70

Published monthly by the

University of the State of New York

BULLETIN 314 JUNE 1904

New York State Museum

Bulletin 63

PALEONTOLOGY 7

STRATIGRAPHIC AND PALEONTOLOGIC MAP OF CANANDAIGUA AND NAPLES QUADRANGLES

BY

JOHN M. CLARKE

State Paleontologist

and

D. DANA LUTHER

Field assistant

ALBANY

UNIVERSITY OF THE STATE OF NEW YORK

1904

Mp113m-Ja4-1700

Price 25 cents

University of the State of New York

REGENTS

With years when terms expire

University of the State of New York

New York State Museum

Frederick J. H. Merrill Director
John M. Clarke State Paleontologist

Bulletin 63

PALEONTOLOGY 7

STRATIGRAPHIC AND PALEONTOLOGIC MAP OF CANANDAIGUA AND NAPLES QUADRANGLES

INTRODUCTION

The region covered by these maps is a classical one in the history of New York paleontology. In the days of the original survey of the old fourth district, 1836 to 1843, Prof. James Hall, the district geologist, frequently made headquarters on the beautiful shores of Canandaigua lake and both then and in later years the richly fossiliferous shale beds exposed along the lake shore and in its ravines, afforded to him inexhaustible resources for collecting their organic remains. As representative of the strata embraced within the "Hamilton group" no series of exposures in the State has been so thoroughly exploited as these. Canandaigua and its lake, 70 years ago, were easily accessible and so were the numerous villages scattered through northern Ontario county, but about the latter the rock exposures have always been few and hard to find because of the great thickness of the drift mantle. Southern Ontario was more remote and though the township of Naples was reached by Hall it was for a brief visit only, and its splendid exposures and interesting faunas were left for subsequent researches.

Canandaigua was the writer's home town and Naples the home of his pioneer ancestors in western New York. During the early years of youthful enthusiasm for geologic study the rocks of Canandaigua and vicinity were the subject of prolonged and careful analysis. In the days from 1870 to 1880 the entire fauna was studied in such detail that the vertical range of every known species, and many before unknown, of the Hamilton stage was established and from other formations large accretions to known facts were made. So productive were the investigations of this period in increasing our knowledge of these faunas that in the "Monograph of the North American Devonian Crustacea," published at a later date as volume 7 of the *Paleontology of New York* nearly 200 figures were given of trilobites and other crustaceans collected by the writer during this time and in this region.

The Portage strata of the township of Naples, as a result of careful researches begun then and continued till the present, opened up a virtually new fauna in the New York series. The study of the Portage fauna, desultory at first, began seriously only when in companionship with Mr D. Dana Luther, it was attacked with unremitting assiduity and in this companionship the exploitation of this fauna has been carried forward throughout the entire extent of this formation in the State. For 20 years no circumstances were permitted to interfere with the yearly joint attack on this problem, and though this long standing companionship in the field has been latterly interrupted by force of circumstance, Mr Luther has diligently carried on the refined stratigraphic study of the Naples rocks and their equivalents while the writer has been more specially concerned in the solution of the paleontologic and bionomic problems to which the faunas have given rise.

In 1885[1] the writer published a geologic map of Ontario county. Up to that time the rock formations of the region had not been delineated in greater detail than given on the old

[1] N. Y. State Geol. 4th An. Rep't.

state map of 1843. This map, which was the summation of some years of observation, served a useful purpose and has been the basis of the maps herewith presented. Accompanying the map of 1885 was a brief account of the variations of the faunas according to the formations represented. Our present data enable and require us to analyze in closer detail variations in sedimentation sometimes accompanied and sometimes unaccompanied by variations in faunation. It was made clearly apparent by the writer's long study of the changes in the fauna of the Hamilton shales and limestones that very few variations of material importance in the composition of the fauna throughout the entire series of these deposits were tangible and this same condition has been shown to prevail in the deposits of this period wherever the sediments maintain the singularly homogeneous character shown in this section.[1]

We have introduced a considerable diversity of coloration on these map sheets but such refined distinctions in sedimentation are now essential to the complete understanding of bionomic conditions and stratigraphic changes during the period of deposition of these strata. They are essential also as an aid to the correlation of the rock section here given to that in adjoining regions of the State. Many of the names may prove to serve only a local, perhaps some of them only a temporary, purpose. Certain of the divisions have however a higher value and indicate periods of uniform deposition over wide areas in western and central New York. An apology or excuse for the refinement of these stratigraphic subdivisions is not necessary. The multiplication of local names as formation terms is one of the imperative accompaniments of progress in the interpretation of ancient marine conditions.

[1] The attempt thus made many years ago to determine a basis of subdivision in these homogeneous sediments on the basis of the range of the fossils, proved as inconsequent as similar efforts subsequently made in this series of sediments. Were one concerned to construct a doll's philosophy from imaginary laws conceived to govern the association of species into faunules the extraordinary uniformity of faunation in these beds should afford an oppugnant problem.

FORMATIONS

The rock formations here represented as units of sedimentation may be grouped in broader divisions in the manner following:

Neodevonic	Chautauquan group	Chemung beds	Prattsburg
	Senecan group	Ithaca beds	West hill
			Grimes
		Portage beds	Hatch
			Rhinestreet
			Cashaqua
			Parrish (lentil in Cashaqua)
			Middlesex
		Genesee beds	Standish
			West river
			Genundewa
			Genesee
		Tully limestone	Tully
Mesodevonic	Erian group	Hamilton beds	Moscow
			Menteth (lentil in Moscow)
			Tichenor
			Canandaigua
			Skaneateles
		Marcellus beds	Cardiff
			Stafford
			Marcellus
Paleodevonic	Ulsterian group	Onondaga beds	Onondaga
	Oriskanian group	Oriskany beds	Oriskany
Siluric or Ontaric	Cayugan group	Cobleskill beds	Cobleskill
		Salina beds	Bertie
			Camillus

SILURIC

General observations. All these formations are so deeply buried under a continuous drift mantle that their variations can be studied only at a disadvantage. We have indicated the contact lines of these as well as the lower Devonic formations as appended, by slightly undulating lines traversing the region in a nearly east and west direction. It is our belief that such lines bound the palpable outcrops over a region which before becoming enveloped in the drift was not deeply channeled and by the rigidity of its rocks was able to resist the erosion which further south has broken up the softer formations into projections and outliers.

Camillus shale

The lowest formation in the rock series and northernmost on the Canandaigua sheet is that subdivision of the Salina group of formations which consists of soft gypseous shale or plaster rock, dark when fresh but becoming light ashen gray on exposure. These beds are both underlain and overlain by thin light gray magnesian limestones or platten dolomites. Entire thickness 50 feet.

On account of the meagerness of the exposures throughout the northern area of the Canandaigua quadrangle the exact position of the contact line between the red or Vernon shales and the gypseous Camillus shales, which is the equivalent of the rock beds of western New York, is not apparent. The lowest rock exposures are along Mud creek below Brownsville and in the bed of Ganargua creek just to the north of the north line of the sheet. Here are two outcrops, one just above and the other about 25 rods below the bridge, which show a few feet of very fine hard dark bluish drab limestones characterized by needle cavities or styliolites, which mark the magnesian limestones of the gypseous deposits of the Salina group elsewhere. These layers are easily broken into small and regularly shaped blocks. Between the dolomites are thin layers of bluish clay shales. In the Goose Egg, an oval hill 1 mile south of Brownsville on the west side of Ganargua creek there occurs the most northerly outcrop of the upper gypsum or plaster bed. The exposure is a small and isolated one and is obscured by drift and disintegrated shale. Gypsum was formerly quarried here. One mile farther south the gypsum outcrops at the foot of the declivity on the west side of the Ganargua creek channel and "land plaster" has been quarried here for many years and ground in Conover's mill near by. In consequence of the expense attending the stripping of the heavy covering of drift, 30 to 40 feet thick, the small amount of plaster produced in recent years has been mined, access to the bed being had through a horizontal tunnel at the base of the hill. The breast of the mine is 14 feet high. The gypsum is purest at the bottom. This bed is a continuation of the one from which "Onondaga land plaster" is obtained in Onondaga county; "Cayuga plaster" in the vicinity of Union Springs, Cayuga co., and "Vienna plaster" along the Canandaigua outlet in the western part of the town of Phelps. It is 30 to 40 feet thick in this region and is composed of the hydrous sulfate principally in the impure condition and not infrequently appears crystallized as selenite and in flaky condition mixed with very soft dark bluish clayey shale. Where the gypsum predominates the rock has a distinctly crystalline appearance but where the proportion of shale is greatest the lines of sedimentation are very apparent and it has every resemblance to ordinary soft dark shale. Joints occur everywhere throughout the rock beds and through these the percolating waters have had access to the gypsum deposits and have frequently removed them, thereby causing a settling of the shale material adjacent and leaving hemispheric masses between the resultant depressions. Doubtless the present hummocky condition of the beds, not alone in this region but throughout the area of surface exposure of Camillus shales is largely due to causes connected with the change from anhydrite to the hydrous sulphate or gypsum. There are a few thin even layers of hard magnesian limestone interstratified with the gypsum and at the top of the bed there are 8 to 10 feet of soft blocky shales containing but very little gypsum. This latter bed is exposed at the east end of the Lehigh Valley Railroad cut 1 mile east of the village of Victor, and also in the bed of Mud creek near the Lehigh Valley Railroad bridge and at Fredon or East Victor. The more productive development of the gypsum industry in this region however is in the territory just east of the quadrangle in the town of Phelps, where for more than 70 years it has been produced on a large scale, though the production has now notably fallen away.

Bertie waterlime

This term, derived from Bertie township in western Ontario, is specially characterized by the abundant presence of the crustaceans Eurypterus, Pterygotus and Ceratiocaris. It consists chiefly, in the Canandaigua region, of hard dark impure hydraulic limestone in thick layers separated by thin seams of dark and apparently carbonaceous matter. The rock weathers to a light brown or buff. Thickness 40 feet.

