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 bimonthly by The University of the State of New York

No. 251 ALBANY, N. Y. March 1924

The University of the State of New York

New York State Museum

JOHN M. CLARKE, Director

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

INCLUDING THE SEVENTY-FIFTH REPORT OF THE STATE MUSEUM, THE FORTY-FIRST REPORT OF THE STATE GEOLOGIST AND THE REPORT OF THE STATE PALEONTOLOGIST FOR 1922

ALBANY
THE UNIVERSITY OF THE STATE OF NEW YORK
1924

M171r-Ap23-1000

THE UNIVERSITY OF THE STATE OF NEW YORK

The University of the State of New York
The State Museum, January 16, 1923

The Honorable Frank P. Graves
President of the University

SIR: I transmit to you herewith my report as Director for the year 1922.

Very respectfully
JOHN M. CLARKE
Director

Restoration of the Cohoes Mastodon in the State Museum.

following first page

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INTRODUCTION

In the 2½ years that have passed since the issuance of the "Wild Flowers of New York" with its 264 color plates, nearly four and one-half million of these imprints have been distributed without cost to the tax-supported educational agencies of the State — the *schools.* In the longer interval since the publication of the "Birds of New York" carrying 106 color plates, somewhat more than five million imprints of these bird pictures have been similarly disseminated to the state schools. The reaction from these efforts to instil and encourage a knowledge and appreciation of these natural resources among the youth of this State, is apparent. Clubs and societies for the study of birds have multiplied, bird sanctuaries on private, municipal and state ground have come into being and the boys and girls of this generation know, and know how to protect, the birds as their parents never did. In a less but still notable degree (perhaps because the flower books are of more recent creation) there has been a similar response in the increase of interest in the flora of the State; a response which has added impulse to the wild flower preservation movement and to the activities of botanical societies and the development of formal gardening.

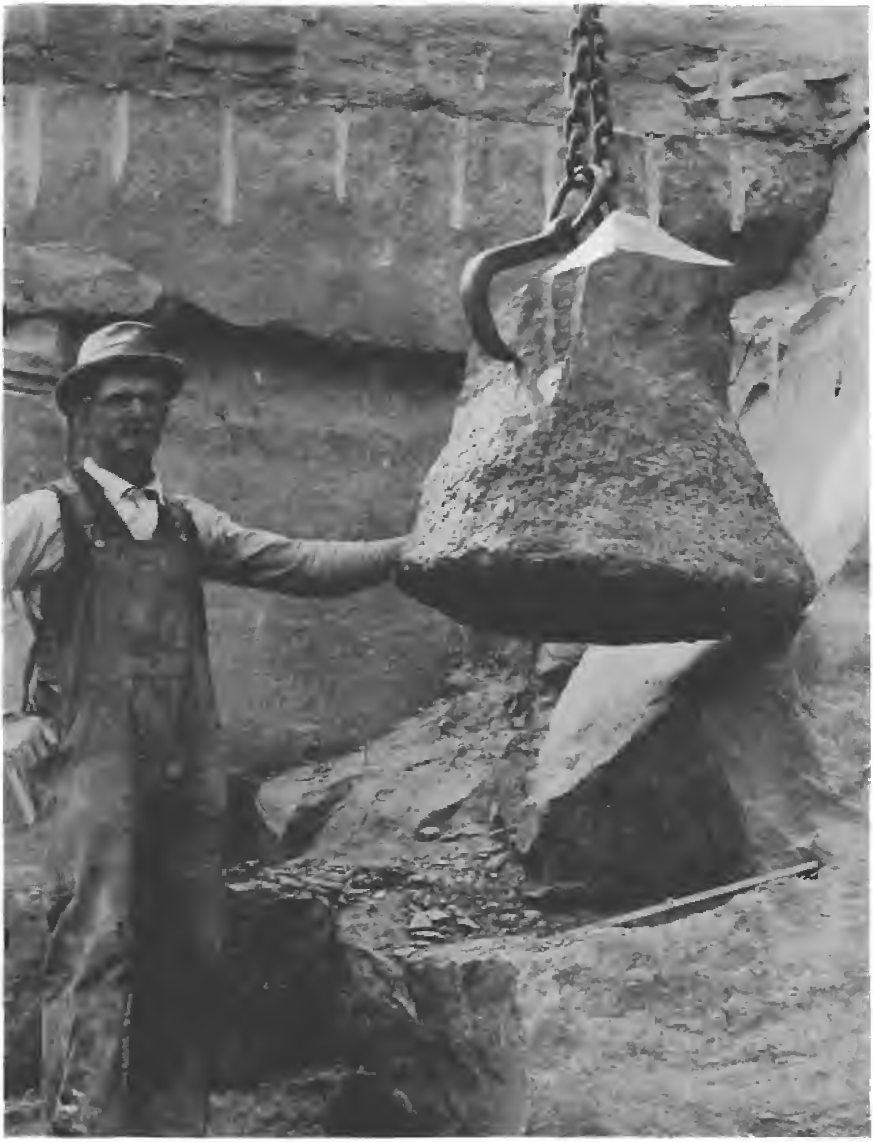
These two instances are cited as indications of the educative effect of the efforts made to summarize and in a certain sense popularize knowledge of our natural resources. It would be easy to cite other evidences of this procedure among other departments of science. We have taken the most obvious, because the publications referred to are the most impressive. But the series of bulletins issued by this department, though of necessity dealing largely with special and technical problems, have this year included one bearing the title "Archeological History of New York" which has made a very wide appeal. Indeed in a State so great, with such a varied population, with men and women of variant professional and amateur tastes, there is a demand for knowledge of every sort that we can produce and the more technical it is, with so much the more right do the people look to the State to produce it and make it available. By such measures the parties of first interest, the citizens of the State, acquaint themselves not only with their rightful knowledge as to the possibilities of increased comfort and happiness which their natural resources may have for them, but through them also they come to apprehend in some measure the underlying laws of nature which are essential to and interpretative of the very purposes of life.

SCIENTIFIC RESEARCH

Anyone detected in the act of looking up a word in the dictionary is, in present parlance, engaged in "research." Thus a variety of "research" artists have sprung into view all along the line from statistical accounting even to the writing of anthologies. Research in its virgin meaning implies unremitting and critical inquiry after the truth, and the source of all truth is in the field of Nature which is the outward and visible expression of the Most High.

The Gilboa Devonian Forest. The continuation of operations at Gilboa, Schoharie county, by the New York Catskill Aqueduct Commission, particularly the active quarrying of the heavy sandstones, have brought to light many more stumps of the great trees which have been referred to in preceding reports. Some magnificent specimens have come to the Museum during the year, two truckloads having arrived in the month of November and the series, now passing 30 individuals, is sufficiently extensive to justify a better attempt to portray this most remarkable occurrence in a museum exhibit. This is a problem presenting some difficulties of execution partly because of the great weight of the bodies to be supported. These remnants of Devonian forests are arranged in practically horizontal layers of rock, at three levels in the rock series. The lowest of these levels is the present quarry which has produced more stumps than the others, probably for the sole reason that it has been more thoroughly exploited. This level is at 960 feet above tide.

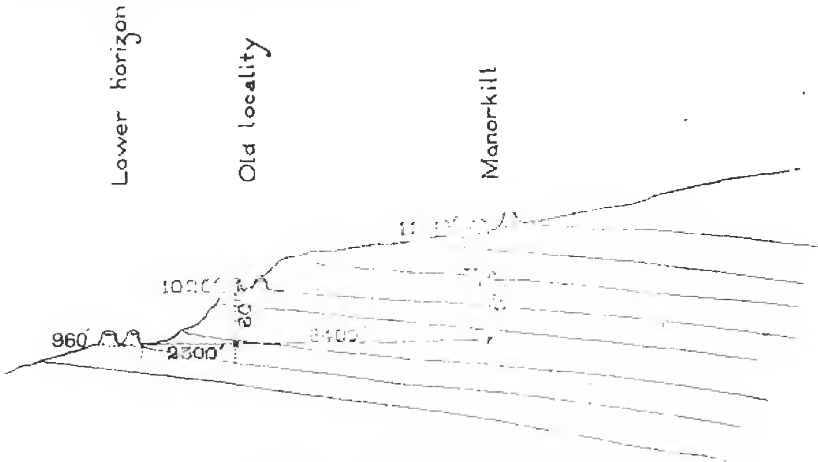
The Riverside Quarry at Gilboa. The 960-foot tree level lies at the base of this quarry where the trunks rested on the shale bed. At the top under the engine house is a collection of stumps that have been removed.



A stump being removed from the Riverside Quarry. The two-foot rule on the rock indicates the size.

(I) following p. 6

The second horizon is the original locality from which specimens were washed out in the flood of 1865. This is at 1020 feet A. T., that is, 60 feet above the former and is 2300 feet away in a direct line. The third level is at the foot of the Manorkill falls 6400 feet away and 100 feet above the last level. This is at 1120 A. T. The intervening rock is gray sandstone in heavy beds, some intercalated sandy shale between. A noteworthy fact indicating that these trees grew in place is the presence of a dark root shale beneath each — a fact which seems to preclude a possibility of the transportation of the stumps to their present place.



This is an ideal north-south rock section showing the three levels of the fossil forests.

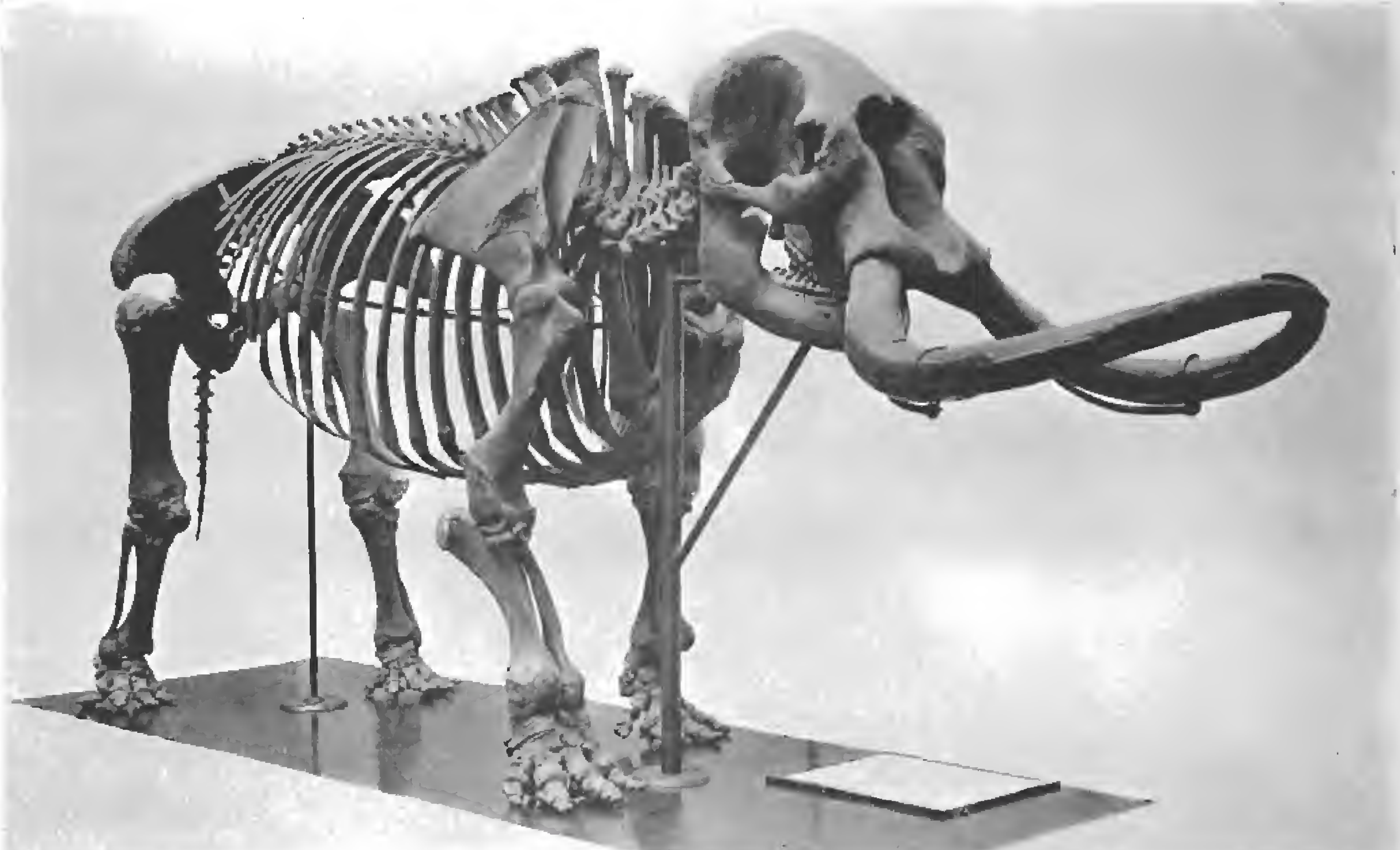
The biological characters of these remarkable plants have never been elucidated, though when they were first found Sir William Dawson, the leading paleobotanist of his time, expressed some views regarding them and applied names which today have no particular meaning. The present report contains an account of the structure and probable relations of these primitive plants prepared by Winifred Goldring.

The restoration of the Mastodon. An adventure to portray the American mastodon as he stood in the flesh, has this year been brought to completion and the restoration made is installed in the Museum. The attempt to bring back into the semblance of life this great and recently extinct member of our fauna was justified by the abundance of the remains which have been uncovered in the State and by the rather extensive knowledge of the structure of the beast which has resulted from long study of it. The Cohoes mastodon whose skeleton has stood in the Museum for more than 50 years, was taken as the subject and basis of the restoration, largely because of general public acquaintance with it and also because the Cohoes animal was not full grown and hence a restoration of it, impressive though it might be, was certain not to have excessive magnitude. The work was well carried out and the method of its procedure is described elsewhere in this report by Noah T. Clarke who did it. Problems of pose, dimensions and hairy skin were among those which required solution and as no one ever saw a mastodon, the solution has depended on careful reasoning as well as skilful mechanical work. What may be said on behalf of the success of this restoration is this; that the best judges of its probable accuracy, those who have closely studied this group of animals, admit that it is as correct a production as can be made with present knowledge. In the process of the work one fact became evident, namely, that the body in the form of the flesh before the addition of the hair, was a finely moulded expression of the gross external anatomy, resulting directly from the procedure of construction. The coating of hair has in large part, unfortunately but necessarily, concealed this expression.

The pathologic jaw of the Cohoes mastodon. The abnormal dentition of the Cohoes mastodon was brought out at the time of its discovery. Osteological irregularities are not infrequent in these great skeletons but this one is obviously pathological. The second or back molar on the right ramus of the mandible failed to develop. A section of the jaw has shown that the cause of failure in the tooth to erupt was that no tooth was ever formed. In consequence the mandible shrank to a narrow dental surface in this field. The single molar that did erupt on this side, is set at an angle to the dental ridge, and it seems that this angle indicates a displacement due to the heavy impact of the upper molars in imperfect opposition to the lower. This brought on a lateral osseous swelling of the ramus, threw the anterior symphysis out of place and produced an obvious distortion of the entire face. Suspecting a diseased bone condition here I asked Dr Minor J. Terry, secretary of the State Board of Dental Examiners, to inspect the jaw and he has been satisfied that the deep sulcus in the bone tissue about the distorted molar indicated a pyorrhoeal condition accompanied by bone necrosis. Difficulty of opposition of the upper and lower teeth throughout the dentition is shown by the comparatively unworn cusps, except at the distal or anterior ends of the other teeth.

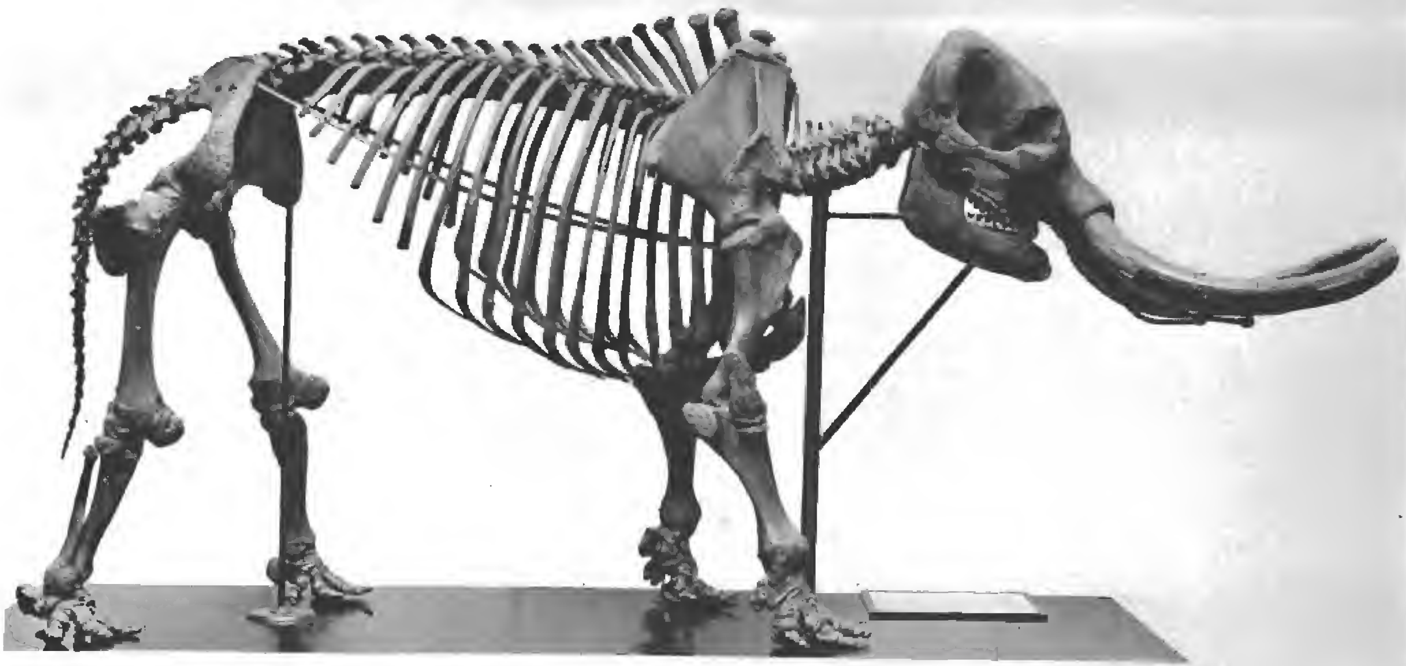
Restoration of the Cohoes Mastodon, three-quarters view from the front.

(1) following p. 8



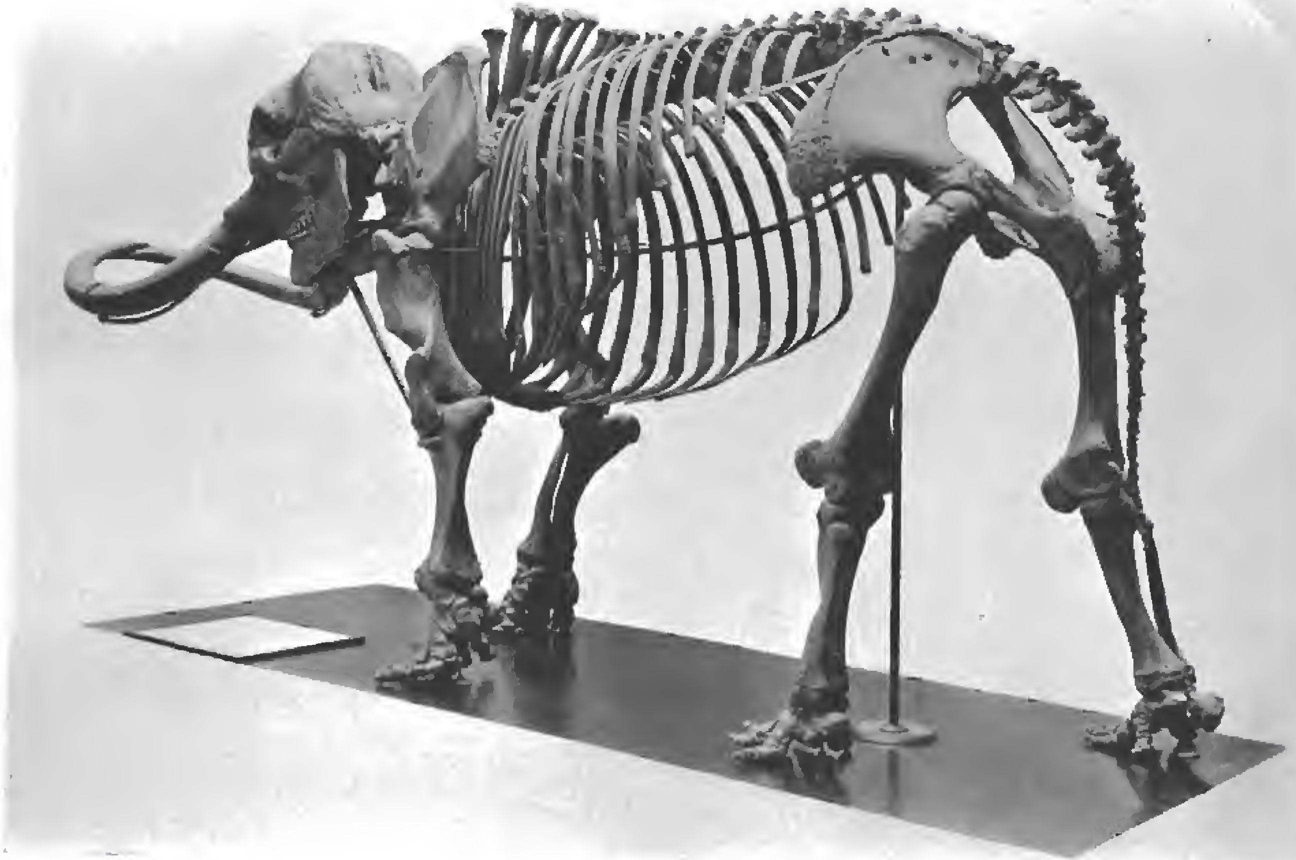
The Temple Hill Mastodon as mounted in the State Museum, three-quarters view from the front.

(B) following p. 8



The Temple Hill Mastodon, side view.

(L) following p. 8



Temple Hill Mastodon, three-quarters view from the rear.

D following p. 8

The Mastodons in the State Museum.

The Temple Hill Mastodon. The splendid skeleton has now been set up in the Museum. Some account of its discovery near Temple Hill, 4 miles west of Newburgh, was given in the last report of the Director. The skeleton has proved to be that of a large male nearly as large as the Warren mastodon, which still bears the palm for size and completeness; though in fact in certain measurements the Temple Hill skeleton as mounted carries some larger dimensions. There are features of special interest in this skeleton: (1) The presence of one of the styloid processes of the temporal bone, extending into the throat and connecting with the hyoid arch, which has been observed but once before; (2) the presence of the milk teeth which have been retained after the full development of the adult molars, thus giving the animal a set of twelve molars instead of the normal adult number of eight; (3) the circling tusks which overlap in front on beveled planes of wear and show the extreme overspecialization of these parts. The Museum acknowledges again the help of the late Emerson McMillin in meeting the cost of acquiring this skeleton, which is to be known as the McMillin or Temple Hill mastodon. The skeleton has been skilfully mounted by Ward's Natural Science Establishment of Rochester, N. Y.

The Postglacial mammals of New York. There is in press a special bulletin on the mammalian remains which have been found in the surface deposits of Postglacial age and this include all occurrences of the mastodon and mammoth and their distribution. This important record, compiled from all available sources in literature and museums, gives an interesting panorama of the higher fauna which occupied the State in comparatively recent times but most of whose members are now extinct.*

Other paleontological work. The monograph of the stratigraphy and paleontology of the Upper Ordovician rocks of New York, comprising the Utica, Frankfort and Loraine formations, on which Doctor Ruedemann, Assistant State Paleontologist, has been engaged for several years, has been finished and the first part, the Stratigraphy of the Upper Ordovician rocks of New York, is ready for printing as a bulletin. The more important second part, dealing with the fossils of these rocks, requires considerable illustration and is held until the pressure of printing other accumulated reports is somewhat relieved. The principal results of this work have been mentioned in former reports.

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* This record has now been issued as a bulletin of the Museum under date of 1922 and entitled "The Mastodons, Mammoths and Other Pleistocene Mammals of New York State" by C. A. Hartnagel and Sherman C. Bishop.

Continued collecting in the Silurian rocks of western New York, the Bertie waterlime and Lockport limestone, mainly by E. Reinhard, has furnished to the State Museum a large amount of striking fossils hitherto unknown. Most important among them are the graptolites, Dictyonema colonies over a foot in diameter, and varied types of the Inocaulis group. The latter with their fingerlike, thick-sheathed anchors and Medusalike crowns composed of a multitude of branching tubes, belong to the most picturesque graptolites yet found anywhere. Equally interesting are the cephalopods and among them a new genus closely related to Hexameroceras, in which the sides of the slit leading to the hyponomic sinus are provided with interlocking teeth, serving for protection as in the case of the narrow slitlike aperture of Cypraea and other gastropods.

An account of these fossils is in preparation. The remarkable graptolite fauna will be described in greater detail in a work on the graptolites of North America. The latter investigation is being undertaken by the writer because the graptolites belong undoubtedly to the best horizon-markers or guide-fossils over very large areas and their closer study will therefore be very helpful in the correlation of the rocks of New York State with those of other parts of the continent.

Among the more striking new exhibits in the Museum is a case devoted to the display of a single species of fossil sponge from the remarkable Silurians of Black Cape, P. Q. A few of the upper strata of these rocks standing almost at right angles to the sea, expose these sponges in every grade of size from that of a chestnut to the size of a half bushel. They stand on the rock surfaces just as they grew in place on the sea bottom. Their preservation is fine and most suitable for intimate study. From a large number brought in by the State Geologist the present exhibit has been arranged by Winifred Goldring to show both their exterior and interior structures. This sponge belongs or is closely allied to the genus Aulocopium, and is termed provisionally Aulocopium hartnageli, the specific name given in recognition of the fact that the first specimens were brought in by C. A. Hartnagel.

FIELD OPERATIONS

Iron region of Southeastern New York. In the studies preparatory to the "Mineral Resources of New York," printed as a Museum Bulletin (No. 223–24) in 1921, it was found that too little was understood of the amounts and mode of accumulation of the

Case exhibit showing the sponge *Aulocopium hartnageli*, which occurs in immense masses in the Silurian rocks of Black Cape.

Case of *Aulocopium hartnageli*, front view.

iron ores in the Orange county and nearby regions, even though this field was the earliest to be opened in the history of iron mining in the State and in which production has proceeded discontinuously from colonial days. A resurvey which was begun a year ago by R. J. Colony, has been brought to a successful conclusion and has succeeded in determining quantities and indicating procedures which can not fail to be helpful to the iron-producing industry. This report is now on the press.

The Schunnemunk region. There is perhaps no part of the State where dislocation, upheaval and breaking down of the rock beds is so extreme as in the region of the Schunnemunk hills west of the Hudson river, south of Newburgh and east of Goshen. During the past season Mr Colony has made a special study of this region for the purpose of elucidating its greatly involved geological structure.

The Newburgh quadrangle. The survey of this region which lies directly north of the Schunnemunk quadrangle, was begun two years ago and has been completed, with the preparation of a geological map. The work has been skilfully done by F. Holzwasser, under the direct supervision of Charles P. Berkey.

Geological map of the Capital District. The capital district comprises the Schenectady, Cohoes, Albany and Troy quadrangles. This large central district affords a comprehensive view of the New York geological formations ranging from Lower Cambrian in the eastern hills to Middle Devonian in the Helderberg section of the Albany sheet. Some of its tectonic problems are difficult, for the reason that the eastern part is intensely folded and overthrust and the western part practically undisturbed, the transitional zone passing through the middle of the capitol district and there forming a belt of complex stratigraphic and tectonic relations which it is hoped to solve by this survey now in charge of Doctor Ruedemann.

Adirondack geology. The survey of this difficult field and the resolution of its complicated problems have proceeded now without interruption for 30 years. Because of the involved character of its structure the work of mapping the area on the scale of one mile to the inch and with intimate examination of regions difficult of access must move slowly. The Adirondack region, expressed in terms of the territory north of the latitude of the Mohawk river is covered by ninety-one topographic quadrangles, seven of which are still unsurveyed. Thirty-nine of these quadrangles have now been geologically mapped and expounded. During the past year the area of the Gloversville quadrangle was covered by Dr W. J. Miller and the report awaits publication.

Interpretation of the Chemung formation. The Chemung formation is a member of the series of New York geological formations as defined in the original geological survey of the State and it has entered generally into the nomenclature of geology in America. It is a heavy mass of sediments terminating the succession of Devonian marine deposits, and while its lithological variations are notable there has never been a successful attempt of the many that have been made, to find a basis for its subdivision into the component elements of its records, sedimentary and biological. The problem has been attacked anew and it will gratify students of geology interested in the integrity and detailed history of the New York formations to understand the construction of this term as elucidated by Prof. George H. Chadwick in a paper printed elsewhere in this report.

Drainage problems of the southern tier. The causes and development of the present natural drainage of the southern counties, the origin of its rivers and their relation to the outflow of Postglacial waters, and in a general way the emergence of the present topography of the extensive Allegany plateau of southern New York, have been subjects of study and field survey for two years. The practical bearing of this investigation lies in affording an intelligent appreciation of natural control of present waterways which must govern their future development for industrial purposes.

Essential Importance of Understanding the Geological History of Rivers and Streams as a Basis for the Successful Development of Water Ways.

It is extremely difficult to convince public and private interests enlisted in water power and river-canal development projects, that the history and mode of evolution of a river, especially a very ancient waterway like the Hudson or the St Lawrence, has an "heredity" which is an effective factor in its behavior, in precisely the same sense that heredity controls human behavior. Too often to an engineer the development of a project for storage, power production or canalization is purely the handling of factors in sight and readily estimable. Such prodigious propositions as the canalization of the Hudson in its upper reaches and directly through its natural bars at the "Overslaughs," or of the upper St Lawrence through its younger rock-paved, incompleted channel, and its lower tidal reaches, seem thus far to have ignored the governance of these rivers, their flow, erosion, transportation, the control of their contributaries and an array of such factors, to which the illimitable ages and changes of their history have subjected them. Such problems can not be enduringly solved without the consent of these contributing factors.[1] The proposal to create a deep ship channel in the rejuvenated and rocky beds of the Hudson river between Albany and Poughkeepsie, has excited the imagination of riparian communities which have dreamed gilded visions of stately seagoing craft bringing to their doors the wealth of other lands. Mayors, common councils, chambers of commerce, boards of trade and less formal citizens' organizations have joined in enthusiastic coalition with countrywide deep waterway organizations in pressing their hopes to a fruition, but at no time, amid these forecastings, have the historical and geological controls of the river been made a matter of serious consideration. The river flows today as it did 10 years ago and 10,000 years ago. Governor Miller, protesting most effectively the proposal to construct a ship channel through the St Lawrence river, meeting with convincing argument every claim set forward by the promulgators of the project, industrial, financial, civic, national and fraternal, quite failed to take account of the geological control of that vast and venerable artery of the continent. Such procedures emphasize the importance, as a matter of intellectual economy and brain salvage, of determining first of all whether such extensive projects are possible of solution where a maintenance is involved which is in itself hostile to the established habitudes of these rivers.

Buried forest at Lyons. In the month of August 1922 a heavy downpour caused a flood in the waters of Canandaigua outlet and where this stream enters the village of Lyons the waters left their channel and cut across the flats from Forgham street north into the Barge canal, discharging so much silt into the canal as to seriously interfere with traffic. The new channel was about 200 yards long, excavated to a minimum depth of 12 feet and in places it was as much as 50 feet wide. This washout exposed, at a depth from the surface of from 3 to 6 feet, a buried forest. The surface here is a level plain, 400 feet above tide. It stands in correct correlation with the level of the bottom of Lake Iroquois which here formed a western projecting arm of the main body of water extending from the Rome district west to central Wayne county, thence trending northwest and west along the beach known as the Ridge road. Most of the trees were found beneath 6 feet of clay evidently deposited

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[1] See Clarke, "A propos de la canalization du St Laurent." Bul. de la Soc. de Géogr. de Quebec. p. 154. 1922.

in standing water. This loose clay contains many snail shells obviously of existing species. The trees were all prone but not flattened. For the most part the trunks were lying in somewhat parallel directions. These trunks varied much in size, one having a length of 30 feet and several had a diameter of 12 to 18 inches. As none of the trunks were found upright and no stumps were exposed it is believed that the material was washed or flooded into a body of standing water. The wood had undergone comparatively little decomposition, though heavily waterlogged and leaves were preserved in great quantities. From them principally it has been possible to determine broadly that the species are of maple, birch, beech, alder, elm, and though there is no evidence of there being among them any strangers to the present tree flora, a closer study of leaves and wood will be required to determine this point.

There can be no doubt that this is evidence of a forest of great age. The deposits in which it occurs belong, in the judgment of Mr Hartnagel, to glacial Lake Iroquois. Prof. H. L. Fairchild is of the opinion that the trees were laid down in standing water during an early stage of that lake. The occurrence at Lyons is not without precedent in western New York. During the excavation of the Barge canal a number of layers of leaves were uncovered at Lock 26, near Clyde, and below, at 22 feet, the tooth of a mammoth was found. Occasional logs buried deep in the soil are of frequent occurrence but we have no record of such an extensive accumulation of buried forest wood in deposits whose geological age can be approximately determined.

Survey of the oil fields. Last year the State Legislature granted a small appropriation for the survey of the oil fields of the State. As the amount given was but one-fifth of the sum deemed necessary for the work, only a portion of the field has been covered. The results, however, have been so important that the survey should be carried out as originally planned. The geological work that this department has carried on in the region of southwestern New York has been of much interest not only to the petroleum geologist but to the oil-producing companies. The region under consideration is the only one in the United States where " flooding " or the " water drive " is being successfully employed in the winning of petroleum. A United States Geological Survey report of 1922 makes the following statement: " In only one region are the geologic conditions so well known and the experience with improved methods on a commercial basis so extensive and so long continued as to justify the formulation of estimates based on the results obtained. This is the region in northwestern Pennsylvania and southwestern New York where the 'water drive' is now employed to obtain oil from the Bradford sand, which was supposed to be largely exhausted. Under the peculiar conditions there the use of this method will result in the recovery of a large quantity of oil that can not be recovered by ordinary methods of production." The purpose of the survey has been to determine the best scientific methods for the employment of the flood for the recovery of oil. This practice of obtaining oil by flooding or restored pressure is still in its infancy and has its possibilities of good as well as danger. It is important that a scientific study of the process be continued in order that the greatest percentage of recoverable oil can be obtained. An important item in obtaining the petroleum from the oil sands is the cost of drilling the wells which must be closely spaced when flooding is employed. At the present time there are over 14,000 producing wells in the southwestern New York field and it is estimated that ten to fifteen times this number will have to be drilled before the fields can all be flooded. By means of a flood the life of the oil field will be extended at least 50 years and perhaps longer, depending on the rate at which operations are carried on. The area that can be flooded comprises some 60,000 acres and as the floods travel only at the rate of between 50 and 200 feet a year, the flooding will take a long period unless many floods are started in many parts of the field. The location and the number of floods which should be used in the oil region is a problem to which attention should be given. The oil leases are in the hands of very many persons and companies and only by cooperation can the best results be obtained as floods will pass from one lease boundary to another and as a result of this the owner of a lease must be familiar with activities of adjoining leases.

What "flooding" is. When the pressure of the gas in an oil well becomes so low that it will no longer force a sufficient amount of oil into the bottom of the well to make pumping profitable, the method of flooding is employed. Flooding is really a process of restoring pressure and, in an indirect way, takes the place of the exhausted natural gas in forcing oil from the sands to the wells so that the oil can be pumped. When it is desired to start a flood, water is introduced into an oil well, and as a result of the hydrostatic pressure thus established the oil is slowly forced away from the bottom of the oil well. The oil well into which water has been introduced no longer produces any oil but serves only as a flood or pressure well. The oil which is forced away from the pressure or flood well and in advance of the water, is called flood oil and is obtained by drilling wells in advance of the oil flood. These oil wells continue to produce oil until the oil flood has passed and they are reached by the water flood after which, unless they are subjected to cross and reversed flooding, they serve only as additional pressure wells forcing the oil beyond into an ever increasing area where new wells are drilled to obtain the flood oil.

The number of floods which now exist in southwestern New York is not known with a certainty. Perhaps as much as 5 or 10 per cent of the sand has been flooded out. This percentage, however, does not apply to the acreage which is somewhat less, since many of the floods have been in areas where the sand is the thickest. During the field season of 1922, eighteen floods were studied and mapped. The floods mapped include some of the old and largest as well as the more recent ones which are, of course, smaller. Most of the floods mapped started from a single flood well and as some of the adjacent wells went to water these were changed to pressure wells thus gradually enlarging the area that is watered out, and at the same time increasing the area of flood oil into which new wells are drilled. The shape of many of the flooded areas is roughly a circle, but on account of loose streaks in the oil sand and other influencing factors, the shape often becomes irregularly oval. Instead of using a single water well in starting a flood, the present tendency is to start by using two or three wells along a straight line as original flood wells, thus producing what is termed a line flood. Floods of this type are more easily controlled and the progress of the flood more easily determined.

The construction of flood maps gives a reliable basis for estimating the percentage of the field that has been flooded out, especially the area of the flooded parts, the velocity of the flood and erratic movement of the water. The maps are also an aid in determining what the effect of cross flooding will be. One of the largest floods mapped covers an area of about 150 acres of which about one-third was actually flooded out and two-thirds affected by the flood. The flood maps also show that the velocity of the flood water varies in the same pool and even in what is considered the same sand. This is due to changes in the character, thickness, depth of the rock and perhaps other factors. Failure to allow for the factors involved, sometimes leads to unsuccessful results at flooding. It is necessary for the producer to study carefully the sands on his own lease, determining as much as he can from his well logs the various changes in character at the different depths, and to notice the direction and rate at which the flood is moving away from his water wells. Methods used in one pool where the sand is loose and deep may fail altogether in another pool where the sand is of a different character, especially where the sand is tight and shallow. The velocity of the flood depends to a large extent upon the porosity and especially the size of the grains of the sandstone. Both of these are likely to vary considerably from well to well, causing the flood to travel faster in some directions than in others. As a rule the velocity of the flood is greatest in the northeast-southwest direction. The cause of this is not clearly understood although it is believed that it is due to variations in the sand rather than to joints in the rock to which the greater velocity in that direction is generally attributed. What relation the actual structure of the oil sands bears to the velocity of the flood has not been definitely determined.

Cross flooding is a method used to obtain additional oil which is left in the sands after the first flood has passed. It consists in changing the original flood wells to producing oil wells by reversing or changing the direction of the flood. The process consists in putting water pressure against the older flood which forces the oil toward the original well which is then again pumped. In this stage of flooding the pump is usually placed at a higher level than in the original well. Results from cross flooding are far from uniform. On some leases this method has produced excellent results, others are reported to have met with no success at all. Considerable study of reasons for the failures and successes of cross flooding should be carried on to determine the methods used where the best results have been obtained and to determine, if possible, the cause of the failures in cross flooding. It may be that the failures have been due to some extent to the structure of the sand rather than to the method used, but at least the reason for the failure to get results should be determined.

The control of the water in a flood well is of utmost importance. To obtain the best results the water must be applied directly to the sand which contains the oil and care must be exercised that the water does not escape through loose streaks of sand, above the oil sand proper, and pass to adjoining wells which are intended to receive the flood oil. These loose streaks of sand may be considerably above the oil-producing sand or directly above it and in either case these higher sands may contain natural gas. Sometimes loose streaks of sand are found within the oil-bearing sand through which the water will pass more rapidly than through the remaining parts of the sand. When this is the case only a partial recovery of oil can be expected but efforts to remedy this condition have met with partial success and it is hoped that further experience with sands of this character will develop a successful method of obtaining a larger percentage of oil. The use of packers in water wells for shutting off the water from loose streaks of sand has been very successful. In many wells it is not necessary to use them at all, but it is always best to test a well for loose streaks of sand to determine whether or not packers can be dispensed with.

In depth most of the wells of the New York oil fields vary from around 800 feet to over 2000 feet, the deeper wells for the most part being located on the higher elevations of the hills. The deeper wells of course have the greatest hydrostatic pressure and theoretically at least will drive the water faster and farther than under similar conditions in a shallow well. Practical results indicate that the theory is sound and the adding of more pressure to the shallow wells is advocated. One advantage of adding more pressure is that fewer wells need to be drilled, the saving in the drilling being more than the cost of producing the additional pressure. Further consideration of the relative merits and costs of obtaining sufficient pressure, which will give the best practical results, is under way and has already been given some attention by several of the oil producers.

The amount of oil that remains in the oil sand after flooding is completed has not yet been satisfactorily determined. The many factors which enter into this problem make its solution difficult. A study of drill cores would give some valuable information and several of the operators are contemplating putting in a core-drilling machine for the purpose of obtaining cores. A study of samples of the sand from wells that have been completely flooded out is also desirable as well as sands that have been cross flooded. It is hoped that some interesting facts can be obtained from a study of the samples of sands from the various flood wells.

Most of the important oil sands of southwestern New York do not contain water. Most of the water that has been reported is found on the borders of the field. Owing to the absence of water, the oil is found in the lower parts of the sand. Such structures as anticlines or synclines are rather difficult to determine on account of the low dip, but oil is sometimes found in synclines. The structure has been made out in only a few instances and it would appear that while the dip is large enough to affect accumulation, it does not seem to have effect on direction of flooding.

In order that the best possible results may be obtained in the survey of the oil fields, a structure map should be made of the main oil pools. Such a map would be based largely on the logs of the numerous wells already drilled. Unfortunately few bench markings have been determined so that in addition to the well logs the elevation of the various wells should be obtained. Such a map would indicate the depth necessary to drill in order to reach a certain sand. Whenever possible, the logs of the wild cat wells should be obtained. In many cases these wells were abandoned before the producing sand was reached and it is believed that certain areas which have been regarded as nonproductive, may yield oil upon deeper drilling.

Although special studies are being made of water for the use of restored pressure, other agents which can create the necessary driving force are being given attention. These include the use of natural gas and air, as well as several new methods. However desirable the use of methods other than water may appear from the point of conservation, it seems likely that the water drive having become so well established will not easily be displaced by other methods unless some greatly improved method is discovered. It is to be hoped that before the field is committed entirely to the water drive, a number of deep tests be made in order to determine the possibility of producing oil or gas-bearing sand below the sands that are to be watered out. If this is done, it will save considerable costs in casing off the watered-out sand should at any future time a supply of oil or gas be found at a depth greater than the present producing sands.

C. A. Hartnagel

Museum expansion. The last report of the Director gave some account of plans and designs for a State Museum building which would not only relieve the present congested condition of the scientific museum but give opportunity to develop the scope of the general museum as outlined in the statute of the State, but for which the State has never made financial provision. Reference was therein made to the fact that the proposition for such new State Museum building had received favorable consideration by the State Roosevelt Memorial Commission. The published report of that commission of which the chairman is Prof. Henry Fairfield Osborn, president of the American Museum of Natural History in New York City, intimates a purpose to commemorate the outdoor aspects of Colonel Roosevelt's career, his love of nature, of wild life, his enthusiastic espousal of, and deliverances upon the themes of natural science, and in view thereof the trustees of the American Museum of Natural History through their president, Professor Osborn, have presented a project to combine such state funds as may be appropriated for this memorial, with such municipal funds as the city of New York may similarly provide and thus erect a joint memorial in the form of an addition to the buildings of the American Museum in New York City. The proposal of the State Museum in its great need of adequate room, is that if a building is to be constructed as a New York State Memorial to Colonel Roosevelt, it might with eminent propriety be an exclusively state building located at the capital of the State.

MUSEUM NOTES

For 6 years past the Museum has given freely to the public courses of lectures on a variety of scientific and related themes. These have been untechnical and of a character to appeal to general audiences which have usually filled the small lecture room of the Museum to its capacity. In large part these lectures, which still continue, are given by the members of the Museum staff.

As a matter of record and suggestion the titles of these informal illustrated discourses are here given:

The State Museum: How to Use It
Diamonds
The Forests of New York
Lake Albany — Our Present Abode
Man and Insects
How Minerals are Formed
Mastodons and Elephants of New York
The Empire State of Indian Days
Harmonies and Cross Purposes in the Insect World
Earthquakes of New York
Nature Monuments
Life of the Ancient Seas
The Cat — A Public Menace
Spiders and Cobwebs
Nature's Mathematics
The Supreme Fight of the Red Man
Why We Protect the Birds
Geological History of Lake Champlain
A Doctor's Garden
The State and the Tree
Where the Weather Comes From
The State and the Fisherman
The Land of the Trembling Earth
What is an Indian?
Paspebiac — A Fish Story
Our New York State Parks
Two Months Underground in the Helderberg Mountains
Our Struggle for Life Against the Insects
Later French Settlements in New York State
Excavations of a Seneca Village Destroyed by DeNonville, 1687
New York Under Four Flags

The Appeal of the Wild Flowers
When the Great Glacier Broke Up in the Mohawk Valley
Wood borers and Their Ways
Keeping Our Treaties with the Iroquois
The Wonderful Spider
Wild Life of Canadian Forests and Streams
Origin of Color and Odor in Flowers
Albany's Part in the Development of the Airplane
The Oyster and the State
John Boyd Thacher Park — A Geological Paradise
The Great Fishing Banks of the North Atlantic
Hunting History with a Spade
By Land from Albany to Scotland
Adaptations Among Insects of the Field and Forests
The Great Flint Mines of the Algonquins at West Coxsackie
Where Do We Get Our Climate
The Natural Life and Beauty of Mount Marcy
The Cultural Value of the Sciences
Animals and Plants from the Water at the Albany Filtration Plant
Gems and Their Lore
Water Plants and Fish Food
Trials and Tribulations of An Entomologist
The United States as a Melting Pot of the Nations
The Pleasures of Butterfly Hunting
The Face of the Earth
A Naturalist in the Adirondacks
Indian Medicine and Medicine Men
Origin and Evolution of the Insects
Are We Still Living in the Glacial Period
Where are We From
What the Salamanders Do
The Story of Petroleum in New York
Insects and Wireless
The Great Devonian Forest
Mastodons and Mammoths
The Background of New York History
Wild Flowers and Their Protection
To Greenland With Peary

Those who have taken part in these lecture courses are, of the Museum staff: Doctor Clarke, Doctor Felt, Doctor House, Doctor Ruedemann, Mr Bishop, Mr Hartnagel, Mr Parker, Mr Whitlock, Mr Newland, Mr Cabeen, Mr Cook, Doctor Stroller, Miss Hartman, Miss Goldring; Llewellyn Legge, chief game protector; Clifford R. Pettis, superintendent of forests; Warwick S. Carpenter, Dr Emmeline Moore, Dr William Wirth Wells, of the Conservation Commission; George H. Hudson, Plattsburg Normal School; George T. Todd, U. S. Meteorologist; Dr Spencer L. Dawes, State Hospital Commission; Dr James I. Wyer, Director of the State Library; Dr James Sullivan, State Historian; Alfred W. Abrams, Director of the Visual Instruction Division; Prof. James W. Mavor, Union College; Ernest A. Norris, Rev. Ure Mitchell, Rev. George W. Walker, C. H. Wilson, Langdon Gibson.

On various occasions, before the legal " emancipation " of woman became effective and associations of women were clamorous for their " rights," the writer urged the fact that essential difference of physiology in man and woman must institute differences in mentality and intellectual function and that in consequence no man is competent to comprehend a woman nor a woman a man. The thought was never very acceptable to women who coveted only the supposed " rights " or civic privileges of man. In a presidential address given before the last meeting of the British Association for the Advancement of Science, Sir Charles Sherrington, speaking on the human mechanism, states that the sex essential extends to and modifies every cell in the animal anatomy, that is, in every constituent part of the human system there are immanent sex differences. Of necessity, therefore, as the body is the physical basis of mentality, there are inherent differences in the mentality of sex. The functions of the civic state can be perfected only by taking full account of these distinctions.

The celebrated chicken's heart which Dr Alexis Carrel has kept alive since 1912, illustrates most effectively the fact of the independent life of the cell which is the ultimate organic component of animal tissue. Each cell lives for and of itself. Sir Charles Sherrington emphasizes the same fact in bringing forward the conception that man or any animal is essentially a " colony " of individual cells, each living its own life and discharging its own function in very much the same sense as the " colony " of such elementary animals as the sponge and its allies among the compound protozoa.

The most competent authorities on petroleum consumption have made a forecast that the American productive supply, at present rate of consumption, will last 16 to 20 years. This statement has no reference to imports or new production. The annual production in the New York field is about 900,000 barrels. Our present estimate of the petroleum reserve still in the New York rocks is approximately 90,000,000 barrels. On the basis of these computations New York wells may be expected to produce oil for a hundred years yet.

The petroleum of the New York field, though limited in quantity, is of very superior quality, especially for lubricating purposes. No other region of the country produces an oil which commands so high a market price.

The great flint quarries of the Algonquins situated a few miles below West Coxsackie, Greene county, discovered and described by the archeologist, Arthur C. Parker, are the property of the New York Central Railroad. The hill which is made up of these flint ledges and the debris of the arrow-maker was acquired by the West Shore Railroad at the time of construction, in the expectation that it would be a source of ballast. It proved unavailable for the purpose, and as it stands far from the right-of-way of the railroad it has apparently never served any useful purpose to the road. It was thought that under these conditions the New York Central would be willing to donate this stony and valueless land to the State Museum as a state archeological reservation. The president of the road has declined to do this except on payment of a purchase price which is not as yet within the possibility of the Museum to meet.

Isle-au-Haut is an island in East Penobscot Bay, Me., about 25 miles southwest of Mount Desert. It is a glaciated mass of highly folded granites of Precambrian age. Between its north-south folds or faults lies a little lake 2½ miles long and one-fourth of a mile wide. This tongue of fresh water is on the east side of the island, separated from the sea by a narrow barrier of rock, only a few rods wide. Its bottom lies 50 feet below sea level and its surface only 10 feet above it. Its water is largely supplied by bottom springs; its outlet to the sea is narrow and disappears between the rocks into the shingle of the beach. The mineral composition of the water is very peculiar; the animal life of the lake is very scanty; its plant life curious. From the bottom of the center of the lake, where it is anchored by its roots, projects the vertical trunk of an arbor vitae tree to a height of 5 feet above the water. These singular features intimate such an unusual history for the lake, that private arrangements were made this past season to get together the data which may help to throw light upon its origin. Sherman C. Bishop and Noah T. Clarke, of the Museum staff, spent some weeks in making observations and collections at this station and a report upon these is attached to this bulletin.

