora of the Eastern Penobscot Region, Maine, 1919) as a "carolinian" plant. It is now known from five Adirondack localities in the counties of Essex, St Lawrence, Hamilton and Herkimer. Its peculiar distribution northward into the Canadian life zone makes it impossible to regard it as a typical carolinian plant, and in this respect it is like Viola lanceolata L., Lycopodium inundatum and a few other species.

Heliopsis scabra Dunal.

Moist roadside thicket near Newcomb. *House 8452,* August 3, 1921. Perhaps not native, as only a single colony was found.

Lycopodium inundatum L.

Common on the marshy shores of Lake Harris, Woodruff pond, Hewitt's pond and other localities in Newcomb. *House 7333,* July 15–30.

Lycopodium tristachyum Pursh

Dry woods near Newcomb. *House 8465,* August 3, 1921.

Lysiella obtusata (Pursh) Rydberg

Common in most of the mossy spruce swamps about Newcomb. *House 7300,* June 10, 1921, and in bloom sometimes as late as August 1st.

Ophrys convallarioides (Sw.) W. F. Wight

Frequent in mossy spruce swamps about Newcomb, and sometimes common. *House 7307,* June 3–10, 1921. Usually out of bloom by August 1st.

The following additional species of orchids were collected in the township of Newcomb:

Ophrys cordata *L.*
Corallorrhiza Corallorrhiza (*L.*) *Karst.*
" maculata *Raf.*
Malaxis unifolia *Michx.*
Cypripedium acaule *Ait.*
" reginae *Walt.*
Gymnadeniopsis clavellata (*Michx.*) *Rydb.*
Peramium ophicides (*Fernald*) *Rydberg*
Ibidium Romanzoffianum (*Cham.*) *House*
Perularia flava (*L.*) *Farwell*
Blephariglottis Blepharigllottis (*L.*) *Rydberg.*
Limnorchis hyperborea (*L.*) *Rydb.*
" dilatata (*Ait.*) *Rydb.*
Limodorum tuberosum *L.*
Pogonia ophioglossoides (*L.*) *Ker.*
Peramium teselatum (*Lodd.*) *Heller*
Lysias orbiculata (*Pursh*) *Rydb.*
Liparis Loesellii (*L.*) *Richard*

Lonicera hirsuta Eaton

Moist woods near Newcomb. *House 7191,* July 15–30.

Poa saltuensis Fernald & Wiegand

Moist shores of Lake Harris. *House 8070,* June 12, 1921.

Calamagrostis Pickeringii A. Gray

Marshy shores of Lake Harris. *House 7384,* July 15–30.

Razoumofskya pusilla (Peck) Kuntze

Parasitic on limbs and twigs of black spruce (Picea mariana) in swamps near Newcomb. *House 7186,* July 15–30. A few young, red spruce trees (Picea rubens) were also found with the dwarf mistletoe parasitic upon them.

Ranunculus sicaeformis Mackenzie & Bush

This has the general appearance of R. septentrionalis Poir., as well as the habit of that species, but is brighter green in color. The early leaves have more rounded lobes and the summer foliage is cut into broader segments. The stems are densely hirsute with white spreading hairs, especially toward the base, and somewhat less so on the petioles. The leaves are quite markedly appressed pubescent on both surfaces, more densely so beneath. The petals are obovate, 8–12 mm long and 6–10 mm wide. The immature akenes are punctate and with a nearly straight, ascending, tapering beak one-half as long as the body.

Marshy soil near Newcomb. *House 8050,* June 10, 1921.

Senecio Robbinsii Oakes

Common in pastures and on cleared land especially east of Newcomb. *House 7292,* July 15–30.

Senecio aureus x Robbinsii, hyb. nov.

This was at first taken to be S. Robbinsii with broad leaves. The plants are exactly intermediate in appearance between S. aureus and S. Robbinsii, the former growing in a bog adjacent to the colony of hybrid plants, and the latter common on a sandy slope above the bog. S. Robbinsii usually blooms much earlier than S. aureus, but not infrequently especially in this section of the State, the blossoming period of the two species overlaps, which was the case at the place and date where this hybrid colony was detected near Newcomb. *House 8013,* June 8, 1921.

Solidago squarrosa Muhl.

Dry hillsides near Newcomb. *House 7547,* September 8, and Cascade lakes, North Elba. *House 7643,* September 16.

Stellaria borealis Bigel.

Marsh near Newcomb. *House 8050,* June 10, 1921.

Scirpus Torreyi Olney

Common in shallow water along the shores of Lake Harris. *House 7359,* August 1–15, 1921. Also observed in shallow water along the Hudson river below Newcomb, and at Hewitt's pond.

Utricularia resupinata Greene

On the muddy shores of Lake Harris and Woodruff pond, near Newcomb. *House 7528,* August 10–15, 1921.

Myriophyllum tenellum Bigel.

Muddy shores of Lake Harris, Newcomb. *House 8517,* August 8, 1921. Fairly common from August 3d to 15th, but before and after these dates (for 1921) difficult to find.

Sanguisorba canadensis L.

Common on the marshy shores of Lake Harris. *House 7273,* August 1–15, 1921.

Trientalis latifolia Hook.

Summit of Mount McIntyre. *Dr C. H. Peck* (state herbarium).

This specimen has been carefully compared with typical material of T. latifolia from western America, and no essential points of difference can be found. As the record rests, however, upon a single specimen, and from an exposed subalpine summit where owing to exposure and altitude the common eastern species might simulate the western species, it is hoped that additional collections of this plant from Mount McIntyre may be secured.

Viola lanceolata x pallens, hyb. nov.

This was taken at first for V. primulifolia because of its broad leaves. Further observations of it during 1921 showed that the petaliferous flowers were always sterile, the flower and its peduncle soon withering and never developing capsules. The leaves simulate those of the more southern V. primulifolia but are entirely smooth and in texture more like those of V. pallens.

Shore of Lake Harris near Newcomb, growing with V. pallens and V. lanceolata. *House 7254*, June 6–12, 1921; August 1–10, 1921.

Woodsia ilvensis (L.) R. Br.

Rocks above Cascade lakes, North Elba. *House 7635*, September 16.

Greene County

Carex spicata Huds.

Rocky woodlands near Catskill. *House 7836*, May 21, 1921. Usually referred to C. muricata in recent floras.

Viola sagittata Ait.

Moist uplands field in clayey soil, 2 miles east of Catskill. *House 7828*, May 21, 1921.

This is several miles north of Saugerties where V. sagittata was once collected by Doctor Peck. It is to be noted that this collection is the typical glabrous slender form such as is found in the turfy meadows adjacent to the salt marshes of Long Island and southward.

Aemnone virginiana L. forma **rubrosepala**, forma nova

The rather small, thickened and somewhat leathery sepals strongly tinged wtih red on the upper surface, silky white beneath.

Cairo. *Leland S. Slater*, June 18, 1918 (type).

Genesee County

Senecio aureus x pauperculus, hyb. nom. nov.

S. aureus x *Balsamitae* Greenman, Rhodora, 10:69. 1808

Bergen swamp, Genesee county, *House* (state herbarium).

Ranunculus alleghaniensis Britton

Near LeRoy. *M. S. Baxter,* May 23, 1921. Also collected in the same vicinity by *E. P. Killip.*

Valerianella chenopodifolia (Pursh) DC.

Near LeRoy. *M. S. Baxter, 5568,* May 23, 1921.

Hamilton County

Agastache urticifolia (Benth.) Kuntze

Along roadsides near Wells. *Dr C. H. Peck* (N. Y. State Mus. Bul. 75, p. 22. 1904, as A. scrophulariaefolia). An examination of the specimens cited by Peck shows that they belong to the far western species. Peck points out the characteristic differences but either from lack of adequate literature or of authentic specimens for comparison, reported it as a form of A. scrophulariaefolia. It is probably an escape from cultivation, since as an ornamental plant it possesses considerable merit.

Aster Tradescanti L., var. **saxatilis** (Fernald) comb. nov.

A. vimineus var. *saxatilis Fernald,* Rhodora, 1:186. 1899
A. saxatilis Blanchard, Am. Bot., 7:27. 1904

Racquette Lake, *C. H. Peck* (state herbarium)

Uncommon or rare in rocky situations in northern New York. Apparently more properly to be regarded as a low race or depauperate development of A. Tradescanti, than of A. vimineus.

Carex abacta Bailey

Common in the marshes along the outlet of Lake Pleasant. *House 7487,* August 12.

Carex Baileyi Britton

Common in moist or wet places about Speculator and Lake Pleasant. *House 7505,* August 13.

Carex lenticularis Michx.

Frequent on the shores of Lake Pleasant. *House 7471,* August 12–13.

Carex viridula Michx.

Common along the outlet of Lake Pleasant. *House 7488* August 12. Also less frequently along the shore of Lake Pleasant. In both places **Carex cryptolepis** Mackenzie (*no. 7484*) is an associated plant. Both here and at Lake Harris in Essex county search was made for forms intermediate between these two species, which by some authors are regarded as varieties of **C. Oederi, native of** the Old World, but no intermediate forms were found. The two are very distinct in color of foliage and in the character of the fruiting spikes, C. cryptolepis always being taller and paler green (yellowish green), and when the two grow associated C. cryptolepis matures its fruit 2 or 3 weeks earlier, but owing to differences in soil, moisture and exposure within short distances along some stretches of these Adirondack lake shores, the maturity of C. viridula often overlaps that of C. cryptolepis.

Cyperus dentatus Torrey

Common on the marshy shores of Lake Pleasant, and along the outlet of the lake. *House 7495,* August 12–13.

Lycopodium inundatum L.

Common on the moist and marshy shores of Lake Pleasant and less frequently along the outlet. *House 7481,* August 12–13.

Associated here, as at most Adirondack localities where observed, with Drosera intermedia Hayne, Viola lanceolata L. Xyris caroliniana Walt., Spiraea tomentosa L. Oxycoccus macrocarpus (Ait.) Pursh, an association of species duplicated with minor variations in places of similar soil conditions upon Long Island.

Myriophyllum tenellum Bigelow

Common in shallow water or emersed on muddy banks along the outlet of Lake Pleasant. *House 7489,* August 12.

Lycopodium clavatum L., var. brevispicatum Peck

Summit of Black Bear mountain, near Inlet. *House,* June 26, 1917. The original of this odd variety was collected by Peck on Wallface mountain.

Panicularia septentrionalis (Hitchc.) Bicknell

Common in moist or wet sandy soil along the shore of Lake Pleasant, and also along the outlet of the lake, occasionally in shallow water. *House 7474,* August 12–13.

Rubus permixtus Blanchard

Frequent in open wet meadows and boggy places near Speculator. *House 7459,* August 13.

Salix pedicellaris Pursh

Frequent in open marshes near Speculator. *House 7493,* August 12–13.

Sambucus racemosus L., forma **laciniata** (Koch) comb. nov.

In woods near Indian Lake. *Dr C. H. Peck* (state herbarium, and 27th Rep't N. Y. State Mus. 111. 1877, as S. racemosa var. dissecta Britton). Described by Koch, as S. racemosa var. laciniata.

Scirpus Torreyi Olney

Uncommon in shallow water along the outlet of Lake Pleasant. *House 7503,* August 12.

Scirpus subterminalis Torrey

Common in shallow water at the mouth of Cherry brook near Speculator on Lake Pleasant. *House 7464,* August 13.

Sparganium diversifolium Graebner

In marshy or wet places along the outlet of Lake Pleasant. *House* August 12. Sparganium angustifolium Nutt. (*no. 7483*) was also collected in shallow water, and Sparganium acaule (Beeby) Rydberg (*no. 7460*), on muddy banks and in very shallow water along the outlet.

Sanguisorba canadensis L.

Infrequent along the outlet of Lake Pleasant. *House 7452,* August 13.

Scirpus georgianus Harper

Frequent in marshy places at Blue Mountain lake. *House 7589,* September 14.

Rubus Randii (Bailey) Rydberg

Thickets near Blue Mountain lake. *House 7583,* September 14.

Spiraea tomentosa L.

Infrequent and mostly of small size along the outlet of Lake Pleasant. *House 7452,* August 13. Recorded because not seen at any higher altitude (1800 feet) in the Adirondacks. Local at Newcomb, Essex county (1550 feet altitude).

Viola lanceolata L.

Common in marshy places along the outlet of Lake Pleasant, and less frequent on the shores of the lake. *House 7492,* August 12.

Xyris caroliniana Walt.

Common on the shores of Lake Pleasant, and less so along the outlet. *House 7475,* August 12–13.

Herkimer County

Botrychium matricariae (Schrank) Spreng.

On moist shaded banks along the shore of Fourth lake. *House 6721,* August 10, 1919.

The bud within the base of the stem is clothed with a dense white silky pubescence. The spores were scarcely mature at this date even on the largest plants.

Galeopsis Tetrahit L.

This naturalized plant is very common in recent clearings, cultivated soil and along roads throughout the Adirondack region. A note by Fernald and Wiegand (Rhodora, 12: 142. 1910), led to an examination of numerous specimens in Herkimer, Hamilton and Essex counties, all of which prove to be the var. **bifida** (Boenn.) Lejeune & Courtois (Comp. Fl. Belg., 2: 241. 1831), as described by Fernald & Wiegand.

Ilex bronxensis Britton

Common in marshes along Fourth lake. *House 6709,* August 6, 1919.

Rubus strigosus Michx, var. **heterolasius** (Fernald) comb. nov.

R. Idaeus var. *heterolasius* Fernald, Rhodora, : 97.

The new canes are like those in the variety canadensis, but the prickles are stout and broad based. Collected by *Dr C. H. Peck* at Big Moose Station (state herbarium).

Jefferson County

Aster novae-angliae L., forma **rosarius,** nom. nov.

Aster roseus Desf. Cat. Hort. Par. ed. 3, 401. 1829. Not A. roseus Bieb., 1812
A. novae-angliae var. *roseus* DC.

Roadsides near Woodville. *House,* September 9, 1921.

A rather distinct form of the species with rosy or nearly red rays. Seen in several places in this part of Jefferson county and growing chiefly in drier soil than the typical species, and the plants lower with more spreading stems and smaller leaves.

Echinochloa Walteri (Pursh) Nash

In marshes along the shore of Lake Ontario near Woodville. *House 8654*, September 9–11, 1921.

Ranunculus longirostris Godr.

Common in shallow water in the inclosed bays or lagoons back of the sand dunes along the east shore of Lake Ontario near Woodville. *House 8156*, June 22, 1921.

Carex Sprengelii Dewey

On the highest parts of the wooded sand dunes, under white pines, near Woodville. *House 8187*, June 23, 1921.

Among the many aquatic and semiaquatic plants collected at Pierrepont pond, near Woodville, on the shore of Lake Ontario during 1921, the following are worthy of record:

Panicularia borealis *Nash*
" grandis (*S. Wats.*) *Nach.*
" laxa *Scribn.*
Zizania aquatica *L.*
" palustiris *L.*
Sporobolus cryptandrus (*Torr.*) *A. Gray*
Homalocenchrus oryzoides (*L.*) *Poll.*
Phalaris arundinacea *L.*
Festuea elatior *L.*
Cinna arundinacea *L.*
Scirpus fluviatilis (*Torr.*) *A. Gray*
" americanus *Pers.*
" validus *Vahl*
" cyperinus var. pelius *Fernald*
" Smithii *A. Gray*
Eleocharis palustris var. major *Sonder*
Carex substricta (*Kuken.*) *Mackenzie*
Potamogeton natans *L.*
" perfoliatus *L.*
" amplifolius *Tuckerm.*
" americanus *C. & S.*
" heterophyllus *Schreb.*
" pusillus *L.*
" diversifolius *Raf.*
" filiformis *Pers.*
" pectinatus *L.*
Ranunculus longirostris *Godr.*
Radicula hispida (*Desv.*) *Britton*
Triglochin maritima *L.*
Sagittaria rigida *Pursh*
" variabilis *Willd.*
Nymphaea advena *Soland.*
" microphylla *Pers.*
" rubrodisca (*Morong*) *Greene*
Castalia tuberosa *Paine*
Juncus balticus *L.*
Comarum palustre L., var. villosum *Pers.*
Philotria Nuttallii (*Planch.*) *Rydberg*
Myriophyllum heterophyllum *Michx.*
Peltandra virginica (*L.*) *Raf.*
Naias flexilis (*Willd.*) *Rost. & Schmidt.*
Valisneria spiralis *L.*

Polygonum Hydropiper *L.*
Rumex brittanicus *L.*
Iris versicolor *L.*
Lysimachia thrysiflora *L.*
Utricularia macorrhiza *LeConte*
Scutellaria galericulata *L.*
Typha angustifolia *L.*
Spirodella polyrhiza (*L.*) *Schleid.*
Sparganium eurycarpum *Engelm.*
Alisma subcordatum *Raf.*

Cornus Baileyi Coulter & Evans

Thickets on the sand dunes along Lake Ontario near Woodville. *House 8460,* June 24, 1921.

Lathyrus palustris L.

Common in the meadows and marshes along the shore of Lake Ontario, near Woodville. *House 8172,* June 23–24, 1921.

L. myrtifolius Muhl. (*no. 8173*) with its somewhat glaucous foliage, practically wingless stems and smaller flowers, stands out with great distinctness, and no intermediate forms were observed. In L. myrtifolius, the lobes of the calyx are always shorter than the calyx tube, the three lower lobes being triangular-ovate to triangular-lanceolate, acuminate and tapering evenly from the base to the apex. In L. palustris, the three lower calyx lobes are equal to or longer than the tube and broadly lanceolate in shape, often tinged with purple. All parts of the flower are uniformly larger than in L. myrtifolius which seemingly can not be regarded as a variety of L. palustris.

In **L. palustris** var. **linearifolius** Ser. (*no. 8174*), the calyx lobes usually average shorter in length and approach the shape of those in L. myrtifolius, but the narrow leaflets without any glaucous indument, and the winged stems relates it closely to L. palustris, and intermediate forms are not rare.

In the specimens here collected the pods of the var. linearifolius are taper pointed in nearly a straight line from the dorsal surture of the pod, while in L. palustris, the pods taper about evenly from both the dorsal and ventral surtures to an elongated tip. Further observations in other localities will be necessary to determine whether this is a character of value or not.

Comarum palustre L., var. **villosum** Pers.

(*Potentilla palustris* var. *villosa* Lehm.)