The passage from the Camillus shales into these beds now termed Bertie waterlime is a very gradual one, the loss of gypsum being replaced by the addition of alumina and carbonate of magnesia, so that the succeeding stratification becomes highly dolomitic. The distinguishing mark of the division as already noted, is the presence of merostome and phyllocarid crustaceans, which attained at this time their culmination of development.

Along the creek for 10 rods below the bridge at East Victor are from 30 to 40 feet of hard compact dolomites with distinct lines of sedimentation, having a characteristic clink and conchoidal fracture. The dark blue of the rock changes rapidly on exposure to a light, dark or ashen gray. The same horizon appears in the Lehigh Valley Railroad cut 1 mile east of Victor, though the exposure here is for only about 6 feet at the bottom, just over the Camillus shales. Eastward also in the adjoining quadrangle occasional exposures are seen. Remains of the crustaceans referred to are by no means as common here as at the well known localities to the west at Buffalo and to the east in Herkimer county but the horizon is doubtless the same, and segments, heads and appendages of these creatures are not uncommon. With them is frequently found a Leperditia, probably L. alta Conrad and the brachiopods Whitfieldella laevis Vanuxem and Leptostrophia varistriata Conrad.

Cobleskill shale and dolomite

This is a rather obscure representative of a formation which has recently been shown by the investigations of Hartnagel to extend without interruption from eastern New York to Buffalo and beyond. It is regarded as deposited soon after the close of the period of the Salina and it here consists of dark, hard shale and straticulate, impure limestone, succeeded by a thick bed of massive dolomite, the top of the formation consisting of platten dolomites. The thickness ascribed to these beds is approximately 42 feet, of which 18 feet are assigned to the shale, 20 feet to the heavy dolomite and 4 feet to the platten dolomite on top.

The section at East Victor exposes the massive beds of this horizon, immediately below the topmost layers constituting platten dolomite. In the high bluff on the east bank of the creek in the rear of A. B. Cooper's residence there are beds of dolomite which, aggregating 8 feet in thickness at the base, are succeeded by 15 feet of dark bluish shale and these are overlain by 6 feet of dolomite like that below. Overlying these layers and exposed for many rods in the bed of the creek is a mass of tough argillaceous limestone 15 feet thick that bears Stromatopora quite abundantly and seems to indicate a western continuation of the well known Stromatopora bed at this horizon in Onondaga county. It is dark brownish gray when freshly broken and usually takes on a darker tinge of brown for a time owing to the exudation of a minute quantity of petroleum but finally turns to a light yellowish drab. It contains many small aggregations of selenite crystals, and the boulders from it by reason of their peculiarly tough character have survived glacial transportation and grinding and are strung in great numbers over the contiguous territory to the south, have many small cavities and a general scraggy appearance due to the weathering out of these crystals.

A bed of shaly dolomite 4 feet thick is the highest member of the group. This appears in the west bank of the creek a short distance below a low fold 60 rods north of the New York Central Railroad bridge at Mertensia. There are several small exposures of these upper beds in this vicinity, the most extensive of which is in the section afforded in the Hog hollow or Great brook ravine on the west side of Boughton hill, where 25 feet of the top layers are well displayed. The two upper members appear ½ mile east of Fredon and have been quarried on the land of A. B. Cooper and Hiram Powell, and at the latter place there are the ruins of two limekilns where material from the Stromatopora layer was formerly burned and then hauled to Conover's mill and ground for cement; there are several other abandoned kilns in the vicinity in which quicklime was once produced from the purer layers below. No other exposures of these beds have been observed in this western portion of Ontario county, but they are of more frequent occurrence eastward, just beyond the line of the quadrangle and are there more freely worked and contain organic remains in greater number. The fossils occurring here, besides the Stromatopora, are Leperditia alta Conrad and L. scalaris Jones, Cyathophyllum hydraulicum Simpson, Spirifer eriensis Grabau and Whitfieldella sulcata Vanuxem. Fragments of Eurypterus also occur at this horizon.

DEVONIC

General observations. The division line between the great Siluric and Devonic systems is very well marked here on account of the entire absence of the Helderbergian limestones, which, in the eastern part of the State, represent the incipient stages of Devonic deposition. There is good reason to believe that the uppermost Siluric beds which we have just considered were for a time exposed above water to the action of aerial decomposition and erosion before the later sediments were laid down on them. This has been found to be the case in Erie county, where the eroded upper surface of the Cobleskill dolomite is overlain by a regular deposition of the following formations.

Oriskany sandstone

In eastern New York this formation takes on, in certain places, the character of an arenaceous limestone but it is an interrupted deposit in its course across the State from east to west, though in places tremendously abounding in fossils. At Oriskany Falls and at Union Springs it assumes the character of a more or less friable whitish sandstone. The formation constantly thickens and thins, forming lenses, as in Cayuga county, sometimes 20 or more feet thick and then again thinning to actual disappearance. As it becomes thin it usually assumes the character of a hard compact quartzite composed of silicious grains cemented by a deposit of silica. Throughout western New York this thin bed frequently contains angular masses, evidently washed from the hydraulic limestone beneath and thus forms a breccia. In Ontario county the exposures of this rock are largely confined to the township of Phelps a few miles to the east of this quadrangle. From its uneven thickness and general appearance at this place and the fact that it fails entirely within a half mile on the east and a mile on the west it would indicate here as elsewhere, that it was a deposit of a sand bar running out from the irregular coast line of the time. This deposit in the town of Phelps is the last of the lentils which the formation assumes in western New York. It is 6 feet, 6 inches thick and consists of several distinct layers. In the upper part of the top layer there are many elongate rounded pebbles and cobbles of black quartzite embedded in the light sandstone and the rest of the deposit is largely of coarse sand with a lumpy or slightly concretionary structure. In these outcrops the only evidence of fossils is the presence of a few obscure corals. On Mud creek 50 rods below the railroad bridge at Mertensia, there is an exposure of the same material but more quartzitic, containing the waterlime pebbles, the layer being 6 to 8 inches thick. In Phelps the sandstone was at one time quarried for firestone for use in the glass furnaces at Clyde.

Onondaga limestone

In general character this important deposit is a compact, dark bluish gray limestone frequently carrying interbedded layers of chert nodules, the limestone itself being bedded in layers from 6 inches to 3 feet in thickness. It contains a large amount of carbonaceous matter, which appears on the surface of the layers and in the shale partings between them and discolors most of the strata, frequently giving them a decidedly black appearance. It is removed by gradual decomposition on exposure and the rock slowly assumes a very light bluish gray color. The chert or hornstone is usually nearly black and slightly translucent, but sometimes lighter colored and bluish. It is very unevenly distributed in the beds in some of which it predominates and in others is entirely absent. The nodular layers in which it lies are frequently continuous for long distances and owing to their resistance to decomposing agencies, old exposures of the beds and the innumerable boulders and fragments from them strewn over the region south of the escarpment formed by this formation, have a peculiarly ragged and scraggy appearance. At some of the outcrops one or more of the layers are shaly but only a small proportion of the formation is of this character and all of the remainder, wherever the amount of chert is not too large, is compact and durable and exceedingly valuable as building stone and for the production of quicklime. If the chert is entirely absent the limestone is easily quarried and makes very handsome dark gray cut stone building material, and the cherty masses have been extensively worked for bridge abutments, canal locks, retaining walls and kindred purposes.

This formation covers a belt 1 to 3 miles wide across the towns of Mendon, Victor and Farmington and some exposures of the uppermost beds occur also in Canandaigua. The more striking outcrops of the rock and those which have long been most available for exploitation are in the region just to the east, specially in the towns of Manchester and Phelps. In a general way it may be stated that at the base of the formation there are from 3 to 5 feet of limestone, very rich in corals and without any chert. The rest of the formation which attains a total thickness of about 120 feet has both chert and shaly layers scattered through the limestones at irregular intervals.

In Farmington the lower beds crop out on the north side of the road leading from Manchester to Victor and have been extensively quarried, the stone used in the construction of the Erie canal locks at Macedon having been obtained from this locality.

In the bed of Mud creek the base of the formation appears about 60 rods below the railroad bridge at Mertensia, in a low anticline, the axis of which crosses the stream diagonally. Here it rests on the Oriskany sandstone and the lower 5 feet are free of chert and are crowded with corals, the stratum being identical in character and appearance with the basal layer farther east. These layers are capped by a series of chert-bearing beds, together aggregating 5 feet in thickness. Above the bridge there is an extensive picturesque cascade and an exposure of 40 to 50 feet of the middle and upper beds, the outcrops extending though not continuously, 100 rods south of the cascade. The rock at this place has been worked for construction stone.

In the section along Great brook or Hog hollow at Victor the lower layers appear overlying the Oriskany and at this point the rock was formerly quarried both for building stone and for burning. In the ledges of the creek above the quarry are some of the higher cherty layers.

For the most part however the formation is buried under the drift and from this point to the western limit of the sheet no other outcrop has been found.

The higher layers of the limestone, lying with glaciated surface beneath the soil cap, are seen in the old Giddings quarry, now known as the Bacon quarry just to the east of the edge of the map.

In general it may be said that this formation forms the most important repository of valuable building material within the region covered by the map, and furthermore in the harder chert layers is a convenient and inexhaustible source of road material not inferior in quality to the field stone that has been generally utilized in the county in recently constructed roads.