The automobile is an essential factor in our modern life for pleasuse and for good, but it is also a greater factor in the rapid destruction of wild flowers by those thoughtless persons who can not be satisfied with seeing wild flowers in their home ground amid incomparable surroundings, but needs must uproot, break down and gather them by the armful. Thus they gain a few brief hours of doubtful pleasure which the flowers may yield from bowls and vases. Then the faded flowers go to join the despised contents of the garbage can. Where they formerly grew in the woods, their beauty will not again delight the passerby for many years, perhaps never in that spot. By methods like this many of our byways and woodlands, formerly so attractive with their wealth of true Americans, have become the abiding place of burdock, thistle, mustard, ragweed, and numerous other obnoxious aliens. Even more regrettable is the fact that the disturbance does not end with the mere change of plant life. The insects, animals and bird life also suffer a marked change, adding nothing to the attractiveness of such byways and woodlands.

Geology is an essential, fundamental science. It comprehends the composition of the earth, the mode of its making, the history of the life upon it. It is the basis of agriculture and mining, meteorology and hydrology, and in a historical sense of all the biological sciences. It is the foundation of archeology and the history of man. Astronomy is the complementary science; of the whole, of which the earth is a part; of the universe, of which our planet is a unit. It deals in immensitudes of space as does the earth in immensitudes of time; it is the mother of supreme conceptions.

Neither geology nor astronomy is taught in the public schools of this State. Both have disappeared from the high school curriculum. The high school graduate who goes through college without electing either of these sciences, comes out ignorant of the fundamental philosophy and controlling facts of his existence and environment. School graduates of today in New York State are less acquainted with these essential departments of knowledge than were the academy students of 50 years ago.

The effect of this inadequacy of education is making itself clearly evident in the present generation of men, in an incompetent understanding of the factors in human living. While interest in the works of nature has vastly grown, love for the objects of field and woodland and mountains, of sky and sea, has become more keen and vital and widespread, yet this acquaintance does not often lead to an understanding of the laws governing the interpretation of these objects. The interest is in the objects themselves, as a lover of books may address himself to first editions. The same laws which have controlled the development of life from the beginning still control and there is little help for the State till they are recognized in the construction of the statutes. And still the State instructs its future citizens in all laws except the basic and fundamental law.

The Finley-Champlain memorials. When Dr John H. Finley was exchange lecturer at the Sorbonne, shortly before assuming his duties as President of the University and State Commissioner of

Education, he visited the little, now almost extinct village of Brouage, the native place of Champlain, founder of Canada. Inspired with the enthusiasm of piety, he brought home from that spot of Canadian nativity, two rather impressive and ponderable reliques of the days when Champlain was a boy and his village an active and prosperous port on the Biscayan shore. One of these consisted of the heavy stones which inclosed a small arched gateway through a masonry wall into the garden of what is locally accredited as the site of Champlain's home; the other the heavy curbs of Caen-stone which capped a well in the garden of the Recollet monastery, contemporary with the times of Champlain. Coming to Albany, Doctor Finley brought these ponderous reliques with him and after the enthusiasm of conscious possession had somewhat passed, it seemed well to place these souvenirs in communities where they would be most effectively preserved and appreciated. So the Champlain archway is now installed in one of the rooms of the Chateau de Ramezay, Montreal, the home of the Numismatic and Antiquarian Society of Canada, having been put in its present place early in 1914. The curbstones have had a varying fortune. Offered to, and accepted by the Recollet church at Limoilou, Quebec, they were sent thither, only to be returned as not large enough, though their several hundred weight made transportation costs sufficiently so. Finally, during the past year, they have been enthusiastically received by the fathers of the Recollet monastery at Ristigouche, Province of Quebec. There could be no more appropriate place for them, as this institution preserves memorials of the old monastery at Brouage which have enabled Father Pacifique to reset the stones as they originally stood, and reconstruct the canopy or well-house over them. Thus, under the direction of the saintly and learned Father Pacifique the erection was carried out, the memorial marked with inscribed marble tablets, and a day set (St Ann's Day, July 26th, 1922) for the public celebration of the installation. This event was of notable, if minor, historical interest and it attracted wide public attention throughout French Canada because of its associations and the linking together of such eminent Catholic and Presbyterian personages. Ristigouche stands on the shore of the broad waters of the Ristigouche river which is the fluid boundary line between French Canada and Scotch New Brunswick. The living waters bathe both shores and the passage over it is but the slender effort of a few moments. Thus once more John Calvin reached out his hand to St Peter. The historic celebration was made the occasion of the publication by

Father Pacifique of a very interesting story of the early life and the influence of Champlain which is a record of special note as it brings into the foreground some details of his career which have not before had their proper emphasis. In a fair sense this occasion was closely and directly related to the State Museum, as the Director's personal acquaintance was utilized in the appropriate disposition of these reliques.

BOTANY

Scientific investigations. The investigative work of the State Botanist during 1922 has been directed chiefly toward the completion of an annotated list of the plants of the State, which has involved much bibliographic work as well as study of the plants in the state herbarium. Collections and field studies have been carried on in the vicinity of Newcomb, Essex county ; Watertown, and the east shore of Lake Ontario, in Jefferson county; and the vicinity of Oneida lake in the central part of the State. Collections of plants from these and other localities which are of scientific value have been incorporated into the herbarium. The ferns and flowering plants of peculiar interest are reported under " Local Flora Notes," and the fungi under " Notes on Fungi." A large number of fungi, both parasitic and saprophytic, chiefly of recent collection, have been studied in colaboration with Dr John Dearness, and reported upon under the heading " New and Interesting Species of Fungi."

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

I. W. Clokey, Denver, Col. (exchange)	254
J. B. Norton, Hartsville, S. C. (exchange)	152
Dr P. O. Schallert, Winston-Salem, N. C. (exchange)	116
Leland S. Slater, Coxsackie	60
Douglas M. White, Rochester	43
Dr J. J. Davis, Madison, Wis	32
Roy Latham, Orient	17
U. S. Dep't of Agriculture, Washington, D. C	15
Gordon T. Doe, Homestead, Fla	10
William C. Ferguson, Hempstead	9
W. C. Muenscher, Ithaca	6
Miss Annabel Martin, Broadalbin	3
British Museum, London, England	3
W. H. Beauchamp, Syracuse	2
G. E. Andrus, Middletown	2
Fra. Hubert, St Bonaventure	2
Prof. John Dearness, London, Ont	1
Charles Gilbert, Honeoye	1
Dr William Mansfield, Albany	1
Frank Dobbin, Shushan	1
W. T. Shoemaker, Elmira	1
Mrs L. F. Jolley, Berkshire, Vt	1
Dr W. J. Nellis, Albany	1
Total	733

Additions to the herbarium. The number of specimens which have been added to the herbarium from all sources during 1922 is 1243. Of these, 733 were received in exchange or as contributions, while 220 specimens were collected by the botanist in the counties of Albany, Bronx, Essex, Jefferson, Lewis, Madison, Nassau, Oneida, Oswego, Rensselaer and Warren. In addition to these, 290 specimens of mosses, lichens and fungi have been collected and added to the herbarium, making the total number of additions 1243. A large number of other specimens were taken, some of them duplicates of those mounted for the herbarium, to be used for the purpose of exchange with other institutions and botanists.

Identifications. The State Botanist's office has been called upon to identify 753 specimens of plants including many edible and poisonous mushrooms during 1922. These identifications were requested by 194 different persons, mostly by mail, some of them however, by personal visit to the office. The summary of this work by months shows that during the late summer and autumn this service is in greatest demand. By months the number of identifications made is as follows:

January	3	July	46
February	7	August	172
March	4	September	179
April	41	October	154
May	23	November	44
June	45	December	33

The identifications made during the past season represents very nearly a 200 per cent increase over 1921, and close to a 300 per cent increase over 1920.

Visitors. The extensive collections of the state herbarium, especially rich in valuable type specimens of fungi, is frequently consulted by specialists in various lines of botanical research. The following botanists have registered in the herbarium for study of material during the past year:

Dr L. O. Overholts, Pennsylvania State College
Dr A. Gershoy, Columbia University
Dr W. A. Murrihill, New York Botanical Garden
Dr K. M. Wiegand, Cornell University
Dr W. C. Coker, University of North Carolina
Dr H. M. Fitzpatrick, Cornell University
Dr C. C. Plitt, University of Maryland
Dr J. R. Weir, United States Department of Agriculture
Dr G. R. Bisby, Manitoba Agriculture College
J. Andrew Drushel, Harns Teacher's College, St Louis
Lawrence Stetson, Johnstown, N. Y.

Lectures. The State Botanist has delivered nine lectures before various organizations upon the subject of wild flowers and wild flowers needing protection.

ENTOMOLOGY

The State Entomologist reports that the season of 1922 has not been particularly remarkable in seasonal developments, except that the month of June was noteworthy in local annals because of the unusual precipitation, the rainfall exceeded that for any previous June since systematic records have been kept and as a result of this and the somewhat low temperatures of that month, the foliage of most plants was comparatively free from insects until into July. The past winter was about normal and differed widely from the extremely early and mild spring of the preceding year. The Entomologist and his staff have been very fully occupied with matters relating to insect life, some of the more important of which are detailed below.

The Europeon corn borer (Pyrausta nubilalis Hubn.) The situation has been watched very closely in the infested areas outside of New York State as well as within our boundaries, since experience has indicated the great difficulty of forecasting developments in relation to this insect and has shown also that exceedingly valuable information may be obtained by studying conditions in other sections. There was in 1921 a somewhat marked increase in the degree of infestation of our western area and this taken in connection with the very serious depredations in the Canadian section centering upon St Thomas, Ontario, justified considerable apprehension as to developments the past season. A variety of conditions, possibly largely seasonal, resulted in no very marked increase in the infestation in either of the New York areas and such also appears to be the case in the Ontario section, though conditions in portions of the latter appear to have been very materially improved by the general adoption of repressive measures. On the other hand, there was extremely severe injury by this insect in the two brooded area near Boston, part of this probably being due to the unrestricted multiplication of the pest in the large weedy areas of that suburban section. The investigations of the past season showed a material extension of the infested area, particularly in the western part of the State. This appears to have been brought about by the drifting of the moths eastward with the wind but in none of the new territory has it resulted in serious injuries to corn. Conditions in both the eastern and western areas support our earlier findings, namely, the very early and moderately late planted varieties are largely free from infestation. This is decidedly encouraging in the event of more serious injury developing. Investigations have also shown the continued practical immunity from infestation of any plants except corn in this State, thus justifying the restriction of quarantine in the single brooded areas to corn, broom corn, sorghum and Sudan grass and the releasing from such restrictions of the numerous plants coming within the provisions of the quarantine as enforced in the two brooded Massachusetts area. This modification in New York State has not reduced the protection given to uninfested territory through quarantine and at the same time it has greatly lessened the expense of administration and removed many vexatious restrictions upon farm produce. The probability of this insect spreading to the warmer areas of the State, particularly the lower Hudson valley and Long Island and the possibility of its developing two generations and causing serious injuries in that territory as in eastern Massachusetts, amply justifies the maintenance of the quarantine for the time being, not to mention the probability of troublesome complications with other States, if all restrictions were removed.

The gipsy moth (Porthetria dispar Linn.). This pest has in the past few months spread to such an extent as to seriously menace a considerable proportion of New York State. The Entomologist has devoted considerable time to a study of the situation and through conferences with representatives of the United States Department of Agriculture, the New England States and New Jersey and various officials of this State, material progress has been made in working out a practicable and constructive policy for preventing the spread of this insect over large portions of New York State and the great expense incident thereto — that is the cost of control, the latter usually not entirely satisfactory, and the very material loss resulting from widespread depredations. The history of this insect shows a gradual spread from the point of original infestation at Medford, Mass. in 1868 until the infested area includes a considerable proportion of the New England States and touches the eastern border of New York State for a distance of some 75 miles. This has occurred in spite of systematic efforts to restrict spread and although experience, throughout much of this period, has shown the practicability of exterminating isolated infestations and preventing spread, this gradual dissemination has resulted from a well intentioned, though parsimonious policy of delayed or insufficient appropriations, frequently both. The infested adjacent New England area is a rough, thickly wooded territory and it is therefore proposed to prevent spread as well as may be along the present border and as the insect issues from this rough, densely wooded area into the more open sections of the Hudson valley, there to establish a line beyond which the insect shall not be allowed to maintain itself, the precise location of this barrier zone to be determined by a careful examination of the wooded and cultivated areas of the Hudson and Champlain valleys and the northern boundary of New York State westward to Lake Ontario for the purpose of establishing a zone where the insect can be held most economically and successfully. The establishment of a barrier zone would be a gradual process extending through a series of years and determined in large measure by the westward spread of the moth. The entire line extending from some point on Long Island Sound northward and westward to Lake Ontario, would be shorter than the present boundary of the infested area, along all of which repressive work is being conducted. The maintenance of a successful barrier zone would mean immunity from gipsy moth ravages for all of our territory west of that area, not to mention the protection given to other States, provided isolated infestations, which presumably will be found from time to time beyond this line, are exterminated. The cost of maintaining such a zone would be much less than attempts to control the gipsy moth over a considerable proportion of New York State, if it became infested, as is to be expected, unless some such plan is put into practice and there would be in addition to the cost of controlling the infestation, the enormous and widespread losses resulting from severe injuries to forest and shade trees throughout the infested area. There is every reason for believing that the Federal Government, in view of the national aspects of the problem, would cooperate in a very substantial way in maintaining this barrier zone, and it is gratifying to state that most of the experts thoroughly cognizant with the situation agree as to the wisdom of testing possibilities in this direction.

The apple and thorn skeletonizer (Hemerophila pariana Clerck). This European insect found well established in Westchester county in 1917 and remaining in that area with comparatively little spread in this State until the past season, has greatly extended its range north in the Hudson valley as shown by our investigations. It is now well established on both sides of the Hudson river northward to and including the southern portions of both Albany and Rensselaer counties and in these latter areas, it was so extremely numerous in unsprayed orchards, as to practically defoliate the trees toward the end of the summer. This stripping, as shown by available data, not only causes the loss of the crop the present season but the blasting of that for the following year, since the trees are so weakened in most instances that blossom buds will not develop next spring. This recent introduction would ordinarily not cause serious injury in orchards which are well sprayed for codling moth and other pests. It does, however, threaten serious loss and perhaps death to many trees in the infested area, which for some reason or other are not or can not be sprayed.

Some of the more important or more interesting species coming to attention during the past year are briefly noticed below.

The grape leaf hopper, Typhlocyba comes Say, appears to have been somewhat unusually abundant, since it was taken in numbers upon rose bushes and small apples and pears were injured presumably by this insect in Columbia and Dutchess counties.

The large and brilliantly colored Say's blister beetle Pomphopoea sayi Lec. was reported from a number of localities, a confirmation of earlier data relating to its periodic appearances.

The grape leaf hopper, Typhlocyba comes Say, was somewhat abundant in portions of the Chautauqua grape belt and in parts of the Hudson valley, considerable numbers of wingless hoppers being observed in southern Columbia county the last of June.

Galls of the grape Phylloxera, Phylloxera vitifoliae Fitch, have been unusually prevalent on grapevine in different parts of the State and judging from specimens received, the same conditions prevailed in the middle states.

A new strawberry pest, Heterostomus pulicarius Linn., a small, black beetle about three-sixteenths of an inch long, was found working in recently opened strawberry blossoms in southern Columbia county and investigations disclosed the somewhat general occurrence of the insect from that point northward into Saratoga county and in portions of Albany county. This appears to be a recent European introduction.

The strawberry weevil, Anthonomus signatus Say, was unusually abundant in Albany, Columbia and Saratoga counties. In some cases the loss in the crop ranged from 10 to, in a few cases, 50 per cent, due to weevils cutting the blossom stems.

The corn ear worm, Heliothis obsoleta Fabr., situation shows a marked contrast to the conditions in 1921. Last year this insect caused general and in many cases serious injury in practically all of the counties of the State and there was much concern respecting the prospects for the past season. The weight of evidence favored the belief that the caterpillars, although extremely numerous in the fall of 1921, would be unable to survive throughout most of the State and this is substantiated by the practical absence the past season of the ear worm, except in the vicinity of New York City and on Long Island where it probably hibernates successfully.

The lined corn borer, Hadena fractilinea Grote, a relatively new pest, brought to notice repeatedly in 1918 and 1919 was not reported during the past season.

The grubs of the green June beetle, Allorhina nitida Linn., and probably those of other June beetles have caused considerable injury to lawns on Long Island and in the vicinity of New York City. Somewhat extensive patches of dead lawn were noted in New Rochelle.

A large series of samples of wheat collected in different parts of the State were sent through the courtesy of Prof. C. R. Crosby of Cornell University and an examination of these showed a very scattering infestation by wheat midge, Thecodiplosis mosellana Gehin, a condition very different from that obtaining in 1918.

The birch leaf skeletonizer, Bucculatrix canadensisella Chamb., which attracted some attention in 1921, has been somewhat generally prevalent in the northeasten part of the State, many of the birches being so badly affected that most of the leaves turned brown and dropped in early fall.

The white pine weevil, Pissodes strobi Peck, continues to be abundant and injurious in young plantings of white pine, the trouble being most serious in areas where the native pines are somewhat badly deformed due to earlier work by this insect. This was particularly noticeable in the northern part of the Hudson valley and on the edges of the Adirondacks.

Another European insect, Ocnerostoma piniariella Zeller, was brought to our notice through correspondence with Dr J. S. Boyce of Oregon. The general character of its work is suggestive of our native pine leaf miner, Paralechia pinifoliella Chambers.

The interesting maple case bearer, Paraclemensia acerifoliella Fitch, was locally abundant and somewhat injurious to sugar maples in both St Lawrence and Warren counties.

Canker worms, probably spring canker worms mostly, Paleacrita vernata Peck, defoliated a number of unsprayed orchards in Orleans and Genesee counties. They were also reported as injurious to elms in southern Westchester county.

The sugar maple borer, *Plagionotus speciosus* Say, continues to be a serious pest in the State and owing to the fact that the injuries develop slowly, the true cause of the difficulty is rarely understood. This insect is generally prevalent in the western part of the State, particularly in the vicinity of Buffalo and in some villages has brought about a very unfortunate condition, most of the sugar maples being badly deformed and in some instances half dead.

Imported willow leaf beetle, *Plagiodera versicolora* Laich., has become generally established on Long Island and in the vicinity of New York City, reproducing in great numbers and practically destroying the foliage of willows in midsummer. It is particularly injurious to the black willow, golden willow and weeping willow.

The elm case bearer, *Coleophora limosipennella* Dup., continues to be a somewhat serious local pest on Long Island and in the vicinity of New York City. It displays a marked preference for the English and Scotch elms and in certain favored localities may practically destroy the foliage in midsummer.

The elm leaf beetle, *Galerucella luteola* Mull., has been somewhat abundant and destructive in the vicinity of New York City, here and there in the Hudson valley, notably in Albany and Saratoga counties and is becoming established in new areas in the city of Rochester.

The bronze birch borer, *Agrilus anxius* Gory, continues to be destructive to ornamental birches in different parts of the State and it is not unusual to see the tops in a dead or dying condition, even in residential areas.

The bagworm, *Thyridopteryx ephemeraeformis* Haw., has been unusually abundant and injurious in the southern part of the State.

The spruce cone gall, *Chermes abietis* Linn. The galls of this insect are frequently received from different parts of the State. This insect and the frequently associated and very obscure spruce bud scale, *Physokermes piceae* Schr., are responsible for considerable damage to Norway spruce.

The box leaf miner, *Monarthropalpus buxi* Lab., continues to be a serious pest here and there on Long Island or in the vicinity of New York City and magnificent growths of box may have a very considerable proportion of the leaves disfigured by the mines of this insect.

A distinctly unusual injury was brought to notice through the reception of a solitary bee, *Halictus virescens* Fabr., in early July accompanied by the statement that they were so numerous upon a lawn in Greene county as to practically destroy it by their burrowing operations.

Technical studies. The Entomologist's work upon gall midges has been continued as opportunity offered and has resulted in a number of most interesting collections from various parts of North America and the Old World, especially India, being submitted for identification. The numerous types of new genera and species erected have been deposited in the state collections, making them invaluable for all subsequent students of the group. A summary of these studies, with special reference to our own fauna, is awaiting publication.

Publications. There have been no Museum publications relating to entomology issued during the period covered by this report. The marked peculiarities in the behavior of the European corn borer in this State as compared with conditions in eastern Massachusetts led to a revision of the Entomologist's account of this insect issued as Cornell Extension Bulletin 31. This appeared in March and contains a digest of the important findings in the investigations of the last few years. A popular discussion of " The Possibilities of Exterminating Insects " appeared in Scientific Monthly and attracted considerable favorable comment. An earlier prepared paper on " Some of the Broader Aspects of Insect Control " appeared during the year in the 51st Report of the Entomological Society of Ontario. An unusual development was the delivery of a brief talk on " Bugs and Antennae " at the broadcasting station of the General Electric Company, Schenectady. This, on account of its historical interest, was published in Science.

A number of brief, popular accounts relating to the more injurious pests have been prepared as heretofore and widely circulated through the agricultural press. There have been, as in earlier years, a number of minor technical papers, which have appeared in scientific journals.

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 held in cooperation with farmers' institutes or county farm bureaus. A number of conferences related to the European corn borer and the gipsy moth, both briefly discussed above.

Cooperative work. The Entomologist has continued to cooperate with the Federal Bureau of Entomology as a collaborator in European corn borer work to the mutual advantage of both interested agencies. He has also cooperated with the insect pest survey, United States Department of Agriculture. This latter covers the entire United States and since it relates to all insects of economic importance, it is broader in scope than most undertakings of this character. It places at the disposal of all official reporters early information respecting recent developments and thus frequently provides warnings of probable outbreaks in addition to the dissemination of much valuable data.

Collections. A number of desirable additions to the state collections have been made. Some of the best material has been reared in connection with studies of various outbreaks or secured as a result of requests for information concerning comparatively unknown forms, such as the deer bot fly, Cephenomyia abdominalis Aldr., received through the kindness of Asa Lawrence of Wilmington and previously unrepresented in the collection. Special attention has been paid to the acquisition and preservation of immature stages, since these are difficult to obtain.

An interesting collection of insects was received in exchange from Mr C. Garret of Cranbrook, B. C., a series of minute parasites from R. M. Fouts, a Washington authority, and an exceptional series of gall wasps belonging to the genus Rhodites and their galls was contributed to the state collection by Prof. A. C. Kinsey, Indiana University, Bloomington, Ind.

A unique and rare contribution was received in early March from L. J. W. Jones, Bainbridge. It consisted of several pairs of the snow-born Boreus, Boreus nivoriundus Fitch, a species very rarely coming to the attention of naturalists.

With a limited staff, it has been impossible to do much needed work on the collections, aside from a certain amount of labeling and rearranging necessitated by current developments.

Office matters. The correspondence has been along the same general lines as before, though the European corn borer and the gipsy moth on account of their outstanding importance, have occupied a somewhat prominent place.

The general routine work has made unusually heavy demands upon the Entomologist and his assistant, the latter being in charge of the office and responsible for the correspondence and other matters during the absence of the entomologist.

The lack of a second assistant has seriously restricted the work of the office and it has been necessary to defer matters which could be put to one side. This has resulted in very little systematic work being done upon the collections. These latter should be kept in the best possible condition and the numerous specimens identified, since they are most important aids to speedy identification and the determination of the economic status of an insect. At present much of the material is simply labeled and put away in the hope that some time it may be properly classified. There is in addition considerable accumulations of earlier years which should be treated in the same way, if due regard be had for the development of the state collections and the maintenance through a considerable series of years of satisfactory records along all lines.

Horticultural inspection. The nursery inspection work of the bureau of plant industry, Department of Farms and Markets, has resulted as in former years in a number of specimens representing various stages of developments, some in very poor condition, being submitted to this office for identification. The satisfactory determination of specimens originating from various parts of the world requires an intimate and wide knowledge of the literature and insects in both this and other countries and illustrates in a concrete manner the need in entomological work of both training and experience. This type of work also emphasizes the importance of a thoroughly classified collection mentioned above.

The general work of the office has been materially aided as in past years by the identification of a number of insects through the courtesy of Dr L. O. Howard, chief of the bureau of entomology, United State Department of Agriculture, and his associates. The Entomologist in turn has been able to render some assistance to Doctor Howard and his professional associates in various states and other parts of the world through the identifications in the group in which he is recognized as a specialist.

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 State Conservation Commission, the State Department of Health, 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. There has been, as in the past, most helpful cooperation on the part of all interested in the work of the office.

ZOOLOGY

The Zoologist has continued the investigation of reptile and amphibian life histories and the study of the very extensive spider fauna of the State, the latter project having been inaugurated several years ago as a joint undertaking with Prof. C. R. Crosby of Cornell University.

Field work carried on in the regions about Mount Marcy in the Adirondacks, near Stamford in Delaware county and in the Helderberg mountains, Albany county, has resulted in the collection of valuable data and materials relating to the particular problems under investigation. In January 1922, 10 days were spent at Ithaca studying the extensive spider collection of the department of entomology at Cornell University.

Two new bird groups designed to show the nesting habits of the rose-breasted grosbeak and the scarlet tanager were prepared by Joseph A. Santens of Buffalo and installed in Zoology Hall and the collection of mounted fishes further supplemented by the addition of about twenty specimens not heretofore represented in the exhibit series. Several of the older groups, including those of the wolf and mink, were completely dismantled and remodeled along more effective lines.

The amount of available space left in the Zoology Hall for additional exhibits is very limited. Much floor room is taken up by capacious habitat groups and it has been necessary to resort to special and very shallow wall cases in order to take advantage of utilizable space. Under existing limitations it is hopeless for this division of the Museum to attempt any more large habitat groups of birds and mammals. It may be remarked, however, that such groups are to be found in all museums; that they are in many ways of the conventional museum type of exhibit and it would seem to be a better policy for this division to undertake the production of small groups of the lesser and more inconspicuous members of our fauna, such as the small mammals, reptiles, batrachians, etc. These are animals which are seldom to be found on exhibition and in which there is none the less a widespread interest.

ARCHEOLOGY AND ETHNOLOGY

The principal line of research of this division is to discover and to record all the facts concerning the archeology and ethnology of the New York aborigines resulting from field and museum activities.

Through the fortunate fact that descendents of the Iroquois, the latest of the aboriginal inhabitants of New York, live within our borders, still in tribal relation, it is possible to obtain many interesting and valuable facts concerning the ethnology of these people.

Many of the Seneca and the Onondaga people still continue their native ceremonies and rites, and not a few of the members of the other nations remember their folk tales and music. There is thus a rich field for the student of aboriginal things.

Information is sought from this office by high school and college students, for essay material, by artists, playwrights, sculptors, musicians, writers, by historians, ethnologists, archeologists and museum men, by various experts, as lawyers, department men and sociologists, and by a large body of citizens requiring certain specific information.

Donations. The Museum has been fortunate in receiving a number of interesting and valuable donations in archeology this year. Among the donors and specimens are the following:

George G. Champlin, of the State Library, a terra cotta pipe having an animal head effigy of the bowl, from Ontario county; Dr R. W. Orr, director of the Provincial Museum of Ontario, parts of a skeleton and skull stained with red iron oxide, from an ossuary near Dunnsville, Ontario; Pheobe P. Smith, of Jewett, Indian mortar found at Ashland, N. Y.; Mrs Hattie Janson Vosburg of Coxsackie, stone mortar from Mine Hill, through Dr. Andrew Webster Van Slyke; James A. Clark of Middletown, 2 grooved axes, 2 bannerstones, 2 argillite cache blades and 6 finely chipped points from the vicinity of Horse Island; Mary Meredith of Euclid, N. Y., collection of flints and polished stone articles from the Seneca River region, in memory of her brother William Meredith; Otis Mason Bigelow, of Baldwinsville, platform pipe with a buzzard effigy on the bowl, from Three River Point; Dr Luzerne Coville, of Ithaca, carved stone amulet of lozenge shape; the Rev. W. R. Blackie of Williamsbridge, collection of prehistoric implements, splinters, slips and fragments of animal bone from the caves of Madeleine, France; Jefferson D. Ray of West Coxsackie, a fine series of chipped articles from Four Mile Point and from Old Orchard Point.

Excavations at Vine Valley. For a number of years the State Museum has been receiving specimens from a certain site situated on the McCombs farm in Vine Valley, Yates county. These specimens, sent for examination by the McComb family, were of such unusual interest that the Museum acquired all that came in from there. The material was found during the excavation of the sand and gravel pit on the south slope of Bare hill, and for more than 30 years the owners had steadfastly refused to permit excavations by any private parties and even by museums, until this year, when the State Museum secured the right to make excavations.

The site lies along the south slope of Bare hill on its westernmost side and on the ridge just above the valley of Vine Valley creek and extends from the lake to a point just east of the Strum farm, a distance of about 1250 feet. The village site is on the flats but extends upland on the north side of the creek and covers a portion of the Robson farm. To the south of the creek it seems to begin along the landing road and run south in the level area back from the lake to the beginning of the steeper rise of South hill or Genundewa. Here are occasional ash pits and surface indications. Arrowheads and now and then polished stone implements have been found here.

The location is reputed to be an early Seneca haunt, and there are traditions of an ancient Seneca fortification on the top of Bare hill. Historic sites are known on both sides of the lake and the Senecas up to the Civil War period wandered about the lake, as if it were hard to abandon this region so sacred to their forefathers. As a matter of fact, however, Iroquoian artifacts in any abundance are not to be found in the vicinity of Bare hill and the evidences of a genuine artificial fortification on the top of the hill are too feeble to admit of plausibility. All the evidences of occupation on the east slope of the hill and in the valley below are Algonkian. Iroquois evidences occur opposite Bare hill at such places as Seneca Point, and south of the lake at such points as Naples. Bare hill itself shows no evidence of having been occupied at any time by any branch of the Iroquoian people.

Owing to the intensive farming of the village area of the old occupation we were unable to make more than a superficial examination, but this was sufficient to determine the culture and its approximate period.

The site that was examined and excavated was the sand pit and the slope just to the south. But a small portion of the pit area, the small plat to the east and up-hill could be excavated. Here nothing of any importance was discovered. Our attention, therefore, was given to the steep slope, graded into grape terraces. Here great piles of earth had been scraped from the top of the hill and graded into the terraces, where 40 years ago vineyards were planted. In digging back to widen the terraces skeletons were sometimes found.

It was under such conditions that the work of excavating was undertaken.

After a month's work in the intense heat, interspersed with terrific rains and wind storms, thirty-eight burials were uncovered all on the side hill and ranging from within 4 feet of the top to a distance of 30 feet down.

Thirty burials were from previous tree or scaffold mortuary disposals; that is, the bodies had been wrapped in skins and furs until skeletonized, when they were removed and buried. The scattered and displaced bones in these burials were evidence of this. With such burials there were only a few shell beads. In most cases a dog had been sacrificed in such graves and buried either over or just to one side of the bundled bones. Some of the bundle burials were of infants but most were original interments and with these were sometimes two dogs. Four of the adult burials were original interments, and in each of these the skeleton was flexed in the usual aboriginal method. Except in one instance there were artifacts with each original adult burial.

Scattered through the grave area were fire or feast pits, some of them just above the graves and others a little to one side, as if there had been watch fires into which the remnants of the death feast or grave watch had been thrown. There was little in these pits except fragments of animal bones — deer, raccoon, turtle, bear and beaver — and an occasional hickory nut or acorn. There was one exception to this — a pit containing several quarts of charred hickory nuts.

Artifacts were rare in bundle burial graves, but in the flexed burials there was always at least a bead or two, save in the case of a female interment.

In pit 22-23, found July 13th, within 12 inches of the surface was found a broken skeleton apparently lying on its face with its knees drawn up under it, and its hands before its face. This burial was near the top of the terrace and directly under the stopping place of the auto trucks which were loaded with sand. This probably accounts for the crushed condition of the skelton. The side hill in which the skeleton lay was "pocketed" and at the bottom of the grave more than a dozen grooved sinkers were found, the grooves being the long way of the oval pebbles. The skeleton was of an adult male of perhaps 50 years. The lower jawbone alone of any part of the skull remained intact. On the back of the head was a *bone bar amulet* and just below it and resting between the shoulders was a broken two holed gorget of gypsum. In the right eye socket was a notched arrowhead.

To the east of this pit and adjoining it were two other pits (given the number 23). One contained a dog burial and the other an infant burial. The infant's skull was missing and the dog had two beads of shell (disk wampum) at its neck.

In pits 9 and 10 which adjoined but were of different depths were interesting objects. Grave 9 was found 3 feet down in the upper terrace. It was of a large child, probably female, and of about 11 years, judging by the skull and dentition. Each joint of the limbs lifted from the diaphysis, appearing as a distinct bone, having a separate surface or suture between it and the shaft. At 5½ feet down, or 2 feet lower than grave 10, another large grave was found. Upon baring the bones and brushing them off, so as not to disturb their relation, we found parts of four skeletons — two infants, a headless adult, and a flexed skeleton of an adult male. With the headless skeleton was a crude clay pipe with a flattened stem, and resting under the sternum of the complete skeleton was a steatite pipe.

Implements found in other graves are: shell beads of the discoid type, broken tubes, a flattened metate, three broken bell pestles, a pendant gorget of the thick type, bone awls, notched arrow points, a copper pin about an inch long and two perforated joints. Other implements found by the McComb family are described in the Director's report for 1913.

New York State Indian Commission. The work of this commission, of which the Archeologist was secretary, by appointment of the Governor, terminated with the adjournment of the Legislature in 1922. The object of the commission was to confer with the committees of Congress on Indian affairs, relative to the status of the New York State Indians and their reservations. This necessity grew out of the apparent conflicts in jurisdiction between the federal and state governments, in the matter of enforcing state laws on reservations, particularly those relating to health, quarantine, education and truancy. By an opinion of the Attorney-General, it appeared that state laws did not apply to reservations and since the Federal Government attempted to enforce its jurisdiction only in the matter of the seven major crimes, it was felt by welfare workers that there were many beneficial efforts that were weakened through the lack of laws capable of enforcement. The several members of the Legislature and of the state departments who were members of the Indian Commission were to see what Congress was willing to do in this situation. A preliminary hearing was held with certain members of the congressional committees, but for 3 years the commission failed to function, largely it appears because the chairman did not call general sessions of the commission for the purpose of discussing the several subjects upon which a report could be based. His meetings with the Indians were personally called and the report rendered by him a personal report in which other members of the commission had no part in discussing or formulating, willing and ready as some of the commissioners were to so participate.

The legal tangle of the New York Indians, therefore, remains as it was before the commission was formed. In a measure it may be said to have been complicated even further by the idea that the New York Indians have a vast land claim against the State based upon the Fort Stanwix treaty, which was superseded by the Canandaigua treaty of 1795, and which the authorized chiefs and head men of the Iroquois signed in good faith. It is said, however, that the Senate of the United States never ratified the Canandaigua treaty and that it is therefore not a functioning agreement, and that for this reason the Fort Stanwix treaty still holds, in which case all western New York west of a line drawn south from Oswego must still belong to the Six Nations. This is an interesting assertion, but it remains with Congress and with the Supreme Court to assert its validity, and not the several Indian commissioners of the State.

New York State Archeological Association. This association is in a flourishing condition and during the year last past has held its scheduled meetings and lectures in Rochester. One publication has been issued during 1922, "The Archeology of the Genesee Valley," by Frederick Houghton. At a meeting of the trustees of the association, a petition was made to the Regents of The University of the State of New York for a charter. After due consideration a provisional charter was granted by the Regents and placed in the hands of President Alvin H. Dewey of Rochester. The trustees of the association are Mr Dewey, chairman, Harrison C. Follett, Walter Cassebeer, John M. Clarke and Arthur C. Parker.

New York Indian Welfare Society. This society, which a year ago met in Buffalo, convened in its 1922 annual session in the rooms of the Albany Institute and Historical and Art Society, through the courtesy of the society and its president. Its sessions were productive of much good and matters of education, health, public nurses, sanitation, agriculture, better schools, care of the indigent, the work of the Indian Commission and other matters were fully discussed. The society refused to consider the matter of claiming that the Indians held legal title to more than 60,000 acres of western New

York land valued at more than two billion dollars, believing it better to consider things of immediate welfare. This determination caused some dissatisfaction on the part of nonmembers who voiced their opinions. The society, which is seeking to cooperate with the state departments and with voluntary relief agencies, reelected its officers and reappointed its committees. Horton G. Elm, an Oneida, is president, and Louis Bruce, a Mohawk, secretary.

The Archeologist of the Museum has assisted this society to the extent of furnishing information and helping its officers, it being thought within the scope of this office to encourage the Iroquois who remain with us as the survivors of the aboriginal "Empire State" to adjust themselves to the requirements of modern civilization.

STATE MUSEUM ACQUIRES ORIGINAL CONTRACT OF FIRST PURCHASE OF LAND NEAR ALBANY FROM INDIANS IN 1630

Note by ARNOLD J. F. VAN LAER, *Archivist*

By gift from Mrs John Boyd Thacher of Albany, the New York State Museum has come into possession of a valuable document on parchment which may be described as the oldest official instrument issued under the hands and seal of the director general and council of New Netherlands, now known to be extant. The document, which lacks the seal, but which is otherwise in an excellent state of preservation, relates to the first purchase from the Indians of land in the vicinity of Albany, in what was later known as the colony or manor of Rensselaerswyck, and is one of the two instruments concerning that purchase which were secured by General James Grant Wilson at Amsterdam in 1889, and which had been preserved in that city for more than 250 years in possession of the Holland branch of the Van Rensselaer family. Facsimiles and translations of the two documents were published by General Wilson in 1892 in the first volume of "The Memorial History of the City of New York," in which this document is called a "contract," while the other is designated as a "deed." Both documents contain formal and almost identical declarations by the director and council that certain Indians appeared before them and upon receipt of certain quantities of merchandise conveyed to them, for and on behalf of Kiliaen van Rensselaer, residing in Holland, various tracts of land situated in the neighborhood of Fort Orange. It is to be noted, however, that the "contract," which is not dated, gives the date of the transaction as August 6, 1630, whereas in the "deed," which is likewise undated, but which in an acknowledgment attached by Vice Secretary Lenaert Cole is stated to have been executed in his presence on August 13, 1630, the transaction is said to have taken place on that date. Aside from this variation, which does not necessarily imply any real discrepancy, or that the Indians appeared before the director and council at two different times, the main difference between the two documents consists in the fact that the "contract" contains a long preamble in which certain statements are made in regard to the former unwillingness on the part of the Indians to sell their land and the subsequent agreement which was made with them by Gillis Housset. It is these statements, which do not occur in the shorter and more formal "deed," that give to the "contract" a greater value as an historical document, since they throw an interesting light on the pressure which at that time was being exercised against the Mohicans by the Mohawk Indians who compelled the former to abandon their lands along the Hudson River and made them willing to sell.

An interesting feature in connection with the description of the land conveyed is the fact that it seems to cover large tracts south and north of Fort Orange and a small tract on the east side of the river, opposite the fort, but does not appear to include the land on which the fort itself stood. Kiliaen van Rensselaer afterwards claimed that his purchase included the site of the fort, but the Dutch West India Company denied this, on the ground that the fort was built long before the purchase for van Rensselaer was made. No document, however, has ever been produced to show that the company bought the land on which the fort stood and it is possible that this land was held merely by sufferance, although the language of the "contract" seems to favor the other view. It will be noticed that the property is described as extending up the river a distance of fully 3 Dutch or about 14 statute miles, but that nothing is said in regard to the width of the land, it being understood that the various tracts that are named included all that was owned by the Mohican Indians, whose territory extended inland from the river a distance of about 2 days' journey.

As to the form of the document, it is to be noted that the "contract" is signed, not by the Indian proprietors, but by the director and council, before whom the conveyance took place. This feature, which is in accord with the contemporary Dutch practice in the case of transfers of land that were made before the court, has had the fortunate result of preserving for us one of the very few known signatures of Peter Minuit, the director of New Netherlands, whose name is identified with the purchase of Manhattan Island from the Indians in 1626. The other signatures, of members of the council, are those of Pieter Bylveltt, the lessee of one of the company's bouweries on Manhattan Island; Jan Lampo, the sheriff, and Reyner Harmensen and Jan Jansen Meyns, both of whom seem to have been master ship carpenters.

It is finally to be pointed out that a copy of the "contract," without the signatures, occurs on page 4 of the first book of Dutch Patents, from which a translation, made by Mr Berthold Fernow, under the title "Indian Deed to Kilian van Rensselaer for a tract of land on the North river (Manor of Rensselaerwyck), is printed on the first page of volume 14 of the "Documents Relating to the Colonial History of New York." Unfortunately, neither the translation published by General Wilson, nor that made by Mr Fernow, is entirely satisfactory, the first giving the date of the transaction as August 8, 1630, instead of the 6th, and the second representing the possible sale referred to at the beginning of the document as having actually taken place, so that for the correct understanding of the document a new translation seems desirable and is presented herewith.

CONTRACT OF SALE OF LAND ALONG THE HUDSON RIVER FROM THE MOHICAN INDIANS TO KILAEN VAN RENSSELAER, AUGUST 6, 1630.

Whereas Bastiaen Janssen Crol, Commissary at Fort Orange, stated here at the Manhatas to the Honorable Council of this place, that the land situated near the aforesaid fort could not be bought this present year from the owners thereof and that, even though it were acquired afterwards, it would be understood by the Virginians to be sold only for so long as he, Crol, should continue to reside at the fort; and whereas likewise, when Wolffert Gerritsz, having orders from his Hon. Masters to inform their Honors of the situation there, expressly inquired of him, Crol, what and what sort of information he should send to their Honors aforesaid, he, Crol, did thereupon reply that there was this year no chance or means of acquiring any land, repeating the same several times, according to the deposition thereof made by the aforesaid Wolffert Gerritsz, it happened afterwards that Gillis Hosset, having on the 27th of July, 1630,[1] in sailing up the river, come to the place where Jan Jansz Meyns was camping with his men to cut round timber for the new ship, there also came by chance to this spot Kotiamak, Nawanemitt, Abantzenee, Sagiskwa and Kanamoak, owners and proprietors of their respective parcels of land extending up the river, south and north of said fort, to a little south of Moenemínne's Castle, belonging jointly and collectively to the owners aforesaid, together with the land called Semesseeck, situated on the east shore, from opposite Castle Island to the aforesaid fort, belonging to the said Nawanemit

[1] In the record of this contract, in Dutch Patents, GG. page 4, this date is given by mistake as the 27th of July, 1631. Partly owing to this mistake historians have mentioned the present purchase as made subsequent to that for land between Beeren island and Smacks island, of May 1631, whereas in reality it was the first purchase of land in the Vicinity of Fort Orange. See Van Rensselaer Bowier Mss., p. 166–68, 181–82.

in particular; also from Petanock, the Mill Kill, northward to Negagonse, extending fully about three (Dutch) miles; and the aforesaid Gillis Hosset, having entered into negotiations with the owners of the aforesaid land to sell, cede and surrender the said respective parcels of land, the same persons declared in presence of and before Jan Jansz Meyns, Wolffert Gerritsz and Jan Tyssen, trumpeter, that they were satisfied to sell, transfer, cede and surrender the said respective parcels of land, as they thereafter, on the sixth of August following, before us, the Director and Council of New Netherland, residing on the island Manhats and Fort Amsterdam, under the jurisdiction of their High Mightinesses, the Lords States General of the United Netherlands, and the Chartered West India Company, Chamber of Amsterdam, voluntarily and deliberately did for and in consideration of certain quantities of merchandise, the receipt whereof into their hands and power they acknowledged before the execution of these presents, and as they hereby, by virtue and title of sale, do transfer, cede and convey the same to and for the benefit of the Hon. Kiliaen van Rensselaer, being absent and for whom we, ex officio, accept the same with proper stipulations, namely the respective parcels of land hereinbefore specified, with the forests, appurtenances and dependencies thereof, together with all the right, title and interest therein belonging jointly and severally to the grantors aforesaid who hereby constitute and substitute the above mentioned Hon. Mr. Rensselaer in their stead, state, right, real and actual possession thereof, at the same time giving him full, absolute and irrevocable power, authority and special order, tanquam actor et procurator in rem suam et propriam, to enter upon the said land, the same to be possessed in peace, cultivated, occupied and used by the aforesaid Mr. Rensselaer, or those who may hereafter acquire his right; also to do and act therewith and dispose thereof as his Honor or others would do, or be allowed to do, with their own property and by lawful title acquired lands and domains, without any part, right, interest, or authority in the least, whether of ownership, command or jurisdiction, being kept, reserved, or retained by the grantors aforesaid, who on the contrary in his behalf, as before stated ad infinitum desist therefrom and surrender, relinquish and renounce the same by these presents. Promising further, not only forever to hold firm, binding and irrevocable and to carry out and fulfil this their transfer and all that may be done by virtue thereof, but also to guard against eviction from the aforesaid land, *obligans et nuncians et a bono fide. In witness whereof these presents are confirmed by our usual signatures and the ordinary seal suspended below.*[1] *Done on the aforesaid island of Manhatas and at Fort Amsterdam, the day and year above written.*

PETER MINUIT, (Director),
PIETER BYLVELTT,
JAN LAMPO, Schout,
REYNER HARMENSEN,
JAN JANSZ MEYNS.

[1] The seal of New Netherland is lacking.

THE UPPER DEVONIAN FOREST OF SEED FERNS IN EASTERN NEW YORK

BY WINIFRED GOLDRING

The "Gilboa trees" have been known to science for over half a century, but only within the last 3 years has it been discovered that New York actually had an extensive and very ancient fossil forest in its eastern domain. This forest remained hidden away in the Upper Devonian (Ithaca) rocks of Schoharie until 1869. In the fall of this year a great freshet swept the upper valley of the Schoharie in the vicinity of the village of Gilboa tearing out bridges, culverts and roadbeds, but greatly benefiting science by exposing in the bedrock standing stumps of trees.

The discovery of these trees was described in the Albany Argus of January 30, 1870, and in the 24th Report of the State Museum;[1] and was considered of so much importance that it was brought by Hall to the attention of the British Association for the Advancement of Science at the Brighton meeting in 1872.[2] Excavations were made during the year 1870 in the beds of sandstone containing these trees and five stumps and a number of fragments were taken out of this ancient forest, all at the same level in the rocks. The greater part of this material was brought to the State Museum where it has for some time constituted a remarkable exhibit of the ancient, extinct flora of the State.

The Gilboa collections were submitted to Sir William Dawson of Montreal for examination, and he determined the fossil trunks to be of two species, which he named Psaronius erianus and P. textilis. The trunks were noted as being in an upright position with their bases resting in and upon a soft shaly stratum, representing the bed of clay in which they appeared to have grown; and the facts of their occurrence led to the conclusion that "we had evidence of comparatively dry land on the eastern margin of the Devonian sea."[3] It was also inferred "that this area during the deposition of these beds was undergoing continuous oscillation of level, with a general downward movement."[3]

This Schoharie, or Gilboa, forest is the earliest recorded forest of the earth. The old locality had long since been covered up and the rocks at the level in which the trees were discovered did not outcrop

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[1] Hall, James. 24th Rep't N. Y. State Cab. Nat. Hist., 1872, p. 15, 16.
[2] Rep't Brit. Assoc. Adv. Sci., 1872, v. 42, Trans., p. 103.
[3] Ref. cit., p. 103.

Plate 1

Restoration of *Eospermatopteris*. The tree is assumed to be monoecious, as that is the more primitive condition.

again in this area. Nothing more was heard of these fossil stumps until 1897 when Prosser,[4] then connected with the New York State Survey, reported finding some small specimens, from a higher horizon, lying loose at Manorkill falls about a mile south of Gilboa. Occasional attempts since then to rediscover this ancient forest were fruitless until the summer of 1920 when special effort was made to add to the collection of Devonian plant material already in the hands of the Museum. The effort to relocate the Schoharie forest or to find some additional evidence as to its extent led to the discovery of upright tree stumps not in the original locality but at the higher level, along the road in the vicinity of the lower falls of the Manorkill, a tributary of the Schoharie creek. These trees likewise were found with their bases resting in a bed of shale, greenish black in color. This second tree locality is at a level of 1120 feet A. T.; the old locality, on the same side of the Schoharie creek, just above the old Gilboa bridge, was at a level of 1020 feet A. T. Since 1920 the city of New York has been doing construction work at Gilboa, preparatory to impounding the waters of the Schoharie creek for the future use of its citizens. The resultant dam will drown the village of Gilboa and its vicinity, including the two above-mentioned fossil tree localities. In the course of quarrying in connection with the work on the dam the old locality, which is directly at the spot where the dam is being built, was uncovered and seven trees were found. In a quarry 2300 feet north (downstream) of the old locality trees were found at the 972-foot (one small specimen) and 960-foot levels. This quarry, known now as "Riverside quarry," has yielded the greatest number and also the largest stumps hitherto found. Eighteen specimens were taken from an area 50 feet square, not counting those destroyed in quarrying. One of the largest specimens of this group has a circumference at the base of approximately 11 feet (diameter approximately 3.5 feet), a height of 22 inches and a diameter at that height of 21½ inches; stumps of greater height, but of smaller girth have been obtained.

At all three tree horizons the stumps were found with their bases resting in and upon shale and in every case in an upright position with the trunk extending into the coarse sandstone above. The shale beds vary in thickness from 6 inches to 2 feet; at the lowest horizon, in the place in the quarry where the greatest number of stumps was obtained, the shale had a thickness of only 6 inches.

[4] Prosser, Charles S., 17 Annual Rep't of N. Y. State Geol., for 1897 (1899), p. 211.

The small specimen found at the 972-foot level was in an upright position and rested upon a black shale layer, about an inch thick, which disappeared entirely a few feet from the stump. The presence of the black shale layer, in the vicinity of the stump would seem to indicate that it was found in the place of its growth; yet it is possible that it may have drifted in and been buried in the upright position in which it was found. At the middle horizon (the old locality) a stump was found 6 feet above the shale layer on which the other stumps that were found rested; but the specimen in this case did not rest upon a shale layer. The present Catskill mountains during this Upper Devonian period constituted the low shore of a shallow sea, the continental land lying off to the east. The coasts of those times were unstable, and it was along the borders of such a coast line that at least three successive forests of these trees reared themselves to great heights, were submerged, destroyed and buried.