Marshes along the shore of Lake Ontario, near Woodville. *House 8196,* June 23, 1921.

The very dense, closely appressed silky indument of the whole plant excepting the petals is very conspicuous and renders the varietal name rather inappropriate. The petioles and peduncles are copiously glandular as in the typical form.

Eleocharis palustris L., var. **major** Sonder (Fl. Hamb. 22. 1851)

Common in the shallow water of the bays and inlets along the shore of Lake Ontario near Woodville. *House 8128.*

This is the variety vigens Bailey, and in its extreme development presents a marked contrast in appearance to the typical E. palustris. Intermediate forms, however, while not common, are occasionally found.

Juncus Dudleyi Wiegand

Sandy soil along Lake Ontario, near Woodville. *House 8169,* June 23, 1921.

Carex radiata (Wahl.) Small

Moist woods near Woodville. *House 8209,* June 23, 1921.

Nymphaea rubrodisca (Morong) Greene

Ponds back of the sand dunes along the shore of Lake Ontario near Woodville. *House 8157,* June 23, 1921. N. advena and N. microphylla are also common.

Panicum Lindheimeri Nash

Sandy fields along Lake Ontario near Woodville. *House 8243,* June 23, 1921.

Festuca rubra L.

In sand and on the sand dunes, along the shore of Lake Ontario, near Woodville. *House 8200,* June 23, 1921.

Lewis County

Carex vaginata Tausch

In deep shade of spruce trees growing in wet moss, Bonaparte swamp. *House 7082,* June 22.

Carex gynocrates Wormsk.

In sphagnum, usually in openings of the cedar and spruce growth, Bonaparte swamp. *House 7079,* June 22.

Carex exilis Dewey

Very common in the extensive bog at the north end of Onjebonge pond, a few miles north of Natural Bridge. *House 7138,* June 24. Other plants conspicuous at this season in this bog were: **Eriophorum callitrix** Cham. **Eriophorum alpinum** L., **Eriophorum tenellum** Roth, **Carex pauciflora** Lightf. and **Arethusa bulbosa** L.

Lycopodium inundatum L.

Common on the sphagnum bog at Onjebonge pond. *House 7138,* June 24.

Symphoricarpos racemosus Michx.

On exposed ledges. Grand island in Lake Bonaparte. *House 7101,* June 23.

Minuartia Michauxii (Fenzl.) House

(Alsine stricta Michx.)

Common on rocky banks about Lake Bonaparte. *House 6267,* June 23.

Juncus Dudleyi Wiegand

Bonaparte swamp. *House 7058,* June 23. Determined by Dr F. V. Coville, 1921.

Linnaea americana Forbes, forma **candicans, forma nova.**

Corollas pure white instead of the usual pink color. On Grand island in Lake Bonaparte there is a large colony of the twin flower in which all the flowers have pure white corollas. *House 7106,* June 23.

Arctostaphylos Uva ursi (L.) Spreng.

Common on Grand island, Lake Bonaparte. *House 7100,* June 23. Not common elsewhere about Lake Bonaparte, doubtless owing in large part to the extensive and destructive fires which followed lumbering operations 25 to 40 years ago. The plants of the bearberry have smooth and glabrous branches and twigs at this station, while all other specimens from New York which have been examined have the branchlets "canescent-tomentulose, not viscid, the minute tomentum persistent," as described by Fernald & Macbride (Rhodora, 16: 212. 1914) for their variety **coactilis.** The geographical value of this variety is doubtful, however, since in the state herbarium there is a specimen from central Europe which is an exact match for the variety coactilis.

Viola Selkirkii Pursh

Common in moist woods near Lake Bonaparte. *House 7043,* June 22.

Viola rugulosa Greene

A plant much resembling V. canadensis, but stouter and more strict, leaves broader and rough pubescent above, notably pubescent beneath, hirtellous on the veins as well as on the stems and petioles.

Harrisville, *Peck, 1904* (state herbarium).

The occurrence of this western species in northern New York is not so surprising as might at first appear, since quite a number of western species have been found to have the eastern limits of their distribution in the Black river basin of Jefferson and Lewis counties, and along the St Lawrence.

Linaria minor (L.) Desf.

Along railroad tracks near Lake Bonaparte. *House 7040,* June 22.

Anemone cylindrica A. Gray

Occasional in rocky or stony fields north of Natural Bridge. *House 7151,* June 24.

Salix serissima Fernald

Common in the southern end of Bonaparte swamp. *House 7108,* June 23.

Salix balsamifera Barratt

(S. pyrifolia Anders.)

Several large individuals of this rather rare willow were observed in Bonaparte swamp. Not in flower or fruit at this date (June 23d) and only leaf specimens were taken for identification.

Thelypteris clintoniana (D. C. Eaton) House

(Dryopteris clintoniana Dowell)

Frequent in Bonaparte swamp. *House 7044,* June 23.

Carex substricta (Kukenth.) Mackenzie

(C. aquatalis, N. Y. Reports)

Frequent in marshy places in Bonaparte swamp and on the shore of Lake Bonaparte. *House 7084,* June 22–23.

Carex leptonervia Fernald

Common in moist woodlands about Lake Bonaparte. *House 7080,* June 22.

Rosa blanda Ait.

Common on exposed ledges on Grand island in Lake Bonaparte. *House 7104,* June 23.

Oxalis Brittonae Small

In dry fields near Lake Bonaparte. *House 7041,* June 22.

Livingston County

Polygonum buxiforme Small

Near the "salt mines," Griegsville. *M. S. Baxter 5511,* August 14, 1921. **Polygonum exsertum** Small, also collected at the same place by Mr Baxter (*no. 5512*).

Both of these species commonly regarded as exclusively maritime, apparently occur inland in saline localities. P. buxiforme has been collected along the Hudson as far north as near Albany, and also on Oneida lake (*House*).

Panicularia melicaria (Michx.) Hitchc.

Shady woods near Canadice. *M. S. Baxter 5405,* August 28, 1921 (about 1900 feet altitude).

This is one of the common species of woodland grasses in northern New York. The records for western New York are few. Paine (Cat. 169, 1865) merely records it from "western New York" upon the authority of Gray. Holzer (Proc. Rochester Acad., 3: 128. 1896) reports it as rare in Monroe county. There is a specimen in the Beck herbarium collected by Gray at Bridgewater, and the writer has collected it at Constantia, Oswego county.

Madison County

Botrychium obliquum Muhl., forma **dissectum** (Spreng.) comb. nov.

B. dissectum Spreng. Anleit., 3: 172. 1804
B. ternatum var. *dissectum* D. C. Eaton, N. Am. Ferns, 1: 150. 1878
B. obliquum var. *dissectum* Prantl. Jahrb. Bot. Gard. Berlin, 3: 342. 1884

Glenwood, near Oneida. *House.*

C. J. Chamberlain (Bot. Gaz., 70: 385–398. 1920) suggests that this is a sterile mutant of B. obliquum, which seems quite probable, as mature spores capable of germination apparently are never developed. From the point of view of nomenclatorial rules it is unfortunate that *dissectum* was described 6 years earlier than B. obliquum. That it should be taken up as the name for the typical species (*cf.* Fernald, Rhodora, 23: 151. 1920) is most incongruous.

Carex cryptolepis Mackenzie

Marly wet shores of Woodman's pond, near Hamilton. *House 7675,* October 19. The date of the collection is interesting as showing the ability of some species of Carex for continuous development throughout the season.

Carex castanea Wahl.

Thin but wet woods near Peterboro. *House 8324,* June 29, 1921 Plants several days past maturity.

Carex Deweyana Schw.

Wet woods near Peterboro. *House 8323*, June 29, 1921.

Carex prasina Wahl.

Marshy places near Oneida. *House 8378*, July 4, 1921.

Carex radiata (Wahl.) Small

Swamp south of Morrisville. *House 8712*, September 17, 1921. Maturing late owing to ground having been disturbed in grading an adjacent roadway.

Cypripedium reginae Walt., forma **album** (Ait.) comb. nov.

Cypripedium album Ait. Hort. Kew., 3: 303. 1789

Castle swamp, Oneida. *House.*

In central New York the showy lady's-slipper occasionally occurs with all parts of the flower pure white. Also in Bonaparte swamp, Lewis county. *Peck* (N. Y. State Mus. Bul. 94, p. 38. 1905)

Polygala paucifolia Willd.

Low woods near Pecksport. *House 6927*, May 26. This is not a rare plant throughout most sections of the State but has not been previously noticed in Madison county.

Linum sulcatum Riddell

In old fields on a dry sandy hillside near Oneida. *House 7671*, October 18. Perhaps naturalized from farther west.

Nepeta hederacea (L.) Trev., var. **parviflora** (Benth.) Druce

Glecoma heterophylla Opiz, Natural., 7: 61. 1824
N. Glecoma var. *parviflora* Benth. in Lab. Gen. & Sp., 485. 1834
G. intermedia Schrader; Benth. in DC. Prodr., 12: 391. 1848

Corollas scarcely more than twice as long as the calyces, which are shorter than in the typical form of the species. Leaves also smaller and less pubescent, the stems glabrous or but minutely pubescent.

Edge of woodlands near Oneida. *H. D. House*, June 5, 1916. Native of Europe, and well established. Doubtless not rare but easily overlooked or taken for the common form of the species. In Glecoma this would be designated as **Glecoma hederacea** var. **parviflora** (Benth.) comb. nov.

Equisetum praealtum Raf.

Low woods near Oneida. *House,* May 15, 1918. Distributed as E. laevigatum A. Br.

According to Dr J. H. Schaffner, true E. hyemale L. does not occur in the eastern United States, most of the specimens so referred to in the past belonging to E. praealtum Raf. Few species are so variable in size and habit as this one, the specimen cited above being nearest typical of any seen from this State; 6 to 25 cm tall and stems 6 to 12 mm thick.

Monroe County

Agropyron pseudorepens Scribn. & Smith

Along railroad tracks near East Rochester. *M. S. Baxter 1002,* August 5. Apparently adventive from the west.

Leptoloma cognatum (Schultes) Chase

Along railroad tracks near Despatch. *D. M. White,* August 22. Adventive from the west and now well established and rapidly spreading in waste and sandy soil in many sections of the State.

Carex Bebbii Olney

A common sedge in Monroe county, represented by collections at Round pond (*House*), Irondequoit bay (*House*), and at Bergen swamp, Genesee county (*House*).

Carex convoluta Mackenzie

Palmer's glen, Rochester. *House,* July 5, 1917. Other Carices collected on this date at Palmer's glen are:

Carex cephalaphora *Muhl.*
Carex communis *Bailey*
Carex laxiculmis *Schw.*
Carex blanda *Dewey*
Carex anceps *Muhl.*

Carex trisperma Dewey, var. **Billingsii** Knight

Mendon bog. *House,* July 5, 1917.

Carex normalis Mackenzie

Churchville. *House,* July 4, 1917.

Carex tetanica Schk.

Near Mendon. *House,* July 2, 1917.

Carex Sartwellii Dewey

Mendon ponds. *M. S. Baxter 5488,* June 19, 1921. A very rare sedge which Mr Baxter has also rediscovered at the original station (Junius marsh).

Scirpus lineatus Michx.

Low ground near Pittsford. *House,* July 5, 1917.

Paspalum pubescens Muhl., var. **Muhlenbergii** (Nash) comb. nov.

(P. Muhlenbergii Nash, in Britton, Man. 75, 1901)

Bushnell's Basin. *Baxter,* September 1910. Perinton, *Baxter,* September 15, 1910. Fisher's, Ontario county, *Baxter,* September 15, 1914.

Although extreme forms appear quite distinct, the so-called P. Muhlenbergii merges freely into typical P. pubescens. More or less distinct plants which can be referred to this variety are cited above. In southern New York intermediate forms are more frequent and difficult to place.

Chaetochloa viridis (L.) Scribn., var. **Weinmanni** (R. & S.) comb. nov.

Setaria Weinmanni R. & S. Syst., 2: 490. 1817
S. viridis var. Weinmanni Brand, in Koch, Syn. Ed. 3, 2690. 1905

A somewhat depressed or spreading plant with leaves mainly less than 5 mm wide, the slender spikes rarely exceeding 5 mm in thickness.

Brighton. *C. M. Booth,* June 25, 1894 (state herbarium).

Froelichia gracilis Moq.

Along railroad tracks at Despatch. *D. M. White,* August 22. Adventive from the western states.

Boehmeria Drummondiana Weddell

(B. cylindrica var. scabra Porter)

In woods near Mendon. *M. S. Baxter 1008,* August 8.

Euphorbia dentata Michx.

Along railroad tracks at Despatch. *D. M. White,* August 22. Adventive from the western states. (Poinsettia dentata Small.)

Helianthus subrhomboideus Rydberg

Along railroad tracks at Despatch. *D. M. White,* August 22. Adventive from the western states.

Ranunculus hispidus Muhl.

On dry banks at Irondequoit bay. *D. M. White 70,* March 16, 1917. Bushnells. *M. S. Baxter 5414,* May 8, 1921.

Gaura coccinea Pursh

Near Rochester. *M. S. Baxter 1007,* August 5. First collected near Rochester by Mr Baxter in 1906 (N. Y. State Mus. Bul. 116, p. 24. 1907), and with an interval of 13 years this species appears to be well established in our flora.

Actaea alba (L.) Mill., forma **rubrocarpa** Killip, forma nov.

Pittsford. *E. P. Killip* (state herbarium).

Plant resembling A. alba, and like that species, having the berries on thickened pedicels, which are reddish at maturity. The berries instead of being white as in the typical form of the species are dark red.

A similar plant was reported from Cattaraugus county by Kneiskern (Torrey, Fl. N. Y., 1: 22. 1843).

Aster novae-angliae L., forma **geneseensis,** forma nova

Ray-flowers white. Near Rochester. *Mrs H. G. Pierce,* 1904. (Also reported in the Roch. Acad. Sci. Proc., 5: 20. 1910.)

Viola sororia Willd., forma **Beckwithae,** forma nova

Petals all white. Rochester. *Florence Beckwith* (state herbarium). Also reported from Staten Island, Dowell (Torr. Club Bul., 37: 167. 1910).

Lepidium perfoliatum L.

Along railroad tracks at Pittsford. *F. S. Boughton,* July 10, 1921. Communicated by M. S. Baxter as *no. 5647.* Native of Europe, and apparently not previously reported from New York.

Thalictrum revolutum DC.

East side of Irondequoit bay. *M. S. Baxter 5609,* May 22, 1921.

Sporobolus asper (Michx.) Kunth

Along railroad tracks, East Rochester. *M. S. Baxter 5501,* September 15, 1921.

Corispermum hyssopifolium L.

Along railroad tracks, East Rochester. *M. S. Baxter 5499,* September 15, 1921.

Eleocharis interstincta (Vahl) R. & S.

Mendon ponds. *Warren Matthews,* July 24, 1921. Communicated by Mr Baxter as *no. 5406.* This constitutes the first authentic record which we have for this rare species in New York State.

Parsonsia petiolata (L.) Rusby

Mendon. *Warren Matthews,* July 29, 1921.

A plant which prefers moist meadows and which is undoubtedly spreading northward in this State, as Clinton (19th Regents Report, 204. 1866), reports it only from New York Island, and later (38th Rep't N. Y. State Museum 107. 1885) from Catskill. Paine (Cat. 80. 1865) reports it from northern New York, on the authority of Stevenson & Kneiskern, a report apparently borrowed from Torrey's flora (1843). This might be Washington county (where collected by Burnham, 46th Rep't N. Y. State Mus. 43. 1893), or an outlying station now unknown. Very common at Saugerties, Ulster county, *House 8720,* October 8, 1921.

Arctium minus Schk.

A form with pure white flowers has been collected near Rochester by *Florence Beckwith* (Herb. Rochester Acad. Sci. & Proc., 5: 98. 1917), and which may be designated as forma **leucocephalum** forma nova.

Sambucus canadensis L.

The form of this species collected near Rochester by *John Dunbar,* with dark yellow fruit, and preserved in the herbarium of the Rochester Acad. of Sciences, may be designated as forma **atroflavula** forma nova. (Proc. Roch. Acad. Sci., 5: 18. 1910). Likewise the form of Sambucus racemosa L. with yellow fruit, also collected near Rochester by Mr Dunbar may be designated as forma **xanthocarpa** forma nova.

Oneida County

Carex leucorum Willd.

Common in sandy fields north of New London. *House 6099,* June 4, 1919. Commonly regarded as a variety of C. pennsylvanicum Lam.

Carex tonsa (Fernald) Bicknell

Sandy fields north of New London. *House 6100,* June 4, 1919.

Carex rugosperma Mackenzie

Dry fields near North Bay. *House 6324,* June 18, 1919.

Carex laevivaginata (Kukenth.) Mackenzie

Collected near Verona several years ago by Dr C. H. Peck (state herbarium, as C. stipata var. crassicuta, in part). Also collected by Doctor Peck at Cedarville, Herkimer county (as var. subsecuta). Castle swamp, Madison county. *House 5898,* June 27, 1915.

Carex Howei Mackenzie

Deep swamps near Clayville. *House,* June 23, 1917. Also at Mud pond, near Zurich, Wayne county. *House,* July 2, 1917.

Carex angustior Mackenzie

Near Taberg. *House,* June 22, 1917.

Carex incomperta Bicknell

Low woods near Sylvan Beach. *House,* June 17, 1918. Also collected at Hannibal, Oswego county, *House 5597,* June 27, 1914; Kasoag, Oswego county, *House,* June 21, 1918, and in Bergen swamp, Genesee county, *G. W. Clinton* (state herbarium).

Carex rosaeoides E. C. Howe

Sylvan Beach. *House,* June 8, 1914.

Lycopodium clavatum L., var. **megastachyon** Fernald & Bissell (var. monostachyon N. Y. Reports, not Grev. & Hook.)

New London. *House,* July 15, 1918.

Ophioglossum vulgatum L., forma **pusillum** (Raf.) comb. nov.

O. pusillum Raf. in Desv. Jour. Bot. II., 4: 273. 1814. Not Nutt. 1818
O. Grayi Beck, Bot. 458. 1833

Depressions in sterile, turfy, sandy soil near the site of the old Fort Bull west of Rome. *House,* July 20, 1918.

Typical plants are often not more than 5 or 6 cm in height, but fertile, the sterile blade frequently less than half an inch long and less than one-fourth of an inch wide. Purely a starved or depauperate form and perhaps not worth any systematic recognition.