Marcellus shale

The term Marcellus shale has been generally applied in New York geology to a black and dark blue shale formation lying immediately on the Onondaga limestone. The lower boundary of the formation is always perfectly clear but not so with the upper, for the mass passes gradually into the lighter gray shales of the Hamilton group above. At Marcellus village, Onondaga co., from which place the name is derived, only the lower layers of this black shale are well exposed and our observations both in that region and thence westward indicate the desirability of restricting the term Marcellus to these lower shales, which are typically exemplified in the original locality but are better delimited upward in Ontario county by the presence here of a limestone cap—the Stafford limestone. Using the term in this restricted sense the Onondaga limestone is overlain everywhere by black slaty shale with a few thin calcareous layers and rows of spheric calcareous concretions. The shales are highly impervious and argillaceous and withstand exposure so well that their outcrops are usually vertical or overhanging cliffs in a region where there has been but little deep stream-cutting. Owing to their rigidity they are highly jointed and rhomboidal, triangular and diamond-shaped slabs being characteristic of all surface exposures. It is difficult to estimate the thickness of this bed but it appears, from comparison of outcrops here with the total thickness afforded by the Livonia salt shaft section where it was 43 feet with a slight tendency to increase eastward, to be about 50 feet. The actual contact of these beds with the underlying Onondaga limestone has not been observed, but the lowest outcrop of the formation on this quadrangle appears on the west side of the fill on the New York Central Railroad, just north of the cut near Padelford. The higher beds are well exposed in this same cut where they are densely black shales with some thin limestone layers. The same beds appear along Mud creek about a mile south of Mertensia.

The distinctive character of this shale as an initial part of the beds which have heretofore generally been assigned to the Marcellus stage, is its uniformly bituminous nature and consequent dark color and its very small proportion of lime content except in the thin calcareous beds themselves.

Stafford limestone

The group of strata which have customarily been incorporated within the general term Marcellus shale embraced an interesting limestone layer, the presence of which was early noted by Professor Hall and which was termed by the writer some years ago *Stafford limestone*, on account of its high development at Stafford in Genesee county. This is a dark chocolate and somewhat nodular limestone, very hard when fresh but breaking easily into angular fragments on exposure. We have shown in various publications that this formation extends eastward with a diminishing thickness and we know that its last surface appearance is along Flint creek in the southwestern part of the town of Phelps, Ontario co. Though not exposed to the eastward it is evident that the formation in slight thickness (it has a thickness of about 8 inches in Phelps) occurs as a thinning wedge through this area, for the very characteristic blocks of this rock are quite freely scattered south of the line of outcrop and specially in the east bank of Mud creek. Two miles south of Mertensia the blocks are so common and in such a condition as to indicate very slight removal from place.

Cardiff shale

The upper beds, heretofore generally included in the old term Marcellus and termed by Vanuxem the "Upper shales of Marcellus" are finely shown in and about the village of Cardiff, Onondaga co. As we have restricted the former term, it seems best to adopt for the succeeding layers a name derived from these excellent exposures near the typical region, as in Ontario county they are nowhere seen to so good advantage.

The Stafford limestone is overlain by a series of dark calcareous and black slaty shales with thin layers of fossiliferous limestone. Both limestone and shales weather to a light ashen gray on long exposure. So far as the fossil contents are concerned they are not essentially unlike those of the darker shales below but the gray aspect of the beds and their much higher calcareous content indicate a distinctive difference, which is readily marked throughout this region. Outcrops of these layers are again very few. The best of them is in the bed and sides of Mud creek at its confluence with Shaffer creek in the northeastern corner of the town of East Bloomfield. They are also exposed in the upper part of the railroad cut section just south of Padelford station. Directly over the line of the quadrangle to the east is an exposure on the east bank of the Canandaigua outlet below Chapinville, and here some of the harder layers were at one time quarried for flagstone and used in the village of Canandaigua but they proved to check very rapidly under exposure and wear. For a quarter of a mile this exposure is continued in the bank of the outlet. At no exposure is the entire thickness of this bed revealed. The heaviest mass of material shown at any one place is in the section on Flint creek just south of Phelps, Ontario co., where there lie on top of the Stafford limestone about 50 feet of these shales, the calcareous material increasing toward the top though the dark shales predominate throughout. The gradual increment of lime content makes the passage from this bed into that following essentially imperceptible, but there are accompanying notable distinctions in the composition of the fauna. Taking into account a proper allowance for dip it is estimated that the thickness of the Cardiff shales is here about 100 feet.

Skaneateles shale

This term was applied by Vanuxem to the beds immediately overlying the upper Marcellus; and exposed on both sides of Skaneateles lake at the north end. They are evidently continuous into the Canandaigua area without essential contraction or change and hence the early term is now employed for them rather than the designation Shaffer shale incidentally used in a recent tabulation of these formations. With the increase in calcareous matter the shales become hard, blue black, in places quite black, passing into light and softer beds above with layers of soft impure limestone. For a thickness of 125 feet this shale bed keeps its distinctive characters across the Canandaigua sheet though the distinction is based on comparatively few exposures. These deposits are exposed in the bed of Mud creek south of the highway bridge near the junction of Shaffer creek, ½ mile north of Wheeler and also along Shaffer creek at ½ to ¾ mile south of Wheeler. A slight exposure of the black shales is also shown in a small drainage section just below the Robertson quarry adjoining the New York Central Railroad on Fort hill in the eastern part of the village of Canandaigua. They are shown in nearly full strength in Miles gully in the town of Hopewell, just east of the east line of the quadrangle.

Canandaigua shale

Including the Centerfield limestone at the base

Two terms which have become ingrained by long usage in the nomenclature are the *Hamilton group* and the *Ludlowville shales*. The former, introduced by Vanuxem in 1840, was at no time employed by the original state geologists in any other form and it is evident that the significance here of the term *group* is its reference to the variability of the strata in the typical Madison county sections where they are sandstones, arenaceous and argillaceous shales, not a composition of defined lithologic units. In other words the term is used with the same breadth of meaning as other unit terms of the series and not as the word was subsequently employed in the final reports of the geologists nor in the widely different sense made use of by Dana and generally current. The division was clearly defined and its place in the series is precisely that ascribed to the Ludlowville shales in the Cayuga lake section as was defined by Hall in 1839. Ludlowville was not altogether well chosen as exemplifying the latter division, for the Tully limestone is present in the village and the Moscow shales beneath; one must go afield to find the true Ludlowville strata, but it is evident that Professor Hall's conviction at that early day that these were the representatives of the Ludlow shales of England, influenced his choice of name. We would reject neither name in favor of the other. Each expresses essentially the same interval but a differing series of sediments and some marked distinction in fauna. Each will be found to have a definite meridional value. Hence further west and in the area here under consideration we find still other differences expressed in this interval both lithologic and faunal and are constrained to express these by the terms employed above.

The Canandaigua shale is constituted of soft, dark bluish and gray calcareous shales with impure limestone beds at the bottom, and irregularly nodular calcareous beds abounding in corals toward the middle of the formation. This is a highly fossiliferous mass and its distinction from the beds beneath lies not alone in the nature of its lithologic character, but essentially in the abrupt manifestation of the highly profuse and typical Hamilton fauna. The Skaneateles and Cardiff shales have been regarded as a kind of transition deposit from the typical bituminous Marcellus shales indicating the gradual approach and encroachment of normal Hamilton conditions together with the advance of the Hamilton fauna. The estimated thickness of the Canandaigua shale is about 125 feet. It is excellently exposed along Shaffer creek immediately south of the exposure referred to above and about a mile north of the village of Centerfield. At this locality the lower calcareous layers and the shale overlain by the coral beds are admirably exposed and have been a most prolific source of fine fossils. These beds also appear within the village of Canandaigua, there being exposures of the impure calcareous beds on east Gibson street at the now abandoned Maggs quarry and also in the more recently opened quarry on the Robertson property south of the Chapinville road. Here the beds, when fresh, are a fairly compact limestone but their schistose character soon checks them on exposure, and they have never proved a satisfactory construction stone. They are however enormously prolific in corals and represent the coral reef better exposed on Shaffer creek. It is probable that beneath them lie the shaly beds, but the limestones which lie near the bottom on Shaffer creek and which are of more compact character, though somewhat more argillaceous in composition, may prove to be absent here. Below the Robertson quarry, to the New York Central Railroad tracks, is a small drainage way which gives indications of the underlying beds down to the blue black Skaneateles shale. The exposure however is not sufficiently clear to demonstrate the presence of the limestone beds referred to. If they are here they would serve as a more substantial building stone for rough purposes such as foundations and cellar walls, than the stone above, that is now or has been worked for this purpose. These lower limestones, which are specially characterized by their fossil contents and have produced some species which have not been found elsewhere, have been designated in a subsidiary sense as the Centerfield limestone.

The upper beds of the Canandaigua shale outcrop on the east shore of Canandaigua lake at Cottage City and in the ravine of Gage's creek and Deep run. On the west side of the lake the shale beds are well shown in the cliffs between Tichenor and Menteth points below the Tichenor limestone, and from Tichenor point northward there are several small outcrops along the side hill as far as Hope point and over the region to the westward; lying just at the lower declivity of the rise of land the rock appears where the drift mantle is thin.

This mass of sediments is probably equivalent in part to the *Ludlowville shales* of Hall, but at Ludlowville a limestone called by Hall the *Encrinal limestone* was taken as a line of division between the shale masses, the upper being called the Moscow and the lower the Ludlowville. It is yet to be determined whether that Encrinal limestone is continuous with the Encrinal or Tichenor limestone of the section under consideration and for the present we can not employ here the name Ludlowville with entire security. Hence the term Canandaigua shale is employed on behalf of more accurate, though perhaps provisional expression.

Tichenor limestone

This name is applied to a compact layer of hard bluish gray often crinoidal limestone which has a thickness of about 1 foot. It is separately designated for the reason that it is a continuous formation across this area and well to the east and west beyond it. It contains some of the characteristic fossils of the rock but they are not specially abundant and are frequently replaced by depositions of strontianite. This rock has been commonly known as the Encrinal limestone, a name applied to it by Hall as long ago as 1839 and has been used by many writers in application to limestone layers lying at actually distinct horizons in these rocks, specially from the meridian here under consideration to Lake Erie. On comparison of this section with that on Cayuga lake where the Ludlowville shales were originally defined and the typical exposure of the Encrinal limestone was located, it was found that there is no concurrence in the horizons indicated there and here by the same term. In view of the various limestone strata that have been referred to under this name and its extraordinarily frequent employment throughout all geologic formations with a great variety of stratigraphic meanings, it is best to abandon the term altogether. At Tichenor point the limestone is exposed along the roadside at the opening of the ravine and it reappears on the shore of the lake just south of Tichenor point where it forms a low but well marked anticline cut off at one end by a slight displacement. Here it dips under the water and reappears at the north side of Menteth point forming a broad platform at the water level.