With the recent additions to our collection, which we owe to the courtesy of the Commissioners of the New York Board of Water Supply and of Mr J. Waldo Smith, chief engineer, we now have a total of 40 stumps partial or complete, and a number of broken pieces. Taking into connection with these the specimens which have gone to other museums, the weathered stumps discarded, and those destroyed in blasting, the number of stumps taken from these primeval forests probably runs into the hundreds; and further quarrying is continually bringing more to light. The Riverside quarry will not be included in the area covered by the Gilboa dam, but its value as a fossil tree locality will be greatly lessened as soon as the quarrying operations in connection with the dam cease. Now that the rock layers containing the stumps have been located it is quite possible that they can be traced around the hills and found outcropping elsewhere. In the area known, the tree localities have been found stretching over a distance of something more than 1⅔ miles.*

As stated above, these ancient trees were described by Dawson as fern trees belonging to the genus Psaronius and represented by two species erianus and textilis.[5] In the report of the Geological Survey of Canada, 1871, P. textilis is noted as occurring at Gilboa and P. erianus in Madison county. In the 24th Report of the State Museum both are described as having been

* Notices of these recent occurrences have been mentioned in the later reports of the Director of the Museum, and an illustrated article entitled "The Oldest of the Forests" by John M. Clarke was published in the *Scientific Monthly*, January, 1921, pp. 83–91.

[5] Geol. Surv. Canada, 1871, p. 58, 59; Quart. Jour. Geol. Soc., 1871, 27:269; 1882, 37:307.

found in Schoharie county (Gilboa); and both species, in fact, are being obtained today from this area. The name P s a r o n i u s was inappropriately used for these trees, and indeed they belong to an entirely different group. The structure of P s a r o n i u s has been worked out in a most elaborate manner.[6] This genus contains a large number of species from the Permo-carboniferous strata, all of which agree in having a highly complex polystelic organization, comparable to that of the most highly differentiated fern stems of the present day. P s a r o n i u s, therefore, is a true fern, or Pteridophyte.

Even when it was definitely known that these trees did not belong with P s a r o n i u s, the problem of their relationship still remained, though it was recognized that the cortical structure bore a resemblance to that of L y g i n o d e n d r o n. The name Lyginodendron[7] was first given to a specimen that had nothing to do with the plant usually known as L y g i n o d e n d r o n o l d h a m i u m, described by Binney[8] as D a d o x y l o n o l d h a m i u m and placed in the genus L y g i n o d e n d r o n by Williamson.[9] This plant later was found to be a Pteridosperm and Potonié in 1899[10] proposed for it the now accepted name of L y g i n o p t e r i s o l d h a m i a. Gourlie's type specimen, L y g i n o d e n d r o n l a n d s b u r g i i, came from the Carboniferous rock of Ayrshire, Scotland and is the cast of a plant having in the outer cortex an irregular, anastomosing mechanical system of sclerenchyma plates. Potonié[11] proposed that the name Lyginodendron would serve a useful purpose for casts of stems similar to Gourlie's type but which can not be assigned to a definite systematic position. The largest example (100 cm long) of this Lyginodendron structure was noted by Seward[12] in a cast from the Upper Carboniferous near Harrogate. Nathorst[13] recently figured a similar cast from Spitzbergen, from the Culm, and has also described under the name of L y g i n o d e n d r o n s v e r-

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[6] Corda, Göppert, Stenzel, Solms-Laubach, etc. in Germany; Zeiller, Renault, Pelourde, etc. in France (*see* Scott, D. H., Studies in Fossil Botany, pt 1, 3d. ed., 1920, p. 270-78).

Derby, Orville A., Observations on the Stem Structure of P s a r o n i u s B r a s i l i e n s i s. Amer. Jour. Sci., ser. 4, 1914, 63:489-97.

[7] Gourlie, W., Proc. Phil. Soc. Glasgow, 1844, 1:105.

[8] Proc. Lit. Phil. Soc. Manchester, 1866, 5:113.

[9] Phil. Trans. Roy. Soc., 1873, 163:404.

[10] Lehrbuch der Pflanzenpalaeontologie, p. 171.

[11] Ref. cited.

[12] Seward, A. C., Fossil Plants, 1917, 3:37.

[13] Nathorst, A. G., Zur Fossilen Flora der Polarländer. Teil 1, Nachträge zur Pälaozoischen Flora Spitzbergens, pl. 7, fig. 1. Stockholm 1914.

drupi[14] impressions of a cortical reticulum from the Upper Devonian of Ellesmere Land.

As pointed out by Seward,[15] this type of cortex is not confined to a single genus of plants, nor even to a single group, since it is found in Pteridosperms and also occurs in some Paleozoic lycopodiaceous stems, and therefore can not be considered a safe criterion of botanical affinity. The name Lyginodendron is nothing more than a form name, therefore; and can serve only as a convenient catch-all for plants of unknown affinities.

Fortunately during the same summer that the Manorkill (1120-foot level) tree horizon was located, while operations were under way for the removal of the new stumps, through the keen observation of Dr Rudolf Ruedemann who was on the look-out for seeds in Upper Devonian rocks, there was discovered partly buried in the bed of the Schoharie creek, a loose block of shale covered with fructifications. The slab was traced to its source at the south side of the lower falls of the Manorkill about 15 feet above the base of the falls and 100 feet below the tree horizon. At this time a few specimens were obtained. Later in that same season and again in the summer of 1922 that and other localities were worked and reworked until a fair-sized collection has been obtained containing seeds (megasporangia), male fructifications, pieces of foliage and roots. Besides these Gilboa trees, occurring in large numbers, only specimens of a Protolepidodendron have been found, and these not in abundance; also the shale layer in which the fruiting bodies were found is at the same level (1020 feet) as the shale layer in which rested the bases of the stumps of the first-discovered locality. The above facts leave no doubt that the fruiting bodies, foliage and roots, occurring so frequently wherever the shale layers in question can be worked, belong to the Gilboa trees.

The presence of seed ferns in the Upper Devonian rocks has long been predicted. Back in 1912 Johnson of the Royal College of Science for Ireland, Dublin, found in the Upper Devonian beds at Kiltorcan, County Kilkenny, impressions indicating the presence of the seeds and microsporangia of a Devonian plant, suggesting that heterospory was already well pronounced at this epoch. The specimens were reserved for description in the hope that specimens showing the parentage of the seed would turn up. With this hope unful-

[14] Die Oberdevonische Flora des Ellesmere-landes. Report 2d Norwegian Arctic Exped. "Fram" 1898–1902. No. 1, 1904, p. 11, 12, pl. 1, fig. 1; pl. 2, figs. 1, 2.

[15] Ref. cited; also 1910, 2:220.

filled, in 1917 he published a short description of this material under the name of Spermolithus devonicus.[16] For this country, Mr David White,[17] paleobotanist of the United States Geological Survey, discovered in 1900 the seeds of Aneimites (Adiantites), whose fern nature had hitherto been unquestioned, in the lower Pottsville (lower Pennsylvanian) of West Virginia; and this occurrence gave us the hope of finding seeds or forerunners of seeds in our Upper Devonian plant beds in New York.

Study of all the Gilboa material collected has shown that this Upper Devonian tree, while of simpler organization, bears a strong resemblance to the Carboniferous Lyginopteris and, with it, belongs among the seed ferns (Pteridospermophyta; Cycadofilicales of some). The generic name Eospermatopteris is here proposed to include the two species of Gilboa trees.

Seed ferns must have had their origin in primitive ferns earlier than the Upper Devonian. The climax of their development occurred in the Pennsylvanian and early Permian; but, beyond the Paleozoic, none are as yet known.

Eospermatopteris gen. nov.

Eos-*dawn*; sperma-*seed;* pteris-*fern.*

Stumps and trunks. Plates 2, 3, 4 and 7 will give a very good idea of the size and shape of the stumps of these trees, and the lower surface of the bases is well shown in plate 5. In the forty more or less complete stumps which the Museum has obtained there is great variability in size and some variability in shape. The bases are bulbous, as might be expected of trees growing under swampy conditions, in some cases more spreading than in others. The height at which the trunks were broken off above the base varies from 1 foot 4 inches in the case of some of the smaller stumps to about 3 feet and slightly over in the case of the largest stumps. The circumference at the spreading part of the base varies from 3 feet 10 inches in the smallest specimen (height 2 feet) to 11 feet in the largest specimen, which has a diameter of 21½ inches at a height of 22 inches. Others of the largest stumps show circumferences between 8½ feet and 11 feet and have diameters up to 2 feet at heights varying from 20 inches to 2 feet. One of these large stumps shows very slight spreading at the base. With a base having a circumference of 8½ feet (diameter 32 inches) the trunk at the height

[16] Johnson, Thomas, Sci. Proc. Roy. Dublin Soc. 1917, 15, no. 23:218, 219, pl. 11, figs. 4–6, pl. 12, figs. 1, 2.
[17] White, David, Smith. Misc. Coll., pt. 3, 1904, 47:322–31, pls. 17, 18.

of 23 inches still has a diameter of 2 feet. In other cases, the narrowing from the bulbous base to the trunk is more rapid and more striking. One stump standing 3 feet high has a circumference at the base of 10½ feet (diameter 40 inches) and at a height of 2 feet a circumference of 6 feet 3 inches (diameter 23.8 inches); another, about 3 feet high has a circumference at the base of 9 feet (diameter 34 inches); at the top of 3 feet 1 inch (diameter 11.7 inches). In both these cases the narrowing is gradual. In two of the most recently acquired specimens, in fact the best specimens we have, the narrowing is very strikingly, in one case very abruptly, shown. One has a height of 3 feet and a circumference at the base of 6 feet 3 inches (diameter approximately 23.8 inches), but at a height of 14 inches, a circumference only of 4 feet 3 inches (diameter approximately 16 inches), while at the top the circumference is about 3 feet (*see* plate 3). Another has a height of 34 inches and a circumference at the base of 7 feet 6 inches (diameter approximately 25.4 inches); at the height of 14 inches a circumference of 6 feet 5 inches; at the height of 24 inches, a circumference of 4 feet 4 inches; at the height of 34 inches a circumference of 36½ inches (diameter 11.6 inches). This last example (plate 4) shows a case of very gradual narrowing of the trunk; the preceding example shows an abrupt change from the enlarged base to the trunk.

Parts of the trunk, above the heights shown in the stumps, have been found infrequently and in a flattened condition. The Museum has two of these specimens, one over 4 feet long and the other over 3 feet long. In the case of the latter, which was taken from the underside of an overhanging ledge, as much again of the trunk had been broken away and lost; and, beyond the section obtained, the trunk continued into the solid rocks with little, if any, diminution in width. Another specimen, too poor to be removed from the rock, shows some 12 feet of slender trunk which must represent a portion near the top of a large trunk or the trunk of a very small tree. Among the Carboniferous seed ferns some were of the "scrambler" type, with long slender stems climbing among other plants; some were herbaceous, and others were tall and stout like the tree ferns. The Carboniferous Lyginopteris belongs to the "scrambler" type, but Eospermatopteris of the Upper Devonian belongs to the type with tall, stout trunks. The largest of these trees must have reached heights of at least 30 to 40 feet. As yet the Museum has not located any specimens of the trunk showing the attachment of the petioles of the frond; but about 1870 or 1871 a Mr Lockwood of Gilboa found the upper part of one of these trunks, with its leaf-scars preserved and petioles attached. This specimen, figure 1, in the collection of Professor J. S. Newberry, was described by Dawson,[18] under the name Caulopteris lockwoodi, as probably the

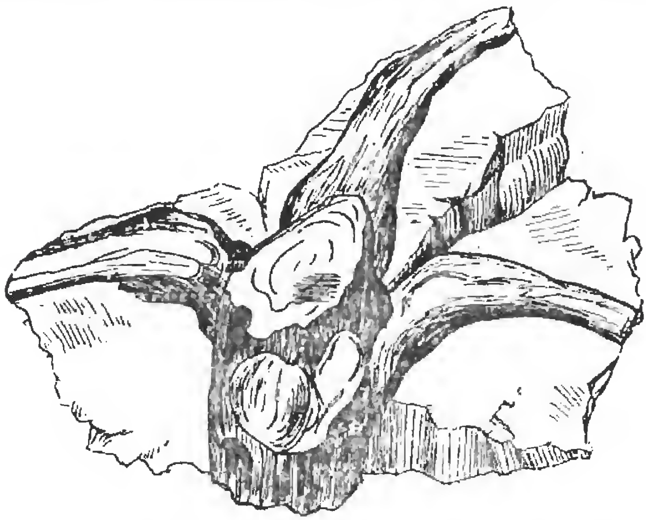

Fig. 1 Portion of trunk of Eospermatopteris (Caulopteris lockwoodi Dawson) showing attachment of the petioles and the leaf-scars. (Reduced; after Dawson, 1871.)

upper part of one or the other of his species of Psaronius found in the same bed. Dawson's description is as follows:

Trunk from 2 to 3 inches in diameter, rugose longitudinally. Leaf-scars broad, rounded above, and radiatingly rugose, with an irregular scar below, arranged spirally in about five ranks; vascular bundles not distinctly preserved. Petioles slender, much expanded at the base, dividing at first in a pinnate manner, and afterwards dichotomously. Ultimate pinnae with remains of numerous, apparently narrow pinnules.

The character of the fronds led Dawson to believe that the plant approached in that respect to the cyclopterids of the subgenus Aneimites. Today we know that both Eospermatopteris (Dawson's Psaronius) and Aneimites are both seed ferns belonging to the important phylum Pteridospermophyta.

The outer cortex is the only structure of the stumps and trunks of these trees that is to any extent preserved. The interior structures

[18] Dawson, Sir J. W., Jour. Geol. Soc., 1871, 27:269–71; Geol. Surv. Canada, 1871, Fossil Plants, p. 59 (figured only).

have been washed out and the cavity left filled with sand which has helped preserve the shape of the stumps in fossilization. The outer cortex, as in Lyginopteris, consists of interlacing strands of sclerenchyma tissue, forming a network (plate 6) or more or less parallel (plate 7). The cellular tissue which in the living trees occupied the space between the sclerenchyma strands is here replaced by sandstone. In a transverse section of the stem of Lyginopteris and the allied genus, Heterangium, the sclerenchyma appears in the form of dark radial bands, but in Eospermatopteris it appears in the form of dots or short thick irregular lines, irregularly scattered. This zone of the outer cortex varies from an inch or less to several inches in thickness depending upon the size of the stumps. In the majority of cases, the outside of the outer cortex is missing, but it is very well shown in several cases. The outer surface is marked with shallow ridges and furrows in some cases, giving the effect of a bark; in other cases the outer surface is only irregularly furrowed and wrinkled or even just roughened some of which is undoubtedly due to shrinkage in preservation. But in either case the outer surface appears to be composed of layers of sclerenchyma forming a kind of bark, which in the living tree undoubtedly had a covering of ramentum or fibers. The underside of the base of the stumps is quite strikingly furrowed in a radiate manner (plate 5) and in some specimens a depression is seen at the center. The base as well as the sides has the outer zone or covering of sclerenchyma layers above which is the zone several inches thick, varying according to the size of the stumps, of interlacing sclerenchyma strands.

The interior structure of the trunk of Eospermatopteris for the present must remain unknown. There seems to be sufficient reason to believe that it belongs to the Lyginopterideae; but whether it has a stele occupied entirely by the primary wood, with no pith, as in Heterangium[19] or whether it has the large pith which is a constant feature of Lyginodendron[19] can not be determined from the material at hand. A transverse section of one of the smaller trunks shows toward the center an irregular, thin ring of sclerenchyma tissue and within this ring and to some extent outside are irregularly scattered strands of sclerenchyma tissue. The

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[19] Williamson, W. C., Phil. Trans. Roy. Soc., 1873, 163:377–408, pls. 22–31. Williamson, W. C. and Scott, D. H., Phil. Trans. Roy. Soc. (B), 1895. 186:703–779, pls. 18–29.

See Seward, A. C., Fossil Plants, 1917, v. 3, ch. 29; *see* Scott, D. H., Studies in Fossil Botany, Pt. II, 1909, ch. 10.

scattered sclerenchyma strands may be due entirely to some maceration before preservation; but the ring itself appears to be a definite zone, part of the missing central cylinder. Transverse sections of larger trunks were made, but nothing was found. Success in this line, I believe, can only be attained when we find a petiole or rachis of a frond preserved in such a condition that thin sections can be made for study.

Roots. Though we have a number of specimens of roots, none of the stumps taken out have any roots attached. For this reason it has been suggested that the stumps perhaps may not have grown in the place in which they were found. There is one trunk now, still in place in the quarry at Gilboa at this time of writing, which shows the roots spreading outward in the shale layer (lowest horizon) in which the stumps rest; roots were likewise observed in the shale layer of the highest horizon from which stumps were taken. These observations taken into consideration with the upright position of all the stumps found, the successive tree horizons with the bases of the stumps in each case resting in and upon a shale layer, representing the clay bed in which the trees are believed to have grown, would all seem to indicate that the forest was destroyed and the stumps buried *in situ*.

Eospermatopteris apparently had no large heavy roots. None have been found and there certainly is nothing about the stumps themselves that would suggest that any might be expected. All the roots found, in their flattened condition, measure between one quarter of an inch or less and half an inch across; but they are not preserved in a condition which permits of their being studied structurally. Numerous long, strap like rootlets, as shown in text figure 2 and plate 8, radiate from the roots, but do not appear to have any regular arrangement. These rootlets, as preserved, measure on the average ⅛ of an inch or less across and there is little, if any, variation in width. Some of the rootlets measure up to 6 inches in length as far as preserved, and there is no indications that this is anywhere near the tip. With a root system such as this, I think the bases of these trees must have been buried to some height in the sediments to give adequate foothold.

Foliage. The fronds of Eospermatopteris are tripinnate; they were at least 6 feet long, and, judging from the fragments of main rachises collected, in the larger specimens they must have been considerably longer. One specimen (figure 3) shows an impression of a main rachis 25 inches long which is apparently at considerable distance from both the tip and the petiole, probably near the middle of the frond, for two of the primary division measure, the one 15 inches, the other which is not fully preserved 12 inches. The impression of the main rachis, at its widest part, measures three-eights of an inch across, the primary divisions one-eighth to

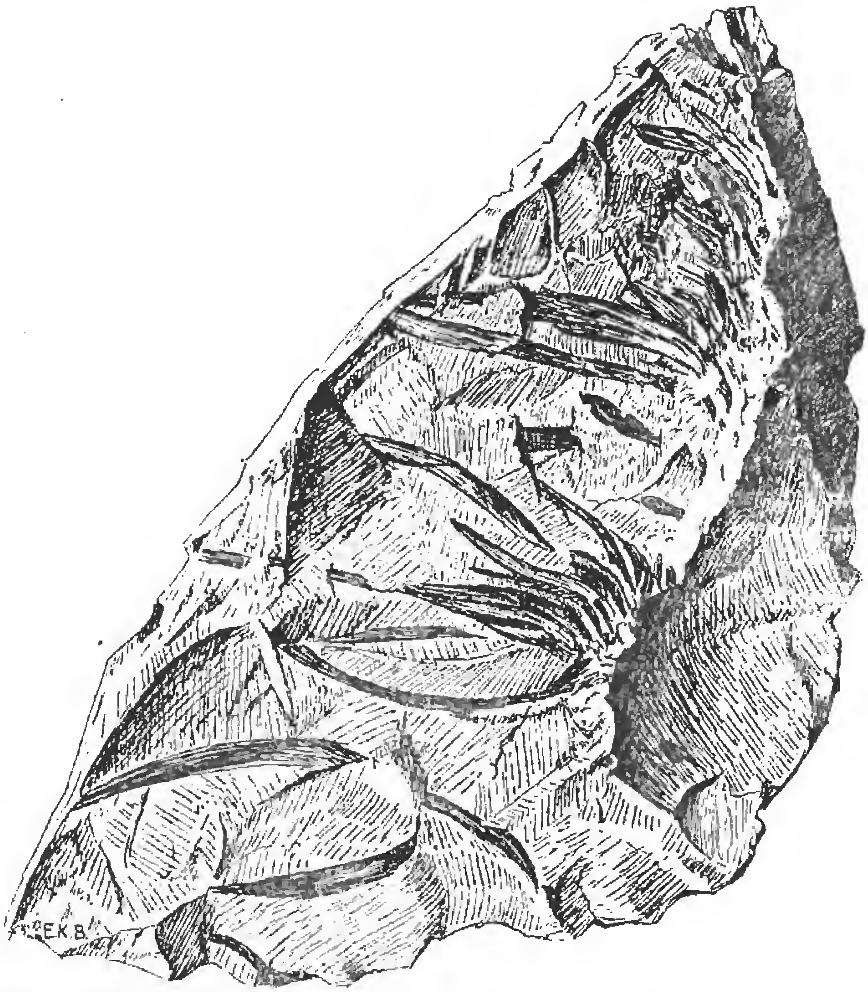

Fig. 2 Slab showing the strap-like, radiating rootlets of Eospermatopteris. (Slightly reduced)

three-sixteenths of an inch. The impression of another main rachis measures 30 inches and apparently not half of the total length is shown (*see* plate 9). The impression of this main rachis is between one-half and five-eighths of an inch in width; of its primary divisions about three-sixteenths of an inch. Both the primary and secondary divisions are alternately arranged : no indication has been found of the occurrence of dichtomous divisions in the upper part of the fronds, as mentioned by Dawson (*see* page 57) under his description of Caulopteris lockwoodi. This specimen of "Caulopteris lockwoodi" is the only clue we have as to the character of the petioles and the arrangement of the fronds upon the trunk. The petioles are described as slender and much expanded at the base and spirally arranged in about five ranks (*see* figure 1). Many of

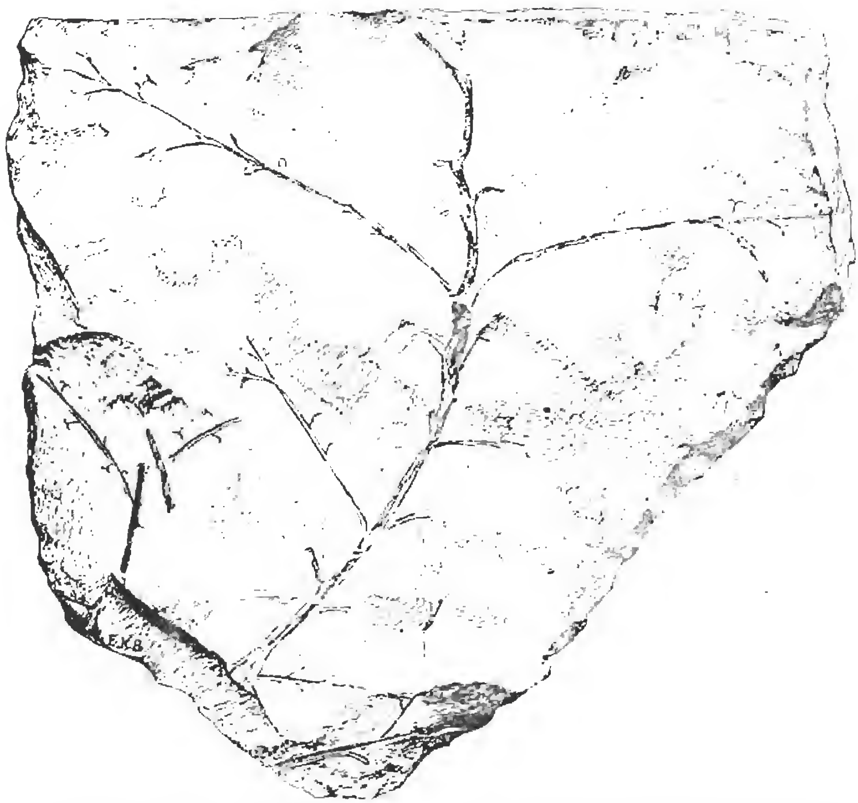

Fig. 3 Part of main rachis and lateral branches of the frond of Eospermatopteris. The slab has a greatest width and length of 2 feet.

the impressions of the frond stems show a central groove or depression with a flattened area on each side (plate 10, figure 4) from which branch off the next smaller divisions and, on the ultimate pinnae, the pinnules. This depression is probably the impression left by the central woody strand or bundle.

The pinnules are of a simple Sphenopteridium type, reminding one of, but simpler than, the Sphenopteridium keilhaui described by Nathorst[20] from the Upper Devonian of Bear Island. A stronger resemblance is shown to certain sterile leaf segments from the same locality, correlated by Nathorst with Cephalopteris (Cephalotheca) mirabilis[21] which will be treated more fully under the discussion of the seeds and microsporangia. The character of the pinnules is shown in

Fig. 4 Part of the frond of Eospermatopteris showing the ultimate pinnae with the pinnules. (Reduced slightly more than one-third)

figures 1-4 on plate 10. They are twice bilobed with the divisions of the first bifurcation more or less recurved; and they do not narrow down proximad but join the stem by a broad base. The first bifurcation occurs at about half the length of the pinnule; the second bifurcations are near the tips which appear to be blunt and rounded.

[20] Nathorst, A. G., Handl. k. Svenska Vetenskaps-Akad. 1902, 36, no. 3, 13, 14, pl. 2, figs. 3–13. *See* Arber, E. A. Newell, Devonian Floras, 1921, p. 62, 63.

[21] Ref. cited, p. 15, pl. 1, fig. 20.

The fragmentary preservation of the pinnules would seem to indicate that they were of a rather delicate nature. There is no evidence of a midrib. The pinnules are set comparatively far apart so that the general effect of the foliage in the case of Eospermatopteris is much less dense (figure 4) than is the case with Lyginopteris, Heterangium and others of the seed ferns.

Seeds. The seeds of Eospermatopteris bear a strong external resemblance to those of Lyginopteris oldhamia, called Lagenostoma lomaxi[22] before the relation between the two was known, and to other Lyginopterid seeds. The character of the seeds is well shown on plate 10, figures 5-12, plate 11, figures 1-5, and in text figure 6. On some of the slabs the seeds are very abundant but on none of the specimens are any sterile laminae found in conection with the seeds, though branches bearing pinnules occur frequently in the same layers. The seeds were probably borne near the tip of the frond or the tips of some of the pinnae, with complete abortion of the sterile laminae; or perhaps there was modification of the bilobed pinnules. At any rate, the seeds are borne in pairs at the ends of forked branchlets. The ultimate division bearing the pair of seeds may be as short as a quarter of an inch, or less, or may be almost an inch long. In a number of cases when the seeds are borne close to the dichotomy, the arrangement of the fruits is rather crowded, and there is an appearance given of more than one seed being borne on a stalk. Sometimes the dichotomies are such a short distance apart as to bring, frequently two, sometimes three, pairs of seeds close together, giving a clustered effect to the seeds. The seeds, as in the case of Lagenostoma, are inclosed in an outer husk or cupule which completely envelops the seed. In some cases the cupule appears to come to a point at the top (plate 10, figures 9, 10); in a few cases, some of which are figured here on plate 10, figures 7, 8, the cupules appear to be lobed as in Lagenostoma lomaxi and L. sinclairi (figure 5). This may, since it is infrequent, be only an accident of preservation; or it may be that the majority of these fruiting bodies are in an immature condition. Some specimens in a very immature condition have been found. A few specimens show the impression of what appears to be a vascular bundle running up through the main branchlet, forking at the dichotomy and continuing up each arm of the dichotomy

[22] Oliver, F. W. and Scott, D. H., Proc. Roy. Soc., 1903, 71:477-81; Phil. Trans. Roy. Soc. (B), 1905, 197:193-247, pls. 4-10; Scott, D. H., Studies in Fossil Botany, pt II, 1909, p. 386-96; Seward, A. C., Fossil Plants, 1917, 3:55-64.

almost to the seed. Some specimens show fine lines on the cupule which may mark the position of fibro-vascular bundles. The seed (plate 10, figures 6, 9, 11, 12; plate 11, figures 1, 2) is broadly oval to round; the impression of it is very distinctly shown in the larger and older fructifications, and can be distinguished even in the immature ones (plate 10, figure 5). The measurements of some of the larger seeds are as follows: 5.3mm x 2.5mm; 5.6mm x 3.1mm; 6.4mm x 3.4mm; 6.3mm x 3.4mm. On several slabs were found groups of small rounded thick bodies, some of them free, others attached to pedicels, plate 11, figures 3-5, which have every appearance of being seeds. The largest of these bodies vary from a length and width of 3mm to a length of 3.2mm and a width of 2.7mm.

Fig. 5 *Lagenostoma sinclairi.* Two seeds of Lyginopteris enclosed in lobed cupules, and borne terminally on branches of the rachis, x3⅓. (From Scott, 1909, after Arber)

Some specimens are slightly wider than long, but this, I think, is due to distortion in preservation. These bodies are, I believe, the seeds without the integument, the nutlets; their general character and thickness carry out this idea, and in addition portions of what appears to be the integument are sometimes seen along the margins of some of the nutlets.

Microsporangia. The sporangia-bearing organs of Eospermatopteris, as in the case of the seeds, are borne at the tips of forking branchlets. There is one specimen in which these organs are borne close to the dichotomy; and another specimen, plate 11, figure 6, in which these organs are borne some distance from the dichotomies, and yet close enough together to give a clustered effect. In both cases, the sporangia-bearing organs are in a young condition. The older specimens in our hands, in all but one case, have become separated from the pedicels.

Fig. 6 Slab showing groups of seeds of Eospermatopteris. The seeds are borne in pairs at the ends of forked branchlets. (x1)

Up until 1905, nothing was known of the male fructifications of the Pteridospermophytes; but during that year Doctor Kidston[23] discovered a species of Crossotheca (C. höninghausi, Kidston) in connection with the foliage of Lyginopteris (Sphenopteris höninghausi). The fertile pinnules are oval in form, measure about 2-2.5mm in length and bear six, rarely seven, bilocular sporangia.[24] The sporangia which are convergent when young, spread out at maturity assuming a fringelike arrangement, which gives to the sorus the form of an epaulet (figure 7).

Fig. 7 *Crossotheca höninghausi.* Fertile pinnae in connection with sterile pinnae of *Sphenopteris höninghausi*, the leaf of Lyginopteris. (x2)

In our specimens no separate sporangia or microspores have been found. The sporangia-bearing organs or modified pinnules are of similar character to that of Crossotheca, but they are considerably larger, broadly funnel-shaped or cup-shaped, with the pedicel attached at the center. In general appearance there is a resemblance, in the younger specimens, to the moplike clusters of sporangia found on fertile fronds of Cephalopteris mirabilis described by Nathorst[25] from the Upper Devonian rocks of Bear Island. Only in the mature specimens is it clearly seen that the sporangia of Eospermatopteris must have been borne directly on the under side of the modified pinnule, while in Cephalopteris the clusters of sporangia are borne on a separate stalk on the lower surface and at the base of the fertile pinnae. In the matter of the sporangia-bearing organ, there is more resemblance between the male fructifications of Eospermatopteris and Lyginop-

[23] Kidston, R., Proc. Roy. Soc. (B), 1905, 76:358-60, pl. 6; Phil. Trans. Roy. Soc. (B), 1906, 198:413-45, pls. 25-28.

[24] *See* Seward, A. C., Fossil Plants, 1917, 3:52-55; Scott, D. H., Studies in Fossil Botany, Pt. II, 1909, p. 396-401.

[25] Nathorst, A. G., Handl. k. Svenska Vetenskaps-Akad., 1902, 36, no. 3, 15-17, pls. 1, 2. *See* Seward, A. C., Fossil Plants, 1910, 2:537, fig. 355.

teris; but the sporangia apparently were clustered more as is the case with Cephalopteris. An interesting fact here is that there is a great similarity between the sterile foliage referred by Nathorst to C. mirabilis and the sterile foliage of Eospermatopteris. Nathorst[26] compares Cephalopteris with a Belgian species of Upper Devonian age described by Crépin[27] as Rhacophyton condrusorum and by Gilkinet[28] as Sphenopteris condrusorum; and this, too, shows striking similarity to our Eospermatopteris as to foliage. It is also worthy of note that, while the exact position of Cephalopteris can not be definitely determined from lack of available data, it is thought probable that it was a seed-bearing Pteridospermophyte and not a true fern.[29]

There are only about a dozen small slabs containing specimens of the sporangia-bearing organs of Eospermatopteris; but we are exceedingly fortunate in having that many, and in having in this collection both young and mature specimens.

From the way in which the sporangia-bearing organs are preserved, it would seem that in the younger specimens, plate 11, figure 6, this structure is more funnel-shaped, and that it broadens out and becomes more saucer-shaped at maturity, plate 11, figures 7, 8. It may be that sporangia are present in the immature specimens, but their preservation as impressions makes any detection of this condition impossible. The older specimens are preserved also as impressions, but flattened out, so that the absence of the sporangia is apparent. On the underside, closely clustered around the place of attachment of the pedicel and extending out toward the margin, are numerous rounded depressions, some of which appear to show a small scar at the bottom. These have been interpreted to mark the place of attachment of the sporangia; and they cease some distance from the margin showing that the clustered sporangia were confined toward the center. In most of the specimens the marginal area is marked with numerous concentric lines or wrinkles; but they would seem to be due to shrinkage or in part to the flattening down of a saucer-shaped structure. When the specimens are so preserved that the impression of the upper surface is shown, lines or wrinkles are seen

[26] Nathorst, A. G., Handl. k. Svenska Vetenskaps-Akad., 1902, 36, no. 3, p. 16.

[27] Crepin, F., Bul. Acad. Roy. Belg., 2d ser., 1874, 38:356; Bul. Soc. Roy. Bot. Belg., 1875, 14:214.

[28] Gilkinet, A., Bul. Acad. Roy. Belg., 2d ser., 1875, 40, no. 8, 139; Mem. Soc. Geol. Belg., 1922, p. 5–10, pls. 1–4.

[29] Seward, A. C., Ref. cited, p. 537; Zeiller, R., Rev. Gén. Bot., 1908, 20:59;

radiating irregularly from the place of attachment of the pedicel. Very fine, closely-placed radiating lines are visible along the margin itself in some of the specimens, and these do not appear to be due to shrinkage in preservation.

The specimens vary in size and, as preserved, are rounded-oval to round in form. The round forms show the following diameters: 8.7mm, 9mm, 9.7mm, 17.4mm, 19mm, 19.5mm; the rounded-oval specimens have the following measurements: 11mm x 9.7mm; 11.3mm x 9mm; 11.8mm x 9.7mm. The oval specimens owe their shape to the fact that in preservation they have been squeezed out along one diameter; but taking this into consideration, they run about the same size as the smaller round forms which represent the average and most frequently represented sizes. As noted in the measurements above, three specimens show measurements about twice the average size, only two of which are completely preserved (plate 11, figures 9, 10). One of them shows a wavy margin and the other an almost fluted margin. Whether these three forms represent simply larger specimens or more maturely developed forms can not be decided, though the latter seems more probable.

Eospermatopteris erianus (Dawson)
Eospermatopteris textilis (Dawson)

Dawson[30] distinguished two species of trees in the Gilboa collections submitted to him. E. erianus was also noted as coming from Madison county, though there is now in the State Museum no specimen of this species from that section. Dawson's descriptions are as follows:

P. erianus. Trunk completely invested with cordlike aerial roots parallel to each other, and either closely appressed or arranged at regular intervals. Each root consisting of an outer, probably cellular, coat, with an axis of fibers and scalariform or reticulated vessels. (*See* plate 7).

P. textilis. Trunk with the outer surface marked with irregular ridges and furrows, produced by tortuous aerial roots, which in the center of the stem are seen to be interlaced with each other. They are less tortuous in what seems to be the upper part of the fragment. (*See* plates 2-6).

Dawson's species, then, were based upon the arrangement of the sclerenchyma strands of the outer cortex, which he interpreted as aerial roots; and today the species can stand only on those char-

[30] Dawson, J. W., Canadian Fossil Plants, Canadian Geol. Surv., 1871, p. 58, 59; Hall, J., 24th Rep't N. Y. State Cab. Nat. Hist., 1871, p. 15.

acters upon which they were originally separated, since we have discovered nothing further to add. Only the one kind of foliage has been found; also only the one type of seed and male fructification. It would appear then that only in the internal structure of the trunks could these two species of trees be distinguished while living; for surely if the two species differed in foliage and fructifications, with all the collections we have made, some evidence of this would have come to light. Stumps belonging to the type of E. textilis have been so far found in numbers greatly in excess of those of the E. erianus type; this might, also, account for the collection of only one kind of foliage and fructification, especially since the localities from which the collection of this material was made were few and of limited extent.

Summary

In 1869 was made a remarkable discovery of fossil tree stumps in the Upper Devonian (Ithaca) beds of Schoharie county, in the vicinity of the village of Gilboa. In 1897, a few loose trees were reported from a higher horizon at the Manorkill falls a mile above the old locality. Special efforts in 1920 led to the discovery of these stumps in place at the Manorkill locality at the 1120-foot level, 100 feet above the old locality. Since 1920 the city of New York has been doing construction work at Gilboa preparatory to impounding the waters of the Schoharie creek to meet with future demands. In the course of operations, the old locality, at the spot where the dam is being built, was uncovered and several specimens obtained; a new quarry at the 960-foot level was opened up 2300 feet north (downstream) of the old location and has yielded the greatest number and the largest stumps hitherto found, one of the largest of this group having a circumference at the base of 11 feet. With the recent additions to our collections the Museum now has a total of forty stumps, partial or complete. At all three horizons the stumps were found with their bases resting in and upon black shale representing the original mud in which the trees stood, in an upright position with the trunk extending into the coarser sandstone above. At least, then, three successive forests of these trees reared themselves to great heights along the marshy borders of the unstable coast line of the shallow Devonian sea, were submerged, destroyed and buried.

At the same time that the new tree horizons were discovered, a shale bed, in the vicinity of the Manorkill at the 1020-foot level, yielded specimens of roots, foliage, and, most important of all, seeds

and sporangia-bearing organs; all of which taken together with the character of the stumps and trunks have shown these trees, originally described by Dawson as tree ferns, under the name Psaronius, to be seed ferns (Pteridospermophytes) intermediate between the ferns and higher seed plants. The name Eospermatopteris is proposed for this Devonian seed fern which bears a resemblance to the Carboniferous seed fern, Lyginopteris.

The bases of the stumps are bulbous as might be expected of trees growing under swampy conditions, and show a circumference at the base from 3 feet 10 inches up to 11 feet. The roots are small with numerous straplike rootlets. The outer cortex as in Lyginopteris consists of interlacing strands of sclerenchyma tissue, forming a network, or more or less parallel; the inner structure is not preserved. Consideration of the size of the stumps and study of the parts of the trunk found indicate that the largest of these trees must have reached heighths of at least 30 to 40 feet.

The only specimen in which are preserved the petioles of the fronds attached to the trunks shows that these have a spiral arrangement in about five ranks. The fronds must have been at least 6 feet long and were tripinnate with the pinnules bilobed and of the Sphenopteridium type, bearing a resemblance to the sterile pinnules referred to Cephalopteris mirabilis Nathorst from the Devonian of Bear Island. The seeds were borne in pairs at the end of forked branchlets and were probably borne near the tip of the frond. As in the case of Lagenostoma, the seed of Lyginopteris, this seed is broadly oval and inclosed in an outer husk or cupule which in some specimens appears to be lobed as in L. lomaxi and L. sinclairi. Separate nutlets were found. The sporangia-bearing organs, like the seeds, are borne at the tips of forking branchlets. They are broadly funnel shaped in young specimens to saucer-shaped in mature specimens, in habit resembling the male fructification of Lyginopteris (Crossotheca). No sporangia were found, but the indications are that they were borne on the under side of these structures in clusters resembling the moplike clusters of sporangia seen in Cephalopteris mirabilis, which is believed to be a Pteridospermophyte.

Two species of these trees were distinguished by Dawson: E. textilis, in which the sclerenchyma strands form a network, and E. erianus in which these strands are more or less parallel. No further distinguishing characters have been found.

Plate 1 shows a restoration of this Devonian seed fern. The Museum plans to have a restoration of this ancient forest in which the actual fossil stumps will be utilized.

Supplementary Note

While this paper was in press, new and valuable specimens of stumps throwing light upon the nature of the root system of these trees, were uncovered in "Riverside quarry." These specimens show the underside of the base of the stumps with the impressions in the sandstone of roots radiating out in all directions to considerable length. One specimen was removed and is in the possession of the Museum. This specimen, with the base of the stump having a diameter of about 12 inches, has root impressions measuring up to an inch or more across. Specimens were uncovered in which the roots were traced for a distance of 6 feet and the tips were not reached then. Unfortunately it was not possible to take the large specimens from the quarry. However, they show that the root systems were considerably larger and more adequate than previously supposed, sufficient, at any rate, to support trees of the height to which these trees must have attained. The finding of the new specimens with extensive root systems also answers the criticism that the stumps as found were not *in situ,* because those so far taken out did not have the roots attached.

Bibliography

Arber, E. A. Newell. Devonian Floras, 1921, p. 62, 63

Binney, E. W. On Fossil Wood in Calcareous Nodules Found in the Upper Foot Coal Near Oldham. Proc. Lit. Phil. Soc. Manchester, 1866, 5:113

Clarke, J. M. The Oldest of the Forests. Sci. Monthly, Jan. 1921, p. 83–91.

Crépin, F. Description de quelques plantes fossiles de l'étage des Psammites de Condroz. Bul. Acad. Roy. Belg., 2d ser., 1874, 38:356

——— Observations sur quelques plantes fossiles des depôts Dévoniens. Bul. Soc. Roy. Bot. Belg., 1875, 14:214

Dawson, J. W. Canadian Fossil Plants. Can. Geol. Surv. 1871, p. 58, 59

——— On New Tree Ferns and Other Fossils from the Devonian. Quart. Jour. Geol. Soc., 1871, 27:269–71

——— Notes on New Erian (Devonian) Plants. Quart. Jour. Geol. Soc., 1882, 37:307

Derby, Orville A. Observations on the Stem Structure of Psaronius Brasiliensis. Amer. Jour. Sci., ser. 4, 1914, 36:489–97

Gilkinet, A. Sur quelques plantes de l'étage du poudingue de Burnot. Bul. Acad. Roy. Belg., 1875, 2d ser., 40, no. 8:139.

——— Flore fossile des Psammites du Condroz (Dévonien supéreur). Mem. Soc. Geol. Belg., 1922, p. 5–10, pls. 1–4

Gourlie, W. Notice of the Fossil Plants in the Glasgow Museum. Proc. Phil. Soc. Glasgow, 1844, 1:105

Hall, James. 24th Rep't N. Y. State Cab. Nat. Hist., 1872, p. 8, 15, 16

——— On the Occurence of Trunks of Psaronius in an Erect Position, Resting on Their Original Bed. in Rocks of Devonian Age in the State of New York; With Some Inference Regarding the Condition of the Sea Bottom and Shore Line During the Deposition of the Strata. Rep't Brit. Assoc. Adv. Sci., 1872, Trans. 42:103

Johnson, Thomas. Spermolithus Devonicus, gen. et sp. nov., and Other Pteridosperms from the Upper Devonian Beds at Kiltorcan, County Kilkenny. Sci. Proc. Roy. Dublin Soc., no. 23, 1917, 15:218, 219; pl. 11, figs. 4–6; pl. 12, figs. 1, 2

Kidston, R. Preliminary Note on the Occurence of Microsporangia in Organic Connection with the Foliage of Lyginodendron. Proc. Roy. Soc. 1905, 76:358–60; pl. 6

——— On the Microsporangia of the Pteridospermeae, with Remarks on Their Relationship to Existing Groups. Phil Trans. Roy. Soc. (B), 1906, 198:413–45; pls. 25–28

Nathorst, A. G. Zur Oberdevonischen Flora der Bären-Insel. Handl. k. Svenska Vetenskaps-Akad., 1902, 36, no. 3:13–17; pls. 1, 2

——— Die Oberdevonische Flora des Ellesmerelandes. Report 2nd Norwegian Arctic Exped. *Fram*, 1898–1902, no. 1, 1904, p. 11, 12, pl. 1, fig. 1; pl. 2, figs. 1, 2

——— Zur Fossilen Flora der Polarländer. Teil 1, Lief. 4, Nachträge zur Pälaozoischen Flora Spitzbergens, 1914, pl. 7, fig. 1

Oliver, F. W. and Scott, D. H. On Lagenostoma Lomaxi, the Seed of Lyginodendron, Proc. Roy. Soc., 1903, 71:477–81

——— On the Structure of the Palaeozoic Seed Lagenostoma Lomaxi. Phil. Trans. Roy. Soc. (B), 1905, 197:193–247; pls. 4–10

Potonié, H. Lehrbuch der Pflanzenpalaeontologie, 1899, p. 171

Prosser, Charles S. Classification and Distribution of the Hamilton and Chemung Series of Central and Eastern New York, pt. 2, 17th Ann. Rep't N. Y. State Geologist for 1897 (1899) p. 211

Scott, D. H. Studies in Fossil Botany, pt 1, 3d. ed., 1920, p. 270–78; pt 2, 1909, p. 355–424

Seward, A. C. Fossil Plants, 1910, 2:220, 537, fig. 355; 1917, 3:35–85

White, David. The Seeds of Aneimites. Smith. Misc. Coll., 1904, 47, pt 3:322–31; pls. 17, 18

Williamson, W. C. On the Organization of the Fossil Plants of the Coal-Measures, Pt. IV. Dictyoxylon, Lyginodendron, and Heterangium, Phil. Trans. Roy. Soc. 1873, 163:377–408; pls. 22–31

Williamson, W. C. & Scott, D. H. Further Observations on the Organi- of the Fossil Plants of the Coal-Measures, Pt. III. Lyginodendron and Heterangium, Phil. Trans. Roy. Soc. (B) 1895, 186:703–79; pls. 18–29

Zeiller, R. Revue des travaux de Paléontologie végétale (1901–06). Rev. Gén, Bot., 1908, 20:59; reprint, p. 20

EXPLANATION OF PLATES

PLATE 2

(Plate 1 faces page 50)

Eospermatopteris textilis (Dawson)

One of the largest stumps found, with a height of 3 feet, a circumference at the base of approximately 9 feet, (dia. 34.3 in.), and a circumference at the top of 3 feet 1 inch (dia. 11.7 in.), Figure about one-ninth natural size.

Plate 2

PLATE 3

Eospermatopteris textilis (Dawson)

Stump showing rapid narrowing above the bulbous base. It has a circumference at the base of 6 feet 3 inches (dia. 23.8 in.); at 14 inches above the base, a circumference of 4 feet 3 inches (dia. approx. 16 in.); at the top, a circumference of 3 feet (dia. 11.4 in.). Figure about one-sixth natural size.

Plate 3

PLATE 4

Eospermatopteris textilis (Dawson)

Stump showing gradual narrowing above the bulbous base. Circumference at the base, 7 feet 6 inches (dia. approx. 25.4 in.); at a height of 14 inches, 6 feet 5 inches; at a height of two feet, 4 feet 4 inches, at the top 36½ inches (dia. 11.6 in.). Figure about one-sixth natural size.

Plate 4

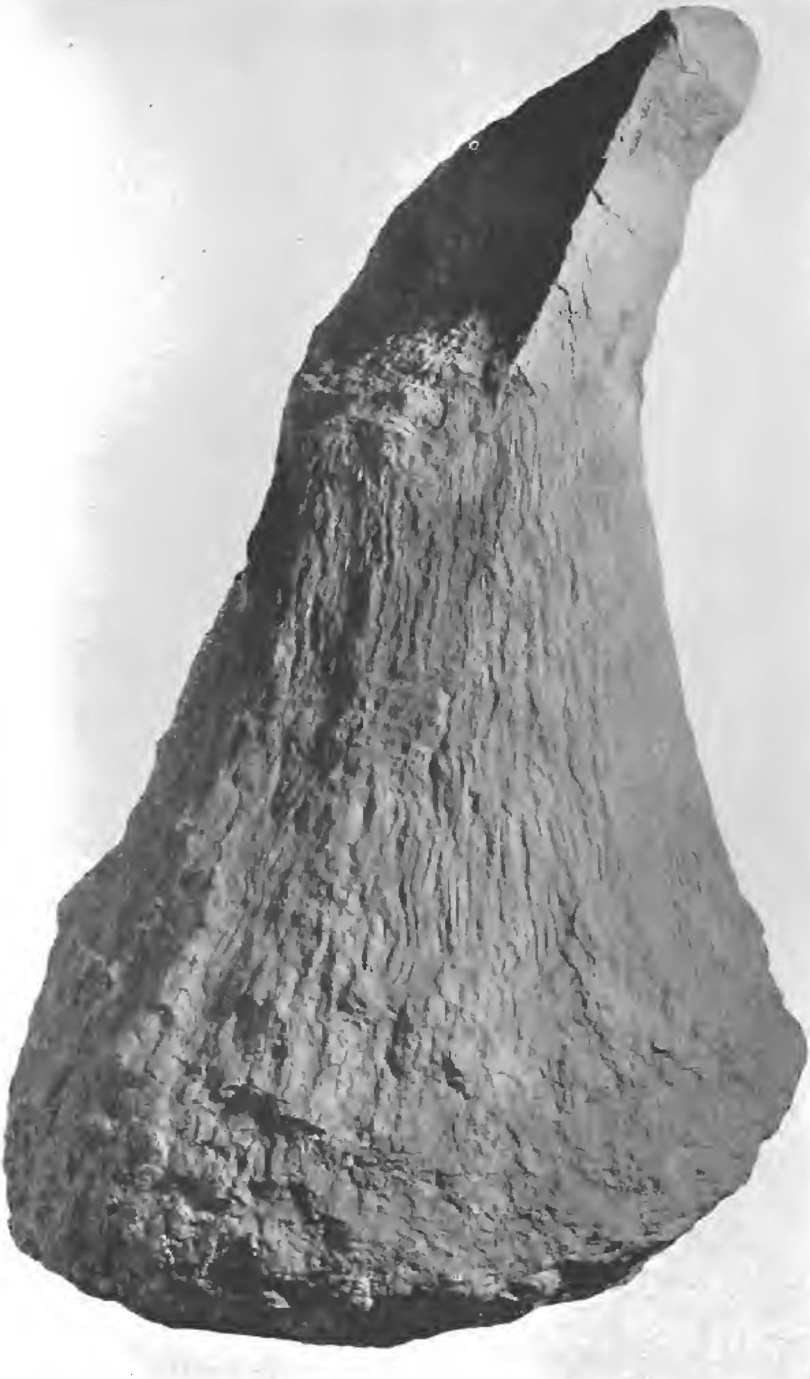

PLATE 5

Eospermatopteris textilis (Dawson)

Underside of the base of one of the stumps showing the striking furrowing in a radiate manner and the central depression. Diameter 25 inches. Figure about one-fifth natural size.

Plate 5

following

PLATE 6

Eospermatopteris textilis (Dawson)

Portion of outer cortex of one of the stumps, showing the network of interlacing strands of sclerenchyma tissue. Figure approximately one-half natural size.

Plate 6

following p. 82

PLATE 7

Eospermatopteris erianus (Dawson)

Stump showing the more or less parallel strands of sclerenchyma tissue characteristic of this species. It has a height of 38 inches; its greatest diameter (left to right in figure) is 38 inches; the diameter at right angles to this being about 30 inches. Figure approximately one-eighth natural size.