Lycopodium complanatum L., var. **flabelliforme** Fernald, forma **Wibbei** (Haberer) comb. nov.

L. complanatum var. *Wibbei* Haberer, Rhodora, 6: 162. 1904

Differing from the typical condition of the variety flabelliforme, by the peduncles having each a single strobile. Near Utica, *Haberer.*

Echinochloa Crusgalli (L.) Beauv., var. **Michauxii,** nom. nov.

Panicum muricatum Michx. Fl. Bor. Am., 1: 47. 1803. Not Retz
Echinochloa muricata Fernald, Rhodora, 17: 106. 1915
E. crusgalli var. muricata Farwell, Rep't Mich. Acad. Sci., 21: 350. 1919

Sylvan Beach. *House,* September 18, 1916.

Common in low grounds, especially about Lake Ontario, Oneida lake and other localities in the Ontario lowlands and the St Lawrence basin, where it appears to represent an indigenous or native form of the European E. crusgalli. Has also been collected by Peck along the Hudson river near Albany.

Eleocharis reclinata Kunth, Enum. Pl. 2: 143. 1837.

Scirpus intermedius Muhl. Gram. 31. 1817. Not Thuill. 1799, nor Poir. 1804
Eleocharis intermedia Schultes, Mant., 2: 91. 1824
Scirpus reclinatus Beyr., in Kunth, l. c.

var. **Habereri** (Fernald) comb. nov.

E. intermedia var. Habereri Fernald, Rhodora, 8: 130. 1906

Common on the sandy shores of Oneida lake.

Juncus inflexus L. (*J. glaucus* Ehrh.)

Growing in dense round clumps, 1 to 3 feet broad, on springy hillsides along and adjacent to the Willanoa creek, near Waterville, town of Sangerfield. *House,* August 18, 1917. Determined by F. V. Coville.

Native of Europe, where widely distributed. Not previously reported from America. It is perhaps introduced at the above locality, although if so, the introduction must have occurred many years ago, as the plants are numerous and thoroughly at home, occupying quite an extent of sloping boggy or springy soil which has apparently never been under cultivation, but has been used for pasturage at various times.

Rosa rubifolia R. Br.

Open swampy ground east of Oneida. *House 6446,* July 11, 1919. Apparently native, and distinguished from R. setigera Michx. by its pale, almost white, velvety under surfaces of the leaves.

Oxalis Brittonae Small

Dry fields in sandy soil, north of Taberg. *House 6140,* June 6, 1919.

Oxalis oneidica, sp. nov.

Stems erect, but more or less decumbent at the base, 5–15 cm high, arising from short or occasionally elongated rootstocks; densely strigulose and quite slender; foliage grayish with a very fine, closely appressed indument; leaflets three, blades 8–12 mm wide, not appreciably ciliate; peduncles longer than the petioles, rarely overtopping the stem and its branches, two-flowered; flowers erect, the pedicels appressed-pubescent and refracted in fruit; sepals oblong-lanceolate, acute, 2.5–3.5 mm long, half as broad; petals pale yellow, 8–10 mm long, obcordate or notched; filaments glabrous; capsules columnar, 12–15 mm long, rather abruptly pointed at the apex and densely appressed-pubescent.

In dry sterile rocky and sandy fields. Taberg, *H. D. House 6140,* June 5, 1919 (type in the herbarium of the New York State Museum). Monroe county, *E. K. Killip* (herb. Rochester Acad. Sciences).

Closely related to Xanthoxalis stricta, as described in the North American Flora, but differs chiefly in its uniform dense grayish indument of fine appressed hairs, which extends to all parts of the plant except the petals and filaments.

Dentaria diphylla x maxima Haberer, hyb. nov.

The rootstocks are slightly constricted but not distinctly articulated; leaves three-foliate, the cauline ones two–three in number and more or less remote, rarely subopposite, more sharply toothed than in D. diphylla, otherwise resembling D. maxima.

Near Utica, *Haberer* (Type, in herb. N. Y. State Museum). Also collected near Oneida and Chittenango Falls, Madison county, *House.*

Dentaria laciniata x maxima Haberer, hyb. nov.

Growing with D. laciniata and D. maxima, and presenting all the appearance of being intermediate between the two species. Deerfield, Oneida county, *Haberer* (Type). Chittenango Falls, Madison county, *House.*

These plants correspond with the description of D. incisifolia Eames (Gray's Man. Ed. 7, 434. 1908). The report of D. heterophylla Nutt. by Paine (Cat. Pl. Oneida Co. 60. 1865) is probably based upon this hybrid, collected by Haberer at the locality cited by Paine. Typical D. heterophylla Nutt., is unknown in central New York.

Dentaria laciniata x diphylla, hyb. nov.

Locally common in several localities in Oneida county and other central New York towns. D. laciniata blooms several days to two weeks earlier than D. diphylla where the two species grow together, but often the blossoming of the two species overlaps. The hybrid is intermediate in leaf and root characters, and more easily recognized than either of the two Dentaria hybrids above mentioned. It appears to correspond to the description of D. anomalt Eames (Rhodora, 5: 217. 1903) although authentic specimens of that have not been seen. The type of this hybrid may be represented by a specimen collected near Oneida. *H. D. House 6898,* May 22.

Ibidium cernuum (L.) House, var. **ochroleucum** (Rydb.) comb. nov.

Gyrostachys ochroleuca Rydb., in Britton, Man. 300. 1901

Differing from the ordinary form of the species by its greenish yellow or creamy white flowers and longer floral bracts. Intermediate forms, however, are not unusual. The typical forms of I. cernuum are confined to bogs or their borders, while the var. ochroleucum occurs more frequently in pastures and on grassy slopes. Both are common in Oneida county.

Blepharoglottis Blephariglottis (Willd.) Rydb. var. **halopetala** (Lindl.) comb. nov.

Platanthera halopetala Lindl. Gen. & Sp. Orch. 291. 1830–40

A rare variety with narrower petals and the toothing of the lip obsolete, the lip less fringed or subentire. North pond near Boonville, Oneida county, from whence it was also reported many years ago by Paine.

Polygala polygama Walt., forma **albiflora**, forma nova

Corollas white. Sand plains north of New London. *House.*

Verbascum Lychnitis L.

In sandy fields about the eastern end of Oneida lake, this European species has long been a familiar sight. Occasionally plants are seen with white instead of yellow corollas, and these representing V. album Mill. (Gard. Dict. Ed. 8, No. 3, 1768) may be designated as **forma album** (Miller) comb. nov.

Verbascum Blattaria L.

The Moth Mullein is one of the common naturalized plants in the sandy fields east of Oneida lake, and as elsewhere in the State individuals are occasionally seen with white corollas. This was described by G. Don (Gen. Syst., 4: 497. 1838) as var. albiflorum, but may more properly be recorded here as forma **albiflorum** (G. Don) comb. nov.

Solidago graminifolia (L.) Salisb., var. **galetora** (Greene) comb. nov.

Euthamia galetorum Greene, Leaflets, 2: 151. 1911

Stems mostly simple, with a narrow corymbose inflorescence of several or few heads; plant entirely glabrous; leaves shining green when fresh, with a suggestion of succulency (as described by Greene), 3–7 cm long, 5–9 mm wide, acute or acuminate, but without a distinctly attenuate apex, broadest near the base which is abruptly narrowed to an obtuse or rounded sessile base.

In bogs and on boggy shores of lakes and ponds. Common on the north and south shores of Oneida lake, about lakes and ponds in the Adriondacks, and locally elsewhere in the St Lawrence basin and the region west of the Adirondacks.

Doellingeria umbellata (Mill.) Nees, var. **oneidica,** var. nov.

Leaves firmer in texture than in the typical species, scarcely paler beneath, only the branches of the small, compact inflorescence pubescent; upper leaves conspicuously reduced and linear-lanceolate; those directly beneath the inflorescence often but 1 to 3 cm long and strongly ascending; pappus white.

Long lake, Oneida county, *House.* Type.

Blephilia hirsuta (Pursh) Torrey forma **albiflora, forma nova**

Corollas white. Taberg. *C. H. Peck* (state herbarium).

Viola pedata L., var. **lineariloba** DC. forma **alba** (Thurber) comb. nov.

Viola pedata var. alba Thurber, Torr. Club Bul., 1:20. 1870

The type of this form is from Flushing, Long Island (*Allen*). It is also reported from Suffolk county, *Coles* (Torr. Club Bul., 2: 23. 1871) and from the pine plains north of Rome, Oneida county, *Paine* (Torr. Club Bul., 1: 22. 1870), where it was again observed by the writer in 1920. Britton (Torr. Club Bul., 17: 23. 1890) makes it a form of V. pedata, but all these white-flowered forms from New York appear to belong to the var. lineariloba DC.

Panicum aculeatum Hitchc. & Chase

Sandy thickets along the shore of Oneida lake, near Sylvan Beach. *House 8140,* June 20, 1921.

Carex Frankii Kunth

In a small marshy depression in a pasture along edge of woods, east of Oneida. *H. D. House,* Sept. 1, 1918. (Determined by Mackenzie). Mistaken at the time for poor specimens of C. Baileyi Britton. The pasture is continuously occupied by cattle, and another search in the autumn of 1921 failed to reveal any additional specimens.

Origanum vulgare L.

A form with white flowers occurs near Trenton Falls, *C. H. Peck* (state herbarium), and may be designated as forma **albiflorum** forma nova, although it may have already received a name in European literature. Doctor Peck has also collected the same form at Phoenicia, Ulster county.

Equisetum laevigatum A. Br.

Sandy shores of Oneida lake, Sylvan Beach. *House 5450,* June 5, 1914.

This has been previously collected in this region and reported as E. hyemale intermedium A. A. Eaton, namely, sand dunes at head of Oneida lake, Vienna (township). *Haberer 1950; 1950a and 1950c,* June 22, 1904. Doctor Peck has also collected the same species in the sandy plains of Albany county at Karner.

Another one of the collections by Haberer (*no. 1950c*) has one to six short branches at each of the upper nodes, sometimes these bearing small or reduced strobili. It may be designated with Doctor Haberer's herbarium name which accompanies the specimen, namely, **E. laevigatum** forma **proliferum** Haberer, forma nova. (E. hyemale intermedium forma proliferum Haberer, in herb.)

Onondaga County

Botrychium Lunaria L. var. **onondagense** (Underw.) comb. nov.

B. onondagense Underw. Torr. Club Bul., 30: 47. 1903

Renewed examination of this fern, apparently confined to Onondaga county, convinces the writer that it is merely a lax variety of B. Lunaria, with smaller, more distant and less lunate segments to the sterile leaf-blade. I am also inclined to regard B. tenebrosum A. A. Eaton as an extreme departure of B. Lunaria.

Cypripedum acaule Ait., forma **albiflorum,** forma nova

Flowers pure white. Reported from several localities. Type from Baldwinsville, Onondaga county, *Rev. W. H. Beauchamp* (state herbarium). Cooperstown, *J. A. Paine* (Cat. 139. 1865). Staten Island, *Heylyn* (Torr. Club Bul., 22: 462. 1895).

Limodorum tuberosum L., forma **albiflorum** (Britton) comb. nov.

Calopogon tuberosus forma albiflora Britton, Torr. Club Bul., 17: 125. 1890

Cicero swamp. *Mrs M. O. Rust* (Torr. Club Bul., 10: 67. 1883). Near Syracuse. *Mrs M. C. Still* (35th Rep't N. Y. State Museum 146. 1884). Bergen swamp, Genesee county, and other localities.

Aquilegia canadensis L., forma **albiflora**, forma nova

All parts of the corollas pure white. Near Syracuse. *Mrs L. L. H. Goodrich* (state herbarium).

Geranium maculatum L., forma **albiflorum** (Raf.) comb. nov.

G. maculatum var. albiflorum Raf. Med. Fl., 1: 217. 1828

Corollas white. Syracuse, *Mrs M. O. Rust* (state herbarium) and reported in 35th Rep't N. Y. State Museum 145. 1884.

Ontario County

Lysimachia terrestris x thrysiflora Fernald & Wiegand (Rhodora, 12: 140. 1910)

Canandaigua. *Miss E. C. Webster,* June 24, 1911.

This plant had been labelled by Doctor Peck as "Naumbergia thrysiflora with terminal spike," but possesses also lower axillary spikes of flowers producing sterile capsules. The terminal spike has all the appearance of that of L. terrestris, but bears near its base two lateral undeveloped short-stalked spikes in the axils of small leaflike bracts. The plant has the unmistakable appearance of being a hybrid between the two named species.

Megalodontia Beckii (Torrey) Greene

(Bidens Beckii Torrey)

Honeoye lake. *M. S. Baxter 5641,* August 15, 1921.

This remarkable species was first collected at Sander's lake, Schenectady, by Dr L. C. Beck, in flower. Paine's catalog (1865) adds the following localities: Canaderaga lake, outlet of Schuyler's lake, Oneida county, Oswego Falls, Sodus bay, and outlet at Owasco lake. Mrs Goodrich (Pl. of Onondaga Co. 189. 1912) reports it from Tully. Doctor Wibbe (Torr. Club Bul., 10: 46. 1883) reports it from Paddy lake, Oswego county, and Doctor Allen collected it at Saratoga lake (Torr. Club Bul., 21: 497. 1894), which collection is the basis for M. nudata Greene (Pittonia, 4: 271. 1901), based upon characters of doubtful value, and apparently representing merely a "habitat variant" such as frequently occurs in Ranunculus delphinifolius, and numerous other semiaquatic species.

Otsego County

Cypripedium arietinum R. Br., forma **albiflorum**, forma nova

All parts of the flower pure white. Summit lake, northern Otsego county. *B. D. Gilbert* (22d Rep't N. Y. State Mus. 103. 1869).

Oswego County

Carex scoparia var. **tessellata** Fernald & Wiegand
(Rhodora, 12: 135. 1910)

Kasoag marsh. *Dr C. H. Peck.* This has been labelled by Peck as "C. scoparia minor Boott," which is C. Crawfordii Fernald. The plants are but 2 to 3 dm high, the 2 to 6 spikes crowded into a dense inflorescence, which makes the plant resemble C. Crawfordii. The scales, however, are brownish and narrower than the body of the perigynia.

Carex Howei Mackenzie

Lily marsh, South New Haven. *House 8147,* June 22, 1921.

Carex incomperta x interior

Open marsh near Colosse. *House 8152,* June 23, 1921.

Panicum albemarlense Ashe

Lily marsh, South New Haven, growing on the turfy surface of a peat bed. *House 8448,* June 22, 1921. New to this section of the State.

Limodorum tuberosum L.

The leaves of this orchid are usually 5 to 15 mm broad and vary exceedingly in length, those in more exposed situations usually being shorter. In Oswego county occurs a rather remarkable extreme in which the leaves are exceedingly narrow (2 to 4 mm broad), long and grasslike, exactly simulating those of the southern L. graminifolium (Ell.) Small. This form may be designated as forma **linariifolium,** forma nova.

Kasoag marsh, Oswego county, *C. H. Peck* (type). Lily marsh, South New Haven, Oswego county. *H. D. House,* July 1, 1917.

Rensselaer County

Anchistea virginica (L.) Presl.

(Woodwardia virginica Sm.)

In a small bog near Brainerd. *House 7173,* July 7.

Carex grisea Wahl.

Common in woods north of Rensselaer. *House 6403,* July 3, 1919. **Carex sparganioides** Muhl., and **C. leptonervia** Fernald, growing with it.

Carex incomperta Bicknell

Low woods near Averill Park. *House 6340,* June 23, 1919. Growing with this species were **C. projecta** Mackenzie; **C. trisperma** Dewey; **C. brunnescens** (Pers.) Poir. and **Carex folliculata** L.

Aster Pringlei (Gray) Britton

In open dry woods near Averill Park. *House 7670,* October 3.

Viola pubescens Ait.

The capsules in this species are usually woolly with a dense white indument. Only two specimens; Bald mountain, Rensselaer county, *Peck,* and Harrisville, Lewis county, *Peck,* have glabrous or nearly glabrous capsules, and may be designated as var. **Peckii,** var. nov. Capsules glabrous or nearly glabrous. The Bald mountain collection by Doctor Peck may be designated as the type.

This variety is parallel to V. eriocarpa Schw., var. leiocarpa Fernald (Rhodora, 23: 275. 1922), to which nearly all of the New York specimens of V. eriocarpa seem to belong.

Galeorchis spectabilis (L.) Rybd., forma **Gordinierii,** forma nova

All parts of the flowers pure white. Schaghticoke. *H. C. Gordinier* (state herbarium). Reported in the 40th Rep't N. Y. State Mus. 73. 1887.

Rubus strigosus Michx., var. **canadensis** (Richards.) comb. nov.

R. Idaeus var. canadensis Richards. Bot. App. Frankl. Jour. Ed. 2, 747. 1823
Batidaea subarctica Greene, Leaflets, 1: 242. 1906
Rubus subarctica Rydb., N. Am. Fl., 22: 448. 1913
Rubus carolinianus Rydb., l. c. 447.

Inflorescence with both glands and minute bristles; new canes with slender bristles and sometimes also stipitate glands; bark of the new canes cineroeus-tomentulose beneath the prickles which are all bristleform.

Stephentown. *Dr C. H. Peck.* Also collected at North Elba, Essex county by *Doctor Peck.*

Typical R. strigosus has the bark of the new canes glabrous or nearly so, usually glaucous beneath the bristles and in age becoming lustrous. I can see no advantage in retaining R. strigosus as a variety of the European R. Idaeus, which has an inflorescence without glands or minute bristles. The leading authority who merges strigosus into R. Idaeus as a variety, does not hesitate to regard the glandular character of the inflorescence as one of specific value in the blackberries.

Calluna vulgaris (L.) Salisb.

Three miles south of Grafton Center. *Dr Rudolf Ruedemann*, September 5, 1921.

These plants were growing around the bases of dead or partially dead spruce trees (Picea picea) which had been imported several years ago from Schleswig-Holstein, Germany. The clumps of heather were not vigorous, but while persisting are not spreading and apparently the climate here is not suitable for this species.