These are the best outcrops of the formation known in Ontario county and the rock also appears slightly in the lower part of the Miles gully in Hopewell and on Flint creek south of Castleton. A limestone of similar character is exposed in the bed of Beebe brook, West Bloomfield, but it is not altogether certain that it belongs to this horizon.

Moscow shale

The Tichenor limestone is overlain by a mass of mostly soft, light bluish gray calcareous shales, becoming darker toward the upper part. Thin layers of limestone usually extending but a few rods and irregular calcareous lenses largely composed of fossils are of frequent occurrence. At the base of the mass lying immediately on the Tichenor limestone the shale is very compact and highly calcareous and breaks out in irregular slabs. This portion of the deposit is very persistent over a wide area and is characterized by the abundance of crinoids which it contains in the most admirable preservation. Indeed this is the horizon which has furnished all the superior crinoid material from these rocks in this part of the State. It is this layer, which with the Tichenor limestone has in previous reports, specially the description of the geology of Ontario county published by the writer, been designated as the Encrinal band. An exposure of this layer on the farm of Mr Sisson, not far from the village of Muttonville, now Vincent, in the northern part of the town of Bristol, afforded to the collectors of the State Museum in 1860, C. A. White and C. Van Deloo, an immense amount of fine material, constituting the best preserved and most complete series of crinoid calyxes ever obtained from the rocks of this State. This exposure is no longer accessible and appears to have been overgrown by vegetation with the drying up of the brook. Seventy-five feet above the Tichenor limestone is another limestone layer lying in the midst of this shale mass. This is here designated as the

Menteth limestone, and is worthy of special remark for several reasons. It is a well defined bench mark in these Moscow shales entirely across the map. As a rock it is a compact layer about a foot in thickness and usually very pure but in places it proves to be quite argillaceous and nodular. It is a notable repository of the fossils of the fauna and these are very frequently replaced by silica with a degree of delicacy and perfection seldom equaled; perhaps not elsewhere in the paleozoic rocks of the State nor in rocks of ancient date from any locality known to the writer is this replacement so satisfactory to the student of the biologic problems of paleontology. The etching of the purer part of this layer has afforded a most beautiful series of the species of the fauna and as these are retained not alone in adult condition but from the earliest shell-bearing stage on, the material has already been the subject-matter of several important treatises on phylogeny, ontogeny and the systematics of different groups of organisms. We may refer to the papers of Beecher on the trilobites and on certain of the corals, to Grabau's investigation of the corals, to the writer's publications on some of the brachiopods, etc. An indication of the delicacy of these replacements is afforded by some of the shells of the brachiopod Productella in which the hairlike spines on the body of the shell projecting for a length greater than the diameter of the shell itself, are preserved without defect. This Menteth limestone forms the first falls in the ravine at Tichenor point and also in that at Menteth point. It and the shales beneath are well exposed in these places and the shales themselves specially along the shore of the lake between the two points. On the opposite or east side of the lake both shales and limestone are found in Gage creek and Deep run, and again on the east side from Menteth point southward to Foster point. Farther north is an exposure of the limestone and some of the underlying shales at Hope point ravine.

The upper part of the Moscow shales is exposed on the east side of the lake in the Gage creek ravine where, about 50 feet above the Menteth limestone, a series of nodular layers of limestone 2 feet thick form a low cascade. Also in the ravines of Bennett's landing, Gooding landing, Long point and along the lake road and shore to the Gorham-Middlesex town line. The same series is displayed on the west side of the lake from $\frac{1}{3}$ mile south of Black point northward to Foster point, and in the upper parts of the Menteth, Tichenor and Hope point gullies. They are shown in the bed of Shaffer creek $\frac{1}{4}$ mile north of the Gooding schoolhouse near the western boundary of Canandaigua township and also in the Bristol valley in several small ravines on the east side between South Bloomfield and Vincent, and in the lower part of the ravine on the east side of Baptist hill.

Tully limestone

Ontario county includes the westernmost and final appearance of this important, though relatively thin, rock formation. In the towns of Geneva and Seneca to the east and also in Gorham, except close on the shore of the lake, this limestone appears with constantly diminishing thickness, and its last appearance is in Gage creek about 40 rods east of the eastern boundary of the map. Here it is a bed of dark bluish gray, hard, brittle limestone and at its last exposure attains a thickness of 2 feet and 8 inches. Doubtless the stratum extends a mile or more beyond this point to the southwest, as some loose blocks 8 inches thick, apparently but slightly displaced, lie in the bottom of the small gully at the side of the road leading eastward up the hill from Bennett's landing. Eastward of this region and throughout central New York as far as Chenango county the Tully limestone is prominently developed and attains at its maximum a thickness of from 20 to 30 feet. On the Canandaigua sheet at all other exposures except those mentioned, the Moscow shales beneath and the Gorham shales above are in contact or separated by lenticular discontinuous layers of iron pyrites from 10 to 50 feet on the edge and 1 to 4 inches in thickness, the material of which is very hard and in damp places is not affected by exposure but in cliff faces is usually disintegrated. This singular deposit is exposed in the ravines on the east side of the lake from Gooding landing southward to Fishers and in the shore cliffs to the Gorham-Middlesex boundary. On the west side from just south of Black point along the shore and northward in ravines at Grange landing, Victoria glen, Foster point and Menteth point; also following the Moscow shales in the localities in the Bristol valley already cited. This layer of iron pyrites is continuous from this region westward to Lake Erie and indicates with striking persistence the horizon of the Tully limestone as a plane of division between the Hamilton group of formations beneath and the Genesee above.

The Tully limestone itself as exposed in Ontario county localities to the east is a very dark bluish gray rock weathering at first to lighter shades of blue and after long exposure to an ashen gray. It is in two or three layers that are very hard and apparently compact when freshly quarried. On exposure the rock checks along irregular seams and develops a tendency to split into irregular angular fragments an inch or two in diameter. It has been used for construction stone and at one time was burned for quicklime near the village of Gorham. On Fish creek 1¼ miles directly east of Reed Corners, where the highway crosses a small brook, is an exposure showing 4 feet and 2 inches of the limestone, and this exposure seems to have been noted in the report by Professor Hall on the geology of this region in 1843, then regarded as the most westerly appearance of the rock. A more extensive exposure is shown however on lot 53, 1 mile southwest of Reed Corners where the north and south "middle road" crosses a small brook flowing west into Canandaigua lake from a ravine about 40 feet deep and 50 rods long above the highway. Here the limestone forms a floor in the ravine for 2 rods and produces a cascade 8 feet high. The exposure continues for 10 to 12 rods on both sides of the gully and at the cascade the total thickness is 5 feet, 10 inches. Still another outcrop is found 2 miles south of the latter on the lake road from Rushville to Canandaigua near the residence of Mr Merritt Cole. This is the outcrop referred to as being near the eastern limit of this map and here the exposure shows not only the black Gorham shales above but the soft Moscow shales beneath. It is separated by a thin shaly seam into two layers, and in the lower layer iron pyrites is highly abundant in nodules, probably representing the commencement of the pyrites layer, which from here westward is the sole representative of this formation. The place of the Tully where the limestone is wanting and the pyrite layer not clearly apparent is always well defined by the sharp line of contrast between the gray Moscow shales beneath and the overlying black Gorham shales.

The Tully limestone, as has been recognized since the observations by Conrad in 1836-37, is distinguished by the presence of the species Rhynchonella or H y p o t h y r i s c u b o i d e s and the equivalency of this geologic horizon with the Cuboides zone of Europe has been a fact of general recognition for more than half a century. This fossil is very abundant in the outcrops in Ontario county but the rest of the fauna is essentially that of the underlying beds of the Hamilton group, specially the Moscow shale. We shall presently note in more detail that the fossils contained in the pyrite layer have all been singularly dwarfed by the unfavorable conditions of growth and are regarded as representing stages of arrested development of Hamilton species, the characteristic H y p o t h y r i s c u b o i d e s not having been found therein.

Genesee shale

This term was originally applied by Hall to a division on the Genesee river section consisting of very dark bituminous beds at the base becoming lighter colored and more sandy upward. The highly bituminous beds are distinctly defined by their character and their definition at the top by the Genundewa limestone. It was clearly this excessively black mass of shale that it was intended to distinguish by the name Genesee and as it is now important to refine the subdivision of this series of sediments for more exact correlation, it is here proposed to restrict the term Genesee to this lower member only.

Directly over the Tully limestone, or its horizon when absent, lies a mass of densely black bituminous shale becoming very fissile on exposure and splitting into large flat plates. Owing to their rigidity these shales are traversed by parallel series of joints intersecting each other at different angles and producing in cliff exposures striking masonry effects like buttresses and bastions and on the surface of horizontal exposure equally striking tesselations, triangles, rhomboids, diamonds and kindred forms. Intermingled with these beds are well defined horizontal rows of calcareous concretions. Occasionally a thin plate of limestone is shown. The beds also contain iron pyrites in nodules and nodular layers. This mass at once recognized by its structural characters as indicated has a thickness of 95 feet and is terminated by the Styliola limestone or as here designated, the Genundewa limestone. All these shales are extremely sparse in fossils, more highly bituminous beds showing remains of plants and Conodont teeth, and where the beds become a little bluer and slightly calcareous are Lingulas and Orbiculoideas with Pterochaenia fragilis.

These strata are finely exposed all through the upper parts of the ravines on the east side of the lake from Gooding landing southward to Fishers and in the shore cliffs to Genundewa which lies at the base of Bare hill as it is termed on the map; on the opposite side of the lake in the shore cliffs from Hicks point northward to Black point, and in the lower part of the ravine at Seneca point and the upper parts of ravines back of Grange landing, Victoria glen and Foster point, and throughout most of the rock section in the Menteth ravine back of the village of Cheshire. In the Bristol valley the upper parts of all the ravines heretofore mentioned from South Bloomfield to Vincent and also at Baptist hill show these rocks. They appear as far north as the upper reaches of Shaffer creek near the western town line of Canandaigua, and west to Baptist hill along the valley of Beebe brook.