Plate 7

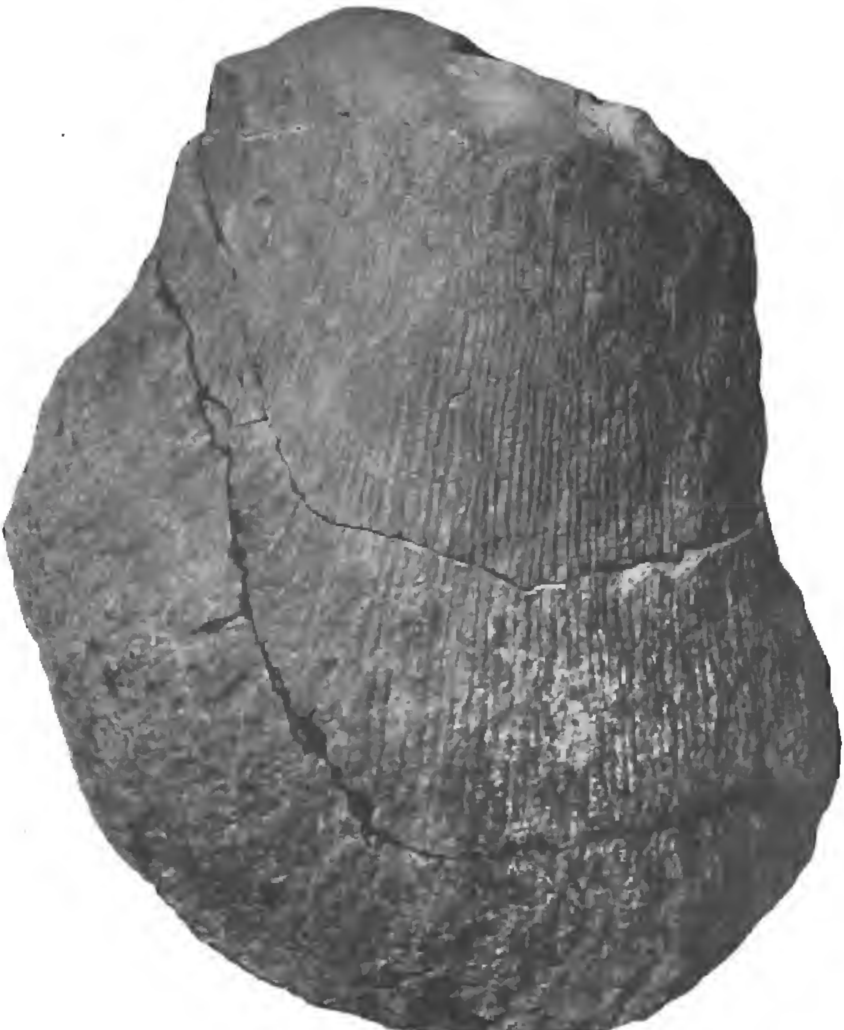

PLATE 8

Eospermatopteris gen. nov.

Slab showing the straplike, radiating rootlets. Reduced about one-third.

Plate 8

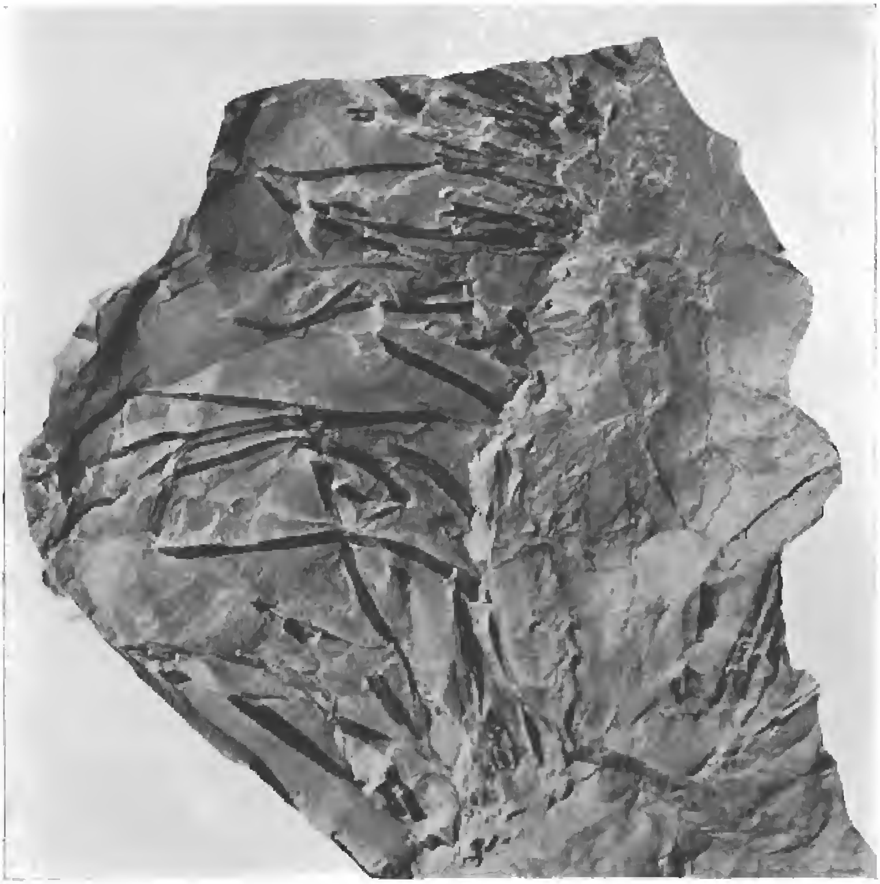

PLATE 9

Eospermatopteris gen. nov.

Large slab showing the main rachis and branches of fronds. Length at lower edge 3 feet; width 2 feet 1 inch. Figure about one-sixth natural size.

Plate 9

following,

PLATE 10

Eospermatopteris gen. nov.

Figs. 1–3. Twice bilobed pinnules. Figures 2 and 3 are tips of the ultimate divisions of the frond. x 1.

Fig. 4. Ultimate pinna showing the arrangement of the pinnules, which are in the fragmentary condition in which the pinnules are usually found. x 1.

Figs. 5, 6. Seeds borne in pairs at the ends of forked branchlets. Figure 5 shows the seeds in a more immature condition. x 1.

Figs. 7, 8. Outer husk or cupule of the seed which in these two cases is lobed. x 3.

Figs. 9, 10. Seeds which show the cupule coming to a point at the top. Figure 9, x 2; figure 10, x 3.

Figs. 11, 12. Specimens showing the impressions of the seeds within the cupule. Figure 11, x 3; figure 12, x 2.

Plate 10

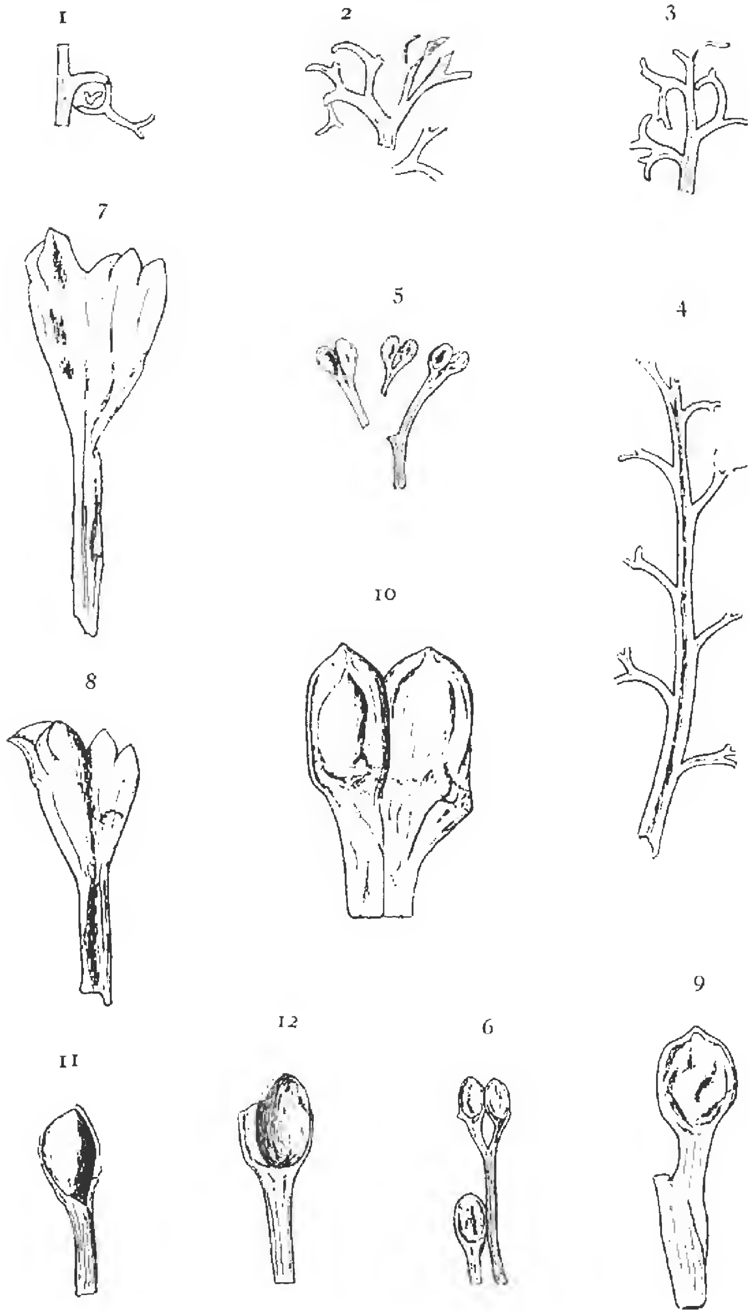

PLATE II

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Eospermatopteris gen. nov.

Figs. 1, 2. Specimens showing the impressions of seeds. Figure 1, x 2; figure 2, x 3.

Figs. 3–5. Groups of nutlets, almost entirely free from the enveloping integuments. x 1.

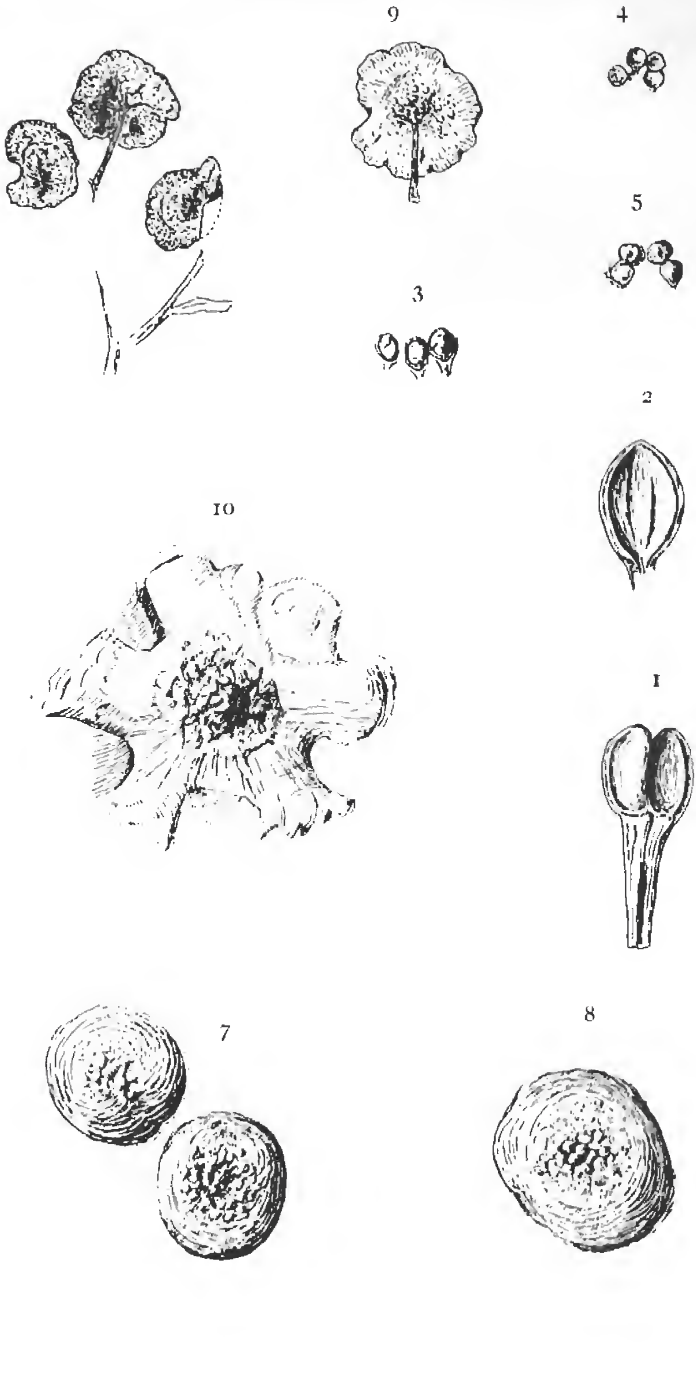
Fig. 6. Cluster of immature sporangia-bearing organs, showing the manner in which they are borne at the tips of forking branchlets. x 1.

Figs 7, 8. Detached sporangia-bearing organs. The clustered depressions at the center, are here seen as casts. x 2.

Fig. 9. Sporangia-bearing organ with wavy margin. x 1.

Fig. 10. The same, with almost fluted margin. x 2.

Plate 11



AN ANCESTRAL ACORN BARNACLE

By Rudolf Ruedemann

While studying Utica and Lorraine fossils of New York, the writer discovered elliptic bodies attached to shells of Geisonoceras, that are composed of 12 triangular plates, which at once suggested their reference to the acorn barnacles. A brief preliminary paper on "The Phylogeny of the Acorn Barnacles" was published in 1918 in the Proceedings of the National Academy of Sciences (vol. 4, pp. 382–386, 1918),[1] and the suggestion made that the fossils, for which the new generic term Eobalanus is proposed, indicate by the inverted form of the middle lateralia (see text, fig. 1, figs. V & VI) the origin of the two series of 5 lateralia from the two valves of a phyllocarid, such as Rhinocaris, and a progressive development from Eobalanus through the Devonian Protobalanus and the later Catophragmus into Balanus is suggested as shown in the diagram.

It was intended to publish the full account with figures in a monograph of the Utica and Lorraine formations of New York. This manuscript, however, has now been ready for the printer for four years and there is no immediate prospect of the paleontologic part being published. Meanwhile the preliminary note has called forth from several students of crustaceans expressions of doubt and requests, both in print and in letters, for the full facts in the case. To satisfy this natural curiosity we publish herewith the chapter on Eobalanus from the manuscript of the monograph.

To the species of Eobalanus originally discovered on cephalopods of the Utica shale, meanwhile another has been added that was found on a cephalopod from the Trenton limestone. This also is here described. We have no doubt that careful search of the Ordovician cephalopods in other countries will bring to light still more species of this highly interesting barnacle, and possibly add important facts on the development of the barnacles, the most mysterious of all crustaceans.

Genus **Eobalanus** nov.

Shell composed of 12 mural compartments, viz: 10 lateralia, the carina and the rostrum. Of the 2 series of 5 subtriangular lateralia

[1] Followed by a note by John M. Clarke on the phylogeny of the Lepadidae, in which is pointed out that the Ordovician Lepidocoleus may indicate a similar path of derivation of the Lepadidae from the phyllopods.

on each side, the middle one is inverted in position, the apex pointing outward (downward). Carina and rostrum little different in size from each other and from the lateralia. Compartments fused only near the base. Terga and scuta not known.

Genotype: Eobalanus informans nov.

Eobalanus informans nov.

Plate 1 — figs. 1, 2; plate 2, figs. 1, 2

Description. Wall elliptic or oval in outline, the major and minor diameters to each other as 4:3; consisting of 12 free plates (termed compartments): 5 symmetric lateralia, and the asymmetric carina and rostrum. Scuta and terga have not been observed. The lateralia are wedge-shaped but so arranged that they interlock, the outer pairs being broadest at the base (outside), the next pair also narrowing toward the top but with the apex truncated, the middle pair, however, widest at the top, thus forming a sort of keystone in the series of plates. One of the asymmetric plates is somewhat larger than the other, this end of the wall having been apparently more acute than the other, producing an oval outline. These wall plates were inserted in an elliptic base, the impression of which projects slightly beyond the basal edges of the wall-plates.

The surface of the compartments is smooth; save the growth-lines that run parallel to the basal margins.

Measurements: The largest specimen observed measures 28 mm in length and 23 mm in width; a smaller complete specimen is 9 mm long and 7 mm wide.

Horizon and locality. All specimens observed were attached to the conchs of Geisonoceras, mainly G. amplicameratum, from the Utica shale at Holland Patent.

Eobalanus trentonensis nov.

Plate 1, fig. 3; plate 2, fig. 3.

This species is based on a single imperfect specimen, which represents an extremely rare fossil, for in a thorough search of the large Rust collection of Trenton cephalopods we obtained but this meagre result. It is of great interest as another, still older, representative of the genus Eobalanus of primitive acorn barnacles.

The specimen exhibits the lateralia of only one side distinctly while those of the other side which became fossilized in their original upright position, are more or less foreshortened. The carina and rostrum are partly preserved. A large elliptic subcentral node indicates the mud-filling of the aperture. The plates of the right side (in the drawing) show furrows which correspond to those seen on the surface of the lateralia in the Devonian Protobalanus hamiltonensis Whitfield and therefore probably indicate that these plates whose substance is dissolved retain the upper surface, while the smooth surface of the plates on the left would suggest the under surface of the plates.

The lack of any substance, except a probably secondary calcareous film on the left side, and especially the absence of any carbonaceous matter, indicate that the originally conchiolinous plates of the phyllocarid ancestors, were already greatly strengthened by calcareous deposits and consequently much thickened, as is also suggested by the height of the central mud-filling.

Compared with E. informans, this form possesses a less elongate outline, the two diameters being subequal ($l = 12.8$ mm, $w = 11.1$ mm). The plates were, therefore, more subequal in outline and size, excepting the elongated carina and rostrum. The most apparent difference rests, however, in the form of the apexes of the lateralia, those of this species being acute while in the genotype they are truncate.

Horizon and locality. Trenton limestone, at Trenton Falls, Oneida county, N. Y.

Remarks on the phylogeny of the acorn barnacles suggested by Eobalanus.

The remarkable crustaceans here described are undoubtedly very primitive barnacles. They at once carry the Balanidae or acorn barnacles, hitherto traced only to the Devonian in Protobalanus hamiltonensis Whitfield back into Ordovician time, and also shed an important light on the origin of the Balanidae.

According to Pilsbry's authoritative view,[1] zoologists "in the absence of paleaeontologic evidence," may assume that all acorn barnacles descended from a primitive stock having 8 mural compartments, for the most generalized genus now existing, Catophragmus, has 8 main compartments, with numerous smaller ones outside, the latter representing the upper scales of the peduncle of pedunculate ancestral forms." The shell of Balanus consists of

[1] Pilsbry, H. A. The sessile barnacles (Cirripedia) contained in the collection of the U. S. National Museum; including a monograph of the American species. Smiths. Inst., U. S. Nat. Mus. bull. 93, 1916, p. 5.

but 6 plates. As a matter of fact paleontology furnishes in Protobalanus a form with 12 compartments arranged exactly as in Eobalanus, viz: in 5 pairs of lateralia and a small rostrum and larger carina. While however in Protobalanus the acutely triangular lateralia are all pointing with their apexes inward or upward, there prevails in Eobalanus the peculiar interlocking arrangement described above. This, in our view not only constitutes the generic difference between the two genera, but also gives us an important clue as to the ancestry of the Balanidae.

The effect of the peculiar shape of the lateralia in Eobalanus is that, if they could be matched together like the parts of a picture puzzle, they would give a perfect, snugly-fitting carapace, as shown in diagram V of text-figure 1. Leaving the two terminal plates separate, we thus obtain the outline of a bivalved carapace, with the rostrum and carina of the barnacle corresponding to the rostral plate of the crustacean in front and the "dorsal plate" behind, exactly as in the Devonian phyllocarids Mesothyra and Rhinocaris. (See diagram of Rhinocaris, text-figure 1.)

We have then to picture the derivation of an Eobalanus from a Rhinocaris-like ancestor as illustrated in the set of diagrams. The first diagram shows the carapace of the crustacean just before attachment with the head portion and the dorsal side downward, a rather natural position for phyllopods, which, like Apus, are wont to swim on their backs, while foraging along the bottom; and presumably also for many of their probable descendants, the phyllocarids.

The head and back being thus protected by attachment, but the ventral side open to attack, the next step will be the separation of the carapace valves along the hinge line and their movement upward towards the ventral side; and likewise the rostral and dorsal plates will have to move upward to fit in between the valves (stage II of diagrams), thus becoming the rostrum and carina of the barnacles. Following this was the breaking up of the valves into the lateralia, owing to stresses exerted at one end or the other, possibly the anterior one, where the originally chitinous and somewhat flexible valve was attached. It is to be inferred that the compartments were formed by successive splitting off of plates from the original valve, each fissure producing a new pair of lateralia. In this way the peculiar interlocking arrangement of the compartments in Eobalanus would finally have come about and each valve of the carapace have been divided up without leaving a useless remainder.

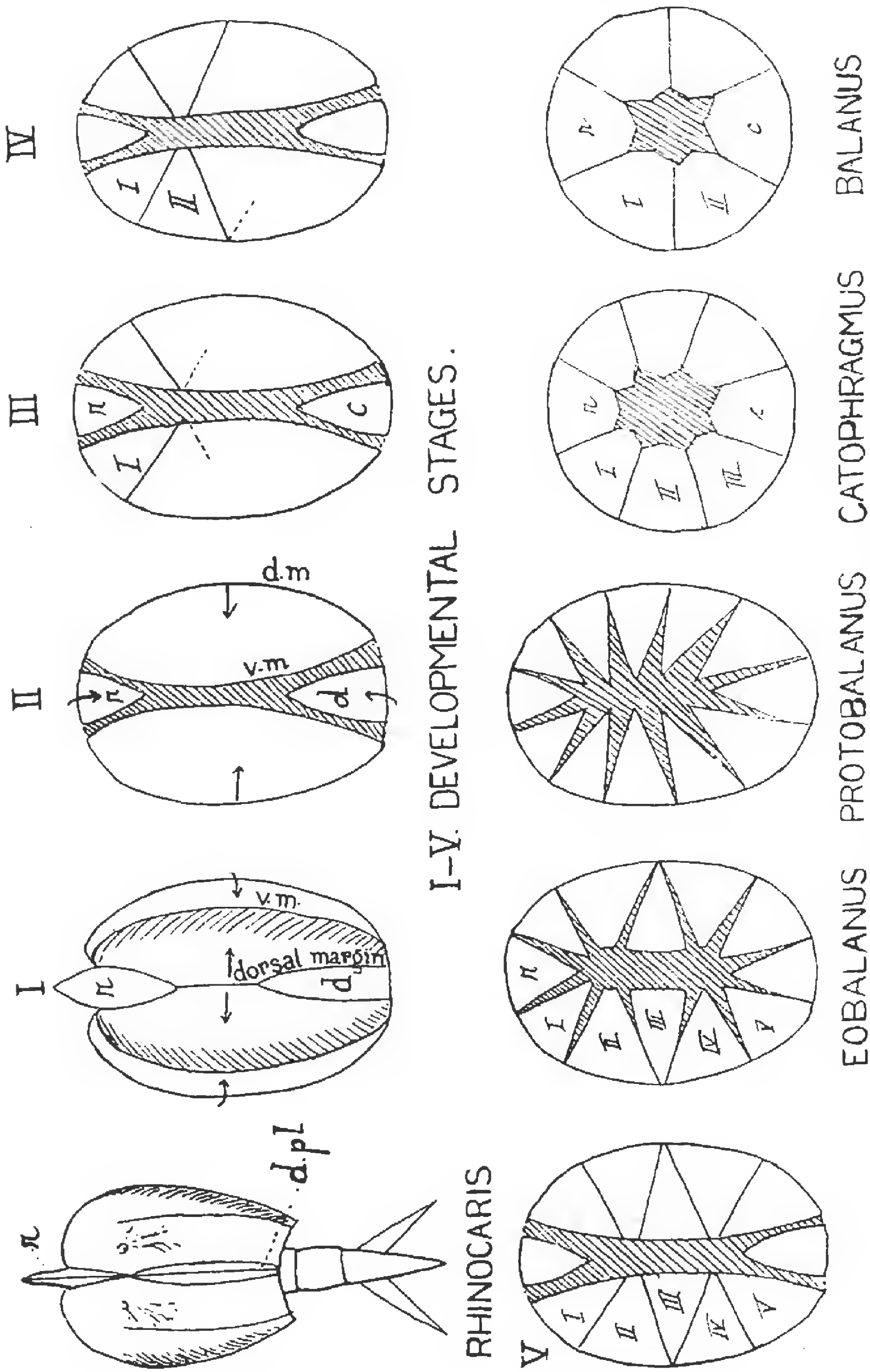


Fig. 1 Diagram of the evolution of Balanus from a phyllocarid

Let us see now how the other paleontologic and zoologic evidence agrees with this hypothesis. We saw already that in Protobalanus we have a connecting link in which the 5 lateralia of each side have become uniform in shape. This leads to the recent Catophragmus with 3 subequal lateralia on each side, which in the common Balanus have become further reduced (by coalescence?) to 2.

Equally convincing is the ontogenetic evidence in recent forms.

Since Darwin's fundamental investigation of the barnacles, the Balanidae are currently regarded as derived from the Lepadidae through reduction of the peduncle. The whole order of Cirripedia or barnacles, on account of their ontogeny and especially the bivalved "Cypris-stage" through which the larval form passes after the Nauplius-stage, are commonly derived from the ostracods, while Balfour (1880, p. 424), emphasizing both the large bivalve shell and the compound eyes, has urged "the independent derivation of the Cirripedia from some early bivalve Phyllopod-form."

This view is adopted by Korschelt and Heider in their authoritative "Text-book of the Embryology of Invertebrates" (1899, p. 209). They state: "We must, however, in consequence of the presence of the so-called Cypris-stage (with a bivalve shell) which occurs in their metamorphosis and brings about the transition from the free to the attached life, assume for them a similarly attached ancestral form, which we must seek among the Phyllopoda."

It seems further significant to us that the *free-swimming* Cypris-stage, which appears after a series of Nauplius-stages, is followed by the *attached* Cypris-stage (pupa), from which proceeds the adult stage (ibid. p. 209). So also in the ontogeny, as well as in the probable phylogeny, it is thus the bivalved stage, which becomes attached and thus marks the turning point in the individual and racial development.

It is this latter view that is well borne out by the interpretation we put on our material: or by tracing the acorn barnacles back to Rhinocaris-like phyllocarids with 4 plates. For while the Phyllocarida Packard (Leptostraca Claus), at present represented only by the well-known relict Nebalia geoffroyi, of the Gulf of Trieste, were formerly a part of the Phyllopoda, and have been removed to the Malacostraca on account of their more advanced structure, they still retain in their phyllopodiform legs and other characters the evidence of their derivation from the more primitive Phyllopoda *s. str.* and are properly considered as connecting the Malacostraca with the less advanced Entomostraca, especially the phyllopods.

All the specimens of Eobalanus informans are so completely flattened that we get a flat projection of the wall only, and we do not know how high the latter was or how the shell looked in the profile view. From the fairly wide interspaces between the compartments, even after they have been flattened down; and from the lack of overlapping among them, it appears that there existed very wide interspaces occupied by connecting chitinous bands when the plates were raised to any fairly steep angle. It is therefore probable that the wall was not at all rigid as in the recent Balanidae, where only the plates bounding the cavity for the mouth and feet (scuta and terga) are movable; and that the animals of Eobalanus were still enjoying a certain freedom of movement and correspondingly less protection, which may explain their scarcity among the Ordovician fossils.

Scuta and terga which form the valvular carapace or operculum of the upper aperture of the later Balanidae and the Lepadidae and which are of great systematic importance, have not been found in Eobalanus and Protobalanus, and in our view did not yet exist, but are a later development designed to close in more completely the ventral side. They are not fundamental structures. The compartments still being movable along their basal hinge, the creatures could probably close the ventral side by drawing the compartments sufficiently far inward.

It is a fact worth noting in this place, that all four specimens of Eobalanus, thus far observed, were found on the upper side of the living chamber of cephalopods, three of them rather far forward. We take this to mean, that just as certain recent barnacles are localized on the head of the cachelot whales, where they come in contact with the most water and most easily procure food particles, so also the species of Eobalanus may have found it advantageous to attach themselves where they would secure the most food and at the same time be least liable to be covered with mud, when the cephalopod dragged its shell over the bottom of the sea.

Explanation of Plates

Plate I

Genus **Eobalanus** nov.

Figs. 1, 2. Eobalanus informans nov. Fig. 1, Cotype.

Fig 2. Type and cotype. Both natural size. Utica shale. Holland Patent, Oneida county, N. Y.

Fig. 3. Eobalanus trentonensis nov. Natural size. Trenton limestone. Trenton Falls, Oneida county, N. Y. The original of fig. 1 is in the U. S. National Museum, those of figs. 2 and 3 are in the N. Y. State Museum.

1 2 3

Ordovician Barnacles

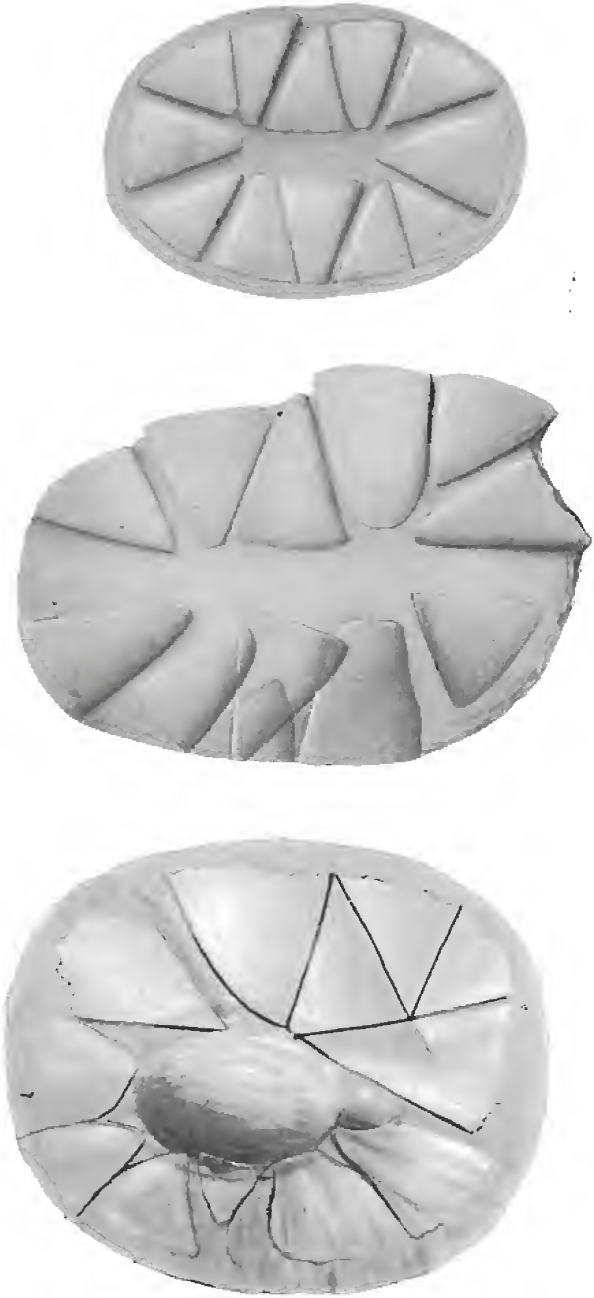
Plate 2

Genus **Eobalanus** nov.

Figs. 1, 2. Eobalanus informans nov. The specimens on the original of fig. 2 of plate 1, enlarged 5 times. Original of fig. 1 is selected as the type.

Fig. 3. Eobalanus trentonensis nov. x5.

Plate 2



Ordovician Barnacles

THE NEW PETROLOGY

BY CHARLES P. BERKEY

I suppose that one is not far wrong in saying that petrology is the science of rocks; but we have not made ourselves very clear by saying it. To the average student of the subject, who must judge from what he is taught and from what he can find in texts, petrology looks like a very complicated lot of methods of discrimination, coupled with still more complicated schemes of classification, by means of which one sometimes succeeds in finding a sufficiently mystifying name for a very innocent-looking fragment of rock to satisfy a perfectly natural craving for worthwhileness.

But this is not petrology — the real petrology that ought to be — no matter how elaborate it is or however minutely every little detail may be described. It is one kind of rock study, one form of petrology. The description of rocks is a form that, no doubt, has served a very good purpose in collecting and recording and classifying data; but there are other things to be done.

After the first step in a new scientific field is taken, it is not sufficient to present simply long lists of names and descriptions and descriptive terms and tabulations of facts and classification schemes. Such data alone do not satisfy the legitimate demands for an explanation of some kind. Such natural grouping of rocks as has been attempted is a first step toward meeting this demand, but it has not gone far enough in petrology.

The Field

It is easy to assume or to adopt too simple a conception of the term *rock*. It is clearly in the interest of beginners for them to think of a rock as a mineral aggregate representative of a structural unit of considerable magnitude, and as a very definite and constant and reliable thing. But this is no great advantage to the investigator; and to insist on its magnitude and constancy may be very misleading indeed.

Petrology by rights includes the whole range of natural products of definite mineral makeup — all kinds of mineral aggregates, all kinds of origin, and all sorts of conditions.

In actual investigations it is a mistake to be content with the types of material representing only the more apparent large physical units. Some insignificant-looking portion, usually too unimportant-looking to be regarded as a rock type at all, may carry more readable meaning than all the rest of the surrounding material. An ore or a vein matter or a contact product are as suitable material for the petrographer as are the igneous rocks or the sediments.

For this kind of petrology the term rock requires a revised definition.

A *rock* is a natural mineral aggregate of sufficiently definite composition and character to be representative of some structural unit or of some process or condition, to justify separate consideration in arriving at a working understanding of the life history and meaning of the physical unit to which it belongs.

How large these units may be, or how small, depends on the detail of the study and the significance of the material in contributing to the solution of the problem involved.

Any petrographer who has tried to make practical use of his petrology and of his own skill in any more systematic or connected way than that of simply naming or classifying separate fragments of rock, knows that it is very easy indeed to overstate the requirement of constancy of mineral makeup. Two pieces taken from the same physical unit in close proximity, often vary enough to require classification as quite different rocks. In many comparatively simple igneous bodies this variation is, in many cases, still greater and a whole series of different types could be secured. If one is content with classification, such classification as we now have, these conditions may easily lead to confusion. There is no indication in the terms usually used of the fact that these varieties are all one geological unit of a very simple history and meaning. Emphasis on these classification differences, therefore, may be very misleading. Many difficulties have arisen where the geologist or the engineer has tried to find in the field as many structural units as the petrographer who described the rocks called for.

The fault has been, in the past at least, that the petrographer dealt largely with mechanical distinctions, whereas the field man had to deal with genetic relations. The time has come now, surely, when a real petrographer must also be a field geologist, or he must at least appreciate the point of view of a field investigator.

The Object

In the past our best petrographers have lent the weight of their influence and the fruits of their labors to the field of tabulated detail and to niceties of discrimination and to schemes of classification, as if the chief aim were to divide and subdivide and to discover still more intricate or arbitrary bases of further subdivision. Description has been recognized as a more or less necessary accompaniment, but this usually covered chiefly the features useful in the scheme of classification. Otherwise it became a more or less rambling account of everything that could be seen.

Thus to be able to describe and classify rocks marked one as an accomplished petrographer and to have discovered a slightly different or new mineral proportion or a slightly different chemical proportion from anything previously described and to be thoughtful enough to give it a new name, marked one as an active contributor to the science.

In an effort to reach the last word in this direction of intimate discrimination, some of the foremost petrographers of our own day have gone so far as wholly to destroy the actual rock by a complete chemical analysis before even beginning the task of classification. Sometimes by this method mineral constituents were listed in the recast of this analysis, and taken into serious account, which never occurred at all in the live rock itself, whereas the much more suggestive constituents and structures that it did have were largely disregarded.

The most serious offender in this respect is the so-called quantitative system of rock classification originated by four eminent American petrographers. In saying these things there is no wish to be understood as attempting to belittle all of this pioneer work. Much of it, doubtless, had to be done to lay the foundation of critical inspection and discrimination and comparison. The quantitative principle was a good one to emphasize. The principle itself has come to stay; but a classification as mechanical as the quantitative system can be, at best, only a side issue in the real petrology that is already coming.

Much as we must value the contributions that have been made by the systematic petrographer and the chemical petrographer through their nice points of discrimination and their increased appreciation of sound chemistry and their rigid requirements of quantitative thinking, I am quite convinced that the apparent object in view is not a sufficiently high goal for the present stage of development of geologic science. This is not the chief or the most promising aim of rock study.

To classify and describe rocks by any system now in use is at best only a first step toward a more rational petrology, just as learning to distinguish and recognize words is a first step toward reading. There is, to my best belief, no such thing as a rational science of petrology wholly apart from the great science of geology. Whatever of significance attaches to a rock is largely gathered to it from the processes and agents and forces and conditions of its own geologic setting and history. Practically all of petrology's own contribution, if these meanings can be read, returns to geology again to enrich the knowledge of that great field — the field of geologic history.

In so far as a nice discrimination and a true sense of proportion serve in detecting evidence of former conditions or processes or changes or sources, they contribute directly to the new aim. It is, of course, appreciated that methods of discrimination and classification may have immense disciplinary and training value in education quite apart from the chief aim of a science itself; but then it should be frankly recognized as an educational objective. For the science itself, discrimination for discriminative sake alone is not enough.

Meaning or history are higher aims. Interpretation is the objective of the new school in petrology, just as it is in the general science of geology.

The reading of the life history of a rock is a much higher accomplishment than to classify or describe. It is the main objective of the new petrology.

The steps in determination of the origin and successive modifications of an ore are as proper a petrographic study as is the life history of an igneous rock or a sediment.

Whether or not a rock has been much modified since its original deposition, whether or not some of its present makeup has been added to it since that time, and whether or not it records some peculiar reversal in the course of development along which it first started, may be of immensely more importance than its name or its mineral proportions or any amount of minute description, or even a complete chemical analysis with all sorts of formal recasts of its elements.

Practical work covering many years and touching a very wide range of materials and problems has convinced the writer that the new aim is practicable and that the greatest usefulness of petrology is in some way involved in unraveling the origin and life history of rocks. The principal field of this kind of petrology lies in the reading of obscure history. Its chief claim to distinction lies in the antiquity of its materials and the reliability of the physical record even down to the minutest detail and the refinement of methods out of which and by means of which their histories are read. Any methods and any criteria and any nomenclature that serve these ends are the legitimate equipment and instruments and media of the petrologist; but he himself is first of all a geologist, helping in his own way to unravel the history of the earth, or else he is not in this class.

The petrology of the past has been developed and advanced in considerable part by men who were, first of all, mineralogists; and it is not at all surprising, therefore, that something of the point of view of the mineralogist should have dominated in this intermediate field. Under this leadership, the mineralogy of rocks, comparison of rocks by means of mineral differences, and classifications emphasizing mineral proportions were perfectly natural growths. Geologic principles thus at first did not make much of an appeal. Other interests of petrology have been brought forward more recently and almost wholly by geologists — applied and economic geologists — rather than by professional petrographers. It has been forced by an attempt to use the methods of petrography as a geologic aid. These attempts are not new, but to regard them as belonging to the true field of petrology is new and no systematic presentation of this kind of petrology has ever been made.

Methods and Criteria

Every refinement of method that can promise any new insight into the obscure features of rocks must be resorted to, for rock interpretation requires all the skill of discrimination that can be brought to bear. The difference, however, between the new and the older use of them lies in the purpose. The new effort is not only to detect differences, but to see meaning in them in terms of life history or in terms of any other claim that a given, special problem may present.

Much attention is given to structure, quite as much as to composition. Structural features are much more likely to have genetic and historical significance than are mineral proportion or composition.

As an equipment one must have a sound appreciation of the working of geologic processes, the complex interplay of chemical change under varying physical conditions, and the influence of the forces and agents that make and modify rocks. One must assemble the supposed criteria and learn how to use them. One must discover, or learn how to apply, new criteria — the criteria that aid in interpretation.

How shall I determine that a rock is igneous in origin if I do not know that fact already from some other circumstance or relation? It is not an easy thing to do, yet most petrographic work starts with that as an assumption.

How shall I determine that the minerals I now see in the makeup of the rock have been in part introduced long since the rock was first made? It is not an easy thing to do, but it may well be the most important thing about the whole history.

How shall I determine that the ore values that I can see in a porphyry copper ore are primary or secondary? And, if they are mixed, as they well may be, what are the evidences of their distribution?

How shall I determine that a specimen of rock has come from a formation that has been deformed and recrystallized and invaded by igneous material and subsequently mineralized and secondarily enriched until it is a workable ore? This is much more important than its name.

How shall I determine that the former constituents have been replaced, that the composition the rock now has is wholly new; and, if I can determine that, how shall I ever find out what the original was?

In a historical direction, and for practical and applied purposes, these are some of the things that one must find ways of doing. These and many other questions one will sometimes solve. These and many others one will many times fail to solve. Sometimes, no doubt, the fault or cause of failure is lack of sufficiently critical training in observation; sometimes it is an incomplete command of the principles of geologic processes; sometimes it is little facility in geologic reasoning or too great facility in loose reasoning; and sometimes it is a lack of properly standardized criteria.

Perhaps, therefore, a word about these needs would not be out of place. The last of these reasons,— the lack of properly standardized criteria,— is a strictly petrographic question; the others are in large part individual and personal.

Difficulties and Needs

I suppose that every rock has impressed on it, and to some degree it preserves, traces of its origin and every subsequent stage in its history. The difficulty is in reading these traces and interpreting them. Doubtless many of them are too obscure to be detected by any methods that we know how to use. Doubtless, also, the effects of the later happenings tend to obliterate or obscure those that existed before. It may even be that beyond a certain period everything is lost because of the very violence or completeness of the revolution. Such a case is where a rock suffers igneous fusion; or, again, where there is complete reconstruction, as in some forms of metamorphism.

These difficulties and the severe limitations set by the nature of the forces and changes that one has to deal with, however, do not furnish sufficient excuse for avoiding the problem. The same kind of limitations surround all branches of geologic research. The inherent difficulties do not remove the problem, they simply emphasize the peculiar nature of the problems of the science.

The great needs are *standardized criteria.* One must now assemble his own; and a little experience in assembling them will soon show how very scattering are the observations and comments that serve as reliable source records, and how much of a task it really is to organize a working scheme along any line of petrographic interpretation.

For example, one needs *criteria of origin,* and criteria for *source* of original material, and for the *order* of appearance of the different constituents, for *deformation* and *recrystallization,* for introduced *mineralization,* for *hydrothermal influences,* for *pneumatolitic action,* for *deep-seated alteration* as contrasted with *weathering* or supergene changes, for *deuteric* effects or end-product changes as contrasted with entirely independent subsequent modifications, for *secondary enrichment,* for *primary* as contrasted with *secondary* constituents, for *high-pressure-temperature* as contrasted with *low-pressure-temperature* conditions, for *silication,* for *cabonation,* for *replacement* or *metasomatism,* for *metamorphism,* or any other geologic process in its effects on rocks or for any *quality* or *condition* that might make them more readable and better understood.

For a good many years the writer and his students and associates have been slowly assembling and trying out such criteria, and have been attempting to interpret rocks. Even the imperfect standards that have been used show beyond doubt that the results are serviceable; but there is a long way to go to perfect a reliable working scheme of criteria.

Its Service

This kind of petrology has already earned a place for itself in studies of ore deposits. It is more readily appreciated in that field than in most others, that origin and subsequent changes and present exact condition of the material are vital matters. On the development of these factors, dependent as they are on perfectly normal geologic processes, depends also the extent and quality and distribution of the ore, as well as its changes in quality or value in depth or distance. No methods other than those of the new petrology have ever been successful in determining any of these fundamental questions.

In that branch of the science of geology where great financial interests are often dependent on correct interpretation of conditions and origin, it is comparatively easy to show the practical value of methods that serve these ends; but, as a matter of fact, wherever a better understanding of the life history and the causes of the present condition of rock material is needed, there the new petrology — the interpretation form of rock study — is of real service.

That kind of service is as broad as are the wants of geologic science. It is probable, indeed, that by petrographic methods designed to this end one could pry much further into the obscure secrets of many phases of geologic history than by any other means. It will do for structural history what paleontology does for stratigraphic history and physiography does for the surficial history of the earth.

It would be easy to illustrate some of these forms of service by a variety of practical problems in which such methods have been used. Two or three certainly will suffice.

1 It appears that a good zinc ore was being worked, and question arose about its extent and probable distribution as a basis for future development. The field indications thus far had not been clear and there were several alternative possibilities. The ore was a mixture and occurred in limestone. It might be (*a*) essentially primary, or (*b*) simply an altered primary constituent in place, or it might be (*c*) introduced, or (*d*) altered introduced material. In the latter case the distribution of the original introduced mineral and its origin would be an important link in the history. It was a strictly practical interpretation problem. One needed only a working knowledge of the criteria of sedimentary and organic rock origin, of metallic mineralization, of replacement, and of mineral alteration. It could be shown then that the ore in question was nearly all secondary;

that it had been transformed by supergene (weathering) agencies from a sulphide lead-zinc bearing ore as the original; that this original ore had been itself introduced into the limestone rock subsequent to its own formation and deformation; and that the principal present ore values did not occupy the place of the original sulphide minerals but, instead, had themselves replaced portions of the limestone, and that there was some selective distribution. The ore was strictly a superficial or near-surface deposit and had no chance of continuing in depth below the oxidized zone.

2 An old silver mine in Mexico, said to have been abandoned after reaching a certain level, not because of any fault with the ore, had been examined by competent mining engineers and sampled. Because, however, of difficult conditions at that time in Mexico, all of their shipped samples had been lost or destroyed, only a handful of small chips remaining, which one of the engineers had with some forethought carried out in his pocket.

The question they wished to ask was a very direct one, that is, has the mine been worked out, or is there real evidence to show that the ore still continues at the bottom much like that at higher levels, so that additional work might hope to find workable values at still greater depth?

It is a perfectly good petrographic problem. The conditions are unusual and discouraging; but it can be solved by those methods or else it cannot be solved at all. One must have a working knowledge of the origin of ores of that kind, and of the principles of alteration and secondary enrichment with their influence on distribution. One must be told about the relative distribution of these samples taken from the old mine and something of the structural facts; then, if he can read the criteria and interpret the evidence, he can venture an opinion based on real data, even in such an extreme case as this.

3 Several years ago the author published a short description of the "bluestone" of New York, making the study chiefly one of composition and micro-structural condition. It was not by any means well done in one respect at least, its interpretation. It was noticed that most of the original grains are now made up of aggregates, but it was then thought that these aggregates were secondary, resulting from the alteration of original, simple mineral grains. This interpretation is certainly wrong. These grains were originally aggregates and are not at all due to subsequent alteration. It is certain, also, that some of these grains, perhaps nearly all of them, are disintegration products from older formations which were themselves fine-grained aggregates in makeup, such as slates or argillites.

Such an interpretation is supported also by the fact that older formations were certainly available to furnish the supply. The bluestone is of Devonian age, and beneath strata of that age and beneath an unconformity lies the so-called Hudson River series, which is made up wholly of slates and graywackes and closely related varieties of sediments.

As far as the Devonian bluestone itself is concerned, the story could end here; but the similarity of the graywackes of Hudson River age to this bluestone of much later origin challenges an examination of it also by the same methods. When this is done it is discovered that the older graywacke of the Hudson River series is made up of original aggregate grains also. In other words, it is made up, in like manner, chiefly of complex aggregate grains, most of which must have been derived from a still older fine-grained rock series not very unlike itself.

But when one looks below the next unconformity for a corresponding rock series, a real difficulty is encountered. Apparently the next underlying series is the ancient crystalline gneisses and schists of the Highlands of the Lower Hudson, and no rocks similar to the grains in the graywacke occur at all.

On the south side of the Highlands, however, there is a crystalline series of disputed age, which was originally, before its extensive metamorphism, or in those parts not so completely metamorphosed, very like the required quality of material. If, therefore, this crystalline series, the so-called Manhattan schist-Inwood limestone-Lowerre quartzite series, is really older than the Hudson River slate-Wappinger limestone-Poughquag quartzite series, it could furnish the required material. Nothing else is known that could do it.

In so far, therefore, as this line of reasoning goes, it supports the contention that these two series of rocks are really of very different age and not one the metamorphosed representative of the other, as sometimes thought. Thus interpretation petrography may throw real light on a problem which is quite outside of the usual field covered by petrographic description.

4 It is usually considered comparatively easy to distinguish between a quartzite and a limestone, yet even this may become a very difficult thing to do. The writer has had occasion to work with material of this kind, in which a microscopic or a chemical determination of the relative amounts of silica would not suffice. The only method left was that of petrographic interpretation on the basis of origin and subsequent modification, including contact metamor-

phism, replacement, silication, silicification, carbonation, and metallic mineralization. Without discovering criteria by which rock material of this history, both original limestones, sandy limestones, and sandstones, could be distinguished one from the other, the determinations could not be done at all. With extreme caution such criteria can usually be discovered and used, as was done in this case. Even in samples where a rock that was originally a limestone now carries as much free quartz as is usual in a quartzite, it was generally possible to distinguish the original limestone representative from the quartzite; and, incidentally, help to solve an important, practical stratigraphic and economic problem.

Its Discoveries

The chief discoveries of the new petrology are:

1 That it is both practicable and very practical;

2 That it is very much more interesting and attractive as an instruction subject than is the old form;

3 That it yields beautifully to the application and teaching of research methods under simple and controllable circumstances;

4 That petrographic nomenclature is sadly deficient in descriptive terms and names for this particular kind of rock description.

The first two items require no additional comment, but perhaps the last one does. It is the chief direction, in addition to the establishing of reliable criteria, for important contributions.

In the new view, *genesis and history*, or *origin and subsequent changes are fundamental factors.* In some way they must be kept in the foreground both in description and in classification. Other features need not be neglected but are, for this purpose at least, of secondary rank. The larger groupings must be on these more important factors where the greater significance lies.

When one tries to apply these revised ideas to his own work it is discovered, in the course of time, that there are very many rock types and rock conditions and process effects for which there are no corresponding petrographic terms at all. Petrology is a branch of science which is thought by many to have too many names and terms now, and with this criticism we may all agree in principle. Many of the terms are too mechanical in their conception and too unproductive in their significance. Yet this can scarcely be counted against new ones if they can demonstrate their usefulness.

My only purpose is to point out a few discoveries of this kind and venture the opinion that within a very few years suitable terms will be in use among petrographers for many more; and that, by and by, a whole new system of nomenclature will be worked out, designed to emphazie these principles.