The European heather so well established in eastern Massachusetts and on Martha's Vineyard island, has, unlike many other European introductions, failed to spread far beyond its original place of introduction. This Rensselaer county record recalls attempts to establish the species in the Adirondacks and on the sand plains between Rome and Oneida lake (Paine, Cat. Pl. Oneida Co. 101. 1865), made many years ago, but which were apparently not successful; at least the plants have not since been seen in these localities, although it might be expected to persist on the sand plains of Rome.

Rubus odoratus L., forma **albiflorus** forma nova

Petals white. Pyrites, St Lawrence county, *Mrs Orra Parker Phelps*.

Limodorum tuberosum L., forma **latifolium** (St John) comb. nov.

Calopogon pulchellus forma latifolius St John, Proc. Bost. Soc. Nat. Hist., 36: 69. 1921

Moreau, Saratoga county, *E. C. Howe* (state herbarium).

The leaves in this broad-leaved extreme are usually shorter than in the typical form and markedly broader, in the Moreau specimen 18 mm broad and 12 cm long, thus forming little more than an approach to the form as described by Doctor St John.

Hypericum majus (Gray) Britton

Along railroad north of Valley Falls. *House 8405*, July 19, 1921.

In the same moist ditch also grows in abundance H. mutilum, H. canadense and H. punctatum. The amount of variation in the size and shape of the leaves of H. majus, suggests the possibility that it might be a hybrid between H. canadense and H. punctatum.

St Lawrence County

Viola rostrata Pursh, forma **Phelpsiae**, forma nova

Petals all white. St Lawrence county, *Mrs Orra Parker Phelps*. Occasionally seen in other localities.

Saratoga County

Dentaria maxima Nutt.

Near Wilton. *Mrs Orra Parker Phelps,* June 10.

Hieracium Pilosella L.

Near Wilton. *Mrs Orra Parker Phelps,* May 10.

Ranunculus Boraeanus Jordan

Near Wilton. *Mrs Orra Parker Phelps,* June. Also previously collected and reported (cf. Rhodora, 21: 208. 1919).

Asplenium ebenoides R. R. Scott

Limestone ledges near Wilton. *Mrs Orra Parker Phelps.*

Iris Pseudacorus L.

Edge of a pond near Round Lake. *Charlotte Borgardus,* July 8.

Schuyler County

Malva sylvestris L.

There are but four specimens of this not uncommon European plant in the state herbarium, three of which belong to the variety **mauretiana** (L.) Boiss. In the Sheldon collection is a specimen from Watkins, *C. S. Sheldon,* July 31, 1881, which represents the typical form of **M. sylvestris.**

Steuben County

Solidago squarrosa Muhl., forma **ramosa** (Peck) comb. nov.

S. squarrosa ramosa Peck, N. Y. State Mus. Bul. 139, p. 36. 1910

A form of the species with the branches of the inflorescence forming a large pyramidal panicle. Corning, *Peck.*

Tompkins County

Meibomia nudiflora (L.) Kuntze, forma **Dudleyi,** forma nova

Corolla white. Thacher's pinnacle, West Dandy, *W. R. Dudley.*

Ulster County

Pogonia trianthophora (Sw.) B. S. P.

Low woods near Ashokan. *Dr H. M. Denslow,* September 1.

Pogonia verticillata (Willd.) Nutt.

Swamps near Ashokan. *Dr H. M. Denslow,* June 1.

Opuntia Opuntia (L.) Coulter

On ledges of rock about 5 miles south of Saugerties. *House 8419,* July 23, 1921.

Viola palmata x sororia hyb. nov.

Early leaves broadly ovate to reniform, entire or with some of the blades slightly lobed, somewhat pubescent above, glabrous beneath and on the petioles; later leaves softly and rather densely pubescent on the petioles and lower leaf surfaces, the blades less pubescent above, variously 3 to 7 lobed or nearly entire; flowers abundant but soon withering without developing fruit; capsules all from cleistogamous flowers on short, horizontal or deflexed and buried peduncles.

Saugerties, Ulster county, *C. H. Peck,* May 10, 1904. Type. Also collected at Van Cortlandt Park, New York City. *House.*

Aster violaris Burgess

Rocky woodlands near Cragsmoor. *House 8579,* August 20, 1921.

Aster Claytoni Burgess

Woods near Napanoch. *House 8566,* August 21, 1921.

In these specimens the leaves are thin, and with the white rays and subumbelliform clusters of the heads of the inflorescence matches well the description and plate by Burgess. It differs, however, in that the branches of the inflorescence and the bracts are densely glandular-canescent, the outer shorter bracts conspicuously green, inner longer ones with green midveins and green tips, all blunt or rounded and conspicuously webby-ciliated on the margins. The disk is pale or whitish, turning to slightly crimson with age. These characters do not accord well with the complete description of A. Claytoni, and the same lack of complete agreement of characters is to be noted in regard to many other recently collected specimens of Biotian asters with the descriptions by Burgess. It leads to the conclusion that following the lines marked out by Burgess an indefinitely larger number of so-called species might be established with as little satisfaction from a systematic point of view as prevails in the treatment of New York Crataegus by Sargent.

Warren County

Lysias Hookeriana (A. Gray) Rydberg

Constantine mountain, near Luzerne. *Dr H. M. Denslow* and *Rev. H. S. Smart,* June 22.

Aster novi belgi L.

On gravel bars along the Hudson river near North River. *House 7596,* September 14.

Washington County

Sagittaria graminea Michx.

Pearl Point, Lake George, in about 2 feet of water. *Dr Emmaline Moore,* September 9.

This is a common species in all the lakes and ponds of northern New York. This collection is interesting, however, because of the fine development of floating leaves. These leaves are on elongated filiform petioles, the blades lance-elliptic in shape with straight or slightly converging basal lobes which are one-third to one-fourth the length of the blades. The usual flattened phyllodia are also present. This is the only collection in the state herbarium of this species showing these floating leaves. The writer has examined scores of colonies in various Adirondack lakes during the past two summers without seeing any of these floating leaves, and it is possible that they develop only late in the season.

Subularia aquatica L.

Shore of Lake George. *Dr Emmaline Moore,* August.

Arctium Lappa L.

Roadsides near Cambridge. *House 7659,* September 17.

Wayne County

Geranium Robertianum L., forma **albiflorum** (G. Don) comb. nova

G. Robertianum var. albiflorum G. Don, Gen. Syst. 1:721. 1834

Corollas white. Sodus bay, *Battershall* (state herbarium). This color form was first reported in the New York State Museum Bulletin 2, p. 26. 1887.

Long Island

Polygonum pennsylvanicum var. **nesophilum** Fernald, Rhodora, 19: 73. 1917

A rather distinct humifuse plant of the borders of ponds and inlets of the coastal region. Collected at Amagansett, by *Doctor Peck* (state herbarium).

Hibiscus Moscheutos L., forma **Peckii,** forma nova

Petals pure white, otherwise like the typical species. Patchogue. *Dr C. H. Peck* (state herbarium).

Limonium trichogonum Blake, forma **albiflorum** (Raf.) comb. nov.

Statice caroliniana var. albiflora Raf. Med. Bot., 2: 94 1830

Corollas white. Occasional in the salt marshes along the south shore of Long Island.

Agalinis purpurea (L.) Pennell, forma **albiflora** (Britton) comb. nov.

Gerardia purpurea var. albiflora Britton, Torr. Club Bul. 17: 125. 1890

Occasional in the salt marshes along the south side of Long Island.

Lobelia syphilitica L., forma **albiflora** (Britton) comb. nov.

Lobelia syphilitica var. albiflora Britton, l. c.

On Long Island, according to Doctor Britton.

Cirsium discolor (Muhl.) Spreng. forma **albiflorum** (Britton) comb. nov.

Cnicus altissimus var. discolor, forma albiflorus Britton, l. c. 124

Reported from Long Island and also from Staten Island.

Polygala viridescens L., forma **albiflora** (Millsp.) comb. nov.

P. sanguinea var. albiflora Millsp. Fl. W. Va. 333. 1892

Corollas white. Rare and local. Hempstead, Long Island. *House.*

Philotria occidentalis (Pursh) comb. nov.

Serpicula verticillata angustifolia Muhl., Cat. 84. 1813
S. occidentalis Pursh, Fl. Am. Sept. 33. 1814
Apalanthe Schweinitzii Planch. Ann. Sci. Nat. Bot. III., 11: 76. 1849
Udora verticillata ? minor Engelm. in Jahrb. Wiss. Bot., 1: 465. 1885, as syn.
P. minor Small, Fl. SE. U. S. 47. 1903
Elodea minor Farwell, Rep't Mich. Acad. Sci., 17: 181. 1916
E. occidentalis St John, Rhodora, 22: 27. 1920

In New York reported only from the southeastern section of the State. New York City, *Torrey & Gilman;* Hastings, *Bicknell;* Long Island. *Miss E. G. Knight* (as cited by Rydberg).

Rhus copallina L., var. **nesophila,** var. nov.

Similar to R. copallina in general appearance. Leaflets 13 to 17 in number, thicker in texture, less pointed at the apex, being merely acute or abruptly acuminate, smooth, somewhat shining and nearly glabrous above or with a very minute and inconspicuous puberulence during the early part of the season, margins chiefly entire, rarely with two or three low, almost obsolete teeth; wings of the rachis very conspicuous and broad.

Moist thickets along the margins of salt marshes near Oceanside, Nassau county. *House,* September 20, 1917 (type).

Viola pedata L., var. lineariloba DC., forma rosea (Sanders) comb. nov.

Viola pedata var. rosea Sanders, Rhodora, 13: 172. 1911

This form with the rosy colored petals is rare. The only known locality for it in this State is on the edge of the Hempstead plains, *House.*

Washingtonia longistylis (Torrey) Britton var. villicaulis (Fernald) comb. nov.

Osmorrhiza longistylis var. villicaulis Fernald, Rhodora, 10: 52. 1908

Cold Spring Harbor. *Percy Wilson,* June 13, 1915.

Lathyrus palustris L., var. pilosus (Cham.) Ledeb.

Wading River, Long Island. *E. S. Miller* (state herbarium). Similar to the var. linearifolius Ser., but the stems, leaves, calyces and pods finely and densely pubescent.

Honkenya peploides (L.) Ehrh. var. robusta (Fernald) comb. nov.

Adenarium maritimum Raf. New Fl., 1: 62. 1836, excel. syn. L.
Holesteum succulentum Nutt. Gen., 1: 89. 1818. Not L.
Arenaria peploides var. robusta Fernald, Rhodora, 11: 113. 1909

Fernald (l. c.) points out that the typical form of this species occurs on the coastal sands of the boreal regions and in America only from Labrador and arctic Alaska. The common form along our coast was described by Rafinesque as A. maritimum. Fernald's reason for not adopting this as a varietal name for our plant is that it is inappropriate as a varietal designation for a plant wholly maritime.

Alopecurus aristulatus Michx.

Fields near Orient. *Roy Latham,* July 4.

Amaranthus pumilus Raf.

In sand along the ocean beach, Smith's Point. *Roy Latham.*

Aristida tuberculosa Nutt.

Sandy woods, Laurel, town of Southold. *Roy Latham,* September.

Centaurea nigra var. radiata DC.

Dry fields near Cutchogue. *Roy Latham,* August 15, 1919.

Cornus Amomum L.

Border of swamp near Orient. *Roy Latham,* September 2.

Diodia teres Walt.

Low pastured land near Orient. *Roy Latham,* August 29, 1915.

Cyperus dentatus Torr.

Near Riverhead. *Roy Latham,* August 4, 1918.

Euphorbia Ipecacuanhae L.

Sandy soil near Riverhead. *Roy Latham,* August 9, 1918.

Draba caroliniana Walt.

Sandy soil, West Long Beach, Orient. *Roy Latham,* May 23.

Onosmodium virginianum (L.) DC.

In dry woods, Cutchogue, town of Southold. *Roy Latham,* September.

Neopieris mariana (L.) Britton

In low woods, Cutchogue. *Roy Latham,* August 15.

Hudsonia ericoides L.

Sandy pine woods, Bay View, town of Southold. *Roy Latham,* July. Mr Latham remarks that this is the only station known for this plant in the town of Southold.

Minuartia caroliniana (Walt.) House

(Arenaria caroliniana Walt.)

Sandy soil. Amagansett. *Roy Latham,* June 28.

Alsine canadensis (Pers.) House

(Arenaria canadensis Pers.; Spergularis borealis Robinson)

A species of the northern shores of eastern America, which appears to reach its southern limit of distribution on Shelter island, opposite Greenport, where collected by *Dr C. H. Peck,* in 1871 (state herbarium).

Panicularia obtusa (Muhl.) Kuntze

Near Riverhead. *Roy Latham,* August 9, 1918.

Spartina juncea var. caespitosa (A. A. Eaton) Hitchc.

Along the borders of salt marshes near Orient. *Roy Latham,* July 20.

Lactuca canadensis L., var. **montana** Britton

(in Britton & Brown, Illus. Fl., 3: 274. 1898)

L. integrifolia Bigel. Fl. Bost. Ed. 2, 287. 1824. Not Nutt.
L. sagittifolia Ell. Bot. S. C. & Ga., 2: 253. 1822; Gray's Man. Ed. 7, 867. 1908
L. elongata var. integrifolia T. & G., Fl. N. Am., 2: 496. 1843
L. canadensis var. integrifolia Gray, Man. Ed. 5, 281. 1869

Leaves thin, acuminate, pale beneath, tapering to a sessile sagittate-clasping base, the lower ones sparingly sinuate-toothed toward the base, the upper ones all entire; stem glabrous and glaucous, achenes black, oval, flattened, one-nerved on each face, finely pitted and transversely wrinkled, the beak about equal to the body of the achene in length; pappus white; flowers apparently yellow.

This is doubtless the plant reported by Burnham and Latham (Torreya, 14: 252. 1914) as L. sagittifolia Ell., which is not uncommon in southern New York. The plants here described were collected by *Roy Latham,* at Cutchogue, town of Southold, and presented to the state herbarium.

NOMENCLATORIAL NOTES REGARDING CERTAIN NEW YORK STATE PLANTS

The purpose of the following notes is to present in a somewhat formal manner changes of names of certain plants, varieties and forms, which have been found necessary in order to secure uniformity of nomenclature throughout the proposed list of New York State plants.

An intensive study of the flora of the State which the writer has been engaged upon for several seasons, develops the necessity which always follows a careful study of local variations, of recognizing formally the existence of distinct varieties, many of which possess a distinct geographical range, others of which seem to be more dependent upon certain ecological conditions. The systematic position of " forms " as they are now designated is less satisfactory, but it seems necessary in a list of this sort to record formally the most marked members of this category.

Torresia Nashii (Bicknell) comb. nov.

Savastana Nashii Bicknell, Torr. Club Bul., 25: 104. pl. 189. 1898

In and along the edges of brackish marshes near New York City.

Eleocharis annua (Thuill.) comb. nov.

Scirpus ovatus Roth, Catal. Bot., 1: 5. 1797. Not Gilib. 1792
S. capitatus Schreb. Spicil. 60. 1771. Not L.
S. compressus Moench, Meth. 349. 1794. Not Pers.

S. annuus Thuill. Fl. Par. Ed. 2, 22. 1799
S. multicaulis C. C. Gmel Fl. Bad., 1: 96. 1806. Not Vahl
Eleocharis ovata R. Br. Prodr., 1: 224. 1810

A common annual species of Spike Rush, found in most sections of the State.

Juncoides intermedium (Thuill.) Rydb.

(J. multiflorum Druce)

var. echinatum (Small) comb. nov.

Juncoides echinatum Small, Torreya, 1: 74. 1901
Luzula multiflora var. echinata Fernald & Wiegand, Rhodora, 15: 42. 1913

A southern extreme of the common wood rush, extending northward, chiefly in the coastal plain across southern New York into New England. Inflorescence looser and rarely with more than one of the heads sessile, others more spreading and often widely divergent, some of the rays 5 cm long.

Quercus rubra L. Sp. Pl. 996. 1753

Q. rubra, B. L., l. c.
Q. rubra maxima Marsh. Arb. Am. 122. 1785
Q. rubra var. latifolia Lam. Encycl., 1: 721. 1785
Q. borealis var. maxima Sarg. Rhodora, 18: 48. 1916

According to Sargent (Rhodora, 17: 39. 1915) the Linnaean type of Q. rubra is the tree more recently called Q. falcata or Q. digitata, and hence chiefly south of our borders. This is quite parallel to the confusion which Sargent has caused in the names of the balsam poplar, the chestnut oak, and other species.

If Q. rubra rested absolutely upon the Gronovian and Plukenet citations, as Sargent seems to assume, the change though regrettable, might be excused. However, it happens that Q. rubra was briefly described by Linnaeus in the Species Plantarum, and the Gronovian and Plukenet citations merely appended; and in this case, as in numerous other Linnaean species of the species Plantarum, wrongly so. Nothing is to be gained by such a change and in most instances of this sort the alternative plant (Q. falcata, in this case), has since received a valid name, and the well-known and long-used Linnaean name can be retained by merely excluding the wrongly appended citations.

It is of little consequence that the specimen in the Linnaean herbarium under Q. rubra is not our northern species. The Linnaean herbarium is full of such examples if we may judge from the detailed reports by various authors upon the examinations made. Asa Gray was one of the first to take formal notice of this condition, and his treatment of such cases shows a wisdom which time has amply justified.

In the case of Populus balsamifera, while the plates cited by Linnaeus are not of our northern species, the species in the species Plantarum rests upon a brief description taken from the Hortus Cliffortianus, which is quite certainly our northern plant, and to which the name P. balsamifera must apply unless we wish to invite a confusion of nomenclature which will render ridiculous all proposed codes.

Professor Sargent should read and reflect upon the common sense statement by Fernald in regard to the name Prunus virginiana L. (Rhodora, 18: 140–141. 1916).

In its typical form the true red oak has very large acorns with very shallow cups, but not infrequently intergrading with the variety known as the gray oak, which has smaller acorns and deeper cups and which does not seem to have, in this State at least, any distinct geographical range separate from that of Q. rubra. It has been regarded by some authorities as a distinct species, but is better placed as a variety:

var. **borealis** (Michx. f.) comb. nov.

Q. ambigua Michx. f. Hist. Arb. Am., 2: 120. *pl. 24.* 1812. Not Humb. & Bonpl.
Q. borealis Michx. f. N. Am. Sylv., 1: 98. *pl. 26.* 1817

Campe stricta (Andr.) Wight, var. **taurica** (DC.) comb. nov.