Genundewa limestone

A dark gray limestone in layers of from 2 to 10 inches in thickness separated by dark or black shale. Some of the layers are even and flaggy, others are concretionary and nodular. Where purest the limestone is almost wholly composed of the shells of

Styliola (Styliolina) fissurella and from that fact has taken the name of *Styliola limestone,* by which it has been generally known. The horizon is well marked and divides the mass of Genesee deposits into nearly equal parts in this section. It is a persistent stratum and has been traced to the east as far as Seneca lake and westward to Lake Erie. The character of this rock is well displayed at the typical outcrop on the shore of the lake at the foot of Bare hill or, as it should be termed, Genundewa. Here it consists of three layers of rather soft and slightly shaly limestone, the rock being impregnated throughout with myriads of the shells of Styliola; is highly bituminous and hence very dark when fresh. The lowest of these layers is 8 inches thick, the second, 7 feet higher, is 6 inches and the third, 6 feet above, 10 inches, making the total thickness of the entire band including the intervening shales, 15 feet. These layers increase in thickness westward, become less shaly and more nodular, and are eventually consolidated. On account of the durability of this rock it is a permanent feature in all exposures of this horizon and as its peculiar character makes them easily recognizable the Genundewa limestone is important as a stratigraphic bench mark. The rock is of singular interest from a paleontologic point of view as will be noticed hereafter. Its calcareous nature being largely due to fossil remains it has afforded a fauna of considerable scope. We find the best exposures of this limestone in the county in the cliffs north of Hicks point and in the Seneca point ravine where it produces the first cascade, also in the Victoria glen and Foster ravine and on the south branch of the Menteth brook where it produced the high cascade ¾ mile south of Cheshire. The point last named is the spot at which the rock was originally located by the writer, though specimens from it had been generally known to students for some time before. It is also displayed admirably at the mouth of the Wilder ravine at Bristol Center and in the ravine on the opposite side of the Bristol valley. In Mill creek or Mill gull in the town of Richmond there is an exposure several rods long in the bed of the stream and the limestones are well developed and highly fossiliferous.

West River shale

Fine, blue black or dark gray shales with thin bands of black slaty shale at intervals of 2 to 6 feet. Spheric or oblong concretions are common, occurring singly or in rows. A few thin, sandy flags occur in the upper part of the beds. These shales are contrasted with the Genesee shale below by their lighter shade and their much less bituminous character, for the most part being highly fissile and breaking out into thin, sharp but small laminae. The lighter parts of the mass are easily eroded, being tenuous and clayey and the streams that flow down the hillside have cut numberless narrow, deep gullies in them, the sides of which are steep slopes of slippery shale. The concretions in the shale are frequently highly characteristic and are the source of most of the very abundant specimens of these bodies which are found scattered over the region and have been collected by the residents on account of their curious forms, suggestive of turtles, human skulls, hats and various other rounded objects. They not infrequently carry fossils in much better condition than found elsewhere in the beds, and these fossils of the concretions are more in accord with the singular fauna of the Genundewa limestone than are those of the shales. In the shales organic remains are of more frequent occurrence than in the Genesee shales beneath but they are seldom abundant.

This rock is shown in the lower part of all the ravines in the Middlesex valley north of the Goodrich gully. There is also a small outcrop by the roadside half a mile north of Rushville and along several small brooks in the southwest part of the town of Gorham. In the Snyder gully just above Woodville at the head of Canandaigua lake they are well shown, and also in the lake cliff at Woodville where their peculiar blocky structure, due to numerous joints, is finely displayed. The deeper parts of the ravines at Coye, Granger, Lapham, Cook and Hicks points and all of the other gullies between the head of the lake and Seneca point are in these shales; also the Seneca point ravine above the first cascade and the upper part of Victoria glen and Foster gully. Northerly exposures are also shown in the bed of the creek at Cheshire. They enter largely into the composition of the lake wall on the east side from Genundewa south to Woodville, but here the rock exposures are extensively overgrown. In the Bristol valley they are displayed in the large ravine of Wilder creek and from there southward in the Reed and Packard ravines and in several other smaller gullies on both sides of the valley. The south branch of Beebe brook in the northwest corner of Bristol township flows through a small gully cut in the shales of this horizon, and in the town of Richmond the rocks are exposed in the cliffs of Mill gull. Here, a short distance above the outcrop of Genundewa limestone, the cliff walls are handsomely banded by alternating layers of black beds recurring among the blue gray layers.

Standish flags and shales

Thin, uneven, bluish gray flags and olive shales. This is a thin bed of rocks probably not exceeding 15 feet in thickness, but it has seemed entitled to distinctive designation because it marks a transition from the argillaceous shales of the West River beds into the arenaceous sedimentation, characterizing for the most part, the mass of the Portage strata. The beds were originally designated by the writer "transition shales" in recognition of the fact referred to. It is not a persistent deposit for any great distance from the region immediately under consideration. The mass, thinning out toward the west, disappears altogether in the Genesee valley and by its absence the overlying bed of black shales (Middlesex shales) is brought directly on the West River beds. The beds show some difference from those below in faunal content. Exposures are seen in the localities already mentioned where the outcrops are sufficiently continuous, specially in the Middlesex valley in the ravine 50 rods north of the Lee schoolhouse and in other ravines at the north to Middlesex Center, and on the west side of the valley in the Goodrich gully running up into South hill and ravines to the north; in the Canandaigua lake valley, in the Standish gully and the ravines from Woodville to Cook point, and in the upper reaches of the ravines farther north; in Bristol hollow near the lower part of the Randall gully and also in the Reed and Wilder ravines.

Middlesex black shale

It has been customary to regard the Genesee group of strata as closing with the foregoing and to place the Middlesex shale at the base of the Portage series. This Middlesex shale is a very black, somewhat slaty shale with thin arenaceous gray flags in the upper and lower portions. When Professor Hall introduced the designation Genesee shale for the black shales in the Genesee river section, he expressed the opinion that eventually it might be found advisable to include them within the limits of the Portage formation. We have shown that on paleontologic grounds this is necessary, and it is clearly apparent that the geologic character of the deposit shows that the Genesee black shales are but an introductory phase of Portage sedimentation repeated in the Middlesex and Rhinestreet bands. The Middlesex shale attains a thickness of 35 feet where fully exposed in the Middlesex valley and decreases westward to 25 feet in the valley of Honeoye lake, just beyond the west line of these maps.

Fossils are of great rarity. Plant remains occur in the shales, and these have also afforded a single specimen of the goniatite Sandbergeroceras syngonum. Occasionally a characteristic lamellibranch of the Cashaqua shales above appears in the gray flags of the lower beds. This mass of black shale is continuous westward to Lake Erie but it decreases gradually in thickness till on the Lake Erie shore at the mouth of Pike creek there are but about 6 feet of it remaining. The rock is well exposed in the Middlesex valley in most of the ravines between the Lee schoolhouse and the village of Middlesex. It is seen on the roadside on the east side of the swamp at the head of the lake and in the Canandaigua lake valley by the road 1½ miles south of Woodville, also on the road leading west at the head of the lake and in the Standish, Coye, Granger, Lapham, Cook, Hicks point and Seneca point ravines, by the side of the Academy road 1 mile south of Cheshire. In the Bristol valley it may be observed in all the ravines already mentioned and in the Hamilton gully, Mill gull and Jason gull in the valley of Honeoye lake.

Cashaqua shale

This name was introduced by Professor Hall for the characteristic olive gray shales with occasional flags and sandstone as developed along the Cashaqua creek, a confluent of the Genesee river. As these beds are continuous from that point eastward to the area under consideration the term is completely applicable here. In this area this mass of shales attains a thickness of about 230 feet, and is mostly bluish gray and olive shale with a few thin dark layers and with two bands of thin sandstone and numerous flags in the lower part. Calcareous concretions and discontinuous concretionary layers occur in the upper part. As a whole the deposit in Ontario county is more arenaceous and less calcareous than that in the Genesee river section. In the lower 75 feet the more sandy beds are rarely fossiliferous, showing occasional lignites and frequently the object termed Fucoides graphicus. At about the middle of the series the shales become softer, and here the characteristic fauna of these Portage rocks is typically developed with numerous goniatites, Bactrites and lamellibranchs of the genera Buchiola, Lunulicardium, Ontaria etc. The character of this fauna is referred to in a subsequent paragraph. Above these more highly fossiliferous beds is a band of compact sandstone and hard shales which is succeeded by 57 feet of soft, blue and olive clay shales, characterized by nodular structure due to irregular concretions of lime carbonate of small size. Six feet above the sandstone is a singular concretionary limestone which is continuous in character, attains a thickness of about 6 inches and is a mass of red and greenish kramenzel abounding in goniatites and Orthoceras. This layer is so distinctive, both on account of its color, its contents and its composition that it is here designated as the

Parrish limestone. It appears first on the western boundary of the Naples valley and is continuous from there eastward as far as Big stream and Glen Eldredge on Seneca lake. Its place in the succession is apparently indicated in the western part of the quadrangle by a row of fossiliferous spheric concretions which appear in the Bristol and Honeoye valleys.