Examples

1 Geologists speak of the residue left by the evaporation of a solution as a *precipitate;* but there is no name for the product of the reaction between two mixing solutions, such as seems to have produced some of our ores. To a petrographer or a chemist the latter is the better precipitate, but he would like at least to distinguish between them. The genetic idea is carried better if the product of evaporation were called an *evaporate,* as Doctor Grabau does in his work on Salt Deposits, and the product of reaction by mixing were called a *reactionate.* Perhaps one could write them *evaporite* and *reactionite.*

2 These are still different from the product of simple reduction of temperature or pressure in an ascending, saturated solution, for which there is no name. Is it to be a *saturite?* And for the product of reaction between a solution and a rock wall, resulting in precipitation from the solution, there is also no name.

3 These are all very different genetically from the product of reaction between solution and rock wall or host when the reaction causes reorganization of portions of the rock itself, taking some thing out of the solution to add to its own constituents. It is a form of reactionite also, but very different indeed from either of the others. There must be a whole family of reactionites differing in various, quite fundamental ways one from another, and altogether producing a most interesting and important lot of petrographic materials encountered in many practical problems.

If one has worked little with ores and their relations, these needs would not necessarily have been felt; but if one has followed applied petrology with mining engineers he will have discovered that there is no name for a very great many of his perfectly typical things. One does not need to invade that field, however, to feel this poverty of nomenclature. *The fact is that geology as related to petrogenesis has outstripped petrography as a separate descriptive branch, and there are now many perfectly clear concepts of processes and products for which there are no petrographic terms.*

4 Sometimes one substance completely replaces another, or certain ones completely replace others, producing an entirely new composition. There must be a whole family of these types. I suppose

we can call them *exchangites* or *replacites* or *metasomatites;* and if we do we shall be easily understood but there are not any such words in petrography.

5 What term shall one use for an ash that has been completely silicified? I know that one form of it has been called novaculite, but not at all because of its origin. And on that very account the term would hardly serve for a rock that had a coarse structure. There simply is not any adequate term. This is not a rare thing. There is much more of this type of rock in the ground than there is of Jacupirangite, or of Luxullianite, or many others that could be named.

6 What constitutes a quartzite? And why should not one distinguish between a quartz rock that is still in its original, unmodified condition and one that has been indurated with silica; and, yet again, one that has been deformed and recrystallized? There are immense differences historically, and all types are very abundant indeed.

In the field of katamorphism there are whole groups of products of immense importance to the practical or applied petrographer, for which there are no classification terms, although there are geologic terms descriptive of the major processes.

7 For example, how shall one designate the average product of simple disintegration? Is it a *disintegrationite?*

8 What shall one call the products of leaching? Shall we call them all *laterites* or *leachites?* Is laterite an extreme condition represented less perfectly by all of the leachites?

9 Or, again, what shall one call the product of simple oxidation? I know that "gossan" is an oxidation product from sulphides; but are they all to be called gossans? There ought to be a better name for the whole family of *oxidationites.*

10 Or how shall one indicate in simple terms or by a suitable name that a rock is a carbonation product, when the original was not a carbonate rock at all? One has had little experience who has not seen such rocks and has wondered how to classify them.

11. Hydration is one of the commonest processes active in the alteration of rocks. Serpentines are of such origin, derived from anhydrous silicate originals; but there is no name for the whole family of *hydrationites.*

12 A sandstone in which carbonate occurs is usually called a calcareous sandstone; but there is a great difference in meaning whether the carbonate is original with the rest of the rock or was

introduced as an induration effect or was traded in a process of replacement for parts of the rock that have disappeared. How shall one designate these conditions?

13 A belief in recrystallization has come to stay. Recrystallization does not presuppose any particular composition or particular structure. Shall we call the group of such products the *recrystallizationites?*

Fundamentally there are two divisions of this group — the massive ones and the foliated or stretched ones; but we have no clearly recognized names for them.

If I call the latter *foliates,* as Miller does in his reclassification of metamorphic terms, in what way shall we distinguish the primary foliated rocks of both igneous and sedimentary origin?

There is, of course, no object in pressing these questions further. They have been used only to indicate at how many points the terminology and classification schemes of petrography fall short of the working conceptions of the applied geologist. If it is true, as it seems to me, that the rightful field of petrology is rock interpretation, and that its greatest service lies in its contribution to geologic history, then, sooner or later, a considerable modification in terminology is sure to come in petrography itself.

Petrologists of the new school will have to be, first of all, geologists both in fundamental training and in thinking habit, rather than mineralogists, because their subject is an intimate part of the field of geologic history, and their science is but a branch of the great science of geology.

Petrogenesis, the life history of rocks — geologic history hid in the obscure inner recesses of the rocks themselves — these are the chief interests of the new petrology and these objectives map out its major service.

A HEMIASPIDAN CRUSTACEAN FROM THE NEW YORK SILURIAN WATERLIMES

BY JOHN M. CLARKE

Little by little the Bertie waterlimes of western New York, which make the terminal member of the Silurian series, have revealed the genera of that singular group of crustaceans or arachnidans which have been for the most part originally described from the Silurians of the Island of Oesel in the Baltic; Lanarkshire in Scotland and Ludlow, England, and which have been called, taken together, the Bunodomorpha. They represent

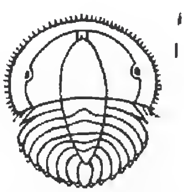


Fig. 1 Hemiaspis stage of embryo Limulus

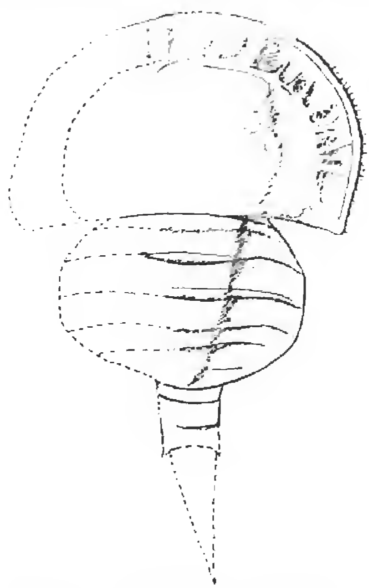


Fig. 2 *Hemiaspis? eriensis* sp nov.

small creatures of merostome (hence arachnid) structure which could not have been very abundant in the Silurian seas, as species and genera are few in number and individuals. Every new link in this group which helps to tie up the New York formations with those of the Eastern hemisphere is worthy of record.

Of the genera (1) Neolimulus, (2) Bunodes, (3) Hemiaspis and (4) Pseudoniscus, all of which were described first from Europe, only Pseudoniscus has been found in the Bertie waterlimes (P. roosevelti Clarke). Bunaia (B. woodwardi Clarke, Buffalo) is an adjusted representative of Bunodes, as is perhaps true of Bunodella from the Silurian of New Brunswick. B u n a i a w o o d w a r d i was described three years ago as a variant generic type. The haphazard occurrences of these fossils have brought to light this year an evident representative of the Hemiaspis-like shrimps; their first appearance in this country. The single specimen found retains only enough of the exoskeleton to verify the approximate identification. Its condition of preservation is bad but what it has to show is seen on the accompanying figure. That it is a true Hemiaspis as that genus is understood on the basis of the Scottish specimen, is not altogether clear. In fact the abdominal segments, regarded as free in those, are apparently coalesced into a single shield in this. The completion of this record must wait on the acquisition of further and better material.

The specimen leaves much to be desired; it is not all there; but for purposes of identification it may be known as Hemiaspis (?) eriensis. It is from the Bertie waterlime quarries at East Buffalo.

A COLOSSAL DEVONIAN GLASS SPONGE

BY JOHN M. CLARKE

It is a pleasure to record the fact that this evidence of the immense size to which the glass sponges of the Devonian plantations in New York grew, was discovered by a venerable lady, when well past her one hundredth year, on her farm near Ripley, Chautauqua county; Mrs H. A. Burton, Prof. Gilbert D. Harris's aunt. It is to the kindness of Mrs. Burton and the courtesy of Professor Harris of Cornell University, that this specimen is now in the State Museum and this opportunity afforded of public notice of this extraordinary fossil.

In a brief oral acount of it I have termed this unique specimen "the Burton Sponge," but technically it appears to be a representative of the genus *Ceratodictya* which is characterized by its long horn shape, covered with concentric rings or annulations. The elevated rings are simple and about equidistant in early growth, but as the sponge grew older and upward these annuli became divided at the top by a low furrow which gradually deepened until it had become nearly as deep as the interannular depressions. Also as growth advanced the rings had a tendency to become less regular, more crowded together, relatively much narrower and on the whole less conspicuous. The specimen is a fragment 14 inches long and 8 inches wide, which presumably represents the final growth of the sponge and shows ephebic conditions in the form of the rings, their irregular subdivision, the terminal ring having divided twice, and in a tendency to become faintly nodose. There is, however, no good reason for disconnecting this expression of growth from that shown in smaller and presumably younger specimens. On the assumption that the present width of the specimen, even though compressed, is approximately the true width of the original and by comparison of its relative proportions with those of younger and larger individuals in the Museum, it seems fairly reasonable to conclude that this specimen attained a length of not less than 10 feet. The restoration of this sponge in its probable original dimensions has been erected in the Museum. The specimen is from the Chemung sandstones (upper marine Devonian).

For further observations on these Hexactinellid sponges, see

Hall & Clarke. The Paleozoic Reticulate Sponges Constituting the Family Dictyospongidae. State Museum Memoir 2. 1895.

Clarke. Devonian Glass Sponges. State Mus. Bul. N. Y. 196. 1918.

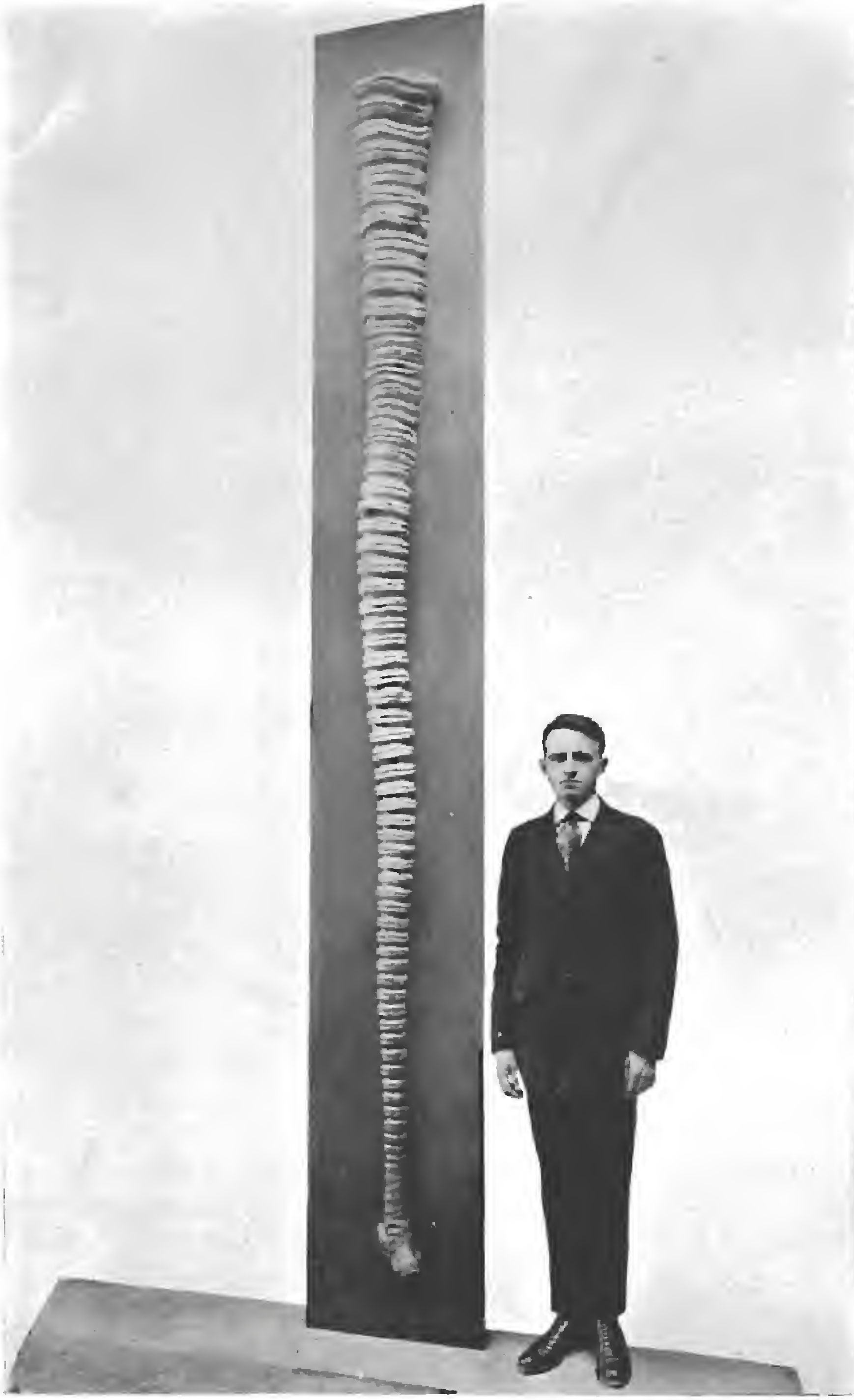
——— The Great Glass Sponge Colonies of the Devonian. Journal of Geology. 1920.

——— Armstrongia. A New Genus of Devonian Glass Sponges. State Mus. Bul. N. Y. 219–220. 1920.

A fragment of the largest known specimen of a Devonian Glass Sponge ("The Burton Sponge"), one-third natural size.

(d) following p. 152

"The Burton Sponge." The other side of the specimen.



The Burton Sponge. Full size restoration based upon comparison of the original with other specimens allied to it. This is from the Chemung rocks of Allegany County.

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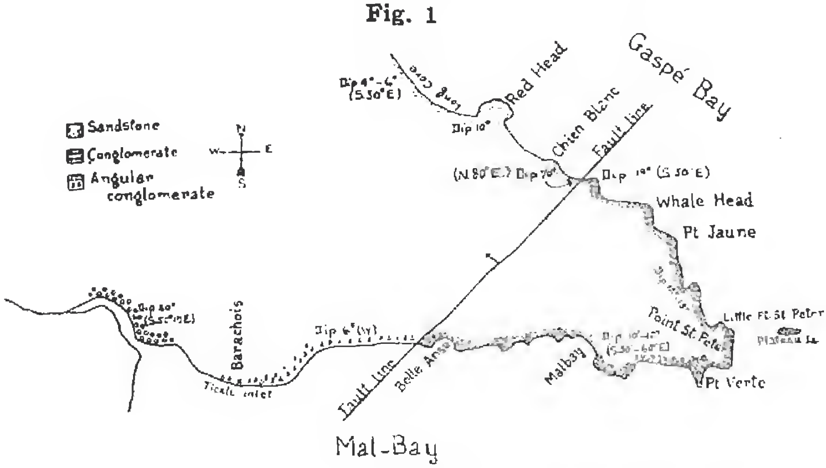
THE GEOLOGICAL AGE OF THE BONAVENTURE FORMATION

BY JOHN M. CLARKE

The determination of this problem has an interesting general bearing on the age of Old Red Sandstone deposits, particularly those represented by the Catskill rocks of New York. Many years of work in the typical region of the Bonaventure series brought the conclusion that while this blanket of red sands and conglomerates in Gaspé was in large part of Carboniferous age, the deposition actually began at the close of the Middle Devonian and continued without interruption into the later period. This

Fig. 1



Surface relations of the rocks in the Barachois _ Point St Peter _ Long Cove area.

interpretation differed from that by Sir William Logan, the founder and describer, only in the ascription of the lower moiety of the series to Devonian time. In the Catskill series of New York the division of this Old Red sedimentation is of like quality though not the same as to apparent quantity; here there is more Devonian in proportion to the Carboniferous; there the proportion is reversed. It is quite possible that in New York the Carboniferous cap formations of the Catskill are incomplete from erosion or unfinished record. I had felt that these conclusions with reference to the Bonaventure were sufficiently secure on the basis of the evidence I had set out in a number of publications on Gaspé geology but my confidence in them was somewhat disturbed by suggestions from Mr R. L. Sherlock of the British

Geological Survey[1] upon the age of the Foraminifera which I had found in the jasper and chert pebbles of the Bonaventure beds. At my request these fossils were studied and identified by Dr Rufus M. Bagg and his determinations were printed in the Fifteenth Annual Museum Report, 1921. These determinations were necessarily based on thin sections and the author frankly admitted that they could only be approximate. The interest attached thereto was primarily the discovery of Foraminifera in this Gaspé series, which was before unknown to us, and secondarily the apparent evidence that they actually do represent the existence at the early date at which these cherts were formed (prob-

Fig. 2

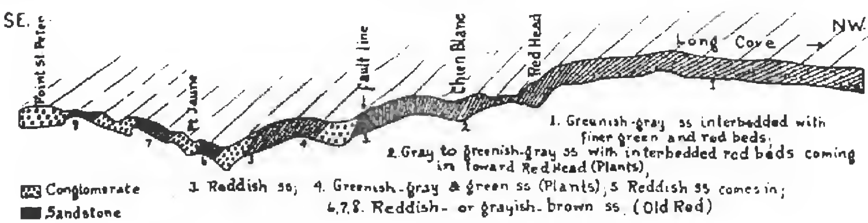


Diagram of shoreline from Point St Peter to Long Cove.

Fig. 3

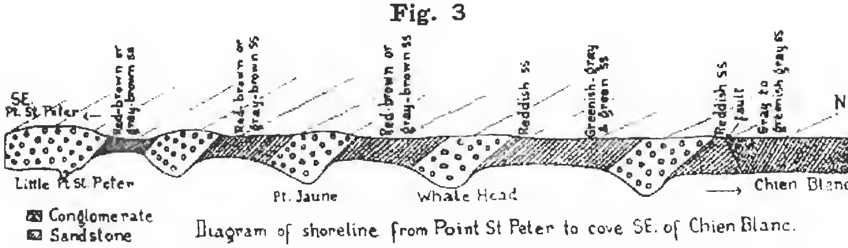


Diagram of shoreline from Point St Peter to cove SE. of Chien Blanc.

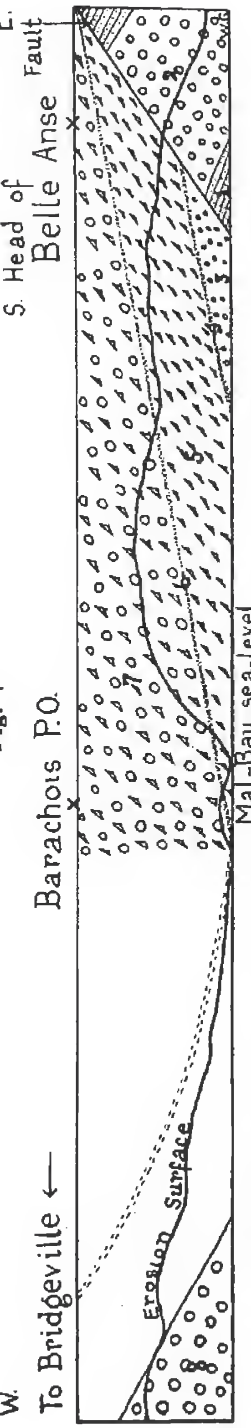
ably Ordovician or Cambrian) of genera, many of which are with difficulty distinguishable from forms now living. Of all the forty-four species identified by Doctor Bagg, it is pointed out by Mr Sherlock that thirty-seven are recorded as still extant. He also emphasizes the fact that eighteen have hitherto been known as found first in the Trias and this large proportion of itself threw out an intimation that the Bonaventure rocks were of Triassic or later age. In view of the known existence and presumable continuity of this red rock deposition further south into the Permian (New Brunswick, Prince Edward Island, Magdalen Islands) and Triassic (Nove Scotia), this suggestion arrested attention as highly reasonable and worthy of careful

[1] The Stratigraphical Value of Foraminifera. Geological Magazine, May 1922, p. 238.

examination. I shall not make any further reference to the character of the Foraminifera, as Mr Sherlock has most kindly offered personally to examine the original slides and now has them in his possession. This part of the problem may await his conclusions.

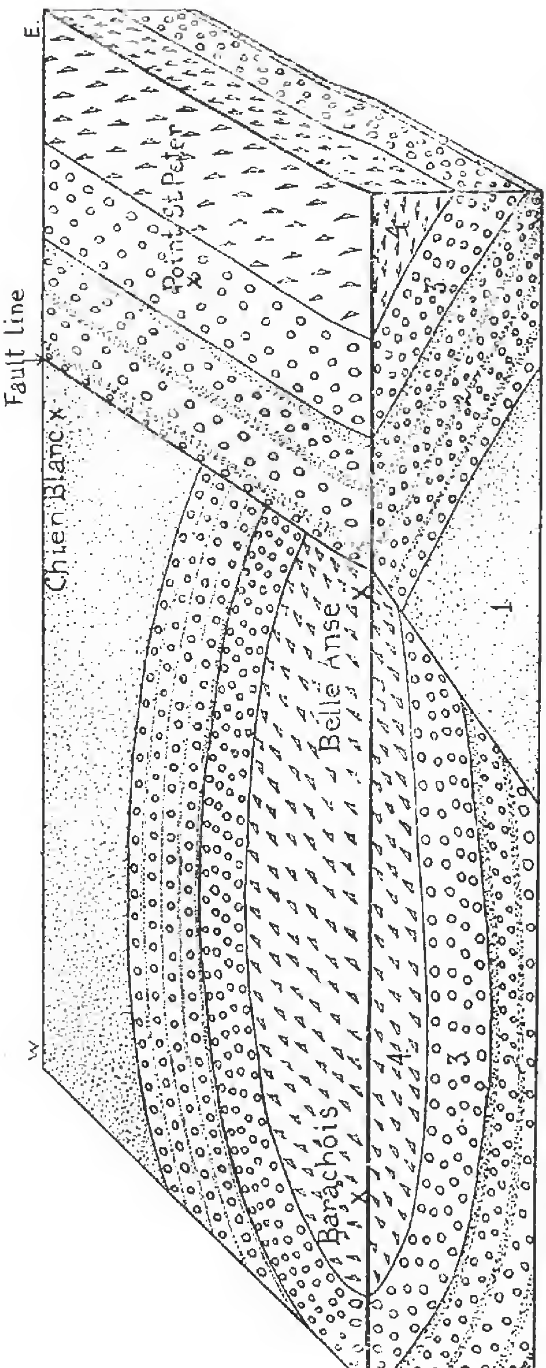
The stratigraphic relations of the Bonaventure to the Middle Devonian Gaspé sandstones which must really be determinative of the age of the Foramininifera pebbles, have been passed under careful field review. The critical region for the precise determination of the stratigraphy of the Gaspé sandstones and the incoming stages of the Bonaventure formation, is the extremity of the St Peter peninsula which on the north makes the south boundary of Gaspé bay and on the south, the north shore of the Malbay. It is a region rather remote from the line of travel in these railroad days and my own personal acquaintance with it has not been sufficiently intimate for the precise purpose in hand, but my associate, Winifred Goldring, who has been engaged in Gaspé in the acquisition of paleobotanical material, has made a close and very satisfactory examination of the stratigraphy of the peninsula, coming out with perfectly conclusive results as to the general accuracy of my previous conclusions to the effect that the Middle Devonian Gaspé sandstone, exposed in the St Peter region only in its upper part, is gradually replaced by Bonaventure sediments coming in from the south. The

Fig. 4



Belle Anse – Barachois – Bridgeville section. 1 Red-brown and green SS; 2 Lowest conglomerate bed; 3 Conglomeratic beds, probably corresponding to uppermost layers of (8); 4, 6 Red and green interbedded SS; 5 Angular conglomerate; 7 Coarser, more typical conglomerate; 8 Typical conglomerate, like the heavy beds at Point St. Peter.

Fig. 5



Barachois_Point St.Peter_Chien Blanc area. Relation of the various kinds of rock after folding, faulting and bevelling. 1. Gaspé ss series; 2. First four heavy beds of Bonaventure conglomerate with thick, interbedded ss series; 3. Fifth and heaviest bed of Bonaventure conglomerate; 4. Angular Bonaventure conglomerate.

accompanying sketch map shows the geographical outline of the Peninsula. To the northwest lie the Gaspé sandstones (Middle Devonian) ; to the north on the opposite side of the bay are the Grande Grève limestones (Lower Devonian) ; to the south are the successive beds of the Bonaventure.

At Chien Blanc, the green-gray Gaspé sandstones disappear terminated in their eastward extension down the bay by a displacement of some magnitude. Against them at an angle lie reddish shales. The dip of all is high, 80° in the former, about 70° in the latter against the fault. Thence outward and eastward follow at least four beds of conglomerate separated by broad intervals of red to brown shales, the first of these, of lighter shade than the rest carrying plant remains of the same character as those in the Gaspé sandstone. The entire series on this north shore is terminated at St Peter point by a very heavy bed of coarse conglomerate which is continued under sea outward to Plato island, a half mile from the point. Here, thus, we have the sedimentary evidence of gradual passage from the Gaspé sandstones into the conglomerate series of the Bonaventure, which is also evidence of shoaling marine waters encroached upon by increasing indrainage from an arid continent at the east. Turning St Peter point to the south shore the fault displacement is shown quite evidently to extend across the early conglomerate bed as well as the shales beneath and I give here the construction of the section from Belle Anse westward to Barachois. The strength of the displacement here noted is not equaled by any other fault recorded in this or the adjoining region. Winifred Goldring's sections are here reproduced together with a block diagram showing the character of the dislocation at the point of this peninsula.

Footnote: Since the foregoing was written, Mr Sherlock has made his examination of the sections studied by Doctor Bagg with great pains, and with most generous consideration has undertaken a comparison with the determinations made in the original study. While Mr Sherlock is not in full agreement with Doctor Bagg's determinations, he recognizes the difficulties confronting specific and even generic determinations from sections only and, with this handicap recognized, he is convinced of many of the points that Doctor Bagg brought out with reference to the very great range of these species and genera. It is with Mr Sherlock's conclusions that we are here most intimately concerned, in view of the fact that there is no doubt remaining now as to the Early Carboniferous or Late Devonian age of these Bonaventure deposits which contain the Foraminifera cherts. Mr Sherlock says: "My general impression of the Foraminifera is that they do not prove the age of the cherts. Had I been handed them without any knowledge of locality and age, my impression would have been that they were probably Mesozoic and more likely Cretaceous than Triassic. There is nothing at all to suggets a Paleozoic age. Stratigraphical evidence must be accepted and we can only infer that Foraminifera have less value for determining age than we imagined."

ROSETTED TRAILS OF THE PALEOZOIC

BY JOHN M. CLARKE

There were boring worms of great size in the Silurian sea as indicated by the accompanying illustrations of a specimen from the beds of Mont Joli, Gaspé. The figures are in natural proportions and essentially accurate though somewhat diagrammatic representations of corrugated saucerlike impressions in the mud, preserved in relief in the sandy overlying layer. The great worm that made them, extending part way out of its vertical tube, whipped its protruded body out radially, in one and eventually in all directions, each such protrusion being followed by a broad groove as the worm drew its body back toward or into its hole. It is interesting to note that the laps or throws of the body always reach the same distance from the central tube, thus producing a very striking rosettelike depression which is emphasized when thrown into relief. We have evidences in plenty of Paleozoic worms which had the habit of looping back their extended bodies into the central tube catching up windrows of sand and making shapes that have frequently been called by the generic names, Taonurus and Spirophyton; and of vertical tubes transecting successive bedding planes. But the flapping ancestral gephyreans (if such they prove to be) have left few of their traces.

This seems an appropriate opportunity to take account of certain rather impressive rosette or chrysanthemumlike tufted casts of which we have brought together a considerable series from the upper-Chemung sand-slabs of southwestern New York. These have been accumulating for many years and have come to be known in the circle that has been interested in them as fossil daisies. They are bodies in high relief, obviously the moulds of natural depressions on the sea bottom, 1 to 2 inches in diameter, their cushion-shaped surface divided into two distinct parts, an inner, like the disk of a daisy, usually circular in outline but sometimes apparenty four-divided by cross-lines, the outer or peripheral part being sharply set off from the rest. The surface of both parts is closely covered by sharp close-set and fine threadlike radial markings not laid regularly but overlapping and crossing. There is no continuity in these lines across the two areas of the surface and indeed their arrangement on these relief mounds suggests the lay of the grass in a haycock. There is no

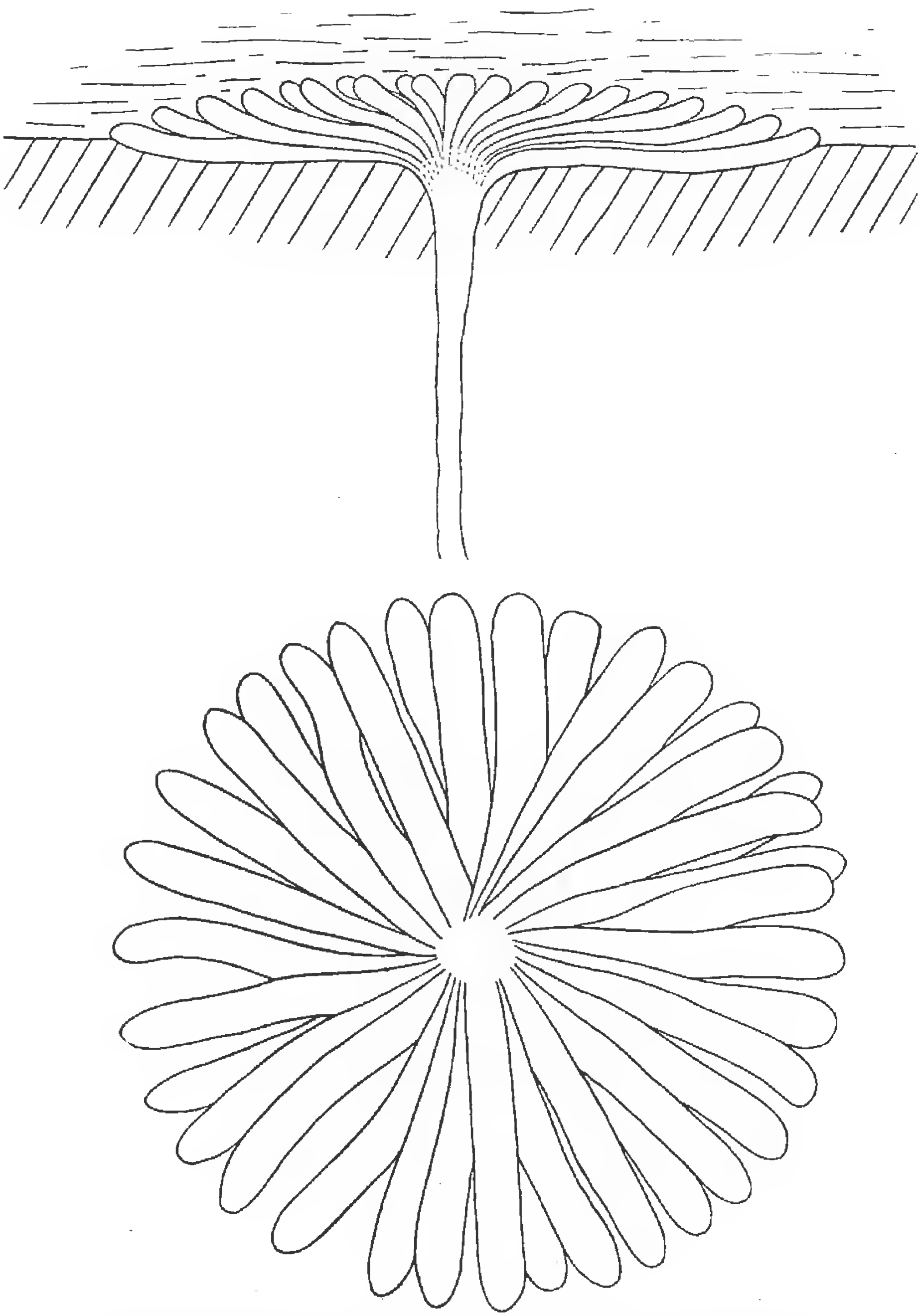
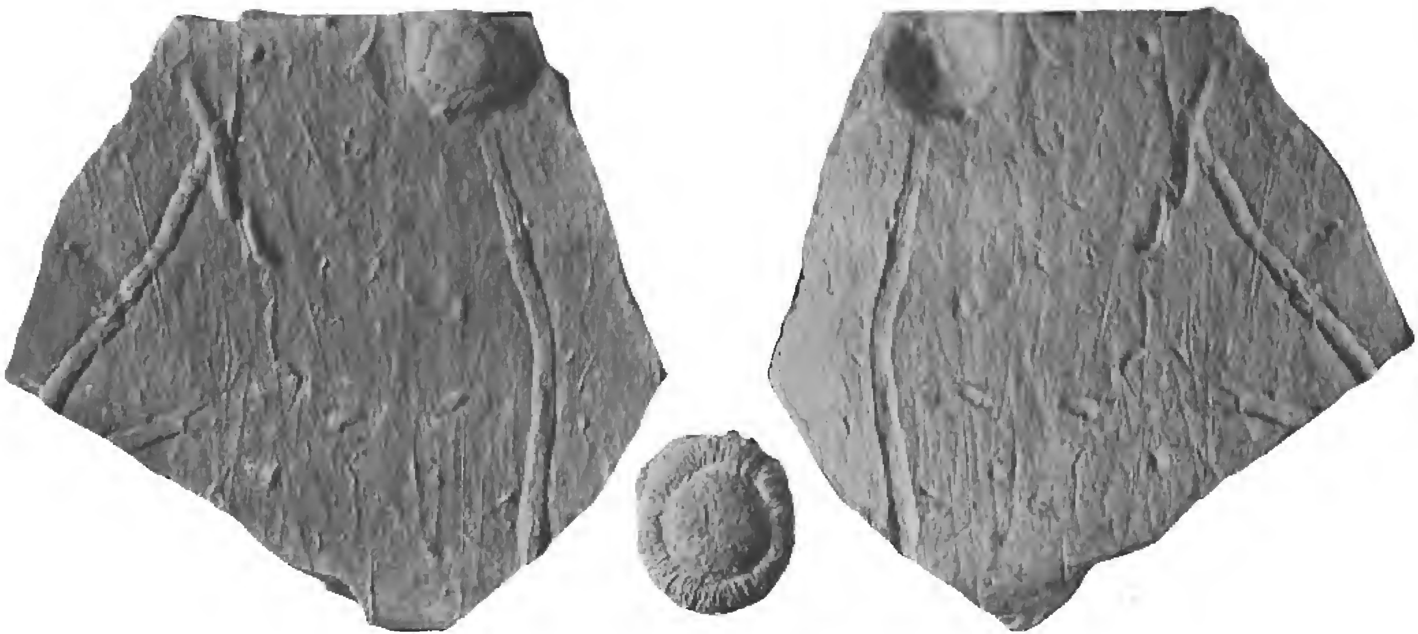


Fig. 1 Rosette-shaped worm burrow; above, theoretical vertical section; below, surface appearance. One-half natural size. Silurian, Mt. Joli, Percé.

evidence at the center, of a hole or elevation representing such hole. Described in terms of the original depression, we have a double saucer with the form of an ogee champagne shell, covered with sharp threadlike depressions, and without evidence of a vertical tube running down into the mud. In two of these specimens there seems to be a connection with a stem or shaft lying horizontal on the surface of the slab, straight in direction but showing traces of jointing or segmentation such as may have been made by a crawling or sliding worm. In some such circular depression, a boring or burrowing sea-urchin may have wallowed; some many-tentacled annelid may have moved along the surface and stopped to flap its armed head back and forth and about; some Porpita-like thing have died and decayed; perhaps some ascidian have left its trace. At all events some nut dropped here for paleontologists to crack. Many years ago the writer sent drawings of these objects to several competent paleontologists with a request for their interpretation of them. Replies but no answers were received and as the lapse of time has brought no light, more general attention is invited to them in this formal way. Someone somewhere may have the correct solution.

These fossils have been found in the Chemung formation at Olean and at Hinsdale, Cattaraugus county, and at Bolivar, Allegany county.



Rosette-shaped worm burrows. Chemung Group, Hinsdale, N. Y.

METHOD OF RESTORING THE COHOES MASTODON

BY NOAH T. CLARKE

The task of reconstructing the Cohoes mastodon in life form and on a scientific basis was, from the start, an adventure which entailed all the emotions that might be expected in the exploration of a new field.

This seemed an opportunity to create something of real scientific value and general interest, something which had never before been attempted and, if a success, well worth the arduous labor it would require. Could it be done successfully or should this museum try it or had we better stand aside and let someone else risk failure. After serious consideration it seemed that the opportunity was too favorable not to make the attempt; with the assurance of every available aid; for what was not actually known about a few points in the structure of the American mastodon, could not be intelligently criticized and our best guess would have to serve and satisfy till the contrary was proved.

The first procedure was to consult Mr Carl E. Akeley of the American Museum of Natural History in New York, whose work as a big game sculptor-taxidermist is beyond comparison. This institution owes a great deal of the success of the restoration to his interest and advice, for what he could not tell us about the makeup of the recent elephant would not matter.

Before starting in on the actual work, many photographs and sketches of living elephants were made at the Bronx zoo and visiting circuses. These gave opportunity for study and a foundation on which to work.

Armed with this material operations were started on a model about one-third actual size on which errors could be made and corrected before the full-sized beast was commenced. A lantern slide of the mastodon skeleton was projected to one-third natural size and an outline traced on which all measurements of the skeleton were placed. A framework was built accordingly and covered with galvanized wire netting on which to model. This was carefully done by comparing the mastodon skeleton with that of the elephant and in proportion to the size of the bones of the mastodon with those of the elephant, the manikin of the sketch model gradually took form. This model was made in plaster and when we were satisfied that it was correct and conformed in proper relation to the mounted skeleton, an enlarging apparatus was devised by which measurements taken on the small model could be transferred and enlarged to full size. The framework for the large beast was plotted out by means of this enlarging apparatus and each piece was patterned on paper for the carpenter to follow. On the completion of this large frame, galvanized wire screen of one-half inch mesh was used over the frame, as a foundation for the plaster work on which to transfer points taken from the sketch. After locating and fixing some thousands of points by means of nails driven in the plaster work, it was only necessary to build up to the heads of each nail and we thus had a roughly blocked out full sized plaster model.

It now became necessary to make a thin shell over the outside of this form which could be removed in sections and taken down to the exhibition hall and reassembled. The first step in this was to lay out certain areas all over the large manikin, which when entirely covered made twenty-seven separate pieces to be made of a thin, strong, light and durable combination of materials. Each area was covered with paper to prevent the material used from adhering to the manikin, then fine steel wire screen (about the mesh of fly screen) was fitted over one of these areas and was made to take the exact contour of the modeling by stretching and rubbing the screen with a blunt steel tool especially made for this purpose. Here and there, in order to keep the screen snugly in position, a wire brad was driven in place just far enough to hold and then turned over so as to be removed easily when required. "Akeley's mixture," which consists of felt paper pulp, whiting, glue and boiled linseed oil was then rubbed into and through this layer of wire screen. This hardened in 24 hours and the brads could be removed without danger of it loosening the form. This process was repeated until three layers of wire screen and this mixture had been applied. With one section complete, the area next adjoining it was made in exactly the same way, without removing the first, and the process continued till the entire manikin was covered and a total of twenty-seven sections or pieces about three-eighths of an inch thick had been made. When removed, the inner side of these pieces was sized and then reinforced with wooden ribs accurately cut from cardboard patterns which had been scribed to conform exactly with the contour of the manikin at the particular point

Method used in the modeling of the Cohoes Mastodon. The first model was a miniature of which the second model is an enlargement by mathematical measurement.

following p

This picture shows the procedure in building the internal form of the final model and the covering of steel net and plaster upon which the ultimate restoration was based.

at which a rib was required to be placed. These ribs were of seven-eighth inch material and 4 inches wide.

While the greater part of the work had now been accomplished it now remained to reassemble the beast and then cover with "hair." Sisal was chosen as the material which most nearly resembled mastodon hair and after dying it a black and several shades of brown it made a surprisingly close imitation of such hair by mixing and combing through a hetchel.

The process of attaching the hair was accomplished by the following method. Strips of cardboard were cut about 2 feet long and 2 inches wide and on one of these strips a layer of sisal was laid at right angles evenly along the length with a couple of inches of it extending over the upper edge and the remainder hanging free over the lower edge of the cardboard. On top of the first strip was fastened another strip by means of wire clips and this held the sisal in place to be easily handled and attached to the beast. With a great many of these made up in this way it was necessary to start at the bottom and work up as one does in shingling a roof. A row was tacked on and where the sisal came in contact with the body, a little of the same Akeley mixture was rubbed through it until it was evident that it would be perfectly secure when dry. Each row above was lapped over the preceding one, carefully blended and combed together, leaving no trace of striation after the cardboards were removed. In places where the skin was almost naked great pains were necessarily exercised to fade the hair out evenly and it practically meant, in such cases, punching a hole with one hand while the other inserted a hair.

All exposed skin areas were modeled in detail with the same mixture over the shell of the body. The tusks, trunk, ears and feet were made separately in this way and then fastened to the main body.

THE BOX-VEIN OF LYONSDALE, LEWIS COUNTY, N. Y.

BY NELSON C. DALE

Introduction

Grateful acknowledgements are due Dr John M. Clarke, Director of the New York State Museum, for the opportunity of investigating this most interesting vein occurrence, also to Dr. C. H. Smyth of Princeton University for his very helpful suggestions and to Messrs G. M. Coram and G. M. Hayes of Utica, N. Y., for their loan of some excellent specimens which have helped to illustrate this report.

Location

About a mile from the mouth of Fall brook, a tributary of the Black river in the township of Lyonsdale, N. Y., is an interesting spot known to the inhabitants of that vicinity as the "old silver mine." As no evidence of the former silver mining can be seen besides what is left of the foundations of the old smelter and some effects of water control and not a trace of the customary mine dump, it is generally concluded that through floodings and the effects of river erosion most of the records of this activity which was concluded in the eighties have been swept away or concealed.

Our interest at present is centered about the peculiar vein fillings uncovered on the north bank of the stream for about 40 feet by the owners of the property, who have been interested in the occurrence of the box structure and of chalcopyrite. The former term, refers to the many and varied hollow pseudocrystal forms of crystalline quartz, an unusual sort of cellular breccia structure.

General Description of the Vein

The vein in which these peculiar forms, known by the collectors as "boxes," occur is characterized by a remarkable platy and cellular development, the plates or bands of which consist of crystalline quartz and brownish pink manganiferous calcite. There are parts of the vein where carbonate and quartz bands alternate with each other, typical of the banded structures; other parts where comb structures of crystalline quartz are found combined with banded zones and still others in which there is a noticeable cellular structure, but generally these features are found in close association with each other The most noticeable features of the vein however are the noncontinuity of the banded parallel structures for any considerable distance and the box devolpment of the cellular structure.

General Geology of the Area

This locality marks a point along the contact of the syenite and the syenite-Grenville mixed gneisses, all of Precambrian age as can be seen by a study of the associated rocks of the vein; for we find that the country rock of the vein is the Grenville limestone, or what was once a limestone but now converted into various colored fine and coarse-grained marbles through the contact metamorphic action of the nearby syenites.

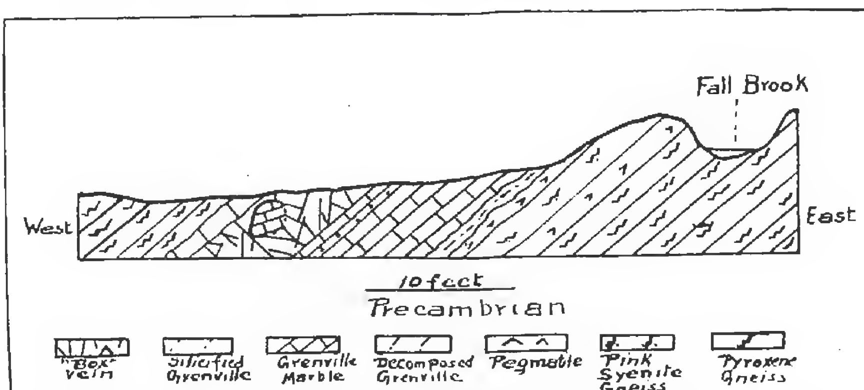


Fig. 1 Cross section through the "box-"vein and associated rocks, Lyonsdale, N. Y.

The box vein follows the strike and dip of the major foliation plane of the associated rocks which is for the former N 20° E and for the latter 40° W.

Owing to the small amount of excavation in the search for boxes and chalcopyrite, only 40 feet of the vein are in sight along the strike and the width is about 11 feet. As fragments of the vein have been noticed on the south side of Fall brook it doubtless follows along the strike and could be found there by further excavation.

The rocks on the footwall of the vein consist largely of pink granitic syenite gneisses and greenish pyroxene gneisses with syenitic pegmatitic intrusions following the gneissic structures very closely. Of the origin of these rocks there can be little doubt, as we find so much of texture and mineral composition that is typical of igneous nature in them. In the pyroxene gneisses and pegmatites are found the following minerals; anorthoclase, orthoclase, pyroxene (green), phlogopite, hornblende and titanite, while in the granitic syenites orthclase, quartz and hornblende are found.

Generally in the Adirondack area the relationship of the syenite to the Grenville is an intrusive one, as C. H. Smyth (1)* and other Adirondack workers have so clearly shown. Though the contact between the syenite series and the Grenville marble is somewhat obscure, due to the occurrence of a bed of residual material or decomposed Grenville between the two, it is believed that this contact is intrusive because of the exomorphic effects observed in the marble, such as the occurrence of scapolite and the coarse crystallinity.

The occurrence of the Grenville marble at this point is difficult to account for unless it is an inclusion incorporated by the intruding syenite magmas. According to W. J. Miller (2); "It has already been stated that the syenite is intrusive into and younger than the Grenville and that the Grenville areas must be regarded as large inclusions. A study of the syenite-Grenville mixed gneisses furnishes convincing evidence of the same kind. Actual inclusions of undoubted Greenville may occasionally be seen in the vicinity of Lyons Falls; one-half of a mile north and 8 miles east of Port Leyden; one and one-half miles above the mouth of Fall brook, etc."

If this is true with respect to this occurrence, namely that it has been torn from some parent mass and later found lodgment in a magma which has long since been hardened and subjected to tremendous mountain-making disturbances, it would be reasonable to ascribe the fissuring of this rock to those movements. But such a fissuring would in all probability be filled with mineral matter more characteristic of the deeper seated rocks and minerals such as is found in pegmatites of which we find no trace in this vein. As a matter of fact the only direct evidence of any of the former constituents of this vein consists in the occurrence of some secondary minerals, as kaolin, vermiculite and calcite, the undoubted derivatives of the Grenville marble and its accessory minerals, such as are found in the hanging and footwall rocks. In these rocks we find very abundant phlogopite and some scapolite as well as their alteration products. Water-worn fragments of Grenville bear witness, in part, to the former composition of the

* Note. Figures refer to notes in Bibliography at end of this paper.

Plate 1

"Box"-vein with hammer head resting on coarse reddish pink ferruginous marble of the Grenville foot wall.

following p. 136

vein before the main infilling. It is maintained in this paper that the original plates or bands consisted of the Grenville marble or as Doctor Clarke (3) has observed of the "thin calcareous lining of the fissure which by shearing or other stresses were scaled off as a veneer" and replaced and cemented by manganiferous calcite and quartz carrying several other minerals, as will be seen later on, all forming a most unusual sort of cellular breccia.

It is not known whether or not the original break in the marble and its subsequent filling were separated in point of time but if they were approximately contemporaneous, and they might very well be, then these events were produced at a time when these ancient metamorphic rocks were subjected to great mountain-making movements and long periods of denudation. These resulted in the change of position of the rocks from the deeper zone of flowage to the higher and more surficial zone of katamorphism where fractures and their cementation by the products of silicification and carbonization are among the most important characteristics.

As further evidence of the high vertical position of this vein in the earth's crust what is believed to be a horse of Grenville marble occurs at the north end of the vein and is very much fluted by the action of ground water where the line of demarkation between the vein and horse is a crescentic or cuspidal curve. The position of the horse and its relation to the vein would show that either through the action of ground water or the stresses which produced the fracture and breccia this block may have become worn off from the wall rock or broken off and fell into the fissure, later to become incorporated within the cementing breccia.