Barbarea taurica DC, Syst., 2: 207. 1821
B. arcuata Reichenb. Flora, 5: 296. 1822
B. vulgaris var. arcuata Fries, Novit. Fl. Suec. 205. 1828

A variety, or perhaps little more than a form of the typical species, with arcuate-ascending pods. Occasional throughout the State as a naturalized or adventive plant.

Carex strictior Dewey

A form of this species growing at Hidden lake in southern Herkimer county and elsewhere, with very short and stout pistillate spikes was described by Doctor Peck as Carex stricta var. curtissima (Howe, in 48th Rep't N. Y. State Mus. 150. 1895). The true C. stricta as distinguished by Mackenzie appears to be limited in this State to the coastal plain, where a similar form was also collected by Peck, but the Hidden lake specimen is the type, and may be designated as **Carex strictior**, forma **curtissima** (Peck) comb. nov.

Carex strictior also passes into another extreme in which the pistillate spikes are but 2.5 to 3 mm thick and 25 to 40 mm long, and less compact, often staminate at the apex. This is Carex angustata Boott, C. xerocarpa Wright, or C. stricta var. angustata Bailey, but is doubtless better recorded as a form: **Carex strictior**, forma **angustata** (Boott) comb. nov.

Carex stricta Lam.

This coastal plain sedge exhibits parallel forms to those of Carex strictior. Forma **brevior,** forma nova. Pistillate spikes stout, 5–15 mm long and 3.5–4.5 (rarely 5) mm thick, sometimes staminate at the apex. Islip, Suffolk county, *Peck* (type). Forma **pedicellaris,** forma nova. Pistillate spikes very slender on short or sometimes somewhat elongated filiform stalks, 2.5–3 mm thick, 15–40 mm long, the peryginia less crowded and toward the base becoming widely separated. Islip, Suffolk county, *Peck* (type).

Vaccinium angustifolium Ait. Hort. Kew., 2: 11. 1789

Leaves narrowly lanceolate, 7 to 20 mm long and 3 to 7 mm wide in the typical form, merging into the commoner, broader-leaved and more glabrous form which may be designated as var. **laevifolia,** var. nov. (V. pennsylvanicum Lam., not Mill.)

Another extreme of the species has the leaves and twigs more or less pubescent, the leaf-blades evidently lustrous, and is var. **myrtilloides** (Michx.) comb. nov. (V. myrtilloides Michx. Fl. Bor. Am. 1: 234. 1803; A. pennsylvanicum var. myrtilloides Fernald, Rhodora, 10: 148. 1908), and while chiefly more northern in distribution, has been collected by Peck at Islip, Long Island.

Asclepias pulchra Ehrh., forma **albiflora,** forma nova

Flowers white. Clove lake, Staten Island, *Hollick.* Also reported in Torr. Club Bul., 6: 294. 1879, under A. incarnata

Lithospermum luteum (Raf.) comb. nov.

L. latifolium Michx. Fl. Bor. Am., 1: 131. 1803. Not Forsk. 1775
Cyphorina latifolia Raf. Am. Mo. Mag., 4: 191. 1819
Cyphorina lutea Raf. Cat. 13. 1824
L. lutescens N. Coleman, Cat. Pl. Grand Rapids. 29. 1874

In dry thickets, fields and woods. Infrequent in the western part of the State.

Pontederia cordata L.

Under Umsena (Med. Repos. II, 5: 352. 1808) and Unisema (Med. Bot., 2: 107. 1830), Rafinesque describes several so-called species, all referable to forms of the Linnaean species. Of these forms occurring in New York, his U. media represents our common form, while his U. Purshiana is the very narrow-leaved form (P. angustifolia Pursh).

Forma **angustifolia** (Pursh) comb. nov.

In this form the leaves vary from 4 to 8 inches in length, and one-half of an inch to 2 inches broad at the hastate base. Stissing pond, Dutchess county, *Peck*.

Forma **latifolia** (Raf.) comb. nov.

(Unisema latifolia Raf.)

Leaves 5 to 7 inches long, occasionally longer, and 4 to 5 inches broad at the shallowly cordate-hastate base. Mud lake, North Hannibal, Oswego county, *C. S. Sheldon*, August 25, 1879.

Other and less-marked forms might be recognized with respect to the base of the leaf-blades which in some colonies are more cordate and in other colonies more hastate. The form of the typical species, forma **albiflora** (Raf.) comb. nov. (Unisema media var. albiflora Raf.) with white flowers, has not, to my knowledge, been reported from New York.

Agalinis tenuifolia (Vahl) Raf., forma **albiflora** (Britton) comb. nov.

(Gerardia tenuifolia var. albiflora Britton)

Occurs rarely with the typical species.

Solidago caesia L.

Gray (T. & G. Fl. N. Am., 2: 199. 1841), states that no specimen of S. caesia exists in the Linnaean herbarium, and that the species must rest upon "Virga aurea marilandic caesia glabra" Dill Elth, *t. 307 f. 395*. This is the so-called var. paniculata.

The common northern form with mainly simple stems, the thin leaves much exceeding the very small axillary flower clusters, appears to be more properly designated as a form than as a variety; forma **axillaris** (Pursh) comb. nov. (S. axillaris Pursh, Fl. Am. Sept. 542. 1814; S. caesia var. axillaris A. Gray).

Senecio pauperculus Michx. var. **praelongus** (Greenman) comb. nov.

S. Balsamitae var. praelongus Greenman, Rhodora, 3: 6. 1901

Reported from northern New York in the seventh edition of Gray's Manual (1908), but is not represented from this State in the state herbarium.

OSTEOSPERMUM L. Sp. Pl. 923. 1753

O. Uvedalia L. is quite obviously the type of Osteospermum L., both in the treatment by Linnaeus and by Miller (Gard. Dict. 4th Abr. Ed. 1754). The Old World species heretofore left in Osteospermum should be placed in Monilifera Adans. (1763), or in Gibraria Cass. (1817).

Rather recently Small and Carter (Fl. Lancaster Co. Pa. 302. 1913) have revived the generic name Polymniastrum Lam. for O. Uvedalia L., although it is antedated by Alymnia Necker. Polymnia L. as a genus can be retained only if P. canadensis is regarded as generically distinct from O. Uvedalia, as is done by Small and Carter. The writer prefers to retain them both under Osteospermum.

Osteospermum canadense (L.) comb. nov.

Polymnia canadensis L. Sp. Pl. 926. 1753

CRATAEGUS L.

The following changes in the names of certain thorns have been submitted by W. W. Eggleston, who has prepared a complete account of the New York State species, for the proposed list of New York State plants.

Crataegus Crus galli x succulenta Eggl., hyb. nom. nov.

To this hybrid name should be referred C. persimilis Sarg., C. helderbergensis Sarg., C. robusta Sarg., and C. cerasina Sarg.

It is known from Buffalo, Niagara Falls, Rochester, Hemlock lake, and at Thompson's lake, Albany county.

Crataegus punctata x succulenta Eggl., hyb. nom. nov.

C. menandiana Sarg. N. Y. State Mus. Bul. 105, p. 69. 1906

Collected at Menands, Albany county, *Peck*.

Crataegus straminea Beadle, var. **Bissellii** (Sarg.) Eggl., comb. nov.

C. Bissellii Sarg., Rhodora, 5: 65. 1903
C. apposita Sarg., var. Bissellii Eggl., Rhodora, 10: 76. 1908

Known from North Greenbush, Staatsburg, Ithaca, Coleman's Station and Moore's Mills, near New York City and at Rochester.

Crataegus chrysocarpa Ashe

(C. rotundifolia (Ehrh.) Moench, not Lamarck)

var. **Faxoni** (Sarg.) Eggl., comb. nov.

C. Faxoni Sarg. Rhodora, 5: 161. 1903
C. rotundifolia var. Faxoni Eggl. Rhodora, 10: 79. 1908

Known from Orient Point, Albany, Crown Point, North Greenbush, Pawling, Fort Ann, North Elba, Lake Placid, Chateaugay, Buffalo and Ogdensburg.

Crataegus chrysocarpa x macrosperma Eggl., hyb. nom. nov.

C. maligna Sarg. N. Y. State Mus. Bul. 167, p. 111. 1913

Collected near Ogdensburg, *John Dunbar*.

Crataegus chrysocarpa x punctata Eggl., hyb. nom. nov.

C. neo-Baxteri Sarg., l. c., 122: 74. 1908

Collected at Tuscarora, *M. S. Baxter*.

Crataegus macrosperma x pruinosa Eggl., hyb. nom. nov.

C. implicata Sarg., l. c., 122: 49. 1908
C. dissociabilis Sarg., l. c. 95

Buffalo, *Peck*. Coopers Plains, *Cornell*.

Crataegus macrosperma x punctata Eggl., hyb. nom. nov.

C. Harryi Sarg., l. c., 122: 124. 1908

Richmond, Ontario county; Canadice lake, and Honeoye lake.

Crataegus pruinosa x straminea Eggl., hyb. nom. nov.

C. brevipes Peck, N. Y. State Mus. Bul. 139, p. 20. 1910

Corning, *Peck*.

Crataegus pruinosa x punctata Eggl., hyb. nom. nov.

C. hudsonica Sarg. Man. 457. *f. 373.* 1905

Albany and Greenbush, *Peck*.

Crataegus coccinea L.

(Crataegus pedicillata Sarg.)

var. **Ellwangeriana** (Sarg.) Eggl., comb. nov.

C. Ellwangeriana Sarg. Bot. Gaz., 33: 118. 1902
C. pedicillata var. Ellwangeriana Eggl., Rhodora, 10: 82. 1908

Widely distributed across the State.

Crataegus coccinea x macrosperma Eggl., hyb. nom. nov.

C. Hadleyana Sarg., N. Y. State Mus. Bul. 167, p. 93. 1913
C. Maribella Sarg., l. c.

Herkimer and Little Falls, *Haberer.*

Crataegus coccinea x pruinosa Eggl., hyb. nom. nov.

C. pallescens Sarg., l. c. 81
C. seclusa Sarg., l. c. 89
C. latifolia Sarg., l. c. 83

Ogdensburg, *John Dunbar;* Richmond on Hemlock lake, Livingston county, *Brown.*

Crataegus Brainerdii var. **Egglestoni x succulenta** Eggl., hyb. nom. nov.

C. Peckietta Sarg., Rhodora, 7: 174. 1905

Piseco, Hamilton county, *Peck;* Lake Pleasant, *Peck;* Keene, Essex county and Horicon, Warren county, *Peck.*

Crataegus succulenta Schrader

C. glandulosa var. macrantha Lindl., C. macrantha var. minor Lodd., C. Halliana Sarg., C. sonnenbergensis Sarg., C. macrantha var. succulenta Eggl., Rhodora, 10: 82. 1908

var. **macrantha** (Lodd.) Eggl., comb. nov.

C. macrantha Lodd. in Loud. Arb. Brit., 2: 819. 1838
C. macracantha Koehne, Deutsche Dendr. 236. 1893
C. ferentaria Sarg., C. Beckiana Sarg., C. microsperma Sarg., and C. ogdensburgensis Sarg.

var. **rhombifolia** (Sarg.) Eggl., comb. nov.

C. rhombifolia Sarg., Rhodora, 5: 183. 1903
C. macrantha var. rhombifolia Eggl., Rhodora, 10: 82. 1908

Crataegus Calpodendron (Ehrh.) Medic. Geschichte Bot. 83. 1793

Mespilus Calpodendron Ehrh. Beitr., 2: 67. 1788
C. Crusgalli Mill. Gard. Dict. ed. 8, No. 5, 1768. Not L.
C. tomentosa DuRoi, Harbk. Baumz. Ed. 1, 183. 1771. Not L.
C. Chapmani Ashe. Bot. Gaz., 28: 270. 1899
C. Chapmani var. Plukenetii Eggl., Rhodora, 10: 83. 1908

Crataegus Calpodendron x punctata Eggl., hyb. nom. nov.

C. celsa Sarg., N. Y. State Mus. Bul. 122, p. 31. 1908

Niagara Falls, *John Dunbar.*

RUYSCHIANA Miller, Gard. Dict. 4th Abr. Ed., 1754.

Moldavica (Tourn.) L. (1735); Adans. Fam. Pl., 2: 190. 1763
Zornia Moench, Meth. 410, 1794, in part. Not Zornia J. F. Gmel.
Dracocephalum Benth. Lab. Gen. & Sp. 490. 1832–36. Not L.

Doctor Britton takes up Adanson's name for this group of the mint family, which is distinguished from the true Dracocephalum of Linnaeus (Physostegia Benth.) by the posterior (upper) pair of stamens being longer than the anterior ones, while in Dracocephalum the posterior pair of stamens is shorter than the anterior pair. In Ruyschiana the calyx is two-lipped, while in Dracocephalum the calyx is nearly or quite equally five-toothed or five-lobed, a combination of characters which in this family is of considerable importance and which places Ruyschiana (Moldavica) in a separate subdivision of the family.

Ruyschiana contains about thirty species, mostly natives of Europe and western Asia, with a single species in North America. The species fall naturally into five sections. The type of Moldavica Adans. is Dracocephalum Moldavica L., while the type of Ruyschiana is Dracocephalum Ruyschiana L., which belongs to a section which differs from the other four sections of the genus mainly in having the anthers villous.

Dracocephalum virginianum L. is quite clearly the type of the genus Dracocephalum, not only in the treatment by Linnaeus, but in pre-Linnaean literature.

Ruyschiana parviflora (Nutt.) comb. nov.

Dracocephalum pariflorum Nutt. Gen. 2: 35. 1818
? D. nervosum Raf. Fl. Ludov. 43. 1817
Moldavica parviflora Britton, in Britton & Brown, Illus. Fl. Ed. 2, 3: 114. 1913

This is the only member of the section **Cryptodracon** (Benth.) comb. nov. (Dracocephalum, Sect. Cryptodracon Benth.)

The principal Eurasian species are as follows:

Sect. 1. **Keimodracon** (Benth.)

Ruyschiana pinnata (L.) comb. nov.
Dracocephalum pinnatum L. Sp. Pl. 594. 1753.

Ruyschiana discolor (Bunge) comb. nov.
Dracocephalum discolor Bunge; Verz. Suppl. Fl. Alt. 51. 1836
D. origanoides Ledeb. Fl. Alt., 2: 383. 1830. Not Steph.

Ruyschiana palmata (Steph.) comb. nov.
Dracocephalum palmtaum Steph.; Willd. Sp. Pl., 3: 151. 1800

Ruyschiana botryoides (Stev.) comb. nov.
Dracocephalum botryoides Stev. Hem. Soc. Nat. Cur. Mosc., 3: 266. 1812
Ruyschiana origanoides (Steph.) comb. nov.
Dracocephalum origanoides Steph., Willd. Sp. Pl., 3: 151. 1800

Sect. 2. **Calodracon** (Benth.)
Ruyschiana grandiflora (L.) comb. nov.
Dracocephalum grandiflorum L. Sp. Pl. 595. 1753
D. altaiense Laxm. Nov. Comm. Petrop., 15: 556. *t. 29. f. 5.* 1770
Ruyschiana imberbis (Bunge) comb. nov.
Dracocephalum imberbe Bunge, Verz. Suppl. Fl. Alt. 50. 1836
D. grandiflorum: Willd.; Ledeb. Fl. Ross., 3: 385. 1846–51. Not L.
Ruyschiana Wallichii, nom. nov.
Dracocephalum speciosum Benth. in Wall. Pl. Rar. Asiat., 2: 65. 1831. Not Sweet.
Ruyschiana fragilis (Turcz.) comb. nov.
Dracocephalum fragile Turcz. in Benth. Lab. Gen. & Sp. 495. 1832–36

Sect. 3. **Cryptodracon** (Benth.)
Sect. 4. **Moldavica** (Tourn.)
Ruyschiana Moldavica (L) comb. nov.
Dracocephalum Moldavica L. Sp. Pl. 595. 1753
Moldavica punctata Moench, Meth. 410. 1794
Moldavica suaveolens Gilib. Fl. Lituan., 1: 79. 1781
D. fragrans Salisb. Prodr. 87. 1796
M. Moldavica Britton, l. c. 115.
Ruyschiana heterophylla (Benth.) comb. nov.
Dracocephalum heterophyllum Benth. Lab. Gen. & Sp. 738. 1832–36
D. acanthoides Edgew.; Benth. in DC. Prodr., 12: 401. 1848
Ruyschiana peregrina (L.) comb. nov.
Dracocephalum peregrinum L. Sp. Pl. Ed. 2. 829. 1762
Ruyschiana verticillata Mill. Gard. Dict. Ed. 8, No. 2, 1768
Ruyschiana thymifolia (L.) comb. nov.
Dracocephalum thymifolium L. Sp. Pl. 596. 1753
Zornia parviflora Moench, Meth. 411. 1794
Ruyschiana nutans (L.) comb. nov.
Dracocephalum nutans L. Sp. Pl. 596. 1753
Zornia nutans Moench, l. c.
Ruyschiana fruticulosa (Steph. Comb. nov.)
Dracocephalum fruticulosum Steph.; Willd. Sp. Pl., 3: 152. 1800
Ruyschiana integrifolia (Bunge) comb. nov.
Dracocephalum integrifolium Bunge; in Ledeb. Fl. Alt., 2: 387. 1830

Sect. 5. **Euruyschiana**
(Dracocephalum, Sect. Ruyschiana Benth.)
Ruyschiana Ruyschiana (L.) comb. nov.
Dracocephalum Ruyschiana L. Sp. Pl. 595. 1753
Ruyschiana spicata Miller, l. c. No. 1.
Moldavica punctata Moench, Meth. 410. 1794
Zornia linearifolia Moench, l. c. Suppl. 139. 1802
D. angustifolium Gilib. Fl. Lituan., 1: 78. 1781
Ruyschiana austriaca (L.) comb. nov.
Dracocephalum austriacum L. Sp. Pl. Ed. 2, 829. 1762
Ruyschiana laciniata Miller, Gard. Dict. Ed. 8, No. 3. 1768
Zornia partita Moench: Steud. Nom. 285. 1821
Ruyschiana argunensis (Fisch.) comb. nov.
Dracocephalum argunense Fisch.; Link, Enum. Hort. Berol., 2: 118. 1822

VIREA Adans. Fam. Pl., 2: 112. 1763.