The Cashaqua shale, flags and calcareous beds constitute the principal situs of the fauna of the rocks and their exposures can be studied to best advantage in the admirable outcrops on the east side of the Naples valley, specially in the great Parrish gully at Parrish, the Caulkins gully and other small ravines cutting back into Hatch hill. The rocks are also shown in the face of Hatch hill behind the fair-ground and southward. The west side of this valley also affords some admirable exposures as in the Lincoln gully and thence northward on the western slope of Canandaigua lake in scores of ravines and gullies and along the dugway roads as far north as Cheshire. They are also displayed in the upper parts of all the gullies in Bristol Center southward to nearly the end of the valley and along Egypt brook and its various branches in South Bristol and also in the upper part of Jason gull. In the Honeoye lake valley the decreasing proportion of the arenaceous layers toward the west is noticeable, the shales becoming more calcareous and concretionary. The Briggs and Hamilton gullies near the west line of the map in the Honeoye valley afford particularly favorable outcrops for study. Nearly all the Cashaqua shales are to be seen under specially favorable conditions along the Whetstone brook west of Honeoye village from the Livonia road to the falls at the Devil's Bedroom. Eastward of Naples they are found in Italy hollow at the mouth of the ravine which crosses the road at the Big Tree schoolhouse. In the Middlesex valley they are well seen in the Clark and Mower gullies and also in the Lee, Goodrich and other small ravines farther north toward Middlesex Center. In fact in these high lands of the southern part of the map wherever the relatively thin drift mantle has been transected by streams these beds are brought to light.

Rhinestreet black shale

Black slaty shale with a small proportion of blue shale and occasionally thin but lenticular sandstones. Thickness 18 feet on the eastern boundary of the quadrangle increasing to 30 feet at the western. This tendency to increase westward is manifested beyond the area of the map, for we find the bed to be continuous from here to Lake Erie, where its thickness is more than 200 feet. It may be traced eastward to Seneca lake, where its thickness is but 1 foot.

The rock is essentially devoid of organic remains with the exception of fragments of plants, specimens of Spathiocaris, teeth of Conodonts and a few small Lingulas. These rocks are to be seen in Italy hollow in the ravine already referred to near the Big Tree schoolhouse, in the Naples valley at the foot of Hatch hill near the salt well, on both sides of the Naples and Middlesex valleys to Middlesex Center, and on the north side of Genundewa. The formation takes its name from the exposure on the road running from Naples to Seaman hill, on the west side, which is known locally as Rhinestreet and along which there are constant exposures of this formation. They may be seen also in the upper part of all the large ravines on the west side of Canandaigua lake to the iron bridge over the Foster gully, 2 miles south of Cheshire; in the Bristol valley in the ravines on both sides as far north as Bristol Center and about ½ mile north of Boswells Corners; in the Honeoye valley in all the ravines between the Hancock farm and the foot of the lake.

Hatch shale and flags

Blue and olive shales with frequent thin layers of black shale and thin sandstones. The sandstones become more frequent and thicker in the upper part of the formation; the lower layers carry very symmetric calcareous concretions from 2 inches to 2 feet in diameter. This mass immediately overlying the Rhinestreet black shales, or the *second black band* of some of our reports, attains a thickness of 290 feet and its resistant character, due to the presence of many layers of hard sandstone and flags, is the fundamental cause of the highlands on the Naples quadrangle. These beds are equivalent in part to the Gardeau beds of Hall in the Genesee valley section, but there are reasons for not applying the latter term in the Naples meridian as it can not be employed with exactitude.

These upper beds occasionally carry the fossils of the Cashaqua shale, but in no place are they of frequent occurrence except occasionally in replaced condition in the calcareous concretions. Toward the more sandy middle and upper portions of the series plant remains are not infrequent and from these beds has been obtained a Lepidodendron of commanding proportions, taken from a horizon at the mouth of Grimes gully, Naples, 74 feet above the Rhinestreet shales. The specimen when taken out measured 15 feet in length from the root upward.

Exposures of these beds are found throughout the Naples valley and constitute the entire lower part of Hatch hill, in the Tannery gully just south of Naples and in the Grimes gully on the west side, also in the higher parts of the Caulkins, Parrish, Hoecker and Lincoln gullies and in all accessible ravines of the Naples and southern parts of the Middlesex valley. Along Canandaigua lake they are seen in the upper parts of the deeper ravines on the west side, south of the Academy tract, in Bristol valley in the upper parts of all the ravines between Boswells Corners and Bristol Center and in the Honeoye valley just west of the sheet between Hunts hollow and the Briggs gully.

Grimes sandstone

Compact or laminated, light bluish gray sandstones in layers 4 inches to 3 feet thick, separated by hard, blue gray shales. In the vicinity of the Tannery gully, ½ mile south of the village of Naples, a part of the sandstone is highly calcareous owing to the presence of masses of molluscan shells, mostly in comminuted condition. Thickness about 50 feet. In the face of the precipice at the third falls of the Grimes gully and exposed in the escarpment on the east side of the ravine 10 feet above the water, is a thin layer of soft shale which has been found to contain Buchiola retrostriata, Manticoceras pattersoni, Bactrites and other typical members of the Naples fauna. This is its highest appearance in this section. Twenty-four feet higher and 9 feet below the crest of the falls occurs the Grimes sandstone which bears a brachiopod fauna with Liorhynchus, Atrypa reticularis, Productella, Ambocoelia, Leptostrophia mucronata, etc.; the first appearance of this fauna in this section and to be regarded as an incursive appearance of the Ithaca fauna lying farther to the east. This formation lies 599 feet above the base of the Middlesex black shale and this is the thickness to be ascribed to the Portage formation in this meridian as formerly defined. In the Tannery gully on the east side of the Naples valley the upper beds have afforded a number of singular organisms associated together but not concurring with species of the characteristic Naples fauna. These are specially noted elsewhere and consist of the fossil Paropsonema, believed to be an aberrant echinoid, some forms of annelids described as Protonympha and Palaeochaeta, also a large Orbiculoidea, some strange and undescribed linguloids, etc. The division occurs also at the Naples reservoir, in the escarpment on Hatch hill, in the Caulkins gully and the quarry near it, at the top of the dugway on the Hunts hollow road, in the road near Freeds and along the hillside northward to Rhinestreet, also near the Muck place on Seaman hill and in the small ravine near the Gardner property, 2 miles north of Bristol Springs. In Bristol hollow it appears in the upper parts of the Randall and Reed gullies and on the north side of Worden hill; in the Honeoye valley on the hillside above E. Alger's property and northward to the upper part of the Briggs gully.

West Hill flags and shale

Light bluish gray sandstones or flags from 2 to 12 inches thick, separated by beds of dark blue, olive or black shale. The sandstones are sometimes quite calcareous owing to the presence of crinoid stems and other fossils usually in fragmentary condition. Thickness 550 feet. This heavy mass of arenaceous deposits like the Hatch beds below is partially equivalent to the Gardeau series of Hall as developed in the Genesee valley. It has however undergone a change faunistically, and remains of the Naples fauna are now no longer seen, though the rocks contain fossils in some measure; but these are largely brachiopodous and indicate continued presence of the Ithaca fauna. The sandstones are quite sharply distinguished from the Grimes sandstones below on account of their thinner bedding and bluish color. This division is exposed in Italy hollow at the south end along Flint creek and in the Italy gully, in the Naples valley in the Tannery gully and Grimes gully. It is found on the south side of the road leading easterly across Deyo basin, 2 miles south of Naples, 5 or 6 rods from the Ingleside road and near the foot of the hill. Here it is an isolated exposure and its stratigraphic position can not be ascertained with precision. It is however not far from 100 feet above the top of the Grimes sandstone. At this spot it has produced a number of interesting fossils; *Hydnoceras tuberosum*, *H. variabile*, *Ceratodictya cincta*, Hysteracanthus, *Spirifer mesacostalis*, *Atrypa hystrix*, Productella, Ambocoelia etc. The same horizon is found near the residence of Charles S. Sutton on the north side of the road leading from Naples to West hollow and here also brachiopods are found. The same beds are seen on the lands of the Pottle estate, 1½ miles north of the last named exposure. One of the sandstones here contains fossils in great abundance, principally of the same species as found in the Deyo basin and on the West hollow road. A survival of the Naples fauna is notable here in the presence of the species *Manticoceras oxy*. In the road leading northward on the top of Worden hill a ledge of sandstone is exposed on both sides that contains masses of brachiopods. This locality is about 1 mile north of the south line of Bristol township. On Hatch hill are outcrops in the lower part of the so called Three Cornered clearing near the top. The rocks are also seen at the upper end of the Hoecker and Lincoln gullies and on the hill north of the Seaman schoolhouse, and in many small ravines on the sides of High point, Frost hill and Gannett hill. They are also the surface rock over the principal part of the town of Canadice to the west of the sheet and extend over the tops of the ridges on both sides of the Bristol valley for a mile or two into the town of Bristol.