Structure of the Vein and Its Contents

Some of the characteristic structural features of the vein have already been referred to and the same illustrated as in plates 1, 2 and 3. To understand more thoroughly the structure of the vein it will be necessary to study the vein and footwall section as given below:

e......	Breccia or box vein..................	11.	feet
d......	Coarse reddish pink marble..........	.5	feet
c......	Silicified Grenville marble.............	.8	feet
b......	Pink marble with calcite..............	.85	feet
a_3......	Gray Marble with mica..............	3	feet
a_2......	White and pink marble..............	4	feet
a_1......	Gray marble		feet
a_{1a}......	Decomposed and disintegrated marble	1.3	feet

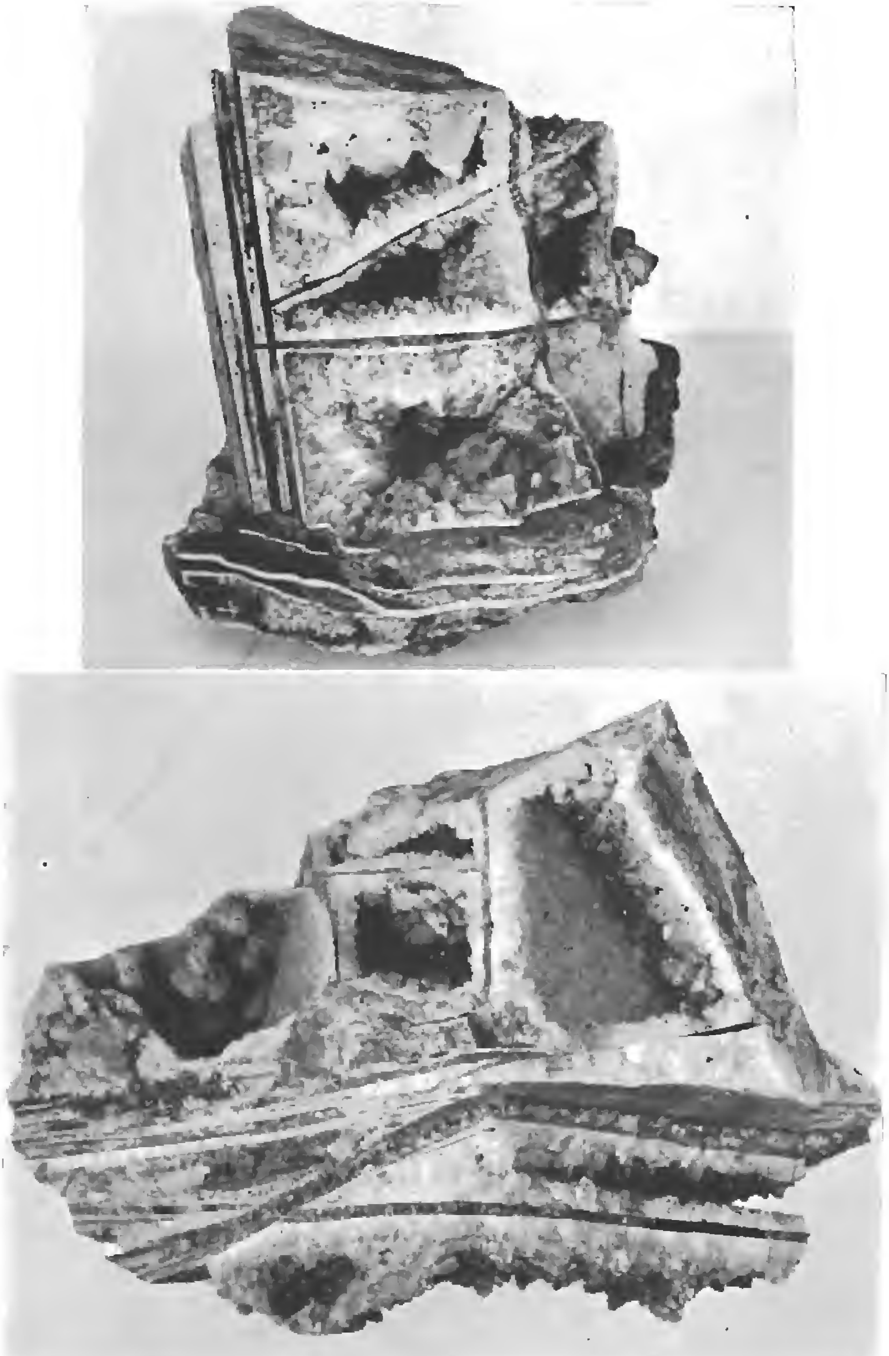
Syenite and Pegmatite

The most interesting parts of this section so far as the structure and origin of the vein and its contents are concerned are those lettered *d* and *e*, a combined specimen of which is shown in plate 1. This specimen shows the cellular and platy structure of the vein, the darker plates consisting of a pinkish brown manganiferous calcite, and the lighter of crystalline quartz alternating with the darker bands and lining the cavities of the cells; but in the combined specimen the clear line of contract of the vein and footwall rock can be seen as well as the angular relationship of plates with the footwall. The microscopic study of the thin section taken from this contract shows that, instead of there being an almost knifelike line of demarkation between the vein and the footwall, there is an interfingering of manganiferous calcite plates with those of quartz, the former, where there is an angular relationship with the footwall, appears to be continuous with it but projecting inward with dovetailed or interfingered plates of crystalline quartz projecting outward toward the footwall. We are led to believe from this observation that the fractures filled now with the darker or carbonate material were filled by solutions flowing in part along the walls of the fissure and that the quartz filled fissures were afterwards filled by silica-bearing solutions coming or flowing from the inner parts of the vein. Positive evidence that the quartz is of later age than the carbonate is seen in many of the specimens where the quartz plates are found cutting and intersecting the carbonate bands at every conceivable angle and developing the box form which will be considered later on in this paper.

Though the carbonate bands have apparently close connection with the wall rock indicated above, it is found that the wall rock *d* of the section given above is of a ferruginous nature, the reddish pink coloration being due to hematite rather than manganese as is found to be the case with the carbonate plates. As the manganiferous calcite is more stable than carbonates containing iron, when they are found in the same solution, the ferrous carbonate is deposited first and the manganese may be carried in solution much farther from the original source (Phillips, 4). It would seem therefore that the manganiferous plates could be a part of a ferruginous wall rock of calcite.

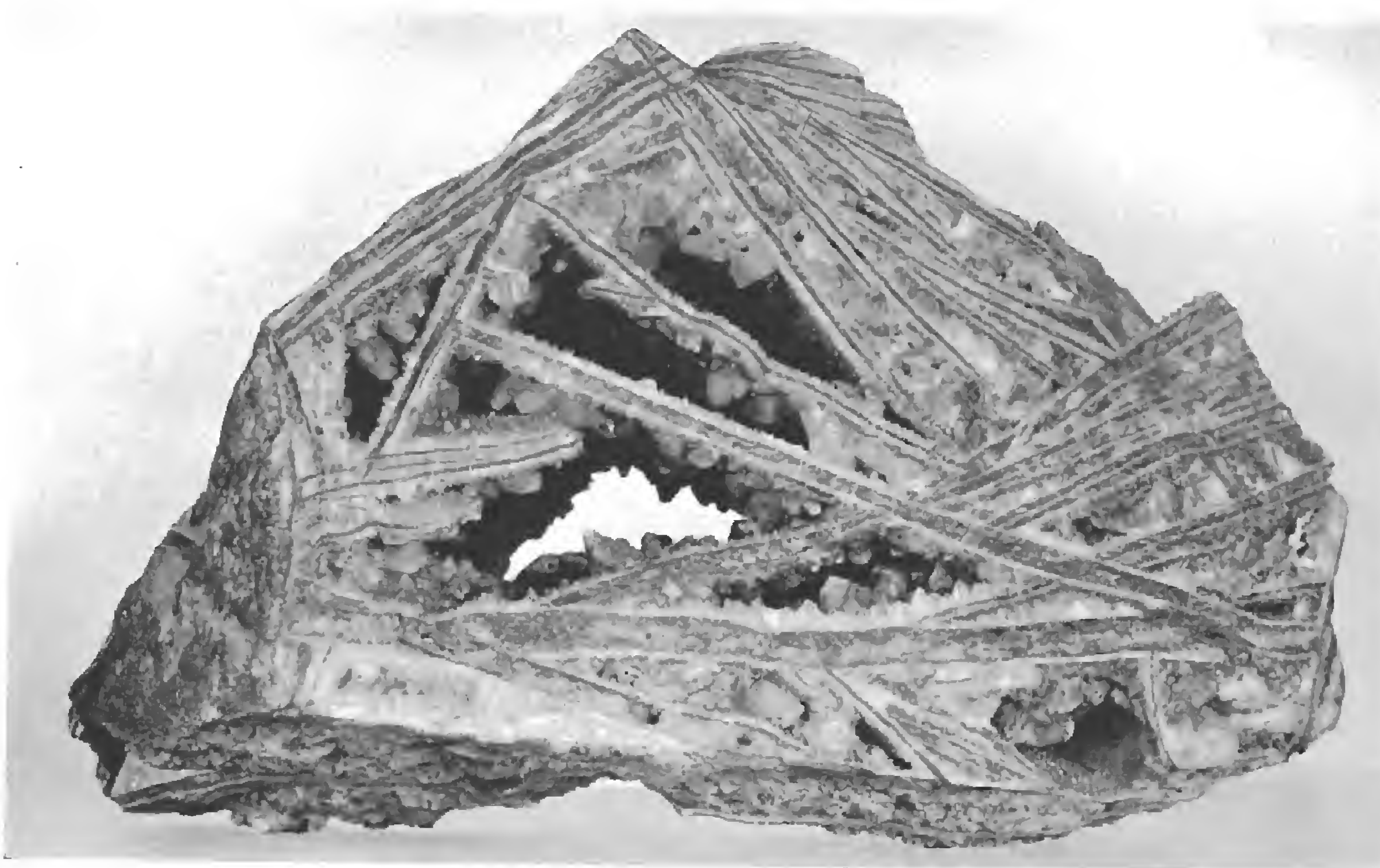
Whether, on the one hand the fragments broken or sheared off from the Grenville marble were originally like the footwall or the fine-grained marble of the hanging wall and replaced by

Plate 2.



Specimens from the "box"-vein showing the collapsed walls and the quartz-lined cavities.

Plate 3



A view of section of the vein showing the collapsed vein linings and the partial filling of the resultant angular cavities.

following p. 13[illegible]

solutions containing manganiferous carbonate and later by quartz, or on the other hand the carbonate band was a primary constituent of the original breccia and later replaced and cut by the quartz it is difficult to state positively. Anyway we have definite evidence in the banded and comb structures that the silica was introduced at a later time than the manganiferous carbonate. As we have seen, some residual products of the original Grenville, such as kaolin and vermiculite, have been found in some of the boxes which fact indicates clearly that a part of the original constituents of the vein must have consisted of fragments of Grenville marble and it is highly probable that the platy structures represent the sheared off calcareous lining of the main fracture or even the fine-grained Grenville itself which was later replaced by manganiferous calcite and quartz.

The dark bands or plates of manganiferous calcite have no developed crystals but occur as thin aggregations of carbonate grains which show perfect rhombohedral cleavage and —½ R twinning. Having a hardness less than rhodochrosite but greater than calcite and responding quickly to the acid test this mineral is tentatively classed as a manganiferous calcite.

These bands vary in thickness from one-fortieth to three-eighths of an inch, of variable length and have every possible angular relationship with each other. Though many bands are found cutting one another, it is believed that the mineral is all of the same generation. Dendritic markings of the dioxide, pyrolusite, are frequently found in the quartz plates to which the carbonate bands adhere.

Interbanded with the manganiferous calcite in the banded structures, or lining the comb structures or the boxes of the cellular structures, is found a crystalline quartz with singly terminated pyramidons within the comb and cellular structures. The fringing character of the quartz on the carbonate plates, the intersecting of the carbonate plates and inclusions of the carbonate in the quartz, all substantiate the conclusion that the quartz was of a later age than the carbonate. As a matter of fact these two minerals, the manganiferous calcite and quartz, may very well have formed so close together in point of time as to have been practically simultaneous. Otherwise there is difficulty in accounting for the formation of the box structure and its mineral contents. Many of the boxes are closed forms as must have been the original carbonate which filled the intersecting fractures which are considered responsible for these forms. If there had been a great separation in point of time between the formation of the carbonate and the quartz, the boxes would show the effect of another movement in the form of fractures. The most noticeable characteristic of the quartz is the faithfulness with which it conforms to the carbonate whether in band, comb or box structure and this would not have been the case had there been a definite secondary set of fractures allowing the silica-bearing solutions to deposit their load at a different time.

Many of the quartz plates or bands show a comb structure, as though the quartz had formed in an open space which is the case with the larger and more typical comb structures and boxes. It is difficult to account for the banded structures in the same way that Ransom (5) does with the banded veins of the Silverton district of Colorado; that is by successive openings and fillings because there is no evidence of the movement responsible for such a reopening and if there was, there would have to be a certain uniformity throughout the deposit, evidence for which is strikingly absent. This much is certain, however, the original breccia fragments of the Grenville marble show evidence of having been replaced by these later minerals, as will be seen when the contents of the vein are discussed.

Origin of the Box Structure

The so called boxes, as can be seen from plate 4, resemble some crystal form, though lacking certain very necessary crystal requirements. The plates of granular crystalline quartz terminate in well developed pyramidons projecting inward, after the manner of geodes, while the exterior surface of the plates is covered with minute crystals or moulds of the same mineral with the *c* axes parallel with the plane of the plate, resembling drusy quartz. Associated with the interior quartz crystals are the following crystallized primary minerals: calcite, chalcopyrite and sphalerite, accompanied by the secondary products limonite, malachite, kaolin and vermiculite. Asphalt is also found intimately associated with the quartz.

Some of the more typical boxes are shown in plate 4. In shape they are extremely varied as they are in size, though in the former respect the number of faces or plates and the interplate angle determine the shape. With the material at hand, forms with as few as seven faces and others with as many as

Plate 4

A series of the "boxes" or cavity fillings from Lyonsdale.

sixteen have been observed, while it ought to be possible to find interfacial angles with nearly every value between 1° and 179°, though, as a matter of fact angles of 20° 30′ and 170° show the extremes that have been found.

For purposes of study and collection it has been found that these boxes are most readily separated from the vein where the work of ground water solution has been most active, causing the loss of the carbonate filler, thereby leaving the hollow quartz form easily removable.

Because of the polyhedral shape of these boxes, it has been supposed that they are pseudomorphs but after measuring and assembling all the interfacial angles of some twenty-two typical examples it was found aside from the facts that they had as few faces as seven and as many as sixteen and a great variety of interfacial angles, there was no constancy of interfacial angle. Some of the results, as found by the goniometrical measurements of the interfacial angles, are as follows:

Interfacial Angle	No. of Recurrences
90° 30′	8
124°	5
79° 30′	
87° 30′	
118° 30′	4
128° 30′	
138° 30′	
22 interfacial angles from 48° 30′ to 151° 30′	3
33 " 37° to 152°	2
56 " 20° 30′ to 170°	1

Furthermore these boxes appear to lack any degree of symmetry except where intersecting plates have made right angles, simulating isometric, tetragonal or orthorhombic crystals.

It would seem, therefore, from a study of these results that the boxes could hardly be pseudomorphous after some former mineral but must be due the cellular structure formed by quartz-filled fractures and their many and varied angular intersections.

Evidence and Kind of Movement

In the vein there are apparent three quite distinct structures which show evidence of at least two sorts of movement. In one of these the plates or bands of carbonate and quartz observe a general parallelism throughout a zone of less than a foot vertically, just above the footwall, as can be seen near the center right of plate 1. Furthermore the plates are parallel with the major divisional planes of underlying marble. But this parallelism of the plates with the underlying structures or within the vein itself can only be found occupying a few square feet. Such a structure would seem to indicate for a portion of the vein, if not for the entire vein, a shearing frictional movement between the walls of the original Grenville — presumably a fine-grained marble which was not unlike that of the hanging wall. This sort of movement might very well have taken place generally and at first throughout the fracture zone producing a general parallelism of the plates of which this particular spot is all that remains. Farther down the dip, by a few feet, may be seen a small anticline of banded or platy structure, as though a compressional movement was also in part responsible for a part of the structure but followed that of the shear. The most conspicuous feature of the vein in this regard is the utter lack of parallelism of plates for any considerable distance either vertically or horizontally and the dominance of the platy breccia and the cellular structure, as though, after the plates had been sheared, they became separated from the parent rock and fell in a hit or miss fashion into the break where the original fragments and plates of carbonate (marble) eventually became replaced in part by the dark carbonate and quartz, forming the breccia cement. This irregularity in the arrangement of the plates might have been produced by a crushing following the suspension of the shear; but whatever movements were responsible for this mass of intersecting plates, the result has been to make the fracture and its contents a favorable place for the deposition of mineral matter.

Mineralogy of the Box Vein

The minerals thus far observed in this vein are quartz, manganiferous calcite, pyrolusite (dendrites), chalcopyrite with its alteration products malachite and limonite, sphalerite, smithsonite, kaolin, vermiculite and asphaltum. Galena has been reported to have been found. Most of these occur either in the boxes or directly associated with other structures.

Quartz. This is perhaps the most abundant mineral of the deposit and is usually found in aggregates of well-crystallized singly terminated forms lining the boxes or comb structures.

The exterior walls of these structures where adjacent to the carbonate bands, consist of a granular crystalline aggregate representing the truncated crystals which project inward to form the interior lining of the box or comb structures. But scattered through or above these grains, are small crystals whose *c* axes lie in the plane of these structures presenting a drusy appearance. On some of the plates, especially those that are a part of the banded structures, there is the drusy habit. As this mineral is not unusual in its physical characteristics nothing further need be said about it other than the fact that it rarely contains spherical inclusions of some black substance, presumably of an asphaltic nature.

Manganiferous calcite. Special emphasis has been given to this mineral because of the nature of its occurrence and its relative age. As can be seen from a study of the deposit and the specimens it is almost if not quite as abundant as the quartz and in its occurrence observes a remarkable parallelism whether in the banded, comb or box structures. It is of a pinkish or brownish pink color, of medium grain and crystalline but without well-developed crystals. Good cleavage is seen in the banded structures. Its ready response to cold hydrochloric acid makes it a variety of calcite rather of rhodochrosite.

So far as its paragenesis is concerned, we find it of earlier age than the quartz, the latter cutting and including it repeatedly. This mineral is the first cementing and replacing one of which there is definite record.

Calcite. In less abundance than the two foregoing minerals, calcite is found as crystalline aggregates of either anhedral or euhedral forms, associated with the quartz linings of the cellular structures. The crystals show normal rhombohedra $(10\bar{1}u)$, scalenohedra $(21\bar{3}1)$ or modifications of both. In some of the boxes and other cellular structures there is a banding of minerals inward from the quartz shell in which the following arrangement is observed: quartz, pink carbonate or manganiferous calcite and calcite. Calcite seems to have been of later age than the quartz and the manganiferous calcite. Incrusting some of the quartz crystals, is a coating of amorphous lime carbonate, not unlike calcareous tufa in habit, a deposit from lime-charged waters.

Chalcopyrite. This mineral is found as isolated sphenoids or as penetration twins. The sphenoids are rarely and exceptionally large; one of them measures seven-eighths of an inch from the apex to the center of the face or half an inch along a crystallographic axis. Most of the crystals of chalcopyrite are between one-sixteenth and one-eighth of an inch in diameter and are usually found in the cellular structures associated with calcite and quartz. It has also been found in veins, where it appears to have a later age than the quartz because of its position as an interstitial ingredient between the box components of the breccia. In other words as a vein, chalcopyrite appears to have followed or conformed to the quartz plates. In the main part of the vein the walls are of crystalline quartz which would be evidence of an earlier age for the quartz. As only one specimen of the vein has been found little can be said about its relationship.

Disseminated grains and crystals of chalcopyrite are occasionally seen in the silicified Grenville marble of the footwall series (*c*) where it is associated mainly with quartz and calcite. In this occurrence the quartz apparently would be its carrier.

More recent changes brought about by oxidation and carbonization have altered the chalcopyrite to limonite and malachite; in fact pseudomorphs of the limonite after chalcopyrite are quite common.

Sphalerite. This mineral is neither as well crystallized nor as abundant as the others described above. It is usually honey yellow in color, of resinous luster and poorly crystallized but having the same associations as chalcopyrite. In one specimen could be seen what was left of a small crystal of sphalerite, very much corroded and about it a zone of amorphous light colored smithsonite incrusting calcite crystals. The effect of carbonic acid bearing waters upon the suphide was doubtless responsible for the corrosion and the formation of the carbonate as well.

Pyrolusite. Dendritic pyrolusite frequently occurs in the banded structures and on the quartz plates where it is found as a result of oxidation of the carbonate which is usually found adhering to the quartz as described above.

Kaolin. In some of the cellular structures, particularly the boxes, is found a claylike substance, of greenish gray color for the most part, but occasionally dark or black, associated with a light colored micaceous mineral of pearly luster and angular grains of quartz. The claylike substance is essentially a kaolin, a residual product of the original contents of the breccia in all probability.

Vermiculite. Associated with the clay or kaolin is one of the altered micas, presumably vermiculite, a mineral of yellowish gray color and pearly luster and exhibiting strong exfoliating characteristics. This mineral might very well have been derived from phlogopite or scapolite so common in the country rock and in all likelihood a constituent of the original brecciated zone.

Asphalt. The most unusual mineral association occurring in this vein is that of asphalt which is found as brilliant jet black substance coating some of the other mineral contents of the boxes, particularly quartz. It hardly occurs in sufficient quantities for chemical examination but sufficient for blow-pipe tests when it showed a cokelike substance after fusing. Which variety of asphalt this is can only be determined after a thorough chemical examination upon more material but what preliminary solubility tests were made would place it either as albertite or gramhite.

It is also found as spherical inclusions in the quartz and sometimes coating lumps of kaolin or clay within the other cellular structures. Whether it found its way down into the brecciated zone from the once overlying Ordovician calcareous formations through the agency of circulating silica-bearing waters or from more distant sources can not be answered at this time. The well known similar occurrence in the quartz crystals in the dolomite at Little Falls and Middleville described by the late Professor Cushing (7) may have some bearing on this problem.

Manner of Formation of the Mineral Contents of the Boxes

The filling of the banded and comb structures as well as the fracture planes forming the sides of the boxes can be accounted for by mineral-depositing solutions causing the formation of manganiferous calcite and quartz either as alternating bands or quartz filling for the comb and box structures, but the filling of the boxes is not so obvious. We find in some of these structures that there is a regular sequence of minerals beginning with the quartz followed by pink calcite and then by crystalline calcite with occasionally sphenoids of chalcopyrite. On other walls, only inward pointing quartz crystals are found with occasional crystals of calcite on the quartz. We have evidence that some of the mineral contents of these structures are the residual products of the originally fractured or sheared limestone and their presence in the boxes can be accounted for by the solution of the Grenville by carbonic acid. Can the same be said for the other minerals such as calcite, chalcopyrite, etc. or were they admitted through the walls of the cellular structures by fissures after the manner of geodes as described by van Tuyl (8) as solutions depositing their mineral content in the above order? In the lack of evidence for this latter method for the formation of these minerals it seems very likely that they were due in part to recrystallization from solution of the original Grenville as well as to crystallization from solutions introduced with the silica-bearing waters when the walls and brecciated fragments were being replaced. As a breccia is the most favorable place for the circulation of mineral-bearing waters, it would not be unreasonable to suppose that this was the method of vein filling.

Effect of Vein Filling upon the Wall Rocks

Underlying the coarse reddish pink marble or *d* of footwall section is a bed *c* of silicified Grenville. The hand specimen shows the constituents to be quartz, pink and colorless calcite, phlogopite, irregular and circular areas of light and dark green kaolin and occasional sphenoidal crystals and irregular grains of chalcopyrite. Under the microscope, the calcite and phlogopite prove to be much older than the quartz and to have been replaced by the latter. The irregular or circular areas of dark and light green substances appear to consist of alteration products of phlogopite such as kaolin, talc (?), vermiculite and limonite. As scapolite is quite a common constituent of the marble it is quite possible that some of these may be due to its alteration.

This rock has in all probability been transformed into its present condition from one very much like the Grenville marble through the permeation of silica-bearing solutions. This silification decreases in its effect toward the over and underlying strata of the footwall section, as shown by the increasing dominance of calcite over quartz in the vicinity of both.

The presence of drusy quartz veins and replacement phenomena in the pyroxene gneisses and hornblende pegmatites of the hanging wall series would indicate not only a later origin for the quartz but also that it doubtless was a part of the same event which effected not only the footwall member but also an after effect or concomitant event with the main silification of the vein breccia.

Source of Vein Filling

It might be supposed that because of the proximity of this vein to the nearby syenites, gneisses and their pegmatities that the source of the main constituent of this vein could be assigned to igneous action but in as much as silica-bearing solutions, which were in large part responsible for the vein filling as well as for the silicification of the gneisses and pegmatites on the hanging wall side, seem to be of a later date a different source will necessarily have to be found.

The shallow position of the vein in the earth's crust, the nature of the fracture as well as its structural and mineral contents all bespeak influences at work in the belts of cementation and weathering where solutions were in active circulation. Under these conditions, a well-known source for silica is the decomposition of the silicates of the nearby rocks by carbonic acid, where not only quartz but carbonates are produced simultaneously (Van Hise), 9). With such conditions, solution silicification, cementation, replacement, carbonization, oxidation and hydration would be effective for producing the essential minerals of the vein.

Age of Vein

As has been shown in the foregoing paragraphs both the fracture and its contents are evidently of shallow origin and the age of the break is certainly post-Archaeozoic. The most important mountain-making disturbances which have in all likelihood effected the Adirondack region or province were those which occurred at the close of the Paleozoic and the Mesozoic, at least these two orogenic periods were of the fault-making types according to Cushing (7) and Miller (2b), but the former known as the Appalachian revolution was responsible for the major faulting of the region (2b). If the break occurred during the Appalachian revolution the once overlying Paleozoic would in all probability have been involved, but not so if the post-Cretacic disturbance or elevation were responsible for it because by that time all or most of the Paleozoic cover would have been eroded.

Just how soon after the fissuring of this rock the infilling took place we have no definite knowledge. Possibly a clue to the age of this infilling might be obtained were we to know when such minerals as sphalerite, galena and chalcopyrite were introduced in their several deposits as found in the foothills of the Adirondacks and in the region south of the Mohawk. At Martinsburg, galena is found in the Trenton limestones in calcite veins, at Rossie and to the south galena, associated with sphalerite and chalcopyrite, occur in a calcite gangue in a country rock of injected gneiss and probably limestone; in the Beekmantown Limestone at Manheim sphalerite has been mined, in the Niagara formation of Clinton, sphalerite and chalcopyrite are found in calcitic geodes and again to the south at Shawangunk, sphalerite associated with galena and chalcopyrite in a gangue of quartz and a country rock of grit (Shawangunk). The fracturing and brecciation at the Shawangunk deposit is doubtless a product of the Appalachian revolution according to Newland (10) but as to whether the origin is due to aqueous or igneous agencies no definite conclusion has been reached.

The freshness of the solution marks seen on the horse and its cuspidal contact line with the vein show positively that the filling took place in a region of active ground water circulation but whether it was a product of pre-Mesozoic or of post-Mesozoic times would be difficult to state in the present state of our knowledge concerning the subject. In other words it seems very likely that the filling of the vein took place either at the close of the Paleozoic or Mesozoic, the two great periods of mountain-making disturbances and when the possibilities of mineral deposition were greater than at other times.

Bibliography

1 **Smyth, C. H.** Crystalline Rocks of the Western Adirondack Region. 51st Ann. Rep't, N. Y. State Mus. 2:476

2 (a) **Miller, W. J.** Geology of the Port Leyden Quadrangle, Lewis Co., N. Y. N. Y. State Mus. Bul. 135, p. 18

(b) ——— The Geological History of New York State. N. Y. State Mus. Bul. 168, p. 73 and 74

3 **Clarke, J. M.** Written communication

4 **Phillips, A. H.** Mineralogy. p. 391

5 **Ransome, F. L.** Economic Geology of the Silverton Quadrangle, Col. U. S. Geol. Surv. Bul. 182, p. 69

6 **Dana, J. D.** The System of Mineralogy. 1914

7 **Cushing, H. P.** Geology of the Little Falls Quadrangle. N. Y. State Mus. Bul. 95, p. 405

8 **Van Tuyl, F. M.** Geodes of the Keokuk Beds. Am. Jour. Sci. 4th series, v. XLIII, 1916, p. 40

9 **Van Hise, C. R.** A Treatise of Metamorphism. U. S. Geol. Surv. Mon. XLVII p. 64–67

10 **Newland, David H.** The Mineral Resources of New York. N. Y. State Mus. Bul. 223 and 224, p. 304–97

THE STRATIGRAPHY OF THE CHEMUNG GROUP IN WESTERN NEW YORK

BY GEORGE H. CHADWICK

Two summers have been spent in field work on the upper Devonian of western New York, one (1918) for the Dominion Natural Gas Co., by whose liberality full publication is permitted, the other (1922) for the Museum, together with intervening sorties at the writer's own charge. The results are here briefly summarized. The field is a large one and much remains to be done. The most puzzling questions yet outstanding exist chiefly because of either lack of topographic maps or difficulty in finding outcrops, both of which time will remedy. The problem is everywhere primarily one of geometry, which no amount of paleontologic acumen can overcome, since the fauna varies deceptively with the sediments.

The highest Portage member on Lake Erie is the Hanover (formerly Silver Creek) shale,[1] which has been traced continuously[2] into the Wiscoy shale[3] of the Genesee valley. The Chemung group commences with the *Dunkirk black shale.*[4] This extends from Van Buren Point, on Lake Erie, by way of Walnut creek ravine,[4] Versailles, North Collins,[4] Boston, Colden and Pipe creek glen,[5] with constantly augmenting thickness, to Holland,[6] where it is over 160 feet thick. Two characteristic (and unlike) septarium zones divide it into three members, throughout this distance, the upper of which three divisions was included by Luther[7] in his overlying Portland shales. Beyond Holland, past Hunter's creek to the Java Village ravine,[2] and above Varysburg,[8] sandstone layers increase rapidly in number and thickness in the black shale. In the Genesee valley, on Wiscoy creek[10] and elsewhere, these sandstones occupy much of the lower half of the Dunkirk and include the fossiliferous

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[1] N. Y. State Mus. Bul. 69, fig. 13, p. 1028. N. Y. State Mus. Hdbk. 19 (2d ed), p. 76

[2] Bul. Geol. Soc. Am. 30, p. 157.

[3] 16th Rep't N. Y. State Geol., p. 34. Handbk. 15, p. 93. N. Y. State Mus. Bul. 69, p. 1008. N. Y. State Mus. Bul. 128, p. 64.

[4] N. Y. State Mus. Bul. 69, p. 2025.

[5] N. Y. State Mus. Bul. 19, pl. LXXXII (name misspelled).

[6] 15th Rep't N. Y. State Geol., p. 321.

[7] N. Y. State Mus. Bul. 69, fig. 11, p. 1025; fig. 13, p. 1028.

[8] U. S. Geol. Surv. Bul. 41, p. 49–50. N. Y. State Mus. Hdbk. 15, p. 210–11. N. Y. State Mus. Bul. 69, p. 1017.

[9] N. Y. State Mus. Bul. 69, p. 1014. N. Y. State Mus. Bul. 172, p. 28–30 and map.

[10] N. Y. State Mus. Bul. 69, p. 1018. N. Y. State Mus. Bul. 118, p. 67–68.

layer termed Long Beards Riffs sandstone.[11] East of the Genesee, above Dalton and Swains, the increase in sand is so rapid that on Slader creek near Canaseraga only two thin courses of black shale remain in the lower part of 150 feet of heavy arenaceous beds with full Chemung fauna that we propose to call the *Canaseraga sandstone*. The massive character of the Canaseraga has led to its confusion[12] with the Nunda at some points to the east, under the name Highpoint.[13] It is believed that the Dunkirk-Canaseraga corresponds in horizon with the Dalmanella danbyi zone[14] at the base of the Cayuta shale in the Ithaca region.

Above the Dunkirk are the *Gowanda beds*[2] (Portland[15] preoccupied), extending from Barcelona (formerly Portland Harbor),[16] on Lake Erie, by the Walnut creek[17] and Big Indian ravines to Gowanda (formerly Lodi)[18] and through the Cattaraugus creek gorges.[19] The Gowanda makes the main mass of the hills of southern Erie[20] and Wyoming[21] counties, curving southward through Pike[22] and Higgins into the Genesee valley at Caneadea gorge.[23] The limited fauna of Portage type which the Gowanda beds carry on Lake Erie[24] and at Forestville[25] gradually acquires the brachiopod facies of the lower Chemung (Cayuta) shale which it has on Caneadea creek,[25] and these beds have been traced from this point through northern Allegany and Steuben counties, by way of Dalton, Bishopville, Bath,[26] Savona[27] and Bradford,[28] into the Cayuta[14] of

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[11] N. Y. State Mus. Bul. 69, p. 1009. N. Y. State Mus. Bul. 118, p. 68. N. Y. State Mus. Hdbk. 15, p. 94.

[12] N. Y. State Mus. Bul. 81, p. 16 (part). N. Y. State Mus. Bul. 101, p. 51 (part).

[13] Defined, N. Y. State Mus. Bul. 52, p. 623. N. Y. State Mus. Hdbk. 19 (1st ed).

[14] U. S. Geol. Surv. Folio 169, p. 10, fig. 6 (field ed. p. 39, 75).

[15] N. Y. State Mus. Bul. 69, fig. 13, p. 1028.

[16] Geol. of N. Y., 4th Dist. p. 494, pl. VIa. N. Y. State Mus. Bul. 69, 1028.

[17] N. Y. State Mus. Bul. 69, p. 1025-26. N. Y. State Mus. Hdbk 15, p. 107-8.

[18] Geol. of N. Y., 4th Dist., p. 258 and pl. XIII.

[19] Ibid. p. 380, 488, pl. XIII, section 2.

[20] Ibid. p. 473.

[21] Ibid. p. 467.

[22] 4th Ann. Rep't (1840), p. 402. N. Y. State Mus. Bul. 118, p. 67.

[23] 4th Ann. Rep't, p. 403-4. U. S. Geol. Surv. Bul. 41, p. 60-62, 77.

[24] Geol. of N. Y., 4th Dist., p. 246-47. 16th Rep't N. Y. State Geol., p. 29 seq. N. Y. State Mus. Mem. 6. N. Y. State Mus. Hdbk. 15, p. 108.

[25] N. Y. State Mus. Bul. 69, p. 1026 and preceding footnote.

[26] Geol. of N. Y., 4th Dist., p. 259. 6th Rep't N. Y. State Geol.: Hdbk. 15, p. 87.

[27] N. Y. State Mus. Bul. 101, p. 52.

[28] Ibid. p. 50.

the Watkins quadrangle at Kendall. The Gowanda everywhere directly overlies the Dunkirk or its Canaseraga equivalent. From a maximum of over 500 feet on the Cattaraugus creek around Gowanda, the formation thins to scarcely half this amount on Lake Erie, while black shales ("Huron")[29] come to predominate. In this area it contains several recognizable horizons[30] that have not yet been satisfactorily followed east of the Cattaraugus.

The *Laona sandstone*[31] succeeds the Gowanda beds. Rising from Lake Erie at Barcelona,[16] this passes west through Brocton[32] and south of Lamberton to Laona,[32] thence above Forestville[33] to Smith's Mills Station and eastward,[32] curving south into the Cattaraugus valley east of Perrysburg to near Dayton, where its continuity is lost under drift. In the Cattaraugus gorges its identity is still somewhat uncertain, but it reappears in Erie county, on the north, in the highest exposures on Rice's Hill west of Boston. A similar sandstone in apparently the same horizon has been quarried south of Arcade,[34] and northwest of Elton[36] with probable intervening exposures north[26] and south of Springville and northwest of Delavan. The Laona must occupy other hilltops in southern Erie[20] and Wyoming[21] counties and is likely to correspond to some one of the sandstones in the upper part of the Caneadea section,[23] and thus to beds near the base of the Wellsburg sandstone[37] south of Elmira. As the Laona is usually petroliferous[38] to some degree it is doubtless an important oil-sand underground.

For the beds between the Laona and Shumla sandstones[39] the name *Westfield shale* may be used. Lithologically indistinguishable from the Gowanda beds, they contain like those, at the west, a persistent Portage cephalopod element in their fauna,[39] yielding eastward wholly to Chemung brachiopods. The thickness increases from about 120 feet on Lake Erie to 160 feet at Laona and perhaps 200 feet near Perrysburg. East of the Cattaraugus these beds appear to maintain their identity as far as Elton,[35] beyond which it is gradually merged in the Wellsburg member.[37]

[29] Ohio G.S., 4th ser. Bul. 15, p. 514, 515.
[30] N. Y. State Mus. Bul. 69, p. 1025-26, fig. 13, p. 1028.
[31] 2d Ann. Rep't (1838), p. 46. 5th Ann. Rep't (1841), p. 177. N. Y. State Mus. Bul. 69, p. 1026.
[32] N. Y. S. Mus. Bul. 69, p. 1027.
[33] Ibid. p. 1026-27.
[34] U. S. Geol. Surv. Bul. 41, p. 52-55.
[35] 4th Ann. Rep't (1840), p. 412, 470.
[36] Ibid. p. 166. Geol. of N. Y., 4th Dist. p. 474.
[37] U. S. Geol. Surv. Folio 169, p. 10, fig. 6 (field ed. p. 39, 76).
[38] 5th Ann. Rep't (1841), p. 177-78. Geol. of N. Y., 4th Dist., p. 497-98.
[39] N. Y. State. Mus. Bul. 69, p. 1027.

The *Shumla sandstone*[39] is not clearly distinct from the overlying mass, of which it is the initial or basal member. It is, in fact, somewhat erratic and discontinuous[40] as a sandstone. This rock is known from Lake Erie near the state line[41] to west of Perrysburg, being seen at Westfield,[41] south of Brocton and Lamberton, at Shumla,[42] thence around the hill slope to above Forestville[39] and again around to northwest of Nashville, where it passes under drift except for a gutter outcrop west of Perrysburg. Its identity eastward is still in doubt; it may well be some of the higher sandstones in the Caneadea section,[23] comprised in the Wellsburg member.[37] The thickness of the Shumla on Chautauqua creek is taken at 22 feet but the limits are uncertain; on the Little Canadaway and at Shumla it is 40 feet and thence eastward maintains a good thickness to Perrysburg.

The Shumla initiates over 400 feet of beds in no wise different from the Gowanda and the Westfield as they enter the State. These the "Portage flags" of I. C. White,[43] here renamed the *Northeast shale*, from the township in Erie county, Pennsylvania. The Northeast beds are fully exposed in Chautauqua creek gulf,[44] with thickness of about 415 feet, and on the Canadaway[45] (Arkwright Falls) above Shumla. Here they are nearly barren[46] except for burrows, but eastward they assume a fossiliferous character with an easily recognized fauna best exhibited in the Pierce quarry west of Machias. The Machias fauna is already present in the road hill south of Persia turnout and at least as far west as south of Wango. It is fully developed in the railway cut at Cattaraugus. In all these localities it involves the Northeast beds from top downwards and the change is lithologic as well as faunal. Apparently the Northeast (Machias) embraces those beds which on the Genesee river intervene between the heavy sandstones of Caneadea and the Cuba sandstone[47] and which become the main mass of the Wellsburg sandstone[37] farther east.

Next to the Dunkirk black shale the most important horizon marker in this area is the *Cuba sandstone*,[47] signifying a westward shift of the profuse Spirifer disjunctus fauna. Th:

[40] Compare Geol. of N. Y., 4th Dist., pl. VIb and p. 497.
[41] Ibid. and N. Y. State Mus. Bul. 69, p. 1028.
[42] 5th Ann. Rep't (1841), p. 177. Geol. of N. Y., 4th Dist., p. 497. N. Y. State Mus. Bul. p. 69, p. 1027.
[43] Pa. 2d G.S. Rep't Q4, p. 119–20, 301–2.
[44] Geol. of N. Y., 4th Dist., p. 238, 248.
[45] Ibid. p. 238.
[46] N. Y. State Mus. Bul. 69, p. 1028–29.
[47] U. S. Geol. Surv. Bul. 41, p. 22, 63. N. Y. State Mus. Bul. 69, p. 968–69.

Cuba sandstone is easily traced up Ischua creek to near Machias,[48] where the name Ischua sandstone[49] was early appropriated to it by Horsford, and so goes above the Machias-Northeast series. It extends down Great Valley creek by way of Devereux and Ellicottville[50] into the north edge of the Salamanca quadrangle,[51] and on the hills above West Valley and north of East Otto to the vicinity of Maples, thence west by Jersey Hollow to the quarries at Cattaraugus, New Albion[50] and Leon.[50] Its position above the Machias fauna is well seen at Cattaraugus and Jersey Hollow. West of Leon it appears to fade into thin barren sandstones on the Canadaway and then to " fine " into shales.

Eastward from Cuba, the Cuba horizon rises to over 1700 feet A. T. on the hill southwest of Belmont and evidently passes on east at such an elevation as to place it not lower than the conglomerates at top of the Wellsburg standstone.[52] The Cuba sandstone marks the upper limit of D e l t h y r i s m e s a c o s t a l i s in New York State.[53]

In Pennsylvania the *Girard shale*[54] overlies the Northeast beds, for a thickness of 225 feet. On approaching the New York line, the upper portion of the Girard becomes increasingly fossiliferous from the top down, carrying specially C a m a r o t o e c h i a d u p l i c a t a ,[55] and changing to a green sandy shale. On Chautauqua creek[56] the normal Girard shale is still about 140 feet thick succeeded by about a hundred feet of the green fossiliferous shale, east of Volusia. On the Canadaway this Volusia shale is about 180 feet and the normal Girard if present can not exceed 40 feet. The Volusia shale evidently passes eastward above the Cuba and corresponds with the interval (zone 11)[57] between the Cuba and the " quarry sandstones " on the Olean area. Whether the soft shale[58] beneath the Cuba at the east can be regarded as any remnant of the Girard shale remains to be seen. It is inferred that the Volusia must be either highest Wellsburg or else " Catskill " in the Elmira region.[59]

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[48] Geol. of N. Y., 4th Dist., p. 492.
[49] 4th Ann. Rep't (1840), p. 466, 469.
[50] Ibid., p. 471.
[51] N. Y. State Mus. Bul. 69, p. 969.
[52] U. S. Geol. Surv. Folio 169, p. 10, fig. 6 (field ed. p. 39, 78).
[53] N. Y. State Mus. Bul. 69, p. 992. U. S. Geol. Surv. Bul. 41, p. 28.
[54] Pa. 2d G.S. Rep't Q4, p. 118, 300-1.
[55] Pal. of N. Y. 4, p. 350; 8 (pt 2), p. 192.
[56] Geol. of N. Y., 4th Dist., p. 253.
[57] N. Y. State Mus. Bul. 52, p. 528. N. Y. State Bul. 69, p. 990, 992.
[58] U. S. Geol. Surv. Bul. 41, p. 63, 64, 71. N. Y. State Mus. Bul. 69, p. 968.
[59] U. S. Geol. Surv. Folio 169, p. 11, fig. 6 (field ed., p. 39, 82).

Near Cuba[60] and at Wellsville[61] this zone contains thin bands of red iron ore suggestive of its "Catskill" affinities.[62]

The highly fossiliferous "Chemung" beds[63] of Erie county, Pennsylvania, there carrying Leiorhynchus newberryi,[64] cross the southern half of Chautauqua county in a broad belt and with increasing thickness. They succeed the Volusia shale in the Chautauqua gulf section west of Mayville,[65] and on Chautauqua lake they include some shales of a distinctly reddish or chocolate color. From the exceptional exposure in the shale-brick quarries at Dexterville[66] (Jamestown) on the Chadakoin river the name *Chadakoin beds* is proposed for this division. These beds pass southward and eastward into the upper "Chemung" of the Warren folio[67] and Olean region,[68] characterized by such chocolate shales. In the Elmira area[69] they must lie wholly above the true Chemung, in the "Catskill," there also distinctly chocolate[69] rather than red. The "quarry sandstone"[70] has been recognized as the base of these beds westward as far as northwest of Little Valley toward New Albion, but much work remains to be done on these strata.

This completes the list of elements assigned for investigation, but the problem impels some consideration of the superjacent terranes, once called Chemung, now assigned to the Bradford group.[71]

The upper limit of the Chadakoin formation is presumably at base of the *Panama conglomerate*,[72] or of the equivalent LeBoeuf sandstone[73] of Pennsylvania. Some uncertainty still prevails as to the true correlative of the Panama in the Warren and Olean sections.[74] The latest opinion[75] seems to be that the Panama lies at or near the horizon of the *Wolf Creek conglomerate*[76] which (or in its

[60] U. S. Geol. Surv. Bul. 41, p. 67, 69. N. Y. State Mus. Bul. 69, p. 970-71.
[61] Geol. of N. Y., 4th Dist., p. 486. U. S. Geol. Surv. Bul. 41, p. 78.
[62] Compare Geol. of N. Y., 4th Dist., p. 280 et ante.
[63] Pa. 2d G.S. Rep't Q4, p. 117-18.
[64] Ibid. p. 298.
[65] Geol. of N. Y., 4th Dist., p. 238, 259, 494.
[66] Ibid. p. 259, 261, 494.
[67] U. S. Geol. Surv. Folio 172, p. 3, fig. 6.
[68] N. Y. State Mus. Bul. 69, p. 968-71, 990-93. U. S. Geol. Surv. Bul. 41, p. 66, 69.
[69] U. S. Geol. Surv. Folio 169, p. 10 (field ed., p. 82).
[70] N. Y. State Mus. Bul. 69, p. 970, 990.
[71] Pa. 2d G.S. Rep't IIII: N. Y. State Mus. Hdbk. 19 (2d ed.) p. 87.
[72] Geol. of N. Y., 4th Dist., p. 290-91, 495. Pa. 2d G.S. Rep't III, p. 57.
[73] Pa. 2d G.S. Rep't Q4, p. 104-6, 112-13.
[74] Ibid. and N. Y. State Mus. Bul. 69, p. 987.
[75] U. S. Geol. Surv. Folio 172, p. 4. N. Y. State Mus. Hdbk. 19 (2d ed.), p. 88.
[76] U. S. Geol. Surv. Bul. 41; p. 86. N. Y. State Mus. Bul. 69, p. 971.

absence the succeeding Cattaraugus red shales)[77] follows the "Chemung" (Chadakoin) in the Olean hills. If the Panama is the higher Salamanca[78] lentil, then some of the beds beneath it must be of Bradford age, but as Spirifer disjunctus and eight of its "Chemung" associates continue[79] above the Wolf Creek while a much larger number of "Chemung" species[80] accompanies Spirifer disjunctus above the Panama-LeBoeuf base into the Venango group of Pennsylvania and this dominance of lower forms is still more marked across the Ohio line[81] as the Venango merges in the (upper) Chagrin,[82] the faunal evidence would not preclude such a reference. Time was lacking to review this question in the field.

The bright red *Cattaraugus beds*[77] of the Olean region are shown by continuity of the included Salamanca conglomerate[78] to fade into the *Conewango beds*[83] of the Warren folio, assuming more and more the full marine facies that characterizes them farther west in the "*Venango group*"[84] and *Riceville shale*[85] of Pennsylvania. The faunal and lithic expression of the Venango-Riceville is such that early workers[86] looked upon this series also as undoubted Chemung, filled as it is to the very top by a Spirifer disjunctus fauna. Of even more typcial Chemung aspect is the equivalent upper *Chagrin*[82] of Ohio, whereas the lower Chagrin (Girard-Chadakoin) has subsided into nearly barren[87] beds of decided Portage facies, though it is likely that every bit of this Chagrin is later than the highest true Chemung of the Elmira region.

Thus at many a stratigraphic level we find barren Catskill red beds at the east grading westward into fossiliferous olive or brown "Chemung" beds with a brachiopod fauna, augmenting as the silica gives way to lime,[88] then falling off rapidly as green shales increase and fading through a Leiorhynchus facies into barren "Portage" or pelecypod-cephalopod fauna and finally "Huron" black shales.

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[77] N. Y. State Mus. Bul. 69, p. 971–78.
[78] Ibid. p. 974.
[79] Ibid. p. 993–94.
[80] Pa. 2d G.S. Rep't Q4, p. 110, 97, etc. Ohio G.S. 4th ser., Bul. 15, p. 415–17, etc.
[81] Ohio G.S. 4th ser., Bul. 15, p. 463, etc.
[82] Ibid., p. 182, etc.
[83] U. S. Geol. Surv. Folio 172, p. 4.
[84] Pa. 2d G.S. Rep't Q4, p. 99.
[85] Ibid. p. 97.
[86] Ibid. p. 96, 110, 117. Pal. of N. Y. 4, p. 145, 249, 251. U. S. Geol. Surv. Bul. 41, p. 16–19.
[87] Ohio G.S. 4th ser., Bul. 15, p. 16, 182.
[88] Compare Pal. of N. Y. 4, p. 256–57.

Many interfingerings[89] of these phases naturally occur, but on the whole these faunal and lithic zones shift progressively westward giving a westerly overlap. The "Portake-Chemung-Catskill" succession is thus a homotaxial one, assuming different time values on every meridian and of steadily later date as to the lower and upper "Chemung" limits in going westward. The relations are best grasped by aid of the following diagram:

It will be seen that this is merely carrying toward conclusion the concepts advanced years ago[90] by Dr John M. Clarke.

The tracing of the beds is complicated by low and sometimes irregular anticlinals, whose unraveling will eventually be of import in locating supplies of oil and gas.

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[89] U. S. Geol. Surv. Bul. 41, p. 26-27.

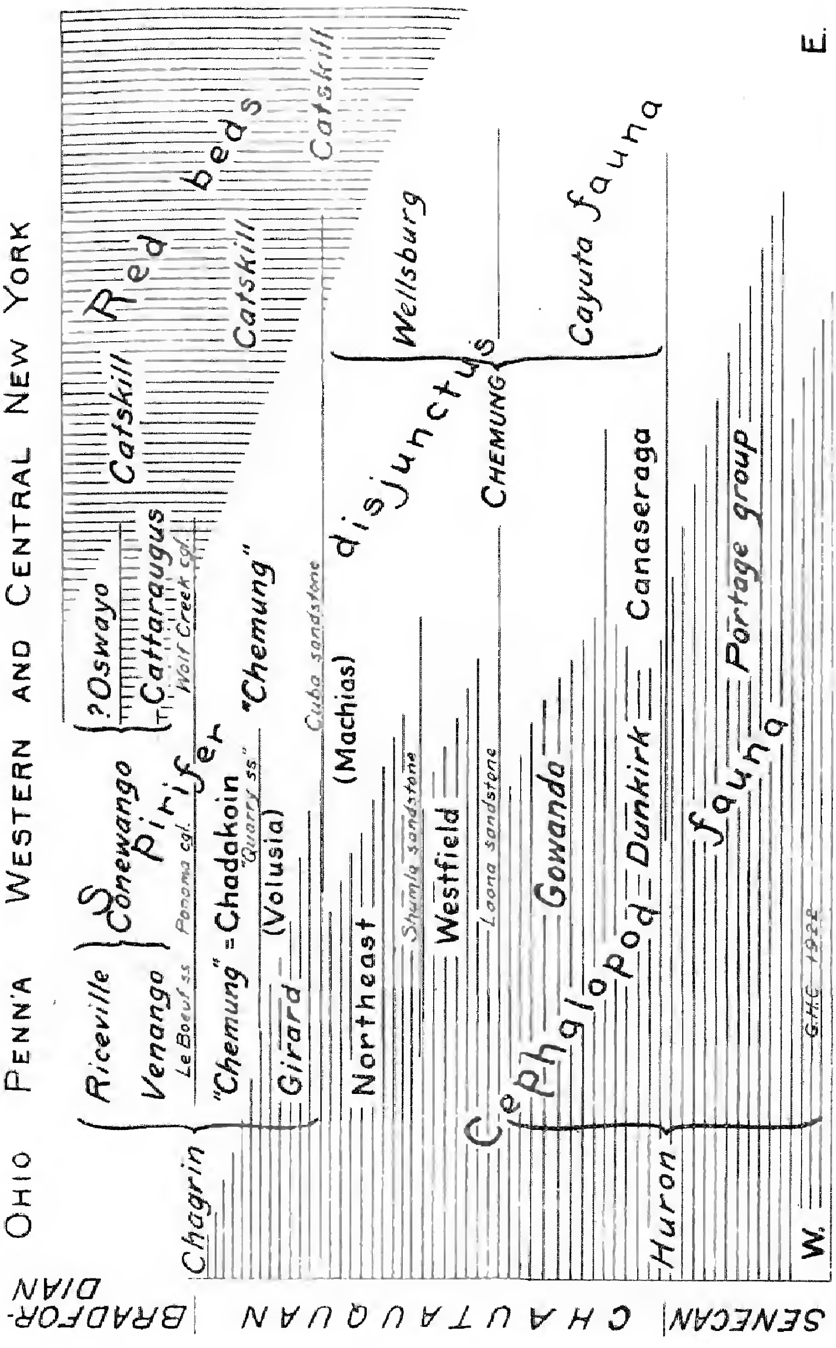

Fig. 1 Correlation diagram exhibiting "faunal overlap" relations in the Upper Devonian beds of western New York and Pennsylvania

THE DISAPPEARANCE OF THE LAST GLACIAL ICE SHEET FROM EASTERN NEW YORK

BY JOHN H. COOK

Some years ago, a survey of the surface geology of the Albany and Berne quadrangles was made by the writer for the State Museum. As the field work progressed it became evident that the region could not be interpreted in accordance with the generally accepted theory of the "retreat" of the last continental ice sheet, namely: the gradual melting back of a fairly definite face of live ice. Small glacial channels across the *southern* slopes of drumlins first attracted attention; later on, the clean, unmodified surface of the fluted and drumlinized area of the Helderberg plateau north of the Catskills[1] negatived the assumption that glacial lakes had ever existed on its northern slopes, held in by an ice barrier at the north, or that ponded waters from the Schoharie valley had ever found outlet across these slopes as such an ice front withdrew. In an early report of progress (unpublished) the suggestion was made that: following the late advance of the glacier during which the drumlins had been made, a mass of exceptionally clean ice (judging from the meager amount of recessional drift) had lain stagnant over the plateau and had melted off in place.