The type of Leontodon L., is L. Taraxacum, the common dandelion, and this is the treatment of the name by Britton (in Britton & Brown, Illus. Fl. Ed. 2, 3: 315. 1913). The numerous other species commonly referred to Leontodon by European writers do not form a wholly homogenous generic group, which is doubtless responsible in large part for the numerous generic names proposed for various species or groups of species more recently comprised in Leontodon.

Apargia Scop. seems to be the generally accepted name where Leontodon Taraxacum is excluded as being typical of Leontodon, although several other names such as Scorzoneroides Moench, Colobium Roth, Oporinia D. Don, and Thrinica Roth have been at various times commonly used.

The type of Virea Adans. is Leontodon autumnale L., and is therefore the earliest generic name for this group of species, none of them native to America, but several of which are well-known naturalized or adventive plants.

The generic synonyms of Virea Adans. are as follows:

Leontodon L. (in part) 1753: Gray's Man. Ed. 7, 863. 1908
Apargia Scop. Fl. Carn. Ed. 2, 2: 113. 1772
Antodon Neck. Elem., 1: 58. 1790
Plancia Neck., l. c. 49
Scorzoneroides Moench, Meth. 549. 1794
Colobium Roth, in Roem. Arch., 1: 36. 1796
Thrinica Roth, l. c. (*Thrica* S. F. Gray, 1821)
Oporinia D. Don, Edinb. New Phil. Jour. 309. 1828–29
Thrixia Dulac. Fl. Hautes-Pyr., 495. 1867
Hedypnois European Authors, Not Scop. 1772, as to type which is Leontodon Taraxacum L.

In addition to these, the generic names Asterothrix Cass., Deloderium Cass., Fidelia Sch.-Bip., Kalbfussia Sch.-Bip., Streckera Sch.-Bip., and Millina Cass., are referable to Virea Adans.

S. F. Gray divided the species between Thrica (*Thrinica*) Roth, and Virea Adans., and this general segregation under varying generic names is common to most of the earlier European floras, but which if maintained, necessitates the recognition of several other genera, which are more logically regarded as sections of a single genus, the earliest name of which is **Virea** Adans.

The species in our flora are as follows:

Virea autumnalis (L.) S. F. Gray (Leontodon autumnale L., Apargia autumnalis Hoffm.)

Virea autumnalis var. pratensis (Link) comb. nov.

Apargia pratensis Link, Handb., 1: 791. 1829. Leontodon pratensis Reichenb., L. autumnalis var. pratensis Koch.

Virea hispida (L.) S. F. Gray

(Leontodon hispidum L., Apargia hispida Hoffm., Hedypnois hispida Huds., Apargia communis Spenn., Leontodon hastile var. vulgaris Koch).

Virea hispida, var. hastilis (L.) comb. nov.

Leontodon hastile L. Sp. Pl. Ed. 2, 1123. 1763. Apargia hispida Willd., not Hoffm.; Apargia danubialis Scop., A. caucasia Bieb., A. heterophylla Moench.

Virea nudicaulis (L.) comb. nov.

Crepis nudicaulis L. Sp. Pl. 805. 1753
Leontodon hirtum L. Sp. Pl. Ed. 2, 1123. 1763
Apargia nudicaulis Britton, l. c. 310
Colobium hirtum Roth; Leontodon nudicaule Banks; Apargia hirta Scop.; and Thrinica hirta Roth.

Several additional species occur throughout southern Europe, northern Africa, western Asia and in central and eastern Europe.

Sambucus racemosus L.

A very rare form of the red-berried elder, with white fruit, is described in Torrey & Gray (Fl. N. Am., 2: 13. 1843) as having been collected in the Catskill mountains by J. Hogg. This form should be recognized as **Sambucus racemosus forma leucocarpa** T. & G.) comb. nov. (S. pubens β. leucocarpa T. & G., l. c.)

Lacinaria spicata (L.) Kuntze

The white-flowered form described by Doctor Britton, as Liatris spicata f. albiflora (Torr. Club Bul., 17: 124. 1890) should be designated as **Lacinaria spicata forma albiflora** (Britton) comb. nov.

Hypopitys lanuginosa (Michx.) Nutt. var. rosea (Torrey) comb. nov.

Monotropa lanuginosa var. rosea Torrey, Fl. N. Y. 1: 457. 1843
Hypopitys insignata Bicknell, Torr. Club Bul., 41: 413. 1914

The characters mentioned by Bicknell which serve to distinguish this from H. lanuginosa are too insignificant for a clear specific recognition. Although lower and more compact in statue its flowering period is not always later, the writer having collected what is apparently this variety, at least the plants were bright rosy red in color, at Merrick, Long Island, on July 28, 1916 (state herbarium).

Silene anglica L.

This name has priority over S. gallica L., by which name the species has been most commonly known. The rather rare variety with more showy petals which are subentire, deep crimson with a white or pink border (S. quinquevulnera L. Sp. Pl. 417. 1753), should be known as **Silene anglica var. quinquevulnera** (L.) comb. nov. (S. gallica var. quinquevulnera Koch). This variety is occasionally seen in gardens and rarely escapes to waste places.

Gnaphalium obtusifolium L. var. Helleri (Britton) comb. nov.

Gnaphalium Helleri Britton, Torr. Club Bul., 20: 280. 1893
G. polycephalum var. Helleri Fernald, Rhodora, 10: 94. 1908

Infrequent or rare from central New York westward and southward does not appear to be always clearly distinguishable from the common G. obtusifolium L.

Helianthus decapatalus L.

The plants collected at Woodlawn, New York City, and described by Britton as H. scrophulariaefolius (Manual 995. 1901) and later considered by Doctor Britton as possibly but a form of H. decapetalus (Illus. Fl. ed. 2, 1913), may for the present be considered as a variety of that species: **Helianthus decapetalus, var. scrophulariaefolius** (Britton) comb. nov. The distinct laciniate-serrate character of the leaves serves as its chief distinguishing feature.

NEW OR NOTEWORTHY SPECIES OF FUNGI, III

BY

JOHN DEARNESS *and* HOMER D. HOUSE

Alternaria Solani (E. & M.) Jones & Grout

Munnsville, Madison county, on Amaranthus retroflexus L. *H. D. House,* October 13. The host plants were growing with Solanum tuberosum L., similarly affected with the "early blight."

Botryosphaeria fuliginosa (M. & N.) E. & E.

Albany, on dead limbs of Ulmus americana L. *H. D. House,* November 15, 1919. This is sometimes identified as Botryosphaeria Quercuum (Schw.) Sacc. (Syll., 1: 456. 1882). The range of hosts, as represented in the state herbarium, includes in addition to Ulmus; Quercus, Fraxinus, Juglans, Sassafras, Acer, Ceanothus and Rubus.

Camarosporium metablitícum Traill.

On dead leaves and culms of Ammophila arenaria (L.) Link. Round pond, Monroe county. *H. D. House,* July 3, 1917. Also collected by Doctor Jelliffe, in May 1893, on the same host at Rockaway Beach, N. Y. (Shear, N. Y. Fungi No. 379), and a collection from the same locality by Doctor Jelliffe (April 1893), was described by Ellis and Everhart as C. grammicolum (Acad. Sci. Phila. Feb. 1893, p. 161).

Cercospora caricis Dearness & House

On living and languishing leaves of Carex arctata Boott. Inlet, Hamilton county, *H. D. House,* August 14, 1919.

Cercospora galii Ellis & Holway

On living leaves of Galium asprellum Michx. Fourth lake, Herkimer county, *H. D. House,* August 11, 1919.

Cercospora cerasella Sacc.

On living leaves of Prunus serotina Ehrh. Karner, Albany county, *H. D. House,* October 2, 1919.

Cercospora menispermi Ellis & Holway

On living leaves of Menispermum canadense L. South bay, Madison county, *H. D. House,* September 16, 1919.

Cercospora tabacina Ellis & Everhart

On living leaves of Rudbeckia laciniata L. Oneida, Madison county, *H. D. House,* September 19, 1919.

Cladosporium gleosporioides Atkinson

On living leaves of Triadenum virginicum (L.) Raf. (Hypericum virginicum L.). Fourth lake, Herkimer county, *H. D. House,* August 9, 1919; Albany, August 22, 1919.

Cercospora kalmiae Ellis & Everhart

On living and languishing leaves of Kalmia latifolia L. Napanoch, Ulster county, *H. D. House,* October 6, 1919.

Cercospora lespedezae Ellis & Dearness

On living leaves of Lespedeza hirta (L.) Hornem. Karner, Albany county, *H. D. House,* August 21, 1919.

Cercospora sagittariae Ellis & Kellerman

On living and languishing leaves of Sagittaria latifolia Willd. Oneida, Madison county, *H. D. House,* August 26, 1918.

Cladosporium aphidis Thumen

On leaves of Helianthus annuus L. Karner, Albany county, *H. D. House,* September 9, 1919. The leaves were heavily infested with aphids (Aphis helianthi Monell), which doubtless serves as the host of the Cladosporium. All the leaves contained in addition a Septoria which matches Septoria helianthi E. & K. (in herb. Dearness), but which does not fully agree with the published description. Puccinia helianthi-mollis Schw. was also frequent upon the same leaves.

Cylindrosporium toxicodendri (Curtis) Ellis & Everhart

On living and languishing leaves of Rhus Toxicodendrum L. Albany, *H. D. House,* August 21, 1919. See Mycologia, 8: 105.

Cylindrosporium clenatidis Ellis & Everhart

On languishing leaves of Clematis virginiana L. Panther lake, Oswego county, *H. D. House,* October 14.

Diatrype albopruniosa (Schw.) Cooke

On dead branches of Quercus ilicifolia Wang. Albany, *H. D. House,* November 23, 1919. This fungus is frequent upon oak and other hosts, and this record is interesting only as a record for it upon one of the oaks of limited distribution in New York.

Diatrype stigma (Hoffm.) Fr.

On dead decorticated branches of Opulaster opulifolius (L.) Kuntze. Albany, *H. D. House,* November 15, 1919. This form, with the strongly cleft ostiola, was originally designated by Ellis as D. dearnessei, but later he found variations between it and D. stigma so numerous and gradual, that the distinction could not be maintained.

Diatrypella Frostii Peck

On dead branches of Acer saccharum Marsh. Oriskany Falls, Oneida county, *H. D. House,* May 26. The same limbs yielded Massaria inquinans (Tode) Fr., and Diatrype stigma (Hoffm.) Fr.

Diatrypella missouriensis Ellis & Everhart

On dead twigs of Corylus americana L. Karner, Albany, county, *H. D. House,* October 15, 1918.

Darluca filum (Biv.) Cast.

Parasitizing Puccinia polygoni-amphibii Pers. on leaves of Polygonum Hartwrightii Gray. Junius, Seneca county, *H. D. House,* August 10, 1917. On Puccinia punctata on leaves of Galium asprellum Michx., Fourth lake, Herkimer county, *H. D. House,* August 11, 1919.

Dinemasporium hispidulum (Schrad.) Sacc.

On dead stems of Leonurus Cardiaca L. Albany, *H. D. House,* November 23, 1919.

Diaporthe aorista Ellis & Everhart

On dead stems of Aster lateriflorus L. *H. D. House,* Bonaparte swamp, Lewis county, June 23.

Entyloma lineatum (Cooke) Davis

On sheaths and leaves of Zizania aquatica L. Glenmont, Albany county, *H. D. House,* September 18, 1918.

Eutypella radula (Pers.) Ellis & Everhart

On dead branches of Populus tremuloides Michx. Albany, *H. D. House,* October 15, 1919.

Epicoccum vulgare Corda

On dead stems of Equisetum hyemale L., prematurely killed by a grass fire. Albany, *H. D. House,* November 17, 1919 and April 30, 1921.

Fenestella fenestrata (Berk. & Br.) Schroeter

(*F. princeps* Tul.)

On dead twigs of Populus nigra var. italica DuRoi. Albany, *H. D. House,* May 13, 1917. The same collection also contains **Valsa ambiens** (Pers.) Fr.

Fenestella vestita (Fr.) Sacc.

On dead twigs of Amelanchier spicata (Lam.) C. Koch. Albany, *H. D. House,* December 28, 1919.

Entomosporium maculatum Lev.

On fallen leaves of Amelanchier canadensis (L.) Medic. Albany, *H. D. House,* September 21.

Gloeosporium hydrophylli Dearness & House

On living leaves of Hydrophyllum virginianum L. South bay, Madison county, *H. D. House,* August 20, 1918. The type collection of this species was made at Kirkville, Onondaga county on Hydrophyllum canadense L. On H. virginianum the spores are larger and measure up to 12 x 3 μ.

Gloeosporium polygoni Dearness & House, sp. nov.

Spots brown, red-bordered, subcircular, soon deciduous, .5 to 2 cm broad, becoming confluent. Acervuli epiphyllous, perforate, reaching 200 μ in diameter. Spores oblong, 5–7 x 2 μ. When opened in water the spores issue in relatively large streams.

On living and languishing leaves of Polygonum Muhlenbergii S. Wats. South bay, Madison county, *H. D. House,* September 16, 1919.

The leaves also bear a scarcely mature Sphaerella which is apparently **Mycosphaerella polygonorum** (Crie) comb. nov. Depazea polygonorum Crie; Sphaerella polygonorum Sacc. (Syll., 1: 512. 1882).

Gloeosporium caryae Ellis & Dearness

On living leaves of Hicoria glabra (Mill.) Britton. Glenmont, Albany county, *H. D. House,* September 23, 1919.

Gnomonia papillostoma Dearness & House, sp. nov.

Perithecia black, hypophyllous but the dark base protuberent and plainly visible on the upper sides of the leaves; except the protruding ostiola covered by the cuticle, 200–300μ in diameter. Ostiola cylindric, shining, often more or less curved, 80–200 μ long by 25–30 μ thick, usually slightly enlarged at the perforate summit. Asci 35 x 7 μ, cylindric. Sporules hyaline, biseriate or very obliquely uniseriate, an obscure septum dividing a small pointed cell from a superior wider one; 9–11 x 3 μ.

On dead leaves of Spiraea latifolia Borkh., hanging on living branches. Albany, *H. D. House,* May 1. The type material is not quite mature and most of the sporidia appear continuous.

Hainesia rhoina (Sacc.) Ellis & Saccardo

On languishing leaves of Rhus Toxicodendrum L. Albany, *H. D. House,* August 21, 1919. In Mycologia, 13: 162. 1921. Shear and Dodge indicate that this is probably **Hainesia**

lythri (Desm.) v. Hohn., and the conidial stage of **Pezizella lythri** (Desm.) Shear & Dodge. The pycnidial stage is given as **Sclerotiopsis concava** (Desm.) Shear & Dodge, and the ascogenous stage has formerly been known as **Pezizella oenotherae** (C. & E.) Sacc.

Harknessia foeda Saccardo & Dearness

On partially dead foliage of Thuya occidentalis L. Newcomb, Essex county, *H. D. House,* September 6.

Haplosporella dulcamara Dearness & House, sp. nov.

Stromata externally black, scattered to crowded, erumpent, tubercular to elongate, often in parallel lines, .5 to .75 mm in width, seated in the cortex and bordered by the upturned cuticle, two to twenty or more pycnidia in a stroma, usually whitish in cross-section. Conidia oblong or many of them curved, nucleate, tardily brown, 17–19 x 6–7 μ, with walls 1 μ thick, on pedicels 5–20 μ long.

On dead stems of Solanum Dulcamara L. Sandlake, Rensselaer county, *Dr C. H. Peck* (Type), year not indicated. Orient, Long Island, *Roy Latham,* 1916. South Bay, Madison county, *H. D. House,* September 19, 1919.

Heterosporium gracile (Wallr.) Sacc.

On living and languishing leaves of cultivated Iris, Iris germanica L. Munnsville, Madison county, *H. D. House,* October 13.

Hypoxylon fusco-purpureum (Schw.) Berkeley

On dead limbs of black ash, Fraxinus nigra Marsh. Caroga, Fulton county, *Dr C. H. Peck,* July (year of collection not indicated).

Leptostromella scirpina Peck

On dead leaves of Scirpus fluviatilis (Torr.) Gray. Albany, *H. D. House,* June 2, 1917 and August 26, 1919. On dead leaves of Scirpus cyperinus (L.) Kunth, Pecksport, Madison county, *H. D. House,* May 18, 1918.

Metasphaeria complanata (Tode) Sacc.

On dead stems of Chenopodium album L. Albany, *H. D. House,* January 6, 1918.

Microdiplodia populi Dearness & House

On dead twigs of Populus nigra var. italica DuRoi. Albany, *H. D. House,* May 13, 1917. Originally described from Colorado material collected by Pringle.

Microdiplodia spiraeocola Dearness & House, sp. nov.

Pycnidia in the bark and on the decorticated branchlets, scattered or gregarious or subcespitose, black, .5–.75 mm; conidia dark brown, septate, on very short basidia or sessile, 9–11 x 4–5 μ.

On dead twigs of Opulaster opulifolius (L.) Kuntze, Rensselaer, *H. D. House,* November 28, 1916 (Type). On dead twigs of Spiraea latifolia Borkh., Albany, *H. D. House,* January 10, 1921.

Mycosphaerella cruris-galli (E. & K.) Lindau

On dead leaves of grass, Tridens flava (L.) Hitchc. Wading River, Long Island, *Dr C. H. Peck* (date of collection not indicated). Originally described from Kansas (Swingle), on Echinochloa Crusgalli (L.) Beauv.

Mycosphaerella lycopodii (Peck) House

On dead stems (Peduncles) of Lycopodium clavatum L. Newcomb, Essex county, *H. D. House,* July 20, 1921. This is but a few miles from Aiden Lair, the type locality.

Mycosphaerella oxycocci Dearness & House, sp. nov.

Perithecia numerous, scattered, hypophyllous, perforate, 90 μ thick. Asci aparaphysate, shaped like a tennis racket, 15–30 x 9–12 μ, stipes 15–30 x 3–4 μ. Sporidia botuliform, 9–12 x 3–4 μ; septum dividing a narrow third from a wider two-thirds. In the material examined most of the sporidia were continuous or very obscurely septate.

On dead or languishing leaves of Oxycoccus macrocarpus (L.) Pers. Newcomb, Essex county, *H. D. House,* July 27.

Myxosporium Ellisii Saccardo

On dead twigs of Populus nigra var. italica DuRoi. Albany, *H. D. House,* May 13, 1917.