Highpoint sandstone

Light gray sandstones in layers from 3 inches to 4 feet in thickness separated by thin beds of hard blue shale. Some of the layers of the rock are compact and calcareous but the larger portion is laminated and sometimes shaly. Lenticular beds of impure limestone composed of crinoid stems and other fossils occur at High point and other outcrops. These sandstones are thinner and softer toward the east. Thickness 100 feet. These beds are nowhere sufficiently exposed to admit of detailed examination of the entire series and the upper and lower contact, but 50 to 75 feet of the formation project in the cliff at the south end of High point at an elevation of 1850 to 1925 feet A. T., and the talus that covers the strata at the base of the hill is principally composed of fallen slabs and blocks of the sandstone. In structure, texture and general appearance they differ from the Grimes sandstone only in being somewhat coarser and weathering to a lighter color but they likewise differ notably in their fossil contents. *Fucoides verticalis*, which is not seen in the lower rocks, is common throughout these beds. The most striking feature of this exposure consists of an irregular stratum of calcareous sandstone and conglomerate 7 feet thick where thickest and thinning out gradually around both sides of the hill. This is a mass of brachiopods, corals and crinoid stems cemented into a hard, compact layer that resists the effects of weather and at one place projects 12 feet beyond the soft sandstone beneath it. Several fallen slabs of this calcareous layer 10 to 15 feet across are to be seen at the foot of the escarpment and many others have been broken up and utilized in the construction of fireplaces in the pioneer days and later in the arches of furnaces beneath steam boilers, its resistance to the disintegrating effect of heat making the "High Point firestone" highly esteemed for these purposes in this locality. It has, however, now fallen into disuse. This highly fossiliferous layer is about 50 feet below the top of the sandstone. In it a well defined Chemung fauna with *Spirifer disjunctus* occurs together with species which were originally described from the upper Devonic beds of Iowa, and attention is here directed to a more complete statement of the fossil contents of these beds in a subsequent paragraph. The rock is not exposed on the south or west sides of the depressions that isolate High point, though calcareous layers of somewhat similar character occur at about the same horizon in the cliff on the northwest end of Knapp hill and also in the escarpment near Mr J. Eldridge's residence on the road from Garlinghouse to Atlanta. Hard, dark shales and thin sandstones come in again at the top of the High point bluff and are slightly exposed in the fields above but no fossils were observed in them and nothing but their position distinguishes them from those below. On the south side of the Naples valley the Highpoint beds appear in some isolated outcrops on the north slope of Pine hill and in the bluff on the west side of Knapp hill and the thick sandstones that form the escarpments above the talus in the vicinity of McClarie's quarry on the dugway road just east of North Cohocton are in the same horizon, but the rock here is almost barren of fossils. They are also to be seen in Lyons hollow by the side of the road leading east, 2 miles south of Ingleside; in the upper part of Italy gully and on the tops of Worden and Gannett hills. Careful stratigraphic work has determined that the Highpoint sandstone is continuous with the original Portage sandstones of the Genesee valley, which in Professor Hall's section capped the Portage section there. It has also been pointed out that while these horizons are stratigraphically continuous the fauna is very different in the two sections. The Portage sandstones still carry the Naples fauna, while in the Naples region that fauna has long before this date been extinguished by the appearance, first of the Ithaca, then of the Chemung fauna from the east.

Prattsburg sandstone and shale

In the lower part of this division the sandstones are mostly olive-gray, rather soft and schistose or in thin even layers, and the shales are in part soft and blocky, similar in appearance to the Cashaqua shales. Layers of blue, olive and black shales occur.

Thickness from 200 to 225 feet. These beds lie in the horizon of the Wiscoy shales of the Genesee river section, which are beds there overlying the Portage sandstones but still carrying the Portage fauna though somewhat modified in character. There also they are overlain by strata carrying the Chemung fauna which appears first at Long Beards riffs with Spirifer disjunctus.

The upper part of the Prattsburg beds in the Naples region are light bluish gray sandstones, usually in lentils and compact or uneven layers. The interstratified shales are mostly blue and hard, but black and slaty layers occur frequently. These beds have a thickness of 300 to 400 feet in the higher land of the southern part of the quadrangle. The lower portion, or the equivalent of the Wiscoy horizon, is exposed in a small outcrop on the road leading from Marsh's Corners southward up Pine hill near the top, and a mile still farther east on the road leading from Ingleside to Lent hill is another exposure in approximately the same horizon, from which Manticoceras oxy has been obtained. Whitney's quarry on the southwest side of Pine hill, which has produced a large amount of flagstone laid for sidewalks in the village of Naples and adjoining towns, is in this horizon. It is exposed also along the dugway road leading up Lent hill southwest from Ingleside near the road on the east side of Pine hill, in the Woodworth quarry 2 miles south of North Cohocton, on Lent hill in the ravine west of the Wheaton farm, in the upper part of the Italy gully, and by the roadside 2 miles north of Prattsburg. The upper beds are seen in the Wheaton quarry on the hill south of Atlanta, by the roadside in several places in the vicinity of Lent Hill church and in numerous small outcrops on the high ridge between the Prattsburg valley and Lyons hollow.

SUCCESSION OF FOSSIL FAUNAS

Camillus shale

We know of no traces of organisms in these deposits except an occasional ostracode shell (Leperditia) and a trail made on the soft mud by such an organism. The sediments were laid down in a sea too shallow and too strongly saturated with brine and alkalis to encourage the existence of life.

Bertie waterlime

The fauna of these beds is that peculiar association of crustaceans which has made this horizon one of the most interesting in the entire series of the New York formations. Occasionally in the outcrops and more freely in the loose blocks of this rock scattered over the country south of the line of outcrop, are specimens of Eurypterus remipes Dekay and Ceratiocaris acuminata Hall, with abundant Leperditias, Lingulas and an occasional Orbiculoidea. Westward of this region specially in the exposure in the quarries of the Buffalo Cement Co. at Buffalo, and eastward in the towns of Sauquoit and Litchfield, Herkimer co., these crustaceans with others are found in great abundance and perfection, but in the intervening region they have thus far proved of rarer occurrence. The fauna of these merostome crustaceans is widely known as one marking the closing stages of Siluric time through northern latitudes on both hemispheres.

Cobleskill shale and dolomite

The fauna here is sparse but indicative of the relation of the horizon to its more typical eastward outcrops. The list of species at present known is:

Eurypterus, occasional fragments
Leperditia alta *Conrad*
L. scalaris *Jones*
Whitfieldella sulcata *Vanuxem*
Spirifer eriensis *Grabau*
Cyathophyllum hydraulicum *Simpson*

Oriskany sandstone

This rock carries no fossils in this district. At Union Springs, Cayuga co. is the nearest point where the characteristic fauna of the arenaceous deposits is developed with Spirifer arenosus Conrad, Hipparionyx proximus Vanuxem, Meristella lata Hall, Chonostrophia complanata Hall, etc. A few imperfect fossils have been found in the outcrops on Flint creek near Phelps Junction but mostly when the rock takes on the form of a thin quartzite or breccia as here it is devoid of fossils.

Onondaga limestone

Throughout the exposures of this rock fossils are abundant but they are not easily obtained because of the difficulty in setting them free of the matrix. Experience has shown that the endeavor to acquire the remains from the unweathered exposures is for the most part fruitless as well as arduous except where there are shale masses intercalated between the limestone beds. The fauna is specially profuse in corals but the agglomerations of these organisms which are seen in the lower beds of this district become immense coral plantations farther westward in the vicinity of Leroy, Genesee co. Nature has helped to solve the difficulties attending the extraction of these fossils by scattering over the county and through the soil southward innumerable blocks of this rock. The corals are partially silicified in the bed and on exposure become more so and the dissolution of the calcareous matrix makes the occurrence of silicified corals of this formation extremely common over much of the region covered by this map. The layers of the limestone that are associated with and more or less impregnated by the chert, weather into all sorts of irregular shapes according to the degree of dissemination of the lime throughout them and when this silicious rock has become thoroughly "rotten," that is, has lost all its lime, the silicious residuum retains with minutest precision the impressions of the organic contents. By the examination of such masses of rotten stone has the fauna in an important degree been made out, and an illustration of their significance is seen in the fact that these masses from Ontario county produced specimens of trilobites alone of which 55 drawings were made for the monograph of these organisms published as volume 7, *Palaeontology of New York*.

In these weathered blocks students of this fauna will find their material in most suitable form for study; these will not however contribute to a knowledge of the zonal distribution of the species. Of this condition we know little; probably variations in range are so slight that the effort to ascertain them would produce a result in no way commensurate with the labor involved.

The student may expect to find in the Onondaga limestone of this district the following species:

Fishes

Machaeracanthus peracutus *Newberry*
M. sulcatus *Newberry*
Onychodus sigmoides *Newberry*

Crustaceans

Acidaspis callicera *Hall & Clarke*
Beyrichia subquadrata *Jones*
Bollia bilobata *Jones*
Cyphaspis diadema *Hall & Clarke*
C. hybrida *Hall & Clarke*
C. minuscula *Hall*
C. stephanophora *Hall & Clarke*
Dalmanites aegeria *Hall*
D. anchiops *Green*
D. bifidus *Hall*
D. calypso *Hall*
D. coronatus *Hall*
D. diurus *Green*
D. myrmecophorus *Green*
D. pygmaeus *Hall & Clarke*
D. selenurus *Conrad*
Eurychilina? reticulata *Ulrich*
Leperditia cayuga *Hall*
Lichas contusus *Hall & Clarke*
L. dracon *Hall & Clarke*
L. eriopis *Hall*
L. gryps *Hall & Clarke*
L. hispidus *Hall & Clarke*
Moorea kirkbyi *Jones*
Palaeocreusia devonica *Clarke*
Phacops bombifrons *Hall*
P. cristata *var.* pipa *Hall & Clarke*
Phaethonides gemmaeus *Hall & Clarke*
P. navicella *Hall & Clarke*
Primitia clarkei *Jones*
Proetus clarus *Hall*
P. crassimarginatus *Hall*
P. folliceps *Hall & Clarke*
P. microgemma *Hall & Clarke*
P. ovifrons *Hall & Clarke*
P. stenopyge *Hall & Clarke*
P. verneuili *Hall & Clarke*
Turrilepas cancellatus *Hall & Clarke*
T. flexuosus *Hall & Clarke*

Cephalopods

Cyrtoceras citum *Hall*
Gomphoceras absens *Hall*
G. eximium *Hall*
Gyroceras cyclops *Hall*
G. laciniosum *Hall*
G. matheri *Conrad*
G. trivolve *Conrad*
G. undulatum *Vanuxem*
Orthoceras geneva *Clarke*
O. inoptatum *Hall*
O. profundum *Hall*
O. sceptrum *Hall*
O. thoas *Hall*

Pteropods

Hyolithus ceratophilus *Clarke*
H. ligea *Hall*
Tentaculites scalariformis *Hall*

Gastropods

Bellerophon curvilineatus *Conrad*
B. pelops *Hall*
Callonema lichas *Hall*
Diaphorostoma lineatum *Conrad*
D. turbinatum *Hall*
D. unisulcatum *Conrad*
Euomphalus decewi *Billings*
E. laxus *Hall*
Loxonema laxum *Hall*
L. pexatum *Hall*
L. robustum *Hall*
L. sicula *Hall*
Murchisonia intercedens *Hall*
Naticopsis compacta *Hall*