As the history of the retreat of the Wisconsin ice sheet from eastern New York had never been worked out in detail the desirability of a wider knowledge of neighboring fields was strongly felt. Both Peet[2] and Woodworth[3] in their parallel surveys of the Hudson and Champlain valleys had, properly, subordinated the problems of the recession of the ice to the main problem in hand and, though many important observations had been made concerning the relations of deposits to the remains of the glacier, the preconception of a withdrawing ice front was apparently never seriously questioned by either. Therefore, the necessity of establishing wider relations which might be expected to throw light on the supposedly stagnant ice field over the Helderberg was the original point of departure for the investigation, the results of which are given herewith.

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[1] *Cf.* Rich, J. L., Bul. Geol. Soc. Am. 25:70, 1914.
[2] Peet, C. E. Jour. Geol., 12:415–69 and 617–60, 1904.
[3] Woodworth, J. B. Ancient Water Levels. N. Y. State Mus. Bul. 84

As the inquiry was pushed into various critical regions the ice front became more and more fictitious and the evidence of wide areas of stagnant ice more and more convincing. Delay in the publication of scientific papers by the State of New York has afforded opportunity for testing the relative values of the two conceptions (the ice-front withdrawal and the stagnated glacier melting *in situ*) as aids in the interpretation of topography, in many widely separated localities in eastern New York. The hypothesis of a general condition of stagnation during the ablation of the Wisconsin ice is, therefore, advanced with a correspondingly greater degree of confidence, in that a general condition demands for its explanation a general cause.

Briefly stated, the hypothesis is this:

That part of the glacier which had been pushed beyond the mountain barriers south of the St Lawrence river from the Adirondacks to Maine, became stagnant almost, if not quite, at its maximum extension and never regained its motion.

This is recognized as an overstatement but the necessary qualifications are easily made and, for the moment, may be ignored. After allowance has been made for local "streaming" through the field of dead ice and for at least one possible thrust of live ice into it, (see page 168) it remains true that stagnant ice and the associated waters-of-melting played the principal roles in shaping the recessional drift.

The high relief and the general topographic relations of the area covered by this part of the ice sheet offered more favorable conditions for early stagnation than the lake basins and smoother surfaces found further west. So that, if any general cause were to operate to deprive the whole glacier of a part of its pressure head, this part would be more likely to respond by stagnating than, for example, the Erie Lobe in Ohio and Indiana. That a general cause did so operate we know. At the climax of the ice burden, the lithosphere subsided under the glacier; the transfer of material in the zone of flow[4] was radially outward from under

[4] The idea expressed by this term has been variously conceived. The use of a name by which to designate *a condition of the deep-seated rocks*, such as *asthenosphere* and the like, seems to imply the existence of a zone or layer beneath the rigid exterior, which is more or less sharply marked off from what is above and what is below. There is probably no such demarkation; rather, the fact is to be understood as follows: On each radius of the earth there is a point or section where the balance between pressure and temperature is nearest to the critical relation where fusion occurs. If all these points or sections be thought of as constituting a

the overloaded region and this resulted in central depression with compensating peripheral elevation. (The latter, being distributed, was very moderate as compared with the former and may be disregarded.) These complementary movements served to reduce the grade all round, and in so far as the glacier was dependant upon grade for its pressure head, they tended to stagnate such portions of the peripheral ice as were situated where conditions were favorable for stagnation. As has been pointed out, the area south of the St Lawrence river from the Adirondacks eastward was so situated; and it appears probable, not only that the ice south of the mountains lost all motion as a consequence of the crustal movement, but also that that movement was sufficiently rapid to destroy the glacier over the St Lawrence valley by floating it in the sea, before the ice to the south had been melted off.[4a]

So much for theoretic considerations.

The several stages of retreat of the lobes west of New York State, as for example the Erie Lobe already referred to, are marked by looped recessional moraines *fronted by consistent glacial drainage features*, sufficiently proving the withdrawal of live ice. When such a region is compared with eastern New York and New England the contrast is seen to be great. Here is no such readable topography: the direct evidence of long, almost continuous, morainal ridges is absent. In addition, the drainage lines south of any assumed position of a retreating ice front, are found to be interrupted by the clear record of thick masses of stagnant ice. This is the case with what is probably the most important transverse belt of drift in the whole area, which has been identified and mapped as a recessional moraine, the Ogdensburg-Culver's Gap moraine of New Jersey.

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unit, it may be called a zone. Within this zone, slight alterations of pressure or temperature may result in a comparatively sudden fusion of the solids which become, in consequence, capable of motion until relief of pressure or a lowering of the temperature carries the balance back through the critical relation where solidification takes place and rigidity is restored.

[4a] The basin of the Salmon river (Loon Lake, Chateaugay and Malone quadrangles) should furnish reliable data on this point. From 1800 feet down to 500 feet the plains and deltas built into the rotting ice edge afford material for tracing the successive steps in the lowering of the ice surface. If, as Professor Fairchild has supposed, (N. Y. State Mus. Bul. 209–210) the delta at 500 feet just north of Malone was built at sea level the glacier was already afloat. If on the other hand the sea did not rise to this level, the ice against which this plain was built must have had at least its lower part submerged, *unless* the maximum depression letting in the Hochelagan sea was not synchronous with the presence of the ice, but later.

It is doubtful if there is an unequivocal frontal-recessional moraine which is at the same time an ice-built dump marking a halt in the retreat of a still moving ice sheet, through the whole length of the Hudson and Champlain valleys. The short sections west of the Palisades which have been identified as such by competent observers are the most difficult to explain. They are commonly weak belts from one to three miles in length, incapable of correlation with each other, with a proglacial topography assumed to have been recently uncovered by the ice, and with the demands of the drainage. Where not open to a different interpretation, they appear to represent either localized streaming through the otherwise stagnant glacier, or the results of that type of motion in a large, isolated body of ice mentioned by Salisbury in the Glacial Geology of New Jersey (page 86). Moreover there are several ways in which transverse belts of drift may be formed *on the surface of glacial ice* and such superglacial accumulations may have been let down upon the land from a stagnated mass without wholly destroying their character and continuity. Every transverse belt of till is not necessarily a frontal moraine.

The term moraine as originally used indicated nothing more definite than the glacial origin of the drift as opposed to theories of "waves of translation" and so forth; it was used to define any recognizable accumulation of drift and should be so used today. However, the preconception of an ice wall retreating reluctantly under the influence of a warming climate was strong, and when the water-built forms were separated and given special designations, whatever was left to fill out the concept "moraine" appears to have been tacitly accepted as something built by ice and water at the margin of the glacier, "the glacier" meaning the still moving body of ice thrusting southward under pressure from an indefinite distance behind it. And evidence of the presence of ice during deposition appears to have been taken as proof of the edge of a still active glacier, even where the stagnant condition of the ice masses is quite clear. All the buried blocks which had given rise to kettle depressions were regarded as fragments broken from the face wall of the receding glacier and conveniently inhumed, the drainage being diverted in time to prevent the obliteration of the pits by further sedimentation as the blocks melted.

All of this remains in the literature and hinders a better understanding of the accumulations of both stratified and unassorted drift associated with the gradual lowering of the surface of an extensive area of dead ice. Salisbury in his volume on the Glacial Geology of New Jersey gives a comprehensive account of the topographic forms referable to such areas and, in the text describing local details, the general principles are illustrated from almost every section of the glaciated part of that State. Yet the character of the recession was evidently assumed by the author to have been normal, for he finds no insuperable difficulty in leaving much of the glacier behind as it receded and in having the remnants remain unmelted while an ice front halted from time to time to build recessional moraines among them.

As far as I have been able to learn, M. L. Fuller and F. G. Clapp, publishing simultaneously in the Journal of Geology in 1904, were the first to interpret the evidence as indicating stagnation of considerable extent. The former, investigating the area of Glacial Lake Neponset[5] writes: " . . . studies . . in Lake Neponset have led to the conclusion that the ice in that region, instead of retiring with a definite and somewhat regular front, had become absolutely stagnant before the history of the lake began . . .;" and the latter, studying the Charles River Basin (Mass.)[6] concluded that: the evidence points to "the decay of the ice *in situ* for many miles back from the ice front — the decaying glacier consisting of a mass of stagnant ice, overlain and buried by sheets of water and by extensive deposits of sand and gravel."

Woodworth[7] noted, concerning the "morainic ridge" north of the city of Albany, that "the rise of the ridge to 360 feet or over, in close accordance with the level of the Schodack terrace, suggests that the remnant of the glacier in this district may have been sheeted over with flood-plains of gravel while the depressions were filled with the same material."

Fairchild[8] writing of the conditions obtaining during the formation of the broad sand plains along the southwestern base of the Adirondacks, says: "the ultimate escape of the waters must

[5] Ice-Retreat in Glacial Lake Neponset and in Southeastern Massachusetts. Jour. Geol. xii, no. 3, p. 181 (April–May).

[6] Relations of Gravel Deposits in the Northern Part of Glacial Lake Charles, Massachusetts. Jour. Geol. xii, no. 3, p. 198 (April–May).

[7] N. Y. State Mus. Bul. 84, p. 129.

[8] N. Y. State Mus. Bul. 160, p. 19.

have been to the south and over the belt of stagnant ice which lay in the Utica-Little Falls section of the [Mohawk] valley."

Aside from these and a few other scattered references which might be quoted, the literature indicates how slight an impression the evidence has made upon the classical assumption of a retreating wall of ice.

Finally: if everything in New England and eastern New York which has been, rightly or wrongly, thought by some author to be an ice-front recessional moraine were mapped together with the recessional moraines of the Erie Lobe on any reasonable scale (say 20 miles to the inch), the comparison would still be a striking contrast.

Lacking the direct evidence of recessional moraines, some indirect evidence ought to be furnished by an application of the ice-front hypothesis to interference with the normal land drainage; there should be found: the records of ponded waters with lowering outlets at predictable points over cols or across land salients as the assumed ice front withdrew. In critical localities this hypothesis breaks down conspicuously, for example, in the following north-sloping hydrographic basins: Wallkill River, Shawangunk Creek, Rondout Creek, Moodna Kill, (Woodbury Creek branch) and Schoharie Creek.

On the other hand the evidence of stagnant ice melting *in situ* is widespread and abundant. Its expression is so varied that generalizations are difficult, while detailed descriptions would expand this paper far beyond the limits contemplated for it. The statements which follow should be accompanied by a running commentary on the published conclusions of others who have investigated the several fields mentioned, but this also is rendered impossible by space limitations.

As has been long known, the Adirondack mountain mass appeared above the lowering surface of the ice sheet as an island. On the principle that the comparatively clean upper ice melted more rapidly than the basal ice which carried the bulk of the drift, the earlier stages of ablation *tended* to produce an irregular surface roughly corresponding to the upper limit of the portion which was heavily drift-laden. There appears to be little to suggest the action of meteoric waters, and the movement and redistribution of the drift as it was released from the frozen matrix was accomplished almost wholly by the waters-of-melting, the higher uncovered basal ice draining down onto the lower ice and sheeting it over with deposits of more or less assorted sand and gravel (fig. 1). Some of this buried ice persisted for a very long time, time being measured in terms of the establishment of unobstructed land drainage. Above about 2,000 feet the record is too obscure to decipher; most of the drift was left as sandy till and the deposits washed out over the surrounding ice fields were subsequently redistributed or destroyed by the disappearance of the underlying ice. At about the level of 2,000 feet, however, conditions locally permitted the building of waterlaid deposits *on the land*. Many of these have been preserved and, where not built out into open bodies of water, they show both by their external form and their internal structure that they were laid down along the margins of persistent ice masses, sometimes covering a thin margin and still retaining the slopes of contact, the kettle-hole record of buried blocks and the kames resulting from slump. Quite frequently the position of these highest plains is distant from any confining wall, in which cases they are either fragments of deposits originally more extensive or the filling of cavities in the ice. In the former case the deposit, flat-topped, is bounded by erosion slopes, in the latter by ice contacts or kames.

At 1,800 feet the deposits of stratified drift *laid on the ground* (as indicated by the undisturbed stratification) become more numerous, and at about 1,600 feet begin to fall into a system of broad plains separated by wide spaces where the ice was not yet out. (See Loon Lake Quadrangle for good examples; northwestern corner.)

The general northeast-southwest trend of the Adirondack main ridges served to deflect much of the southward drainage to the west. Partly because of this deflection and partly because the surface of the glacier remained higher in the Hudson and Champlain valleys, the high level sand plains and kame-belts are developed much more extensively along the western and southwestern margins of the mountains than at the southeastern base.

Until the glacier had so far wasted away as to uncover the divide between the Black River basin and southern drainage, and to establish partly free lacustrine conditions in that basin, the succession of falling levels is exceptionally complete. For the most part these levels are marked by discontinuous sand-plains separated by areas of ice occupation in which the present streams follow consequent courses. The Post-Hochelagan uplift has warped the levels and much of the country is accessible with

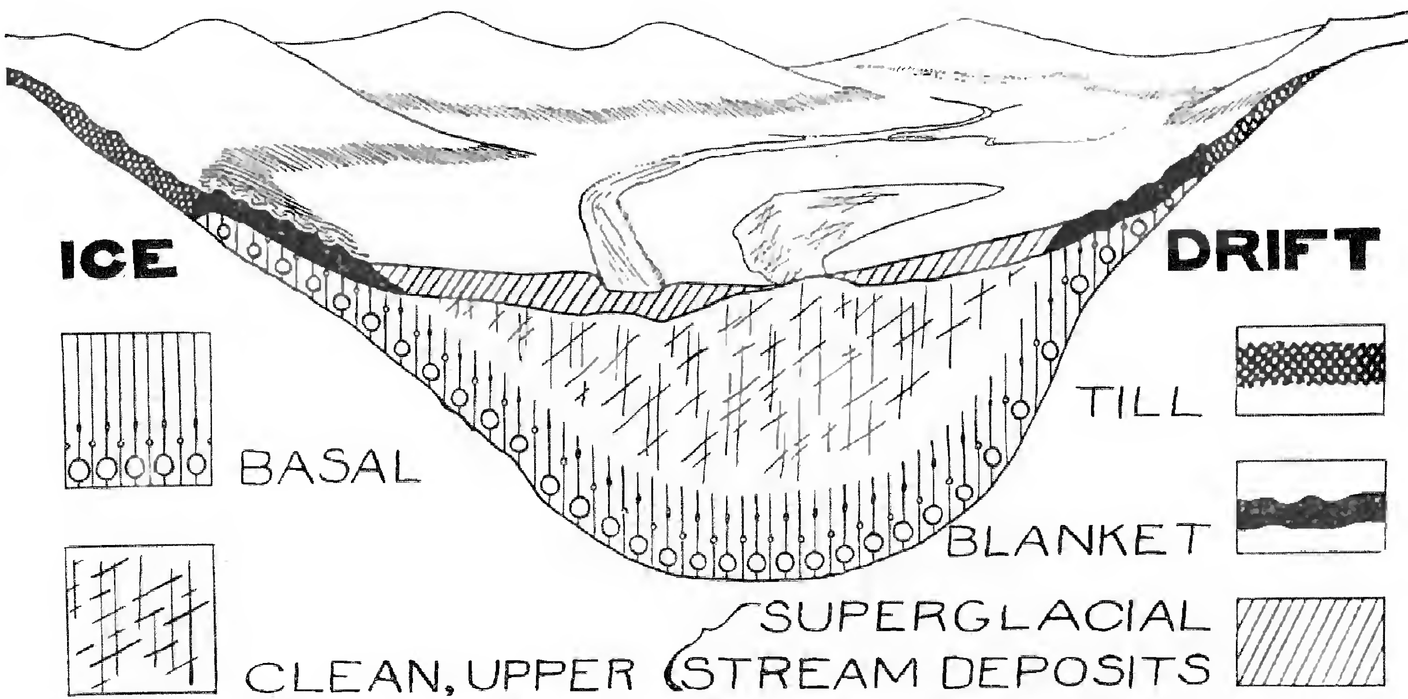

Fig. 1 Diagram illustrating a stage in the ablation of a stagnant regional glacier. Melting of the basal ice on the higher slopes has been retarded by the accumulation of the inclosed drift to form a protective blanket. The surface of the deeper, cleaner ice over the depression is being sheeted over with (mostly) stream-borne sediments derived from the blanket.

difficulty, nevertheless the evidence is so abundant and clear that the general outline of the history can hardly be misinterpreted. The coarser drift which has been moved little if any from the position it held when the ice first became motionless is easily distinguished from the finer materials washed out from exposed basal drift to become superglacial; and, of the "modified" drift accumulations, those which have been deposited on land are quite different both in internal structure and external form, from those which have collapsed from a former position on the ice.

The "Adirondack sands" were distributed widely over the encircling ice. At the lower levels (400 feet down) they sometimes form a sharp contrast with the locally derived material. From the marked level northeast and east from Trenton Falls which Professor Fairchild has called the Herkimer Lake "the ultimate escape of the waters must have been to the south and over the belt of stagnant ice" to Susquehanna drainage. There is reason to believe that the ice to the east in the Mohawk and Hudson basins had been thickened by a thrust of live ice, possibly into the stagnant glacier, by way of the Champlain portal (see page 168) thus barring the way to outlet in that direction.

Where was the "ice front" at this stage of the "recession"?

All the headwater streams of the Susquehanna system, from the Chenango river to the Schoharie basin follow rather high-walled well-opened valleys. All these valleys held long tongues of ice when forced drainage began to run through them and still held, as remnants of those fillings, considerable masses of dead ice *after the last forced drainage was diverted* (probably westward) beyond the northern divide. Such widespread stagnant ice, existing contemporaneously, seems to the writer to demand a general condition of stagnation for its explanation. Though the deposits throughout this part of the plateau are principally concentrated in the valley bottoms, terraces having the form of kame-terraces appear here and there on the slopes and a few complexes of till and mostly unstratified gravels associatel with kettles indicating deposition over thin dead ice were found on the tops of the inter-stream ridges.

That waters ponded by stagnant ice against the southwestern slopes of the Adirondacks, escaped somewhere into the Susquehanna system while its headwater valleys were still filled with remnants of the glacier is reasonably certain; it is not so clear that we can judge by the land topography alone just where the northern divide of that system was crossed, for the crossing may have been over ice. As has been noted above, there is reason to believe that the ice in the Mohawk valley had been overthickened and, if that was the case, it is possible that all the drainage from the north was deflected westward beyond Utica. We are concerned here with the origin and significance of the region of probable overthickening.

This region is characterized everywhere by heavily drumlinized topography remarkably free from any subsequent accumulations of recessional drift. The drumlins and the associated flutings and striae evidently mark the last movement of the glacial ice in this district which has left a record. If the movement be thought of as due to pressure transmitted from a great distance it may be said to have entered the Hudson and Mohawk valleys by way of the Champlain portal,[9] to have reached and climbed the Helderberg escarpment, crossed the dissected plateau to the lower slopes of the Catskills and there stopped. It is possible that some movement down the Hudson valley belongs to this episode and also some southeastward movement away from that valley but, if so, the effects of these late movements cannot be differentiated from those of the general advance of the glacier. But that there was more resistance offered to southward motion than can be accounted for by the land topography alone would seem to be obvious, for after spreading southwestward over most of the Schoharie basin, the principal line along which the relief of pressure took place was westward, up the valley of the Mohawk, nearly to Utica. This would seem to indicate that the ice was not advancing into unoccupied territory. The high altitudes reached by this drumlin-forming ice over the Helderberg (it climbed from the 300 foot level to over 2,000 feet) do not favor the idea that "drumlins are a product of the sliding movement of a thinning ice edge when under efficient thrustal motion of thick ice in the rear" advanced by Professor Fairchild.

[9] The writer is of the opinion that the pressure head which moved the ice was not all derived from some limited area in the Labrador near the geographic center of the glaciated territory; atmospheric conditions are are not likely to be so selective in the distribution of precipitation. Everywhere over the ice sheet and perhaps beyond it, snows accumulated from year to year and the ice was being thickened locally by greater average snowfall over some parts of the glacier than over others. An attempt to trace this Mohawk thrust back to what might be called its root was not successful; it may well represent the effects of a movement occasioned by overthickening of the ice in a region no further distant than the St Lawrence.

It is very doubtful if any such sliding motion of thin ice is in accord with the known physics of ice movement. In order to get the matter before the reader briefly and without entering upon a discussion involving physics and mathematics, it will be convenient to picture the glacier as made up of two major layers, a thin basal layer carrying most of the drift and moving slowly and a much thicker layer of comparatively clean, upper ice moving more rapidly. The acceleration of velocity due to increasing pressure is greater in the upper ice than in the basal layer. If the accelerations are increased by a thickening of the ice beyond a certain critical ratio the upper ice practically overrides the basal layer with its inclosed drift, and, forming beneath it a fluted surface bounded by streamline curves, it slowly squeezs the lower ice free from its burden and carries it forward, leaving the drift content pressed against the ground in elongated ridges.

If this is the true explanation of drumlin fields, it follows that they were formed under thick ice; hence we have interpreted the barrier to drainage which unquestionably existed during the earlier stages of ablation in the Mohawk and upper Hudson valleys, the Schoharie basin and over the plateau north of the Catskills, as due to the longer persistence of an overthickened portion of the glacier, which lay above and protected the drumlinized area from both erosion and sedimentation while the surrounding thinner ice was melting off.

There is nothing to indicate whether this thrust of live ice was made before or after the general condition of stagnation of the glacier; if before, the thick ice became stagnant immediately after the drumlins were formed; if after, it was pushing into a body of dead ice of such extent that it "took up" and dissipated the motion (mainly along a path of least resistance up the Mohawk valley). Because the latter is a possibility it is allowed to stand as a qualification of the first statement of the hypothesis presented in this paper (see page 159). But in either case, the persistence of this mass with no subsequent modification by advancing ice of the land surface which it produced, is proof of stagnation over the area which it covered.

Because the southeastern Adirondack drainage was blocked by this overthickened ice, the freeing of the upper Hudson River basin was not accomplished until a time somewhat later than the freeing of corresponding levels at the southwest base of the mountains as previously noted. The first important level of the lowering ice surface in this basin is marked by sand-plains built over and against its thin edge by the Sacandaga river near Northampton and by the high level kame-terraces west and southwest of Corinth (the latter mapped and described by Stoller).[10] Both of these deposits are below the contour line of 1,000 feet. The southward outflow from the Sacandaga was not investigated.

The waters of the Hudson coming from the Adirondacks carried considerable quantities of coarse detritus out over the ice at a level as much above the sagging kame belt above Corinth (elevations from 600 to 900 feet) as the thickness of the ice margin onto which it was built. Much of this coarser material was not moved far and remained for the river to rehandle and sort over as the body of the ice shrank, but the finer sands at this level and lower levels were carried to great distances and covered parts of the stagnant glacier so effectually that they were not floated by the rising waters of Lake Albany, and *remained partly unmelted even after this body of water had disappeared.* In addition to the basins of Round and Saratoga lakes there are other evidences of buried ice which outlasted Lake Albany in the same district. Both the Hoosick river and the Batten Kill built deltas over stagnant ice occupying the Hudson gorge. The gradual melting of the block covered by the former gave rise to those stream terraces behind it which are not represented by corresponding terrace levels elsewhere in the vicinity. The delta still covers the gorge and forces the Hudson westward onto the higher floor of the valley. The delta of the Batten Kill also forced the Hudson into what has been called the Coveville channel as long as the ice block which it had covered remained unmelted. The melting of the buried ice permitted the river to again take its course through the gorge as in Preglacial time. (See Cohoes and Schuylerville quadrangles.) The basin of Ballston lake has had no mysterious origin; together with the basins of Otsego lake and a few smaller bodies of water, it represents, east of the Adirondacks, the same kind of glacial ploughing exhibited west of that barrier by the basins of the Finger and associated lakes. It is not a *graben* and is not of Postglacial origin. It could not have escaped being filled with sand if crossed by a river engaged in cutting away the section of sand plain which formerly filled the Mohawk valley

[10] Glacial Geology of the Saratoga Quadrangle. N. Y. State Mus. Bul. 183.

above Schenectady, *unless it contained an unmelted remnant of the glacier*. (See Schenectady quadrangle.)

The overthickened ice extended to the Catskills and, in the Hudson valley, probably some distance southward along their eastern base, though south of Cairo Roundtop no effort was made to trace it. An extensive area of drift, originally deposited over thin stagnant ice, north of Broome Center (Gilboa quadrangle) on the divide between Schoharie and Catskill Creek drainage, at an elevation of from 1,960 to 2,050 feet, appears to have been outside its influence, but otherwise the entire basin of the latter stream was covered by it. The deposits along the creek between Cairo and Leeds, first described by Davis[11] as a dissected delta built in the Hudson estuary (Coxsackie quadrangle) are quite typical of the very insignificant accumulations of recessional drift found here and there over the drumlinized area and associated with the melting out of the last remnants of the ice which first molded and then stagnated above that area.

Inasmuch as the field of stagnant ice surrounding the Adirondacks has not been traced further south at the higher levels, it will be convenient at this point to begin at the New Jersey line and indicate the more important features connected with the shrinking of the motionless glacier on the west side of the Hudson valley from south to north.

The Wallkill basin heads in New Jersey with a low point in the divide north of Augusta (Franklin Furnace quadrangle) where an area of till partly covered by stratified sands separates the headwaters of Papakating creek from those of the southward draining Paulin's Kill at a present elevation of 500 feet. The divide is here uncut and has never been the outlet of a lake ponded in the basin. Yet until a retreating ice front had uncovered a lower outlet some thirty-six miles to the northeast, this must have been the site of an ever lengthening body of water under the hypothesis of the gradual melting back of a live glacier. It will be sufficient here to state that the Wallkill basin was practically obliterated by a filling of stagnant ice until superglacial streams had carved out drainage lines north of Goshen. The evidences of this stagnant mass are alike both north and south of the State line and have been described in detail by Salisbury in the Glacial Geology of New Jersey. We will return to a consideration of the drainage (page 172) after gathering up certain details of importance.

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[11] Proc. Boston Soc. Nat. Hist. v. xxv (1892) p. 318-35.

Shawangunk mountain (Port Jervis, Monticello and Ellenville quadrangles) appeared above the lowering ice surface and, in the northern part, began to receive sediments immediately. As the higher slopes were uncovered, stagnant ice occupied the lower lands on both sides of the ridge. The more abundant drainage from the plateau south of the Catskills appears to have wasted the valley filling to the west more rapidly, for a stage was reached where the surface of the ice covering the basin of the Shawangunk Kill drained westward through the gap at Otisville (Port Jervis quadrangle) onto the ice in the adjoining valley. This stage was short-lived for the gap was not wholly cleared of ice[12] when the superglacial waters found outlet in another direction. The basin to the east (Shawangunk Kill) contains a very fine series of kame-terraces and pitted plains at falling levels eastward as the superglacial and marginal waters followed the lowering ice. On the west of the ridge the stagnant valley tongue held up the waters of the several streams draining the plateau, and ice-contact deltas mark the local levels of escape against and over it. A massive filling of a cavity in the ice chokes the valley between Summitville and Phillipsport (Ellenville quadrangle) at the divide between northern and southern drainage. In this valley the divide (at 540 feet) has been swept by glacial waters but only while stagnant ice lay both north and south of it.

The same general assemblage of features continues northward to the point where Esopus creek turns northward eight miles southwest of Kingston (Rosendale quadrangle). At this point an ice-contact, consisting of kames and broken ground, separates a pitted plain surrounded by contact slopes (elevation 380 feet), lying to the south, from the area of ice occupation now followed by the lower course of the Esopus.[13] The level of this plain marks approximately the surface of a body of water sheeting over a field of dead ice in the Rondout valley. To the southwest are areas of ice occupation and lacustrine clays deposited among separated and

[12] There is an error in the mapping at this point. The spot north of the railroad marked by depression contours is a bare rock knob, the end of a spur cut through by the railroad. There is, however, a small ice-block kettle across the road to the east, not shown on the map. The only land channel used by glacial waters follows the road around and north of the rock knob improperly mapped. Right up to the narrow pass, kameterraces and flat-topped heaps of drift rise to elevations of as much as 30 feet above the level of the small channel. The evidence is here very compactly assembled and would repay more careful study than I was able to give it.

[13] This may represent the southern end of the thickened ice mentioned above but no attempt was made to correlate it with the area north of the Catskills.

perhaps floating masses of ice. This water level did not reach to the divide at Summitville,— it was over 100 feet below it —; there is nothing to indicate an outlet along the only possible confining salient (the northern end of Shawangunk mountain one mile southwest of Rosendale); and the ice contact west of Stone Ridge does not mark the position of a front of live ice but an edge of motionless ice. There is no outlet for this "lake" other than a long course over the surface of what was left of the glacier in the Hudson valley with escape through the Highland gorge or through one of the low passes east of the river, for there is no pass west of the gorge low enough to drain it.[14]

If we carry the inquiry into the lower courses of Shawangunk Kill and the Wallkill river, we find that stratified clays were deposited here at about the same level and that there is no confinement for lake waters in the valley of the latter except a tongue of stagnant ice filling the Hudson valley north of the Highlands. This must have been more than 400 feet thick over the present river bed opposite Newburgh and must also have covered the slopes now drained by the Moodna Kill and its branches. Had the character of the recession of the glacier been by the gradual withdrawal of an ice front, the Wallkill could not have failed to turn eastward along such a front and to have joined the Hudson by way of the Otter Kill and Moodna Kill, between Cornwall Landing and Newburgh. Two miles southwest of Montgomery, in the extreme northwestern corner of the Schunemunk quadrangle, there is a low point in the eastern divide (of the Wallkill basin) at 360 feet, which has not been crossed by a stream and which is a few feet *lower*, according to hand-level measurements, than the plains immediately west and southwest which were built among remnant ice masses. And yet, the river continues northward for some twenty-five miles before it falls, by way of a course protected from clay-filling by persistent ice, into Rondout creek and so to the Hudson.

In the northeastern corner of the Newburgh quadrangle there is a still lower point in the divide (about 350 feet) and an eastward leading channel crossing it. The channel begins about three miles east of Newpaltz and if it ever carried glacial drainage the stream must have soon run out on stagnant ice for its course can not be traced beyond Lloyd.

[14] There is a possibility that this region was somewhat higher relatively to the lower Hudson when this ice-cumbered lake existed but probably not enough to make the other outlets to southern drainage available.

The same kind of argument applies to the lower body of water ponded by the Hudson valley ice tongue in the valley west of the upturned limestones, extending from the bend in Esopus creek at the ice contact southwest of Kingston, to Catskill creek at Leeds. An ice-front recession would have turned the Esopus into the Hudson at Kingston, where today, what is left of this artifically beheaded stream hangs above the mouth of Rondout creek in a manner to tempt the engineer seeking waterpower.

If stagnant ice filled the Hudson valley opposite Kingston at this stage there ought to be a fair chance of finding direct evidence of the fact. The delta sands of Kingston Point (Rhinebeck quadrangle) rise to an elevation of 220 feet; they were built from south to north that is to say, up-river; overlie nearly 200 feet of clay; and appear to have direct relation with the Rondout valley. At Rosendale (Rosendale quadrangle) some eight miles to the southwest is a glacial sand plain rising to the same elevation and also apparently related to the Rondout valley. No sections were found to exhibit its structure. If these two deposits so close together were not made in the same water body the according levels are difficult to understand. Assuming that they are contemporaneous deposits, either they were originally separated by remnant ice in the lower Rondout valley or they were once continuous. If continuous, they have been separated by the removal of the intervening material by subsequent erosion. (No evidence of postglacial faulting was noted in the region). The ground between the 220 and 240 foot contours was searched for remnants of this supposedly continuous plain and below 220 feet for evidences of normal dissection or dissection complicated by the melting out of ice. Terrace levels of both clay and sand were found, some higher and some lower than the required level but nothing to indicate that the Rosendale Plains and the Kingston Point delta were once continuous. On the contrary the bare rock surfaces, especially north of the creek, give every indication of having been protected by a covering of ice from receiving sediment. The dissection of the valley-filling from Rosendale to Rondout and Port Ewen was partly governed by the melting out of ice. It is very doubtful if even the sands at the latter place (at 140 feet) were built out into open water; while the occupation of the lower valley by ice, preventing the deposition of clays there while the Kingston Point deposit was building, renders it probable that this latter deposit was made while the Hudson valley proper still contained a considerable amount of ice.

It is very difficult to select a set of delta plains or terrace levels from Kingston to Troy which can be referred to an open body of water; Woodworth says:[15] "It has proved well nigh impossible to find any systematic relation of the various water levels which are indicated in this portion of the valley, after making due allowance for such deposits as appear . . . to have been built in waters confined along the ice margin or held up on the rock terraces of the Hudson gorge by ice remaining in it." This much is evident; all of the clays in the valley north of Rondout do not belong to a single waterbody which may be called Lake Albany; some of them were laid down in ponded water marginal to the ice tongue filling the main valley and parts of the smaller valleys tributary to it. For example there is a fragment of a sand delta one mile northwest of Catskill village (Catskill quadrangle) crossed by a section of the Old King's road, which is but little more than 180 feet above tide; the clays at Leeds, south of the creek, attain an elevation of 190 feet and are more than two miles upstream. There is much to suggest that Lake Albany was cumbered with ice, both floating and anchored in the gorge, that cobble-covered ice formed the bed of its outlet for many miles and that this protected ice in the lower valley *existed contemporaneously with the buried masses in the upper valley* already mentioned, as long as this "lake" endured.

The eastern side of the Hudson valley calls for little description. Woodworth's "Newburgh stage" deposits were built against stagnant ice or on its thin edge overlying the rock terraces and represent only the last terms of a series which begins high up among the hills of the eastern watershed near the Connecticut and Massachusetts boundaries. The accumulations marking the earlier and higher levels in this region have been described in part by F. B. Taylor (Journal of Geology vol. xi, 1903, pp 323–364) who attempted their correlation and the reconstruction of the ice borders along which they were laid down. If the general method used in the reconstruction of these fragments of the recessional positions of the "icefront" is at all reliable, the great irregularity of the frontal line, the thinness of the ice occupying the valleys, the evidence of much persistent ice to the south of any assumed front and the absence of tracable lines of drainage beyond that front (erosion and sedimentation) tending to obliterate the deposits of the preceding positions, furnish that combination of circumstances which the writer has used

[15] Ancient Water Levels, etc. p. 191.

as a criterion of the absence of glacial movement. The same argument applies to all the deposits examined in this area from the Highlands to the Hoosick river. Everywhere is the evidence of stagnant ice melting *in situ*, and nowhere was the suggestion of a receding ice front rendered probable.

Areas of dead ice do not seem to have been much noticed and in consequence comparatively little attention has been given to the evidences which they have left or the character of the deposits which are associated with their ablation. The work of Salisbury, already referred to, contains a good general description of the phenomena in English. Of the German Geologists, Schneider[16] has given an account of the melting off of such a mass in Hinterpommerania, and Gagel[17] has described high level lake waters over the Masurian Plateau in East Prussia which could have been confined only behind the stagnant margin of the last ice sheet. The available literature does not appear to be voluminous and yet the subject is of sufficient importance to merit the attention of geologists working at the interpretation of the Pleistocene deposits, for the more general problems of the contemporaneous diastrophic movements depend for their solution largely upon the evidence furnished by warped and tilted water planes. And if open waters are not distinguished from areas partly occupied by stagnant ice, the value of the criteria will be greatly lessened.

Conclusion and Summary

In reviewing the literature in the light of the conclusions here set forth two points have impressed the writer as deserving of mention. The *a priori* assumptions of different investigators as to just what kind of effects can be produced by flowing water under varying circumstances of load, grade and volume differ greatly. Also the *a priori* assumptions made concerning the degree of plasticity exhibited by the marginal zone of an ice sheet in retreat grade from a conception of ice so rigid that only the major features of the land topography can affect its course, to a willingness to believe it capable of turning aside and thrusting long shoestring shaped tongues up side valleys. With regard to the stream action it need only be said that the laws governing the development of a new valley over a

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[16] Bericht über die Aufnahme der Blätter Boissin und Bulgrin in Hinterpomern. Jahrbuch der Kgl. preuss. geolog. Landesanstalt, xxvi (1905), S. 705–10.

[17] Die letzte, grosse Phase der diluvialen Vergletscherung Nord-deutschlands. Geologische Rundschau (Leipzig), Band vi, Heft 1 & 2, 1915, S. 86–87.

consequent course determined by glaciation and sedimentation have been worked out by the physiographers with sufficient accuracy to enable one to distinguish normal effects from those produced by the combined action of a stream and a stream bed or banks which are liquifying. With regard to the ice, in lieu of opportunities for direct study, what it actually did at the terminal position is probably the best obtainable guide to what it was capable of doing, and it does not seem likely that a few miles of recession would enable it to develop a flexibility which it did not possess at its maximum extension. Many of the protrusions from the general line of front which have been noted by investigators undoubtedly existed, but the idea that they represent minature lobes of active ice, rather than stagnant shreds, is merely a part of the general preconception that the receding and melting ice continued to move southward to the very last.

It will be understood that in the ablation of even a motionless glacier, a kind of recession can be made out; and that here and there very striking proof of the former presence of abrupt distal margins may be found, like the contact mentioned above which turns Esopus creek northward. Like the valley-head deposits of the Finger Lakes region this contact descends northward some 150 feet in about one-half mile. There can be, then, no objection to the use of the terms " retreat " and " ice front " so long as the implication of glacial motion is avoided. Such a recession is complicated (1) by the persistence, mostly at low elevations, of masses of ice which have been covered by superglacial drift, and (2) by the early breaking up of parts of the ice field far back from its edge, by the hydrostatic pressure exerted by waters accumulated about elevations protruding above the thinning glacier. But for the most part, the ragged margin of the main body of the ice was melted off progressively from south to north. It would not seem, therefore, that the possible contemporaneity of laminated clays as far separated as, for example the southern foothills of the Adirondacks (Little Falls quadrangle) and the northern end of Shawangunk mountain (noted above), would, of necessity, vitiate the value of the chronology worked out by Antevs[18] on a basis of such clay laminae.

[18] The Recession of the last Ice Sheet in New England. Amer. Geog. Soc. Research Series No. 11, New York City, 1922.

New York State Museum

JOHN M. CLARKE, DIRECTOR

PUBLICATIONS

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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.

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Paleontologist's annual reports 1899–date.

See first note under Geologist's annual reports.

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

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5	.25	16 (" 36)	.25	28 (" 165)	.40
6	.15	18 (" 64)	.20	29 (" 175)	.45
7	.20	19 (" 76)	.15	30 (" 180)	.50
8	.25	20 (" 97)	.40	31 (" 186)	.35
9	.25	21 (" 104)	.25	32 (" 198)	.40
10	.35	22 (" 110)	.25	33 (" 202)	.35
11	.25	23 (" 124)	.75	34 (" 231)	.35
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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
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23 Entomology
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Clarke, J. M. Limestones of Central and Western New York Interbedded with Bituminous Shales of the Marcellus Stage.
Wood, Elvira. Marcellus Limestones of Lancaster, Erie Co., N. Y.
Clarke, J. M. New Agelacrinites.
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DIVISION 1 ZOOLOGY. De Kay, James E. Zoology of New York; or, The New York Fauna; comprising detailed descriptions of all the animals hitherto observed within the State of New York with brief notices of those occasionally found near its borders, and accompanied by appropriate illustrations. 5v. il. pl. maps. sq. 4to. Albany 1842–44. *Out of print.*

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Catalogue of the Cabinet of Natural History of the State of New York and of the Historical and Antiquarian Collection annexed thereto. 242p. 8vo. 1853. *Out of print.*

Handbooks 1893–date.
New York State Museum, 52p. il. 1902. *Out of print.*

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.*
Classification of New York Series of Geologic Formations. 32p. 1903. *Out of print.* Revised edition. 96p. 1912. *Free.*

Guides
Guide to the Mineral Collections, prepared by Herbert P. Whitlock. p. 45. 1916. *Out of print.*
Guide to the Collections of General Geology and Economic Geology, prepared by Robert W. Jones, p. 31. 1917. *Free.*
Guide to the Paleontological Collections, prepared by Rudolf Ruedemann. p. 35. il. 1916. *Out of print.*

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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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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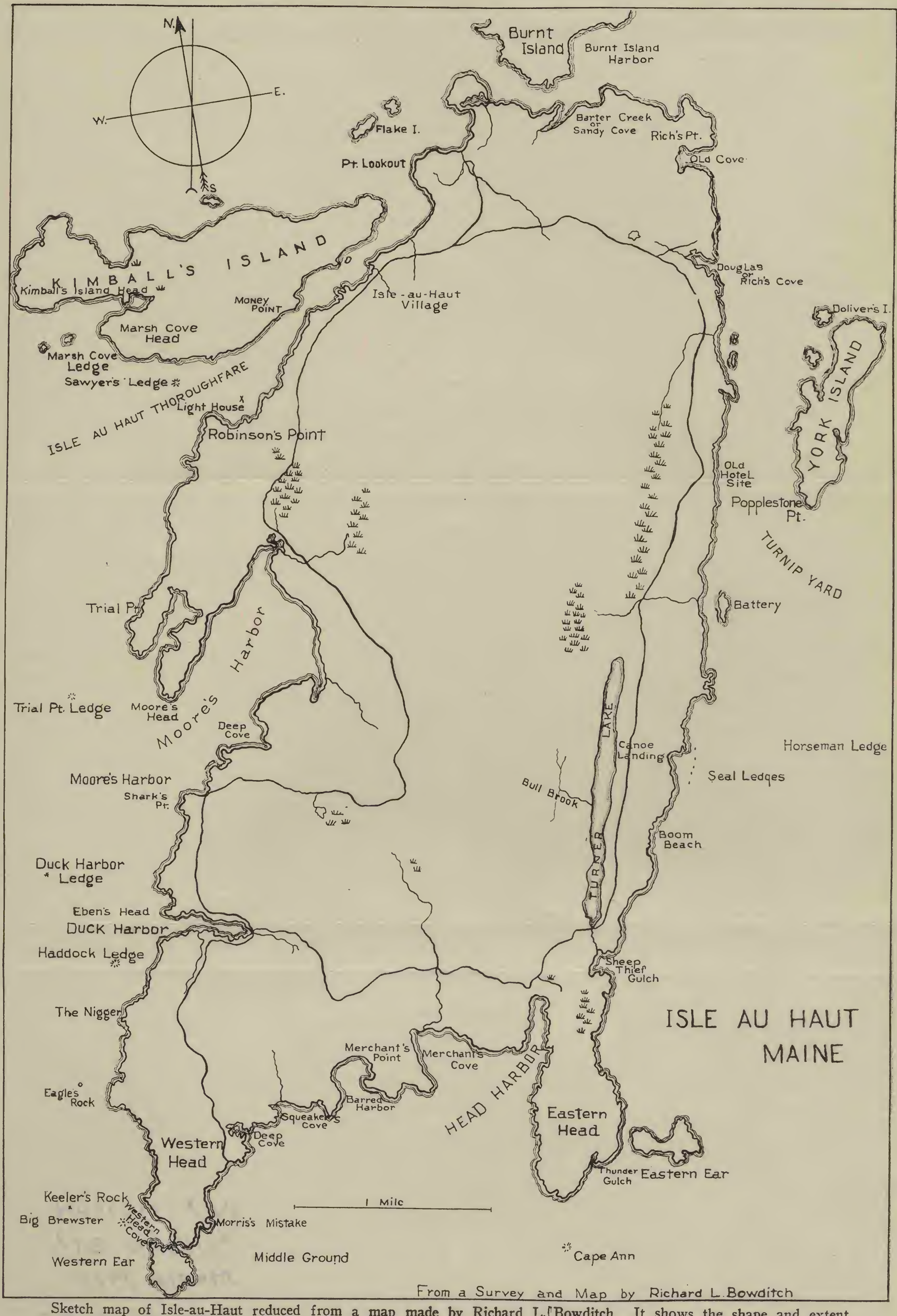

Sketch map of Isle-au-Haut reduced from a map made by Richard L. Bowditch. It shows the shape and extent of Turner's Lake and its relation to the coast line and shore outlet. The continuous black lines are roads.

A Scientific Survey of Turners Lake
Isle-au-Haut, Maine

Made by SHERMAN C. BISHOP and NOAH T. CLARKE

1922

With Special Examinations and Notes by

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NEW YORK STATE MUSEUM
ALBANY, N. Y.
August, 1923

ISLE-AU-HAUT, MAINE, AND ITS LAKE

A NOTICE OF SOME OF THEIR NOTEWORTHY NATURAL FEATURES

Isle-au-Haut is an island far out in East Penobscot Bay, Maine, one of the larger among scores of islands on this coast which are but the tatters of the original shore lands, broken bits of the bones of Maine left on the field after the long battle between sea and land and glacial ice. Isle-au-Haut was discovered and named by Champlain in 1604, although Champlain knew his own language better than to call the island by its present designation. To him it was Isle Haute. Today the name is the survivor of various transmogrifications which have come about through contact with the English who have ever had a genius for disjointing the significance of French place names. For generations of English settlement it was the Isle of Holt, the Great Isle of Holt, associated in the early records of the State of Maine with the Little Isle of Holt, now known as Kimball Island, close upon the northwest shoulder of Isle-au-Haut.

The island has a greatest length of 11.4 miles and a greatest width of 5 miles and its northern end is surrounded by the lesser islands of the archipelago to which it belongs. As a small continental island it shows general features of structure and physiography common to its neighbors and the mainland, but there are certain details of special interest which have been created by its insulation and its individual history.

Geology

The island has a basic rock structure and surface conformation which are in essential harmony with those of other islands and of the adjoining continent. Its greatest length, northeast-southeast, is determined by the direction of the folded crystalline rocks which makes its axis, Mt. Champlain, whose highest summit at the north attains an elevation of 500 feet. This fold or complex of folds is an index to the direction of all the other more or less concealed and involved folds which constitute the rock foundation of the island. These rocks are for the most part heavily hornblendic gneisses and schists with plenty of diabase intrusions and frequent granite injections. The folds are pre-appalachian and are a part of the fundamental directive series of folds on which the true Appalachian folds of the paleozoic rocks have adjusted themselves. Just where this series is to be fitted into the subdivisions generally recognized as composing the Pre-cambrian is uncertain, but the rocks are obviously of a later term, as among these are stratified quartzites still retaining the cross-bedding of the original beach-sand composing them. The island rocks have been thoroughly glaciated and ice scratches are to be seen from the shore line to the summit of the hills, wherever the composition of the rocks has enabled them to hold against the weathering. This is not often as most of the rocks yield easily to decomposition and it is chiefly on the diabase dikes and hard hornblendic schists that such scratches are retained. The level of the island above the sea has changed in comparatively late times. The "Thoroughfare" which separates Isle-au-Haut from Kimball Island at the northwest, is at full tide open to craft of slight draft, but at low water it is completely choked by broad mussel banks. An extension of these banks has been found well inland along the filled rock trough at the north, lying at a depth that indicates considerable elevation above the present sea line. Evidences of such slight upward movements are to be seen in the generally rounded contour of the rock shores at the east and west. At the south the steeper cliffs, many of which are conspicuous, seem to owe their origin less to any change in the elevation of the land than to the attacks from the open Atlantic against a rock wall weakened by cross folds and joints.

The ice sheet and its consequent debris are doubtless responsible for much obstructed drainage which has produced swampy areas over the uplands, and to that agency we must ascribe the apparent overdeepening or scouring of the rock valley at the east, in which arises the extraordinary lake which it is the purpose of this publication to describe;— Turner's Lake; the name stands for one of the oldest families on the island, and to those who are wont to resort to the place on summer days it is still reminiscent of the times when the self-reliant islanders, depending upon the resources of the fishing, leaned less heavily than today upon contacts with the world outside.

It is not quite certain to the writer whether this lake lies in a fault valley parallel with the crystalline rock folds, or is a cleaned-out synclinal or a glacial trough. Its shore is bounded by low rock outcrops, but they are not sufficiently different in inclination or composition to determine this point. However, the following are the salient introductory descriptive features of this little lacustrine basin: It is 1.2 miles long, 1/10 mile wide, straight, and almost due north and south; its north end is 700 yards from the Atlantic Ocean at the east, the boundary between lake and sea being a rock ledge 20 to 40 feet high; at the south it is 150 yards from the sea into which

Eastern Head harbor from the Sea

Turner's Lake looking north from boat landing.

Turner's Lake, looking south.

it discharges by a narrow and choked outlet running through a constricted rock channel into a mass of beach boulders and gravels thrown up by the sea, and at low tide the fresh water discharge is practically subterranean, as it passes through the beach boulders and its outflow can be seen to best advantage from the sea itself. The sea, however, has not been observed to rise high enough to cover the beach boulders and find its way inward through the basin of the lake itself. The greatest depth of the lake is about 40 feet below sea level. Its greatest actual depth is 56 feet; its average elevation above the sea is 10 feet: its only known inlet is a little stream from the west flowing out of swampland of the Mt. Champlain ledge. The lake has no tide, periodic rise and flow, and as the visible inflow is much less than the visible outflow, it would seem necessary to infer that it is fed by ground water springs at the bottom.

The biological survey of this lake and the gathering of the material on which the following biological and chemical notes are based were carried out by Sherman C. Bishop and Noah T. Clarke of the State Museum during the month of September, 1922. The appreciative interest of Mrs. Mary Clark Thompson has made the work possible.

Chemistry of the Lake Waters

The water of Turners Lake is notable to the eye for its amberine tints and to the touch for its obvious and velvety softness. There follow herewith analyses of these waters based upon samples taken with all reasonable care from the surface and from the bottom. The analyses have been made by Herbert Ant, Chemist to the Division of Saratoga Springs, New York State Conservation Commission, whose experience in water analyses has been very extensive. Mr. Ant also has given his construction of the actual combinations of the solids in the water.