Pestalozzia monochaetoidea Sacc. & Ellis, var. **parasitica** Dearness & House, var. nov.

On reddish brown areas producing the typical gloeosporial effect, namely, circinately discolored and killed tissue. The conidia are two to six septate, mostly four to five septate, and reach in exceptionally long examples to 30 μ, otherwise agreeing with typical saprophytic material on dead twigs of the same host.

On living leaves of Opulaster opulifolius (L.) Kuntze, Albany, *H. D. House,* August 27, 1919.

Coccomyces coronatus (Schum.) DeNot.

(*Phacidium coronatum Fries*)

On fallen leaves of Quercus alba L. Oneida, Madison county, *H. D. House,* May 22, 1919. Also collected at North Elba, by *Dr C. H. Peck,* on fallen leaves of Betula lenta, and Fagus grandifolia.

Phyllosticta caryae Peck

On living leaves of Hicoria alba (L.) Britton (*Carya tomentosa* Nutt.). Glenmont, Albany county. *H. D. House,* September 18, 1918.

Phyllosticta guttulata Halsted

On living and languishing leaves of Oxalis stricta L. Albany, *H. D. House,* September 1, 1919.

Phyllosticta iridis Ellis & Martin

On living and languishing leaves of Iris versicolor L. Lakeport, Madison county, *H. D. House,* October 20. Also collected on the same host at North Elba, Essex county, September 15.

Ramularia occidentalis Ellis & Kellerman

On living and languishing leaves of Rumex Britannica L. Sylvan Beach, Oneida county, *H. D. House,* August 29, 1918.

Septoria cirsii Niessl.

On living leaves of Cirsium odoratum (Muhl.) Britton. Glenmont, Albany county, *H. D. House,* September 14, 1918. Previous collections appear to be chiefly on Cirsium arvense.

Septoria canadensis Peck

Fourth lake, Herkimer county, on living and languishing leaves of Cornus canadensis L., *H. D. House,* August 8, 1919. Newcomb, Essex county, *H. D. House,* June 6, 1921. Type collected by Peck at Sandlake, Rensselaer county, and another collection by Peck is from North Elba.

Doctor Peck's description needs amending to state that "the pycnidia are mostly epiphyllous but not wholly so." With the Newcomb collection, several wholly dead leaves were collected upon which the pycnidia were largely hypophyllous. Not many

Septorias are traced to their ascigenous forms. Doubtless many of them "carry on" without asci. The fruiting Septoria on the old dead fallen leaves of the Newcomb collection made when Septoria spots were just beginning to appear upon green leaves suggests that Septoria canadensis may be capable of infection through successive generations without asci.

Septoria dentariae Peck

On living leaves of Cardamine bulbosa (Schreb.) B.S.P. Near Rensselaer, *H. D. House,* May 10, 1921.

Septoria pallidula Dearness & House, sp. nov.

Spots pallid, bounded by the veinlets but not bordered, gradually extending over the entire leaf; pycnidia conic, pale brown, perforate, amphiphyllous, but mostly epiphyllous, 60–65 μ in diameter; sporules mostly straight, none to three-septate, not guttulate, 16–30 x 1–2 μ.

On living and languishing leaves of Hydrocotyle americana L. Albany, *H. D. House,* August 27, 1919.

Septoria hydrocotyles Desm. on Hydrocotyle repanda, has subregular spots, 1 mm in diameter, pycnidia epiphyllous, dark; sporules curved, eight to ten-guttulate and other minor differences as compared with the one here described. It is also different in marked characters from three other South American and African species of Septoria which have been described on Hydrocotyle.

Septoria lobeliae Peck

On living leaves of Lobelia syphilitica L. Oneida, Madison county, *H. D. House,* August 27, 1918. On leaves of Lobelia syphilitica L. and Lobelia cardinalis L., Newcomb, Essex county, *H. D. House,* July 15–30.

Spegazzinea rubra Dearness & House, sp. nov.

Sporodochia scattered, pulvinate to hemisphaeric, .25 to 3 mm, black to the naked eye when dry, dark red under the microscope; conidia dark brown, sessile, not very numerous, globose, 6–16 μ, mostly 12–15 μ, when fully developed, with polygonal markings on the walls, 3–4 μ in diameter.

On dead stems of Polygonum scandens L., Sylvan Beach, Oneida county, *H. D. House,* May 16, 1918.

Sphaeropsis betulae Cooke, var. **lutea** Dearness & House

The variety here considered occurs upon Betula lutea. The pycnidia are gregarious and distinctly though minutely stromate; conidia nucleate, 18–22 x $7\frac{1}{2}$–$8\frac{1}{2}$ μ. None of the conidia measured was found to exceed 24 μ in length.

On dead branches of Betula lutea Michx. Sandlake, Rensselaer county, *Dr C. H. Peck*, June (year of collection not indicated).

The varietal distinction of the above is indicated by comparison with the description of Sphaeropsis betulae Cooke taken from Saccardo: "subgregaria, interdum sparsa, cuticula elevata tecta; peritheciis depresse globosis, vix pepillatis; sporulis ellipticis, intrigue rotundatis, continuis, luteolis, 30–32 x 9 μ." On. Betula alba.

Sphaeropsis gleditschiaecolae Cooke

On dead twigs of Gleditsia triacanthos L. Albany, *H. D. House*, February 20, 1918.

Sphaeropsis linearis Peck

On dead twigs of Quercus ilicifolia Wang. Albany, *H. D. House*, June 7.

Sphaeropsis populi Ellis & Everhart

On dead twigs of Populus nigra var. italica DuRoi. Albany, *H. D. House*, May 13, 1917.

Sphaeropsis physocarpi Ellis & Everhart

On dead stems of Spiraea latifolia Borkh. Albany, *H. D. House*, December 21, 1919 and May 13, 1921. Previously collected within a few yards of the same spot on Opulaster opulifolius (February 28, 1915).

Sphaerulina acori Dearness & House, sp. nov.

Perithecia numerous, innate, in the upper side of the discolored leaves, containing each 12 to 20 asci; walls very weak, asci aparaphysate, 30–50 x 15–20 μ; sporidia hyaline, three to five-septate, nucleate, 26–30 x 4–5 μ.

On languishing leaves of Acorus Calamus L. Glenmont, Albany county, *H. D. House*, August 25, 1919.

Externally this does not appear distinguishable from Leptosphaeria microscopica var. calami Karst.

Valsa ambiens (Pers.) Fr.

On dead branches and twigs of Opulaster opulifolius (L.) Kuntze. Albany, *H. D. House,* November 29, 1917. The host material for this ubiquitous Valsa, as represented in the state herbarium includes the following species:

Acer rubrum
Amelanchier canadensis
Carpinus caroliniana
Cornus circinata
" florida
" paniculata
" stolonifera
Ceanothus americanus
" ovatus
Corylus americana
Crataegus coccinea
Fraxinus americana
Hamamelis virginiana
Magnolia virginiana
Pyrus Malus
Populus alba
" deltoides
Rhus glabra
Rosa carolina
Rubus strigosus
Salix alba
Tilia americana
Ulmus americana
" fulva
Viburnum dentatum

Valsa leucostoma (Pers.) Fr.

On dead twigs of Sorbus americana Marsh. Bald mountain, Third lake, Herkimer county, *H. D. House,* August 9, 1919.

Valsa cincta Fr.

On dead branches of Amelanchier canadensis (L.) Medic. Clear pond and Aiden Lair, Essex county, *Peck.* On Amelanchier bartramiana (Tausch) Roem., North Elba, *Peck.*

Zythia ovata Peck

On dead bark of Populus grandidentata Michx. Albany, *H. D. House,* October 10, 1919.

NOTES ON FUNGI — VIII

In the following notes on recent collections of fungi in New York, the determination of species of the Thelephoraceae has been made by Dr E. A. Burt, of the Missouri Botanical Garden, while most of the Uredineae have been determined by Dr J. C. Arthur of Purdue University.

Allodus tenuis (Schw.) Arthur

(*Puccinia tenuis* Burrill)

On leaves of Eupatorium urticaefolium Reich. Bonaparte lake, Lewis county, *H. D. House,* June 22.

Cercospora granuliformis Ell. & Holw.

Newcomb, Essex county on leaves of Viola septentrionalis Greene, *H. D. House,* July 29. This species has been collected in this State upon Viola cucullata, and V. pallens, and probably occurs upon other species of violets.

Coniophora byssoidea (Pers.) Fries

Near Cohasset on Fourth lake, Herkimer county, on dead bark on ground in woods. *H. D. House,* August 12, 1919.

Coniophora olivacea Fries

Oneida, Madison county, on decayed logs in woods. *H. D. House,* November 25, 1918.

Cercospora Cypripedii Ell. & Dearn.

Newcomb, Essex county, on leaves of Cypripedium reginae Walt. *H. D. House,* August 4, 1921.

Cercospora Gentianiae Peck

Newcomb, Essex county, on leaves of Gentiana linearis Froel. *H. D. House,* August 4, 1921.

Erysiphe lamprocarpa Lev.

Napanoch, Ulster county, on leaves and stems of Gerardia quercifolia Pursh (*Aureolaria glauca* (Eddy) Raf.) *H. D. House,* August 19–21, 1921.

Aecidium Dicentrae Trel.

On Capnorchis Cucullaria (L.) Planch., VanCortlandt Park, New York City, *Percy Wilson 52,* April 20, 1915; Williamsbridge, *no. 230,* April 28, 1916.

Cintractia caricis (Pers.) Magn.

To the list of host species for this smut given in the North American Flora (vol. 7, p. 33, 34) may be added Carex tonsa (Fernald) Bicknell. Karner, Albany county, *Peck.* On Carex limosa L., the smut has been collected by Peck at Sevey, St Lawrence county. Most of the reports of this smut on Carex stricta Lam., doubtless refer to Carex strictior Dewey, as the latter sedge is distinguished by Mackenzie, the true Carex stricta Lam. being apparently restricted in range in this State to Long Island.

Cintractia subinclusa (Korn.) Magn.

On Carex monile, Newcomb, Essex county, *Dr C. H. Peck*. On Carex utriculata, Lake Sallie, Essex county, *Peck*. Determined by Dr H. S. Jackson.

Cintractia Taubertiana (P. Henn.) Clinton

On Rynchospora fusca (L.) Ait. f. Sandlake, Rensselaer county and Riverhead, Suffolk county, collected by *Dr C. H. Peck*. Determined by Dr H. S. Jackson.

Doassansia opaca Setch.

On leaves of Sagittaria latifolia Willd. Watkins, Schuyler county. *Dr C. H. Peck*. Determined by Dr H. S. Jackson.

Coniophora sistotremoides (Schw.) Massee

Near Albany, on decorticated and partially decayed limbs of Pyrus Malus L. *H. D. House,* November 30, 1919.

Corticium arachnoideum Berkeley

Near Albany; overspreading and seemingly parasitic on Hypochnus isabellinus, on fallen limbs of Pinus strobus L. *H. D. House,* October 15, 1919.

Corticium bicolor Peck

Oneida, Madison county, on fallen bark of Pinus Strobus L. *H. D. House,* November 25, 1918.

Corticium confluens Fr.

Albany, on dead branches of Opulaster opulifolius (L.) Kuntze. *H. D. House,* November 15 and 22, 1919; and on dead branches of Alnus serrulata Willd., November 8, 1919.

Corticium galactinum (Fries) Burt

Oneida, Madison county, on dead trunk of Larix laricina (DuRoi) Koch. *H. D. House,* May 20, 1918.

Corticium vellerum Ell. & Cragin

Ottawa, Canada, on dead willow (Salix, sp.). *J. M. Macoun* 281, October 2, 1897.

Dicaeoma calthae (Grev.) Kuntze

(*Puccinia calthae* Grev.)

Bonaparte swamp, Lewis county, on leaves of the marsh marigold, Caltha palustris L., *H. D. House,* June 22. Other collections of this rust in the state herbarium are from Cattaraugus, Fulton, Albany, Tompkins and Herkimer counties.

Dicaeoma hieraciata (Schw.) Arthur & Kern

(*Puccinia patruelis* Arth.; *P. hieraciata* Jackson)

Pycnia and aecia on leaves of Nabalus albus (L.) Hook. Bonaparte swamp, Lewis county. *H. D. House,* June 23. Aecia have also been collected in this State on Lactuca virosa L., L. canadensis L. and L. hirsuta Muhl., and previously reported as *Puccinia Opizii.*

The telial stage occurs on Carex brunnescens, C. Sartwellii, C. siccata, C. Sprengelii, and C. sparganioides, and has been collected in New York only on C. sparganioides.

Dicaeoma iridis (DC.) Kuntze

Uredo stage common on Iris versicolor L., Bonaparte swamp, Lewis county, *H. D. House,* June 22. Also collected on same host at Tupper Lake, Franklin county; Panther lake, Oswego county; Kirkland, Oneida county; and Lakeport, Madison county.

Dicaeoma Lysimachiae (Schw.) Kuntze

(*P. Limosae Magn.; P. lysimachiata* (Link) Kern)

Aecial stage on the leaves of Lysimachia thrysiflora L. Bonaparte swamp, Lewis county, *H. D. House,* June 22. Also collected at Harrisville, by Doctor Peck, on the same host. Other closely related species upon which the aecial stage of this rust have been found in this State are: Lysimachia quadrifolia, and L. terrestris (L.) B. S. P.

The telial stage occurs upon Carex arcta, C. brunnescens and C. limosa, of which only the last occurred at Bonaparte swamp in company with the aecial host species.

Dicaeoma minutissimum (Arthur) Kuntze

(*Puccinia minutissima* Arth.)

Aecia on leaves of Decodon verticillata (L.) Ell, Bonaparte swamp, Lewis county, June 22. The telial stage of the rust was found close by on old leaves and culms of Carex lasiocarpa Ehrh. (*C. filiformis* Am. Auth.)

Dicaeoma violae (Schum.) Kuntze

(*Puccinia violae* DC).

On leaves of Viola scabriuscula Schw., (aecia), Oneida, Madison county, *H. D. House,* May 24.

Glenospora melioloides Curt.

Albany, on leaves of Galax aphylla L., offered for sale in the form of wreaths, etc., during the holiday season. *H. D. House,* January 2, 1921.

Dicaeoma Cicutae (Lasch) Kuntze

Woodville, Jefferson county, on leaves of Cicuta maculata L. *H. D. House,* June 24, 1921.

Dicaeoma Cnici (H. Mart.) Arthur

Newcomb, Essex county, on leaves of Cirsium lanceolatum (L.) Hill. *H. D. House,* August 11, 1921.

Dicaeoma Polygoni-amphibi (Pers.) Arthur

I. on leaves of Geranium maculatum L., Catskill, Greene county, *H. D. House,* May 21, 1921. This collection was made in a moist upland wood, where the only species of Polygonum was P. virginianum L., but the locality was not visited later to ascertain if that was the alternate host.

Dicaeoma Veratri (DC.) Kuntze

Near Oneida, in Oneida county, on leaves of Veratrum viride L. *H. D. House,* June 30, 1921.

Dicaeoma Trientalis (Tranz.) Arthur & Kern

(*Puccinia Trientalis* House)

I. on Trientalis borealis Raf. (*T. americana* Pursh), Newcomb, Essex county, *H. D. House,* June 10, 1921. III. on dead leaves of Carex paupercula Michx., same locality, June 10, 1921. II & III. on same host at same station, August 10, 1921, and at Long lake, Hamilton county, August 11, 1921.

Diaporthe euspina C. & E.

On dead stems of Chenopodium ambrosioides L., Orient, Long Island, *Roy Latham,* March 1919. Determined by Dearness.

Diatrypella verruciformis (Ehrh.) Nke.

On dead stems of Myrica carolinensis Mill., near Orient, Long Island, *Roy Latham,* December 1919. Determined by Dearness.

Gibberella pulicaris (Fr.) Sacc.

On old stalks of Zea Mays L., Orient, Long Island, *Roy Latham,* July 22, 1919. Determined by Fairman.

Melanconiella decorahensis Ellis

On dead branches of Betula populifolia Marsh., Orient, Long Island, *Roy Latham,* March 1919. Determined by Dearness.

Dicaeoma cyperi (Arthur) Kuntze

(*Puccinia cyperi* Arthur)

Telial stage on Cyperus Grayi Torrey, Bay View, town of Southold, Long Island, *Roy Latham,* September. Also on Cyperus strigosus L. at Orient in 1915.

Dicaeoma majanthae (Schum.) Arthur

Aecial stage on Polygonatum biflorum (Walt.) Ell., Orient, Long Island, *Roy Latham,* May 30. Previously reported from Southold on Vagnera racemosa (L.) Morong.

Uredinopsis mirabilis (Peck) Magnus

II, III, on fronds of Onoclea sensibilis L., Gardiner's Island, *Roy Latham,* August 1919. On fronds of Lorinseria areolata (L.) Presl., at Greenport, *Latham,* August 1920. The aecial stage (**Peridermium balsameum** Peck) occurs upon Abies balsamea (L.) Mill., a host tree, not known to occur on Long Island. It has also been collected by Peck, on Anchistea virginica (L.) Presl. at Manor, Long Island.

Nigredo hedysari-paniculati (Schw.) Arthur

(*Uromyces hedysari-paniculati* Farlow)

On leaves of Meibomia Dillenii Darl., at Bay View, town of Southold, Long Island, *Roy Latham,* August 21.

Glomularia lonicerae (Peck) comb. nov.

(*G. corni* var. *lonicerae* Peck)

On living and languishing leaves of Lonicera canadensis Marsh., near Taborton, Rensselaer county, *H. D. House,* June 30, 1921, and at Newcomb, Essex county, on the same host, July 20, 1921. The type collections were made by Doctor Peck at Long lake and Aiden Lair.

Hypochnus granulosus (Peck) Burt

Near Albany, on fallen branches of Pinus rigida, *H. D. House,* October 20, 1919.

Hypochnus rubiginosus Bres.

Napanoch, Ulster county, on decayed branches and débris on the ground in woods, *H. D. House,* October 5, 1919.

Hypochnus subvinosus Burt

Near Albany, on dead bark of Pinus Strobus L. *H. D. House,* October 15, 1919.

Leptosphaeria Crepini (Westd.) Karst.

On spikes of Lycopodium annotinum L., which seem to have been aborted and killed by the fungus, near Newcomb, Essex county, *H. D. House,* July 15–30, 1921. Previously collected by Doctor Peck on this host on Mount Marcy and Mount Skylight.

LEUCOLOMA Fckl. Symb. 317. 1869

Peziza, Sect. Humaria Fr. Sym. Myc. 2: 42. 1822
Humaria Sacc. Syll. 8: 118. 1889
Pseudombrophila, Coprobia and Discinella Boud.

The generic name Leucoloma appears to possess priority over Humaria, and several New York species in the state herbarium may be transferred to this name.

Leucoloma adusta (C. & P.) comb. nov. Peziza adusta C. & P.; Humaria adusta Sacc.

Leucoloma deligata (Peck) comb. nov. Peziza deligata Peck; Humaria deligata Sacc.

Leucoloma echinosperma (Peck) comb. nov. Peziza (Humuria) echinosperma Peck.

Leucoloma gallinacea (Pec) comb. nov. Peziza gallinacea Peck; Humaria gallinacea Sacc.

Leucoloma Gerardi (Cooke) comb. nov. Peziza Gerardi Cooke; Humaria Gerardi Sacc.

Leucoloma hydrophila (Peck) comb. nov. Peziza hydrophila Peck; Humaria hydrophila Sacc.

Leucoloma Peckii (House) comb. nov. Humaria Peckii House.

Lophodermium sphaeroides (A. & S.) Duby

On fallen leaves of the Labrador tea, Ledum groenlandicum Oeder, Bonaparte swamp, Lewis county, *H. D. House,* June 23. Also collected by Doctor Peck at Sandlake, Rensselaer county.

Marasmius campanellus (Peck) Atk. & House

On dead twigs of Arbor Vitae, Thuja occidentalis L., in Bonaparte swamp, northern Lewis county, *H. D. House,* June 22, and at Newcomb, Essex county, July 20. This curious little Agaric, typically a Marasmius in texture, but with a densely hirsute pileus, appear to be quite common on dead twigs of Arbor Vitae which are still attached to the tree or on branches and twigs lying loosely upon the ground, throughout the cold cedar swamps of central and northern New York.

Melampsorella elatina (A. & S.) Arthur

Abundant on the dwarfed needles of " witches brooms," which it causes on the balsam fir, Abies balsamea (L.) Mill. Newcomb, Essex county, *H. D. House,* July 21, 1921. Not uncommon in Essex, Hamilton and Greene counties, but the alternate stage on Cerastium arvense, appears to have been collected in this State only at Poughkeepsie, many years ago by Gerard.

Melampsoropsis abietina (A. & S.) Arthur

II and III, on leaves of Labrador tea, Ledum groenlandicum Oeder, Bonaparte swamp, Lewis county, *H. D. House,* June 22. Not previously reported from this State, and the aecial stage, **Peridermium abietinum** Thum., occurring on Picea mariana, P. rubens and P. excelsa, has not been collected in New York.

Melampsoropsis chiogenis (Dietel) Arthur

On the under surface of leaves of the creeping snowberry, Chiogenes hispidula (L.) A. Gray. Bonaparte swamp, Lewis county, *H. D. House,* June 22. The upper surface of the infected leaves are conspicuously yellow, and this serves as a ready means of finding what is otherwise a very inconspicuous and rare rust. It has been reported from North Elba by Kauffman (N. Y. State Mus. Bul. 179, p. 85. 1915) as Chrysomyxa chiogenis Dietel.

The adjacent conifers were Pinus Strobus, Larix laricina, Abies balsamea, Picea mariana and Picea rubens, while Tsuga canadensis occurred within 200 yards on an adjacent slope. The aecial stage is suspected to occur upon the cones of one of the species of Picea.

Melampsoropsis ledicola (Peck) Arthur

(Peridermium decolorans Peck)

Newcomb, Essex county, on needles of Picea mariana (Mill.) B. S. P., and Picea canadensis (Mill.) B. S. P., *H. D. House,* July 28, 1921. This rust is found generally distributed throughout the Adirondack region in most swamps where spruce and Labrador tea (Ledum groenlandicum) occur together, and also locally elsewhere across the State.

Melampsoridium betulae (Schum.) Arthur

On leaves of the gray birch, Betula populifolia Marsh., Averill Park, Rensselaer county, *H. D. House,* October 3. Practically every leaf on a small tree, about 2 inches in diameter, was found to be heavily infected. The tree grew almost in the shade of a white pine, and a few hemlocks and pitch pines grew within a short distance. The aecial stage of this rust occurs upon Larix laricina, a species which is not known to occur within a mile of this spot. No infection was found on any of several other gray birches close by.

Metasphaeria Peckii (Speg.) Sacc.

(Sphaerella Peckii Speg.)

On fallen leaves of June berry, Amelanchier spicata (Lam.) C. Koch, near New London, Oneida county, *H. D. House,* May 17, 1921. Peck's original collection of this from near Albany contains what appears to be leaves of both A. spicata and A. canadensis.

Micropuccinia conglomerata (Strauss) Arthur & Jackson

(Puccinia nardosmiae E. & E.)

On leaves of Petasites palmata (L.) A. Gray, near Newcomb, Essex county, *H. D. House,* June 15 and July 21, 1921. This rare rust has not heretofore been reported from New York, and Doctor Arthur states that it has been found only at the following American stations: Vermillion Lake, Minn., Stittsville and Nipigon River, Ontario and Glacier, British Columbia, all on the same host. In Europe it is recorded as occurring upon several species of Senecio, Cacalia, Adenostylis and Homogyne.

Dicaeoma orbicula (Peck & Curt.) Kuntze

(Puccinia orbicula Peck & Curt.)

On leaves of Nabalus albus (L.) Hook., Pecksport, Madison county, *H. D. House,* May 26, 1921. Also represented in the state herbarium by collections from Erie, Onondaga, Lewis, Schuyler and Herkimer counties.

Micropuccinia porphyrogenita (Curt.) Arthur & Jackson

(Puccinia acuminata Peck)

On leaves of dwarf cornel, Cornus canadensis L., Newcomb, Essex county, *H. D. House,* July 28, 1921. This rather uncommon rust has been collected at North Elba and Sandlake by Doctor Peck, and at Sylvan Beach, Oneida county, by the writer.

Microsphaeria diffusa C. & P.

Karner, Albany county on leaves of bush clover, Lespedeza capitata Michx. *H. D. House,* September 12, 1919. A common leaf fungus on Meibomia canadense, and also known on Lathyrus ochroleucus and L. myrtillifolius.

Nigredo houstoniata (Schw.) J. Sheldon

On leaves of Houstonia coerulea L., Newcomb, Essex county, *H. D. House,* July 17, 1921.

Melampsoropsis empetri (Pers.) Arth.

Summit of Mount Marcy, on leaves of Empetrum nigrum L. *H. D. House,* August 5, 1921. Collected by Doctor Peck on Mount Skylight.

Microsphaeria Russellii G. W. Clinton

Oneida, Madison county, on leaves and stems of Oxalis cymosa Small, *H. D. House,* October 18, 1921. On same host, Newcomb, Essex county, August 10, 1921. Other collections are Argusville, *Peck;* Poughkeepsie, *Gerard;* Buffalo, *Clinton;* North Greenbush, *Peck.*

Nigredo Howei (Peck) Arthur

On Asclepias Syriaca L. New London, Oneida county, *H. D. House,* September 14, 1921; Oriskany Falls, Oneida county, September 16, 1921; Woodville, Jefferson county, September 10, 1921; Lewis Point, Madison county, September 12, 1921.

On Asclepias incarnata L. Lewis Point, Madison county, *H. D. House,* September 12, 1921.

During several seasons that the writer has been interested in rusts, search had been carefully made for this species, but until 1921 unsuccessfully. During the season of 1921, however, this rust was universally present on almost every clump of milkweed throughout central New York. In many cases the infection was so complete that the rust could be detected from a considerable distance.

Nigredo Junci-effusi (Sydow) Arthur

Napanoch, Ulster county, on Juncus effusus L. *H. D. House,* August 19–21, 1921.

Nigredo piriformis (Cke. & Peck) Arthur

On Acorus Calamus L., Woodville, Jefferson county, *H. D. House,* September 10, 1921. Lewis Point, Madison county, September 12, 1921. Pecksport, Madison county, September 16, 1921.

Like Nigredo Howei, this rust occurred during the season of 1921 in unusual abundance.

Nyssopsora clavellosa (Berk.) Arthur

Newcomb, Essex county, on leaves of Aralia nudicaulis L. *H. D. House,* August 10, 1921, and on the same host at Long Lake, Hamilton county, August 11, 1921.

Micropuccinia ornata (Arth. & Holw.) Arth. & Jackson

Woodville, Jefferson county, on Rumex Britannica L. *H. D. House,* September 10, 1921.

Micropuccinia recedens (Sydow) Arth. & Jackson

On Senecio aureus L., Arkville, Delaware county. *Percy Wilson 117,* July 25, 1915; Williamsbridge New York City, *no. 303,* June 2, 1916.

Mollisia Iridis (Rehm) Sacc.

South Bay, Madison county, on languishing leaves of Iris versicolor L. *H. D. House,* September 16. Determined by Dr F. J. Seaver, who states that "the apothecia are more superficial than those of European specimens."

Otidea grandis (Pers.) Rehm

On ground in woods. Newcomb, Essex county. *H. D. House,* July 28. Determined by Dr F. J. Seaver.

Pyrenopeziza subatra (C. & P.) Sacc.

Lake Bonaparte, Lewis county, on dead stems of Decodon verticillatus (L.) Ell. *H. D. House,* June 23. Determined by Dr F. J. Seaver.

Peniophora cinerea

Most of the resupinate members of the Thelephoraceae appear to have no definite host relationships, but are merely saprophytic upon any convenient material. Recent collections of the common Peniophora cinerea have been made upon dead branches still attached to the parent plant, in moist shaded places, of the following species:

Rubus strigosus *Michx.*
Alnus serrulata *Willd.*
Viburnum dentatum *L.*
Ilex verticillata *(L.) Gray*
Vitis aestivalis *Michx.*

On fallen branches of the following:

Hicoria alba *(L.) Britton*
Prunus serotina *Ehrh.*
Prunus pennsylvanica *L. f.*
Amelanchier canadensis *(L.) Medic.*
Cornus florida *L.*
Corylus americana *Walt.*
Ulmus americana *L.*
Acer spicatum *Lam.*

Peniophora incarnata Fries.

Near Albany, on dead branches of Quercus ilicifolia Wang. and dead branches of Opulaster opulifolius (L.) Kuntze, *H. D. House,* November 15 and 23, 1919.

Peniophora Eichleriana Bresadola

Bergen swamp, Genesee county, on decayed and fallen branches of Acer rubrum L., *H. D. House,* August 23, 1918.

Peniophora sera (Pers.) Burt

Lyndonville, Orleans county, *C. E. Fairman,* November 1, 1910.

Phyllachora agrostidis Orton

On leaves of Agrostis alba. Orient, Long Island, *Roy Latham, no. 610,* October 18, 1914. Determined by Dr C. R. Orton.

Phyllachora graminis (Pers.) Fckl.

On leaves of Elymus virginica. Catskill, *Peck*. On leaves of Elymus canadensis, Albany, *Peck*. On leaves of Agropyron repens, Sylvan Beach, Oneida county, *House*. On leaves of Triticum repens, West Albany, *Peck*. Determined by Dr C. R. Orton.

Phyllachora elymi Orton

On leaves of Elymus virginica, North Bay, Oneida county, *House*. Determined by Dr C. R. Orton.

Phyllachora vulgata Theiss. & Sydow.

On leaves of Muhlenbergia mexicana, North Greenbush, *Peck*. On leaves of Muhlenbergia glomerata, Karner, *Peck*. Determined by Dr C. R. Orton. On M. racemosa, Newcomb, Essex county, *H. D. House*, August 4, 1921.

Phyllachora luteo-maculata (Schw.) Orton

On leaves of Andropogon furcatus, Karner, Albany county, *Peck*. Determined by Dr C. R. Orton.

Phyllachora puncta (Schw.) Orton

On leaves of Panicum latifolium, Yaphank, Long Island, *Peck*. On leaves of Panicum Wrightianum, Southold, *Latham, no. 611*, November 4, 1914. On leaves of Panicum clandestinum, Wading River, *Peck*; Hempstead, *House*. On leaves of Panicum dichotomum, Shokan, *Peck*. Determined by Dr C. R. Orton.

Sorosporium syntherismae (Peck) Farl.

On the inflorescence of Cenchrus pauciflorus Benth. (*C. carolinianus* Auth.), Karner, Albany county and Port Jervis, Sullivan county, *Dr C. H. Peck*. The host plant for this smut in New York has been commonly referred to Cenchrus tribuloides, a species of the southern Atlantic coastal region.

Urocystis occulta (Wallr.) Rab.

On cultivated rye, Secale cereale L., near Albany, *H. W. Firch*, August 3.

Ustilago neglecta Niessl.

On the spikelets of Chaetochloa lutescens (Weigel) Stuntz (*Chaetochloa glauca*). Westport, Essex county; Menands and Bethlehem, Albany county, *Dr C. H. Peck.* Determined by Dr H. S. Jackson.

Ustilago levis (Kellerm. & Swingle) Magn.

On the spikelets of cultivated oats, Avena sativa L. Wood farm, North Elba, Essex county. *Dr C. H. Peck,* August. Determined by Dr H. S. Jackson.

Pucciniastrum agrimoniae (Schw.) Tranz.

Near Cambridge, Washington county, on leaves of Agrimonia hirsuta (Muhl.) Bickn. *H. D. House,* September 17. The collections of this rust in the state herbarium indicate the following distribution by counties: Albany, Saratoga, Washington, Rensselaer, Oneida, Madison, Ulster, Queens and Suffolk.

Pucciniastrum potentillae Kom.

On leaves of Sibbaldiopsis tridentata (Soland.) Rydb. (*Potentilla tridentata* Soland.), near Elizabethtown, Essex county, *H. D. House,* September 16.

This rust has also been collected on the same host at Berlin mountain, Rensselaer county, by *W. G. Farlow,* September 1901; and at Black mountain, Washington county, by *S. H. Burnham,* August 19, 1909. At Elizabethtown the infected plants grow in an open barren field with numerous clumps of Juniperus sibirica, and in the adjacent woodland there are white pine, hemlock, balsam fir and white spruce.

Ramularia multiplex Peck

Newcomb, Essex county, on leaves of Oxycoccus Oxycoccus (L.) MacM. (*Vaccinium Oxycoccus* L.), *H. D. House,* July 28. The type of this parasitic fungus was collected by Dr C. H. Peck at Caroga, Fulton county, on the same host. The infected leaves turn a bright pink or reddish color, or when only a portion of the leaf is infected, there is a yellow band between the unaffected portion and the reddish infected part.

Septoria agrimoniae Roum.

Newcomb, Essex county, on leaves of Agrimonia gryposepala Wallr., *H. D. House,* August 11, 1921.

Peronospora pygmaea Ung.

Wemple, Albany county, on leaves of Anemone pennsylvanica L. *H. D. House,* May 18, 1921.

Venturia Dickiei DeNot.

Newcomb, Essex county, on leaves of Linnaea americana Forbes. *H. D. House,* June 6–14, 1921.

Septoria aquilegiae Penz. & Sacc.

Bonaparte swamp, Lewis county, on living leaves of Aquilegia canadensis L., *H. D. House,* June 22.

Septoria corylina Peck

Newcomb, Essex county, on leaves of Corylus cornuta Marsh. (*C. rostrata* Ait.), *H. D. House,* July 27.

Septoria Ludwigiae Cooke

On leaves of Ludwigia sphaerocarpa Ell., Westchester county, *C. S, Sheldon,* August 1902. Frequent in many parts of the State on leaves of Isnardia palustris L. (*Ludwigia palustris* Ell.), and collected once on Ludwigia alternifolia L., at Menands, Albany county, by Dr C. H. Peck.

Septoria osmorrhizae Peck

Lake Bonaparte, Lewis county, on leaves of Osmorrhiza Claytoni (Michx.) Clarke, *H. D. House,* June 22. Also collected by Peck at Lowville, Lewis county, and at Schoharie, (type) by Peck, and near Albany by House.

Stereum gausapatum Fries

Near Wemple, Albany county, on bark of dead standing trunk of white oak, Quercus alba L., *H. D. House,* September 15, 1919.

Stereum Murrayi (B. & C.) Burt

Near Cohasset on Fourth lake, Herkimer county, on dead branches of Betula lutea Michx. f., *H. D. House,* August 11, 1919; also near Oneida, Madison county, on dead trunk of Betula lutea, May 13, 1919.

Stereum ochraceo-flavum Schw.

Albany, on dead branches of Betula populifolia Marsh., *H. D. House,* November 30, 1919; and on dead branches of Quercus ilicifolia Wang., November 17, 1916.

Stereum purpureum Pers.

Oneida, Madison county, on dead stump of some hardwood tree. *H. D. House,* November 25, 1918.

Stereum rameale Schw.

Oneida, Madison county, on fallen trunk of Betula lutea Michx. f., *H. D. House,* May 13, 1918; and on Alnus serrulata Willd., Albany, November 8, 1919; on Alnus serrulata Willd. near Napanoch, Ulster county, October 6, 1919.

Uredo Bigelowii (Thum.) Arthur

(Melampsora Bigelowii Thum.)

II and III, on leaves of Salis pyrifolia Anderss., Bonaparte swamp, Lewis county, *H. D. House,* June 22. A new host species for this common rust in New York. The aecial stage on Larix laricina (DuRoi) Koch, was also collected at Bonaparte swamp, on the same date.

Ustilago Heufleri Fckl.

(U. erythronii G. W. Clinton)

Near Oriskany Falls, Oneida county, on living leaves of Erythronium americanum Ker. *H. D. House,* May 26.

Venturia compacta Peck

Newcomb, Essex county, on leaves of Oxycoccus Oxycoccus (L.) MacM., *H. D. House,* July 24. This constitutes a new host for this fungus in this State. All the several other collections in the state herbarium are on Oxycoccus macrocarpus (Ait.) Pers.

Pezicula fasciculata (Tode) comb. nov.

Tubercularia fasciculata Tode, Meckl. Fungi, 1790; Peziza carpinea Pers.; Pezicula carpinea Tul.

On dead branches of Carpinus caroliniana. Fish Creek, Oneida county, *H. D. House,* September 1918.

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