Dr. Frank Wigglesworth Clarke of the United States Geological Survey, whose repute as a geochemist is of the highest rank, has at my request expressed his judgment upon possible combinations in the water. Finally, Barnard S. Bronson, Professor of Chemistry at the New York State College for Teachers, has contributed a very notable expression as to this matter.

John M. Clarke

Surface Water

Saratoga Springs, N. Y., *Nov.* 14, 1922

The following are the results of the mineral analyses of the last sample of water which you sent to me. There has been a slight delay in giving you the results, owing to the fact that I was on my vacation:

Parts Per Million

Ions and Radicles		Theoretical Combinations	
SiO_2 silica	2.20	Silica	2.20
Cl chlorine	27.27	Sodium chloride	44.96
Ca calcium	4.00	Calcium carbonate	10.00
Mg magnesium	2.53	Magnesium carbonate	8.77
Na sodium	17.69	Iron and aluminum oxides	21.00
K potassium	4.01	Potassium plus organic matter	24.04
Fe_2O_3 plus Al_2O_3 iron and aluminum oxides	21.00		
CO_3 carbonate radicle	12.24		
Organic matter	20.03	Total solids	110.97

You will note that the water is quite similar to the next sample, with the exception of the organic matter, potash and iron content. The iron is considerably higher in this sample than in the other, while there is a great reduction in the amount of potash and organic matter which would tend to verify my arguments on the first sample — that the potash is in combination with the organic matter with the water. It would seem that the iron content of this water is derived from some sort of iron secreting bacteria. The sample of water received had a decidedly fishy odor. There was an entire absence of the putrid odor that accompanied the other sample.

Yours very truly,

Herbert Ant,
Chemist

Bottom Water

Saratoga Spa, *Oct.* 9, 1922

The following are results of the analysis of the sample of water received by me on October 2, 1922. The results are given in Parts per Million and as ions and radicles. I have endeavored to give a theoretical combination of the ions; but this is somewhat difficult on account of the very high organic content.

South end of lake, looking toward outlet.

Turner's Lake near the outlet.

B following p. 6

The outlet at the south end of the lake. The water comes through the boulder barriers and flows into the sea at and above high tide.

Ions and Radicles		Theoretical Combinations	
SiO silica	4.40	Silica	4.40
Cl chlorine	24.00	Sodium chloride	39.45
Na sodium	15.52	Calcium carbonate	10.35
K potassium	11.20	Magnesium carbonate.	11.12
Ca calcium	4.14	Iron and aluminum oxides	5.20
Mg magnesium	2.92	Potassium combined with organic matter..	83.79
CO carbonate	13.41		
FeO–AlO iron and alumina	5.20		
Organic matter	72.59		
	153.38		

In making the theoretical combinations I found that there is not enough mineral matter with which to combine the potassium, so that it must be associated with the organic matter.

The water has a very disagreeable odor, an intense brown color and a heavy sediment. I have never encountered a water anywhere similar to this one and I am wondering if the peculiarity is not due to an unclean jug in which cider or some such liquid had been kept. (see p.)

Very truly yours,
HERBERT ANT,
Chemist.

DEPARTMENT OF THE INTERIOR, UNITED STATES GEOLOGICAL SURVEY, WASHINGTON, NOVEMBER 23, 1922

DIVISION OF CHEMICAL AND PHYSICAL RESEARCHES

The two water analyses which you sent me are not easy to interpret, for I do not know how the samples were collected and shipped, nor how the analyses were made and calculated. The sodium and chlorine are doubtless of oceanic origin, in part if not wholly cyclic, that is, brought down in rain over the drainage basin of the lake. The other constituents, except the organic matter, came from the feldspars and ferromagnesian minerals of the granite. The apparent excess of potassium may be held in equilibrium with silica, although the balance between the two is not very close. How much of the trouble is due to analytical errors, which are never wholly avoidable, I will not attempt to say. I doubt, however, that any organic salt of potassium is present, but it is possible that some of the needed silica, itself collodial, may have been retained by the collodial organic matter. That might account for the discrepancy.

F. W. CLARKE.

NEW YORK STATE COLLEGE FOR TEACHERS

ALBANY, *June* 14, 1923

The correct interpretation of the analyses of water submitted is very difficult if not impossible.

Time has not been available for the consideration of this problem in all its phases. Accepting the analyses as given it would seem to me that other theoretical combinations than those presented would be more consistent.

In both analyses I should assume that the potassium is held in theoretical combination with the silica and the alumina. In the analysis of the surface water therefore the theoretical combinations might be:

K_2SiO_3	5.64
$K_2Al_2O_4$	2.75
NaCl	44.94
$CaCO_3$	10.00
$MgCO_3$	8.77
Al_2O_3, Fe_2O_3	19.49
Organic	20.03

The iron and the aluminum could very well be held in solution in the form of colloidal hydrates. This water would be alkaline but with an uncalculated P_H value.

Similar theoretical combinations might be made from the report of the bottom water. The hydrogen ion concentrations however differ inexplicably. Determination of the P_H values might have helped considerably in formulating a consistent hypothesis.

Combinations, such as those given, relieve the necessity of imagining so great an amount of the potassium in combination with the organic matter. This hypothesis to me seems doubtful.

K_2SiO_3	11.28
$K_2Al_2O_4$	4.74
Fe_2O_3	2.60
K_2O	3.90

Outlet at the sea beach. The lake waters come down through the mass of pebbles in the foreground.

Outlet of lake looking from the sea.

Other combinations as given, except that the potassium in combination with organic matter will be correspondingly decreased.

BARNARD S. BRONSON.

At the south end of the lake flocks of herring gulls from outside are, on summer days, ever cavorting in the soft waters, in their enjoyment of a fresh-water bath. It seems reasonable to suppose that some part of the potassium in the water may be due to their presence.

J. M. C.

THE BIOLOGY OF TURNER'S LAKE

SHERMAN C. BISHOP

This narrow strip of water lies in a spoon of the island like an amber bar in a setting of green, gold and white. The cedars, maples and birches, banked steeply at the water's edge, thinning somewhat, climb to the summit of the ridges that lie to the west and form the backbone of the island. Eastward a lower ridge follows the line of the lake and carries the road which traverses the woods at the north to Head Harbor at the southeast. At the south, the rocky barrier that pockets the slow waters beats back an encroaching alder swamp following the short outlet up from the sea; northward a gentle gravel slope, once cleared, brings to seed a crop of lusty weeds.

Halfway down the west side, the rivulet Bull brook creeps in after a noisy journey over a rough bed, from its source in the sphagnum bogs on the axial ridge. The outlet leaves the southeast end in a tangle of undergrowth and stranded, rotting logs grown over with moss and ferns.

The narrow trough filled by the lake seems to be a continuation of the swampy valley lying to the north which is held back at a higher line by the gravel slope which separates them. The lake itself has a length of only a little less than a mile and a quarter and an extreme width of about two hundred and twenty yards. At the north end where surface wash from the slope above has built up a sandy bottom, the water is shallow but south of this, in the mid-line of the lake, the depth regularly increases for five hundred yards to the maximum of fifty-six feet. South of this point for a thousand yards, the water gradually shallows marking a gentle rise of bottom leading to a rocky cross-ridge whose highest point is some twenty feet below the surface. The position of this drowned ridge is marked by a vertical white cedar log which rears a broken trunk a foot or two above the surface. The depth again increases to forty-eight feet midway between the tree and the boat landing at the south end of the lake. The surface of the lake is only a few feet above tide; its bottom fully forty feet below.

Along the west shore in stretches of comparatively shallow water and near the outlet, bedrock reaches the surface; at these places and along both banks where the waves have cut away the turf, the rocks are sometimes pitted as if by action of some strong solvent. The water itself is amber except in the shallows because rich in organic materials derived both from the sphagnum bogs that feed the inlet and from decaying vegetation. Huge cedar trunks that dwarf the living trees of the shores sprawl over the bottom, their skeleton arms hairy with trailing filaments of algae and blotched by livid green of sponges.

In its organic life the lake is perhaps more notable for its lack of many common plants and animals than for the presence of unusual forms. No cat-tails are there to hide the floating nest of the grebe and invite the marsh wren, nor duckweed greening the surface in the quiet coves; no waving ribbons of eelgrass nor rough-stemmed stoneworts or pondweeds common to muddy bottoms. In the shallow areas near either end of the pond the waterlilies float their broad fans or, caught by the breeze, roll them in glistening cylinders. Here too the floatingheart dangles its spur-like roots and rides at anchor. No pickerel weed blues the shores with its stiff pikes or arrowhead brandishing broad blades, but in their places a few burweeds and sedges, loosestrife and woolgrass. The leathery mantle of *Nostoc* blankets the sandy bottom at the north, punctured here and there by some stiff stemmed rush; and in scattered patches the pipewort spreads its myriad-pointed stars.

In summer and autumn the birds of the lake are largely borrowed from the sea. Herring gulls gather almost daily in the south shallows to cleanse themselves of the sea-rime in the soft waters; they drop urchins on the rocks and leave the shells of crabs to bleach in the crevices; or a sea duck varies his diet by a cruise over the shallows; ospreys visit the pond but leave the small prey to the kingfishers.

No turtles were found in the lake nor were they reported by those who fished its waters; frogs are infrequent, for only three were seen and those near the swamp from which they may have come. Even the fish are few in kinds though our nets and traps yielded a proper quota. Eels abound but they are mostly small, and numerous sticklebacks found our traps in twenty feet of water; these and the smelt and the introduced salmon were all that were taken.

The Arbor-vitae stump projecting above the water near the south end. Total length 26 feet.

A [illegible]

View looking south showing the Arbor-vitae stump.

The bottom rubbish near the shore, usually so prolific of life is here almost barren; only a few snails, small and thin of shell, and caddisworms tumbling their cases over the stones that hid the may-fly nymphs. Leeches abound and are easily collected if one wades barefooted. On the surface water beetles (gyrinids) and water-striders occur sparingly. The open water offers the richest catch if the net is of fine mesh. Myriads of minute crustaceans (Entomostraca) of several species, and water mites are present, the latter the most conspicuous organisms of the lake at a depth of thirty feet. These small mites, seemingly so ill adapted to aquatic life in spite of their specialized swimming devices, are surprisingly abundant, every haul of the net bringing them in by hundreds.

Insects that pass the larval stage in water are strongly represented in the air above the lake by the mosquitoes; but these may well have bred in the swamps nearby rather than in the lake itself; for larvae were absent in the water that half-filled a stranded boat; neither were larval exuviae to be found in the shore litter washed up in narrow windrows at the north end. If indeed mosquitoes do not breed in the lake, perhaps a clue to their control may be found in the analysis of the water. Tandem-flying dragon flies appeared from time to time and others flying single, dipping their tails between the lily pads and hawking the open swarms of *Plecia* that passed in sluggish, weaving flight over the water.

The white cedar trunk which tops the buried ridge in the lake is a watermark of considerable note for it was standing up to the wind and above the waves when the earliest settlers came to the island It still serves as a convenient mark for hunters who wish to prove the merits of their rifles. Anchored by its root it stands almost erect in 4 fathoms of water. Whence this great tree came is a problem for some ingenious brain. That it long antedates the present forest conditions is obvious, for there are no such great cedars left on the island. There seem to be no currents in the lake that could have transported it erect from the shore, nor are there movements of ice in this little lake which would be at all competent to float and drop this heavy load into its present attitude. For some hundreds of years, no doubt, it has resisted the decomposition by the water whose singular chemical ingredients may have helped in its preservation. This arbor vitae tree stands forth as one of the many mysterious things that enter into the make-up of this unusual body of water. Long dead, the old stub each year greens into life with an alien verdure of freshwater sponge worn as a belt about four feet below the surface. The sponge itself is worthy of record for imbedded in its tissues and crawling about over the surface are the micro-caddisfly larvae which clothe themselves in mantles of silk and the delicate crystal spicules borrowed from the host.

The dominant trees of the shores are the white and yellow birches, maples (*Acer spicatum*), and the arbor vitae; but scattered among them are balsam and spruce, poplar and mountain ash, with thickets of alders in the wet spots. Near the outlet and along the southwest bank, the withe-rod (*Viburnum cassinoides*) grows and with it the mountain holly (*Nemopanthus mucronata*.)

The plants and animals named in the lists that follow are the common obvious forms present in the lake and along its shores found during September, 1922. Collections made at other seasons of the year would doubtless augment the various lists, particularly that of aquatic insects. Enough evidence was collected however to show that the character of the water inhibits the growth of many organisms and that further study might throw some light on problems of soil and water preference.

Considerable time was spent in taking soundings to determine the topography of the lake bottom; the results are shown on the accompanying sketch map. Samples of water for analysis were taken with great care at the surface and at a depth of about fifty feet; the latter sample by means of a weighted container from which the stopper was removed and replaced by lines manipulated at the surface.

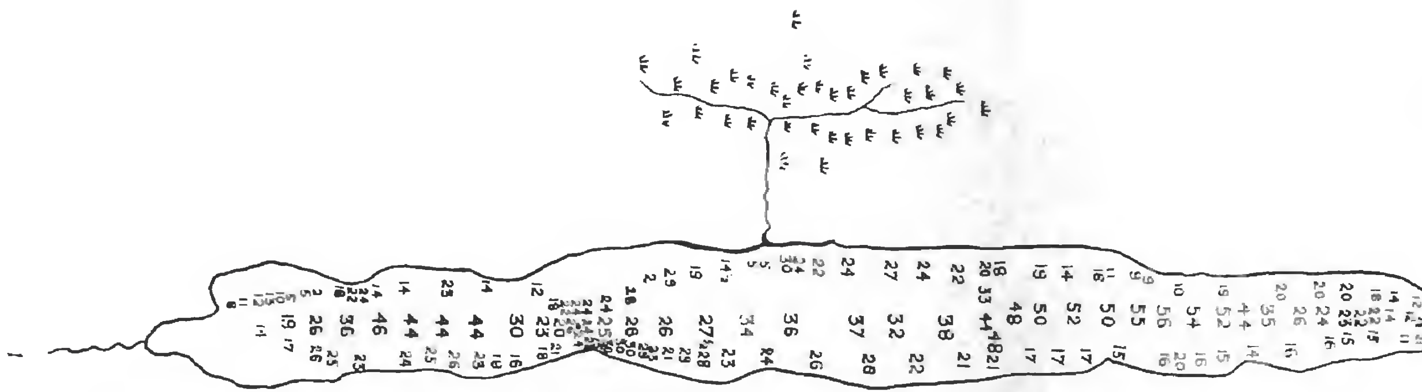
We are greatly indebted to the various specialists who have identified the materials collected and whose names accompany the lists; and to Mr. and Mrs. Ulysses S. Grant for many courtesies and much information concerning the island and its lake.

PLANTS

Determined by Dr. Homer D. House, N. Y. State Botanist; reviewed and checked by Nathaniel T. Kidder whose acquaintance with the flora of Isle-au-Haut is intimate.

The majority of the plants listed below are aquatics or, in some cases, plants growing as aquatics that are ordinarily found in drier situations. No attempt was made to collect the species of the bordering woods.

Sparganium americanum Nutt. Bur-reed. This species and the next were found only in scattered patches in shallow water at the south end of the lake and infrequently along the west shore. It is rather common in low grounds from Nova Scotia and Ontario to Iowa, Oklahoma and South Carolina.



Sketch map of Turner's Lake showing the soundings in feet. The direction of the lake is nearly due north-south.

Sparganium minimum Fries. This bur-reed has been recorded in cold, shallow waters from Labrador to Alaska, Oregon and New Jersey. Seven or eight species of bur-reed are known to occur in northeastern North America.

Potamogeton epihydrus Raf. Pondweed. Only a few single plants found at the north end of the lake, all with submerged leaves. Of the thirty or more species and subspecies of *Potamogeton* recorded from the northeastern United States, only one seems to have become established in the lake. Moore [1] found seven species growing in greater or less abundance in Cayuga Lake, New York, and Baker [2] investigating the conditions in Oneida Lake, New York, reported ten.

In ponds and streams, Newfoundland to British Columbia, North Carolina and Iowa.

Leersia oryzoides (L.) Sw. Rice Cut-grass. This is the common form found in swamps and along streams from Newfoundland to Oregon, south to Florida and Texas.

Calamagrostis canadensis (Michx.) Beauv. Blue-joint grass. The typical form is found in wet places from Newfoundland to British Columbia, North Carolina, New Mexico and California.

Dulichium arundinaceum (L.) Britton. Occurs in wet places and along borders of ponds from Newfoundland to Ontario, Minnesota, Washington, Texas and Florida.

Scirpus cyperinus var *pelius* Fernald. Wool grass. The variety *pelius* is the common form from Newfoundland to Ontario south to Connecticut, New York and Michigan. In Turner's Lake found in shallow water near outlet.

Carex lurida Wahlenb. Sedge. Swamps and wet meadows from Nova Scotia to Minnesota, Nebraska, Texas and Florida. The only member of the genus found in Turner's Lake.

Eriocaulon septangulare With. Pipewort. Common at both north and south ends of the lake and in patches along the west shore. It is generally distributed from Newfoundland to Ontario, Minnesota, Florida and Texas.

Juncus militaris Bigelow. Rush. Lake margin particularly at south end. Nova Scotia to northern New York and Maryland.

Nymphaea advena var. *variegata* (Engelm.) Fernald. Yellow cow lily. In mud bottomed areas at southwest end of lake and in scattered patches along west shore; a large patch in shallow water at north

1. Bull. Bur. Fisheries. 1913, 33:261-268
2. Tech. Pub. No. 9. N. Y. State College of Forestry, 1918, 18:51

end. The variety *variegata* is more commonly found in the northeast than the typical *N. advena*.

Castalia odorata (Ait.) Woodville and Wood. Sweet-scented water lily. Small groups among larger masses of the yellow cow lily. This is the common white water lily of the east. A form having pinkish flowers is said to have been introduced a few years ago but we could find no evidence of its development. Newfoundland to Manitoba, south to Florida, Louisiana and Kansas.

Spiraea latifolia Borkh. Meadowsweet. Growing at the edge of the water. Newfoundland to Saskatchewan, Virginia and Pennsylvania.

Hypericum virginicum L. March St. John's-wort. Common in swamps from Newfoundland to Florida, west of Manitoba, Nebraska and Louisiana.

Lysimachia terrestris (L.) B. S. P. Loosestrife. The loosestrife grows in low grounds from Newfoundland and Hudson Bay, south to Georgia and Arkansas.

Nymphodes lacunosum (Vent.) Fernald. Floating-heart. The floating heart grows at both ends of the lake in moderately deep water. The floating leaves with clusters of spurlike tubers at their bases drag at the ends of a slender stem often several feet in length. It is found from Nova Scotia to Florida and locally westward.

Lobelia Dortmanna L. Water Lobelia. In shallow water at south end of lake. Newfoundland to New Jersey and Pennsylvania and northwestward.

Solidago graminifolia (L.) Salisb. var *Nuttallii* (Greene) Fernald. Grows with its roots in the shallow water at south end of the lake and along the east shore. Distributed from New Brunswick to Saskatchewan, Alberta, Florida, Nebraska and Wyoming.

Aster longifolius Lam. Aster. This species and the next following, grow from the rotting driftwood at the outlet and in the shallows along shore. Found from Labrador and Saskatchewan, northern New England, Ontario to Montana.

Aster novi-belgii L. Aster. Newfoundland to Maine and Georgia, mainly near the coast.

ALGAE

(Identified by Dr. Marshall A. Howe, New York Botanical Garden)

Phormidium Retzii (Ag.) Gomont. In Turner's Lake found growing with patches of *Bryum bimum* Schreb.

Stigonema ocellatum (Dillw.) Thuret. Free floating or attached to submerged twigs and stones.

Oedogonium sp. A few sterile filaments collected from submersed twigs.

Rhizoclonium hieroglyphicum (Ag.) Kütz.

Mougeotia sp. Sterile filaments only collected.

Nostoc Linckia (Roth.) Bornet. Over many square yards of bottom at the north end of the lake, in water that reaches a depth of four or five feet, the gelatinous envelope of this alga forms a continuous blanket which excludes all other plants except a few stiff stemmed rushes.

MOSSES

(Identified by Mrs. N. L. Britton, New York Botanical Garden)

Bryum bimun Schreb. In rounded clumps at the water's edge.

Fontinalis antipyretica L. Water Moss. Grows beneath the surface on rocks and stones at Turner's Lake.

ANIMALS

PORIFERA

(Identified by Professor Frank Smith, University of Illinois)

Fresh Water Sponge

Heteromeyenia ryderi Potts. This sponge was found growing on logs at a depth of four or five feet below the surface. Statoblasts of two species of *Bryozoa* were collected with the sponge material and these have been provisionally identified as belonging to *Cristatella mucedo* Cuvier and *Pectinatella magnifica* Leidy.

HIRUDINEA

(Identified by Dr. J. Percy Moore, University of Pennsylvania)

Leeches

Erpobdella punctata (Leidy) This is a common and widely distributed member of the family, very active and voracious. It will take human blood when given the opportunity.

Holobdella stagnalis (Linn.) Very abundant in the shallow water along shore in Turner's Lake but not usually observed unless the bottom rubbish is disturbed.

MOLLUSCA

(Identified by Dr. H. A. Pilsbry, Academy of Natural Sciences, Philadelphia)

The meagreness of the molluscan fauna of the lake is one of its striking features. Only four species were found and these represented by less than a score of individuals although careful search was made in the rubbish raked from several square yards of bottom at both the south and north ends. This condition may be better appreciated by comparing the results of investigations carried on in some well known inland lakes. Baker[1] found 91 species and varieties in Oneida lake, N. Y. and as many as 16 individuals per unit of 16 square inches. Evermann and Goldsborough[2] without giving particular attention to the group collected 15 species in Chautauqua lake, New York.

In the following species, the shells are all below normal size and unusually thin.

Planorbis antrosus Conrad. This is a common species in the eastern United States and Canada south to New Mexico.

Physa heterostropha Say. Widely distributed in eastern states from Maine to Georgia, west to Michigan and Illinois.

Musculium securis Prime. Common throughout the United States east of the Rocky Mountains.

Pisidium abditum Hald. One of the most widely distributed members of the genus. Occurs in eastern Canada and United States south to South Carolina; also found in California and Honduras.

CRUSTACEA

ENTOMOSTRACA

The Water-Fleas

(Identified by Dr. Chauncey Juday, University of Wisconsin)

The water-fleas are mostly minute forms which occur in great abundance in fresh water ponds, lakes and streams all over the world. In spite of their small size they are of great importance not only as the chief food of many young fishes but of certain larger species, like the white fish, that have specialized devices for straining them out of the water.

In Turner's lake eight species are found, all of which are well known and widely distributed.

Collections were made by means of a conical net of fine silk dragged at the surface and at depths of fifteen and thirty feet.

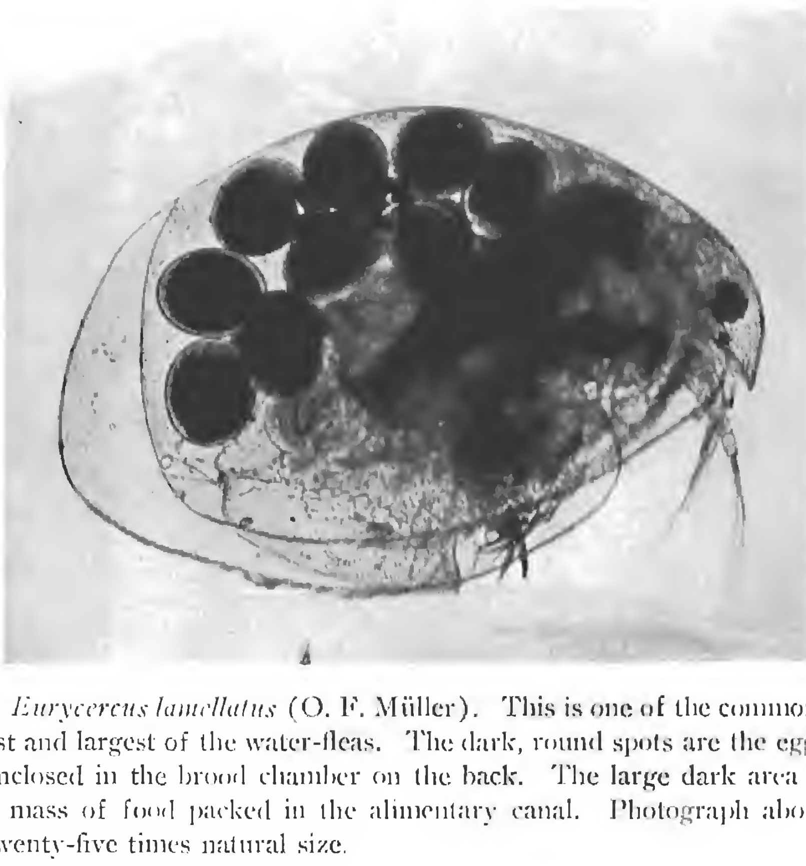
The species found at the surface:

Diaphanosoma brachyurum (Liévan). This species is common in marshes and in weedy margins of lakes and ponds.

Ceriodaphnia quadrangula (O. F. Müller). Common in all regions among weeds and in deeper waters of lakes.

Bosmina obtusirostris Sars. This is a variable species found in pools and lakes in many regions.

1. Tech. Pub. 9, N. Y. State College of Forestry, 1918, 18:181
2. Rept. U. S. Fish Commission for 1901 (1902) p. 175



Eurycercus lamellatus (O. F. Müller). This is one of the commonest and largest of the water-fleas. The dark, round spots are the eggs enclosed in the brood chamber on the back. The large dark area is a mass of food packed in the alimentary canal. Photograph about twenty-five times natural size.

Polyphemus pediculus (Linné). Common in northern United States in lakes and pools.

Epischura lacustris Forbes. Central and eastern United States in lakes and ponds.

Diaptomus minutus Lilljeborg. Northern United States and north to Greenland and Iceland.

Cyclops viridis var. *americanus* Marsh. This is a widely distributed species in pools and lakes.

The species found at the surface were taken again at a depth of 15 feet with the addition of:

Eurycercus lamellatus (O. F. Müller).

This is the only species of the genus found in America and is common in permanent pools and lakes. The figure is enlarged about 25 diameters and shows a mature female with eggs in the brood chamber on the back.

At a depth of thirty feet were all species found at the surface with the exception of *Polyphemus pediculus* (Linné).

It is perhaps worthy of remark that none of the larger crustaceans were collected in Turner's Lake, although careful search was made in all situations. This is the more remarkable because of the great abundance of the smaller forms.

INSECTA

(Identified by D. B. Young, Assistant N. Y. State Entomologist, Professor P. W. Claassen and Dr. W. T. M. Forbes of Cornell University)

Ephemeridae

The May-flies.

No adult May-flies were taken, but a few nymphs belonging to the genus *Rhithrogena* were found under stones near shore.

Odonata

The Dragon-flies

Dragon flies were not uncommon about the lake, particularly the small *Sympetrum vicinum* Hagen. On Sept. 16th a pair of *Aeschna constricta* Say was taken and a few days later a pair of *Somatochlora tenebrosa* Say. These are all common and widely distributed species.

Hemiptera

The Bugs

Arctocorixa calva (Say).

Metrobates hesperius Uhl.

Trichoptera

The Caddis-flies

Stenophylax scabripennis Ramb. The adults of only a single species of caddis-fly were taken but empty cases of two or three distinct types were noted in shallow water. A separate account of caddis-fly larvae found living with the fresh water sponge, is given in another place.

Lepidoptera

Moths, Butterflies etc

Larvae of *Nymphula (Parapoynx) maculalis* Clemens were commonly found on the under surface of lily leaves, in cases made from fragments of the leaves; in a few instances they were collected in the plankton net drawn at the surface.

Diptera

Flies.

Plecia heteroptera Say. Many found in open swarms over the lake and along the road.

Aedes stimulans Walk. No evidence was found to indicate that mosquitoes were breeding in the lake in spite of the great numbers flying over the water. Lake water in a half sunken boat held no larvae nor were the larval exuviae found in the shore litter or in the plankton net drawn at the surface. It is probable that the majority of the mosquitoes came from the nearby swamps.

Coleoptera

Beetles

Gyrinus borealis Aube.

Dineutes assimilis Aube.

Galerucella nymphaeae (Linn.) Larvae on lily leaves.

ARACHNIDA

Hydracarine

Water Mites

(Identified by Dr. ROBERT H. WOLCOTT, Lincoln, Neb.)

Unionicola crassipes (Mull.) These mites are exceedingly abundant at a depth of thirty feet but were taken in lesser numbers at the surface and intermediate depths.

Piona inconstans (Wolc.) Both sexes were taken at various depths down to thirty feet.

VERTEBRATES

(Identified by SHERMAN C. BISHOP)

FISHES

Eel, *Anguilla chrisypa* Rafinesque. Very abundant in the pond and usually of small size. Many taken on set lines and in the small traps set for stickle backs.

Nine-spined stickleback, *Pygosteus pungitius* (Linn.) Extremely abundant and taken at all depths down to 20-25 feet. Small, the largest observed only one and three-quarters inches long.

Smelt, *Osmerus mordax* (Mitchill). A few are usually taken each year through the ice near the mouth of the inlet. Two specimens 7½ to 8 inches long were taken on worms in 24 feet of water. Land-locked salmon, *Salmo sebago* Girard. Introduced a few years ago and now apparently established. A few are taken by trolling and still fishing with worms. The larger specimens average about three or four pounds in weight. Two specimens were taken in September, 1922, on worms.

AMPHIBIANS

Ambystoma maculatum (Shaw). Spotted salamander. A single large specimen under a stone at the water's edge.

Rana palustris Le Conte, Pickerel frog. Three recently transformed specimens in shallow water at south end of lake; these may have come from the nearby swamp. Residents of the south end of the island say that frogs are infrequently seen in or about the lake and that the calls are not often heard in the spring.

REPTILES

No specimens were seen in the immediate vicinity of the lake but a small red-bellied snake *Storeria occipito-maculata* (Storer) was found in the road a short distance away and garter snakes (*Thamnophis*) are occasional and the green snake (*Liopeltis*) abundant on the island.

Turtles were not found in the pond nor have they been noticed by those who fished its waters.

SUMMARY

The Isle-au-Haut lake is clearly not the remnant of a fiord. It has no residual inflow nor any indication of prior river erosion. The drainage that keeps it in existence is small and highly obstructed; hence, in some degree no doubt, the lack of a normal circulation of the waters makes them somewhat stagnant and overloaded with organic matter. It is probable that this excess of organic matter has made conditions of living unwholesome to many lacustrine forms of life usual to the lake waters of eastern America. These suggestions, however, still leave many things to be explained, for adaptation is clearly evident in the case of the introduced fish, the salmon, and would hence seem to have been possible for other normal lacustrine species here absent. The boundary of the lake at the south is so obviously barricaded by a rock wall, that one can not ascribe the making of the lake valley to sea action; that is, it seems to have no relation, in origin, to the "goes" elsewhere described as caused by the removal of a joint-bounded rock prism. The tangible explanation of the origin of the lake basin seems now to rest upon the conception of a down-sunken fault bluff of the rocks, bounded and controlled by major fault lines parallel to the axial rock structure of the Island.

J. M. C.

A LIST OF SPIDERS TAKEN ON ISLE-AU-HAUT, JULY TO OCTOBER, 1922, TOGETHER WITH A DESCRIPTION OF A NEW SPECIES

By Sherman C. Bishop

During July, 1922, a considerable number of spiders and phalangids were collected on Isle-au-Haut by Miss Sally Bowditch and Mr. E. Lufkin. A dozen or more additional species were taken by the writer in September of the same year. The list is by no means representative of the spider fauna of the island for in general it includes only the larger and more easily collected species; but it adds something to our knowledge of the distribution of some eastern species and is herewith presented for purposes of record.

Dictynidae

Amaurobius bennetti (Blackwall).

Drassidae

Gnaphosa gigantea Keyserling.
Herpyllus vasifer (Walckenaer).
Zelotes ater (Hentz).

Theridiidae

Steatoda borealis (Hentz).
Theridion tepidariorum C. Koch.

Linyphiidae

Drapetisca alteranda Chamberlain.

Argiopidae

Araneus angulatus Clerck.
Araneus marmoreus Clerck.
Araneus nordmanni (Therell).
Araneus patagiatus Clerck.
Araneus sericatus Clerck.
Araneus trifolium (Hentz).
Cyclosa conica (Pallas).
Meta menardi (latroille).
Pachygnatha brevis Keyserling.
Tetragnatha extensa (Linne).

THOMISIDAE

Misumena vatia Clerck.
Thanatus coloradensis Keyserling.
Tibellus oblongus (Walckenaer).

CLUBIONIDAE

Castaneira descripta (Hentz).

AGELENIDAE

Agelena naevia Walckenaer.
Hahnia agilis Keyserling.

LYCOSIDAE

Alopecosa beanii (Emerton).
Lycosa frondicola Emerton.
Pardosa xerampelina (Kyserling).

ATTIDAE

Dendryphantes montanus Emerton.
Dendryphantes purpuratus (Keyserling).
Salticus scenicus (Clerck).

PHALANGIDA

Oligolophus pictus Wood. One specimen, September.

A CADDISFLY GUEST OF THE FRESH-WATER SPONGE

BY SHERMAN C. BISHOP

Some fragments of a fresh-water sponge* collected in September 1922 in Turner's lake, Isle-au-Haut, Maine, and preserved both in alcohol and by drying, were found on examination to contain a considerable number of the larvae and cases of an interesting micro-caddisfly. Some of the cases were wholly enveloped in the sponge tissue, others only partly overgrown, while a few individuals retained their hold on independence by moving about often enough to prevent permanent attachment.

In the construction of the case a silk foundation is used but the external protective material is composed of the transparent sponge spicules laid first in more or less regular transverse rows then apparently stuck on haphazardly or perhaps simply entangled on the surface. The cases are minute, slightly curved and tapering cylinders varying from 2 to 5 or 6 mm in length and greenish in freshly collected material but turning to light brown in preserved specimens. The smaller end, in perfect cases, is sharply constricted and usually free from spicules; the anterior end has a slightly projecting hood (pl. 1, fig. 2.) Only a single case was observed that had served as a pupal chamber and this was provided at each end with a net work of fine silk supporting heavier rings of the same material (pl. 1, fig. 3). The insect had escaped by cutting away the silken barrier until it hung on one side like the lid of a coffee pot.

The larva (pl. 1, fig. 1) itself is slender and almost transparent and lacks the abdominal respiratory filaments; the legs are progressively longer and slimmer from before backwards. The first legs are decidedly heavier than the others and have the femora provided with serrated ridges bordered on each side by stout spines (pl. 1, fig. 4); the tibiae are widened distally and each armed with a single blunt spine and a few hairs; the tarsi, like the femora, bear serrated ridges which may be opposed to those of the femora to form effective grasping organs. The second and third pairs (pl. 1, figs. 5-6) are long enough to extend to the front of the head or beyond and bear many slender spines or hairs

*1. The sponge has been identified by Prof. Frank Smith as probably *Heteromeyenia ryderi* Potts; positive determination is impossible owing to the lack of gemmules in the young colonies.

Plate I.

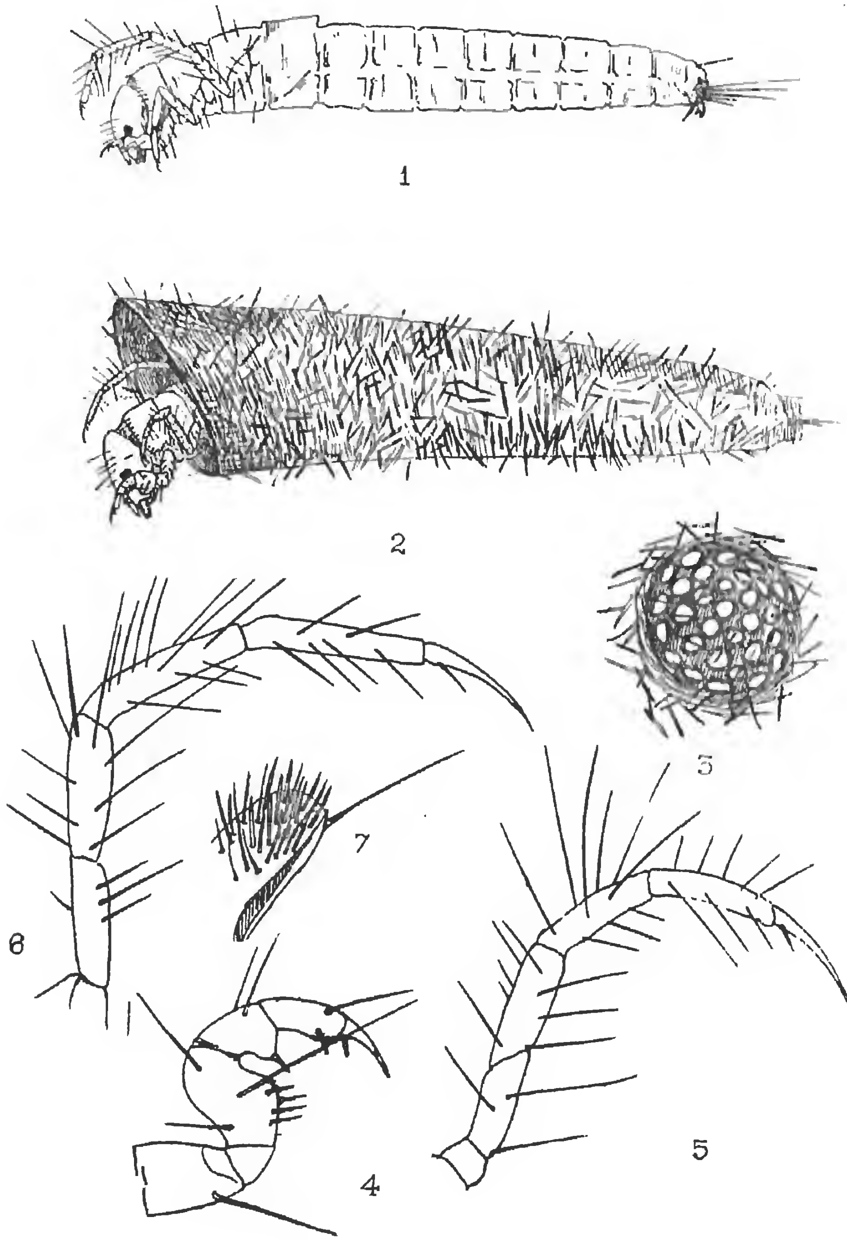
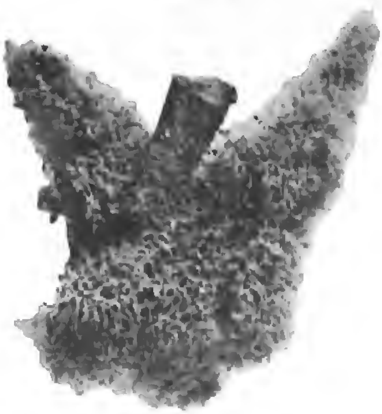


Plate 2.



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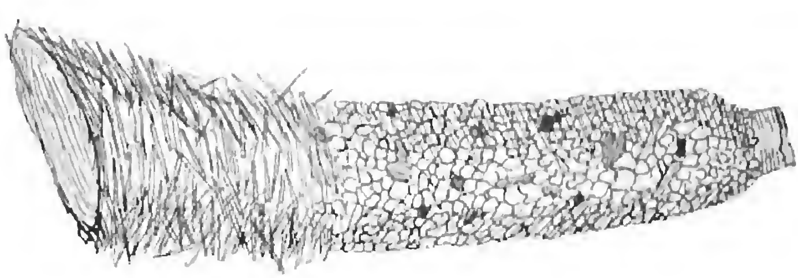

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some of which may perhaps be tactile; the spinose hump on the first abdominal segment (pl. 1, fig. 7) is directed forward and down and backed by a chitinized ridge. The photograph (pl. 2, fig. 1.) shows a small fragment of dried sponge with a larval case attached.

This association is, perhaps, an example of dependent life in its incipiency; for not only do certain individuals maintain their cases free from the growing sponge but one was noticed (pl. 2, fig. 2) which had started to decorate its case with small grains of sand and finished it off with spicules after having grown over half its normal length. If there is any advantage to be derived from the association in the way of food or shelter, it would seem to be a one-sided affair with the caddisfly on the long end of the bargain. When the case is stationary, the sponge probably reacts to it as it would toward any alien bit of rubbish and proceeds to grow around and over it; when the larva continues active, the sponge tolerates it as a necessary evil along with other similar uninvited guests like the spongilla flies, *Climacia* and *Sisyra*. But any temporary advantage is probably offset in the long run by the restrictions placed not only on the movements of individuals but by the limitations imposed by the distribution of the sponge itself.

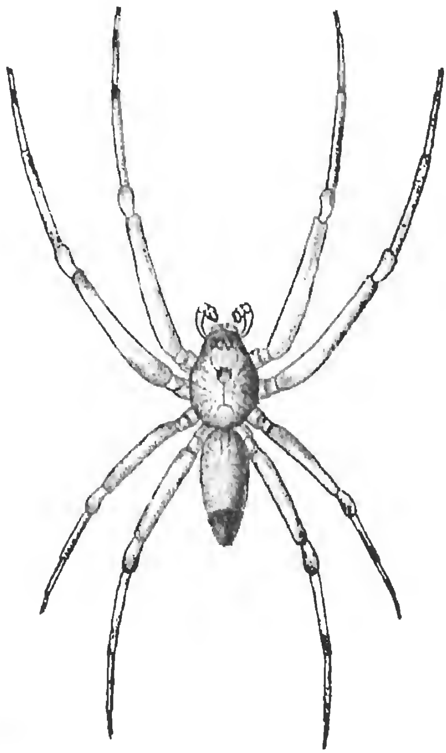
Frederic H. Krecker in the Ohio Journal of Science (1920, 20: 355) reports the discovery of caddis-fly larvae (*Rhyacophilidae*) whose cases instead of being attached to sponges, were supporting living colonies and apparently acting as distributing agents. The larvae were dredged from Put-in-Bay, Lake Erie and appeared to have been actively crawling about in the bottom rubbish. In this case it would seem that the association might be of advantage to the sponge if it, as a normally sessile animal, is more rapidly or widely distributed. At any rate the condition is interesting in its oppositeness to that found in the sponge from Isle-au-Haut.

A NEW SPIDER FROM ISLE-AU-HAUT, MAINE

Microncta bowditchiae nov. sp. (named for Miss Sally Bowditch, the discoverer) Male — 2.2 mm long. Cephalothorax yellowish brown, lighter on the disk; a narrow, curved, dark line from each posterior lateral eye to a small grey area in front of the dorsal groove. Lateral eyes contiguous and surrounded narrowly with black; posterior median narrowly ringed with black and the anterior median in an oval black spot that extends, in front, half way to the lower margin of the slypeus; eyes of posterior row in a straight line, equal in size and equidistant, slightly less than the diameter of one of them apart; anterior row straight or nearly so; the median eyes smaller and closer to each other than to the lateral. Height of clypeus about three times the diameter of an anterior median eye. Chelicera (Fig. 2) yellowish brown, narrowed distally and with a wide excavation on the inner distal third; a large tooth in front on the outer edge of the excavation and several inconspicuous ones on the inner edge; furrow of the chelicera very short unless the wide excavation is to be regarded as an extension of it; a large tooth near the base of each claw on the lower margin of the furrow. Abdomen above light grey with the apical third much darker; below dark except in front of epigastric furrow; legs yellow slightly dusky; sternum large, dusky yellow and prolonged between the hind coxae.

Palpus: (Fig. 1) The tibia is broadly dilated distally and armed with a few fine hairs. The cymbium of the tarsus is angular and has a bilobed apex and two knobs near the base (Fig. 3), paracymbium very broad and flat at the base but narrowed and sharply angled distally.

Remarks: *Micronta rectangulata* Emerton (Tran. Conn. Acad. 1913, 18:217, pl. 2, figs. 5–5*b*) has the chelicera narrowed distally and with a small tooth on the front but the shape of the cymbium and paracymbium is very different and easily distinguished. *Bathyphantes micaria* Emerton (Tran. Conn. Acad. 1882, 6:71, pl. 22, fig. 5) has a cymbium that somewhat resembles it but there is no mention made of the peculiar excavations of the chelicera or of the large tooth in the front. Type locality, Isle-au-Haut, Maine. July, 1922. Type in the collection of the New York State Museum.



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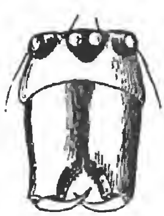

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BOOM BEACH — A SEA MILL

By John M. Clarke

A novel expression of sea action as a geological factor is exhibited on Boom Beach which is a short stretch of the coast on the eastern shore of Isle-au-Haut, only a few rods away from the middle part of Turners Lake. This beach is perhaps a quarter of a mile in length and is bounded at the north and at the south by barricades of the rock pavement of the island which, though not high, exert an effective control of the movement of the waves. The beach is exposed to the full force of the Atlantic storm waves from the east. Doubtless the shallow waters bounding the island play over accumulations of large and small ice-worn glacial boulders, and this material washed up from the shallower depths is mixed with water-worn boulders of rocks indigenous to the island itself. The walled-in character of this sea exposure has resulted in piling up a tremendous mass of very heavy beach material of great width, its crest representing the highest reach of the storm waves, and as a further result the slope of the beach is steep. As the wave action on the beach is controlled by the sentinel rocks north and south, a boulder once caught in this place is ground up and down and back and forth over the other heavy stone of the beach, so that such a boulder seems to be a captive forever. Thus the beach material is made up of various sizes of stones up to a number of feet in diameter, which have been put through this milling process to a greater or less degree. The newer pieces, those which have been recently acquired by encroachment upon the rock beds of the land have only their native angles subdued, but those which have been longer subjected to the process are well rounded and approach a symmetry which is in accordance with the original shape of the angular blocks out of which they have been made. The ultimate result of this grinding process, so far as it is expressed in the form of the boulders, is a perfect or an approximate symmetry in the form of an ellipsoid, or an ovoid, or a spheroid or a discoid. The observer is at once impressed by the very large number of these symmetrically rounded blocks, all crystalline rocks and all shaped by the action of the sea. Nowhere has the writer seen so impressive an illustration of this ultimate result of the action of the sea on a beach of boulders.

This exposition leads to a further consideration for somewhat similar occurrences which are to be seen on smaller beaches similarly controlled by governing lateral rock walls. There is an old physiographic term long used by the Scotch and which the writer has applied on this side the Atlantic, namely, the word "goe" which means the place left on a sea coast through the removal by wave action of a prism of rock originally bounded by more or less vertical joint planes. The creation of such prismatic retreats and endroits on a coast gives it a peculiarly hatched aspect and often when carried to extreme, results in the creation of a natural bridge or a sea gully which may run through a projecting peninsular head from one side to the other. Such *goes* are common in the north of Scotland and in the Orkney Islands. They are also beautifully represented on the shore of the Forillon in Gaspé, where their place is taken by short crescentic beaches. On the south shore of Isle-au-Haut there are places at Western Head and the coves adjoining it, where the approximately north-south direction of the joint planes has permitted the sea to knock out rock prisms, leaving behind little retreats with sharply vertical rock walls and often a beach in which the small pebbles have been symmetrically rounded, the result being the same and due to the same causes as more extensively and emphatically expressed at Boom Beach. The illustrations accompanying this note show very effectively the results of this sort of sea milling.

General View of Boom Beach from the North

The pebbles on Boom Beach. A few selected at random.

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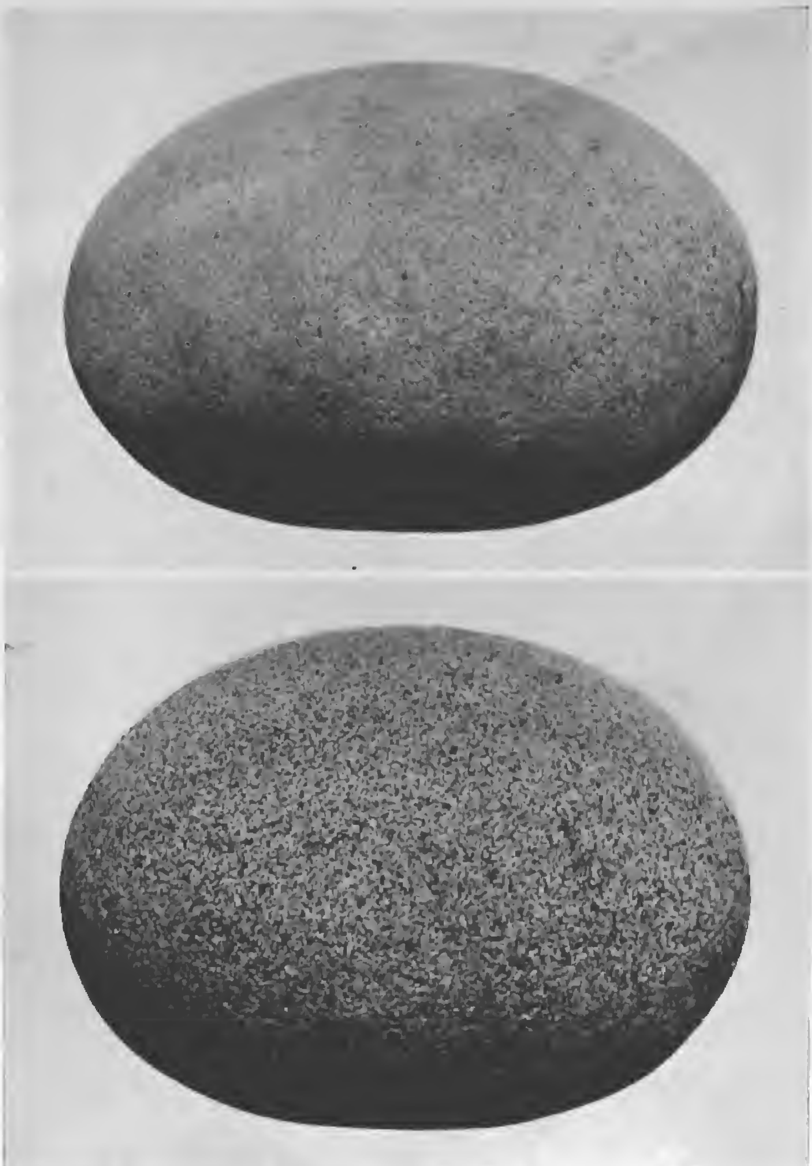

Boulders from Boom Beach showing approximation to perfect ellipsoidal symmetry. These are all blocks of hypersthenite and quartzite.

Boom Beach boulders.

Boulder of perfect symmetry lying on the shore.

Series of small boulders of similar materials, all approximating a perfect symmetry.