Platyceras ammon *Hall*
P. argo *Hall*
P. carinatum *Hall*
P. concavum *Hall*
P. crassum *Hall*
P. cymbium *Hall*
P. dentalium *Hall*
P. dumosum *Conrad*
P. erectum *Hall*
P. fornicatum *Hall*
P. nodosum *Hall*
P. perelegans *Hall*
P. rectum *Hall*
P. subrectum *Hall*
P. undatum *Hall*
Pleurotomaria adjutor *Hall*
P. delicatula *Hall*
P. hebe *Hall*
P. lucina *Hall*
P. plena *Hall*
P. quadrilix *Hall*
P. unisulcata *Conrad*
Strophostylus varians *Hall*
Turbo shumardi *de Verneuil*

Lamellibranchs

Aviculopecten pectiniformis *Conrad*
A. ignotus *Hall*
Conocardium cuneus *Conrad*
C. trigonale *Conrad*
Cypricardinia indenta *Conrad*
Limoptera pauperata *Hall*
Lyriopecten dardanus *Hall*
Megambonia cardiiformis *Hall*
Modiomorpha clarens *Hall*
Nyassa elliptica *Hall*
Palaeopinna recurva *Hall*
Panenka multiradiata *Hall*
Paracyclas elliptica *Hall*
Pterinopecten insons *Hall*
P. undosus *Hall*

Brachiopods

Amphigenia elongata *Hall*
Atrypa reticularis *Linné*
Camarotoechia billingsi *Hall*
C. inequiplicata *Hall*
C. royana *Hall*
C. tethys *Billings*
Centronella glansfagea *Billings*
Chonetes acutiradiatus *Hall*
C. arcuatus *Hall*
C. lineatus *Hall*
Chonostrophia reversa *Whitfield*
Coelospira camilla *Hall*
Leptaena rhomboidalis *Wilckens*
Leptocoelia acutiplicata *Conrad*
Leptostrophia perplana *Conrad*
Lingula desiderata *Hall*
Meristella doris *Hall*
M. nasuta *Conrad*
M. scitula *Hall*
Orthothetes pandora *Billings*
Pentagonia unisulcata *Conrad*
Pentamerella arata *Conrad*
Productella navicella *Hall*
P. shumardiana *Hall*
Rhipidomella lenticularis *Vanuxem*
R. semele *Hall*
Schizophoria propinqua *Hall*
Spirifer acuminatus *Conrad*
S. arctosegmentus *Hall*
S. disparilis *Hall*
S. divaricatus *Hall*
S. duodenarius *Hall*
S. fimbriatus *Conrad*
S. gregarius *Clapp*
S. macer *Hall*
S. macrothyris *Hall*
S. manni *Hall*
S. raricosta *Conrad*
S. varicosus *Hall*
Stropheodonta ampla *Hall*
S. concava *Hall*
S. demissa *Conrad*
S. hemisphaerica *Hall*
S. inequiradiata *Hall*
S. inequistriata *Conrad*
S. patersoni *Hall*
S. textilis *Hall*
Terebratula lens *Hall*

Crinoids

Codaster pyramidatus *Hall*
Cyathocrinus bulbosus *Hall*
Edriocrinus pyriformis *Hall*
Myrtillocrinus americanus *Hall*

Corals

Alveolites squamosus *Billings*
Aulacophyllum princeps *Hall*
Cladopora cryptodens *Billings*

C. laqueata *Rominger*
C. labiosa *Billings*
Cyathophyllum corniculum *Edwards & Haime*
C. juvenis *Rominger*
C. robustum *Hall*
C. validum *Hall*
Cylindrophyllum elongatum *Simpson*
Cystiphyllum scalatum *Hall*
C. sulcatum *Billings*
Eridophyllum simcoense *Billings*
Favosites canadensis *Billings*
F. emmonsi *Rominger*
F. epidermatus *Rominger*
F. hemisphaericus *Troost*
F. tuberosus *Rominger*
Heliophyllum annulatum *Hall*
H. cancellatum *Hall*
H. exiguum *Billings*
Michelinia cylindrica *Edwards & Haime*
Pleurodictyum convexum *d'Orbigny*
Ptychophyllum striatum *Hall*
Syringopora nobilis *Billings*
S. perelegans *Billings*
Zaphrentis complanata *Hall*
Z. fastigata *Hall*
Z. gigantea *Edwards & Haime*
Z. tabulata *Hall*

Marcellus shale

With the close of the limestone epoch there was an abrupt change in the sedimentation, and here begins a new series of sediments and very distinct aggregate of faunas. The Marcellus shale introduces black, carbonaceous and pyritous sedimentation, evincing a deepening of the waters and a foul bottom, over which but few forms of life prevailed and these depauperated in size and of very tenuous shell. All the species here found are the apparent proper accompaniments of such bionomic conditions; Liorhynchus limitaris, which puts in an appearance during this stage of the Devonic wherever the sediments become highly charged with bituminous matter; Chonetes mucronatus, C. lepidus, Strophalosia truncata, Pleurotomaria rugulata, Styliolina fissurella and Orthoceras subulatum also follow these conditions. Occasionally members of the congeries have apparently dropped into the deposits from the higher and more prolific zone of life.

The exposures at Padelford and along Mud creek have furnished the following:

Orthoceras subulatum *Hall*........c
Styliolina fissurella *Hall*..........cc
Pleurotomaria rugulata *Hall*......c
Nuculites oblongatus *Conrad*.......c
Chonetes lepidus *Hall*.............c
C. mucronatus *Hall*...............r
Strophalosia truncata *Hall*.......cc
Liorhynchus limitaris *Vanuxem*...cc
L. multicosta *Hall*................r

Stafford limestone

We have shown in papers relating specially to this deposit[1] that its very extensive fauna is that of the Skaneateles, Canandaigua and Moscow shales in unusually favorable development. It was the first appearance in this region of that fauna, but for western New York as a whole, the second invasion of this Hamilton fauna from the west into the Appalachian basin. For a full account of the formation and its contents where best developed, reference is made to the papers cited and to Elvira Wood's discussion of the fauna of the Stafford limestone at Lancaster, Erie co. [Bul. 49, p.139]. The absence of outcrops of the rock over the area of this map restricts the representation of its fauna to such species as are to be found in the loose blocks, but the following is a list of the species which may be expected from the formation.

Undetermined plates and scales of fishes

Worms

Spirorbis

Crustaceans

Homalonotus dekayi *Green*
Phacops rana *Green*
Cryphaeus boothi *Green*
C. boothi *var.* calliteles *Green*
Proetus macrocephalus *Hall*
Cyphaspis craspedota *Hall & Clarke*
Primitiopsis punctulifera *Hall*

Cephalopods

Nautilus liratus *Hall*
N. *cf.* magister *Hall*
Nephriticeras bucinum *Hall*
Orthoceras subulatum *Hall*
O. aegea *Hall*
O. marcellense *Vanuxem*
O. fenestrulatum *Clarke*
O. staffordense *Clarke*
O. eriense *Hall*

Pteropods

Tentaculites gracilistriatus *Hall*
Styliolina fissurella *Hall*

Gastropods

Platyceras attenuatum *Hall*
P. bucculentum *Hall*
Cyrtolites mitella *Hall*
Bellerophon lyra *Hall*
Diaphorostoma lineatum *Conrad*
Pleurotomaria lucina *Hall*
P. rugulata *Hall*
P. itys *Hall*
P. capillaria *Conrad*
P. sulcomarginata *Conrad*
Loxonema hamiltoniae *Hall*
Onychochilus nitidulus *Clarke*

Lamellibranchs

Pterinopecten exfoliatus *Hall*
Actinopteria muricata *Hall*
Liopteria laevis *Hall*
Cypricardinia indenta *Conrad*
Panenka mollis *var.* costata *Hall*
P. radians *Conrad*
Pterochaenia fragilis *Hall*

Brachiopods

Terebratula lincklaeni *Hall*
Cryptonella planirostris *Hall*

[1] N. Y. State Geol. 8th An. Rep't. 1889. p.60; and N. Y. State Mus. Bul. 49. 1901. p.130.

C. rectirostris *Hall*
Camarotoechia sappho *Hall*
C. horsfordi *Hall*
C. dotis *Hall*
C. prolifica *Hall*
C. pauciplicata *Wood*
Spirifer audaculus *Conrad*
S. fimbriatus *Conrad*
S. subumbona *Hall*
Ambocoelia nana *Grabau*
Meristella barrisi *Hall*
Trematospira gibbosa *Hall*
Strophalosia truncata *Hall*
Productella spinulicosta *Hall*
P. shumardiana *Hall*
Chonetes mucronatus *Hall*
C. scitulus *Hall*
C. lepidus *Hall*
Tropidoleptus carinatus *Conrad*
Stropheodonta inaequistriata *Conrad*
Leptostrophia perplana *Conrad*
Orthothetes chemungensis *Conrad*
O. arctostriatus *Hall*
Rhipidomella vanuxemi *Hall*
R. cyclas *Hall*
Crania crenistriata *Hall*
C. recta *Wood*
Craniella hamiltoniae *Hall*

Bryozoans

Hederella canadensis *Nicholson*
H. cirrhosa *Hall*
Reptaria stolonifera *Rolle*

Blastoids

Nucleocrinus lucina *Hall*

Corals

Favosites placenta *Hall*
Stereolasma rectum *Hall*
Striatopora limbata *Conrad*
Romingeria
Aulopora

Cardiff shale

The darker beds which chiefly comprise this mass bear but few traces of organic remains. Conditions here as in the Marcellus shale were not favorable to life. Its species are

Orbiculoidea minuta *Hall*
Liorhynchus limitaris *Vanuxem*

The more calcareous and upper beds, which form blue black harder layers, show an addition of representatives from the constantly nearer zone of prolific life in the overlying shales. These have been taken from the beds at Chapinville and along Mud creek and are:

Rhinocaris veneris *Hall & Clarke*. . r
Phacops rana *Green*. . . . . r
Orthoceras nuntioides *Clarke*. . . . . r
Gomphoceras mitriforme *Clarke*. . r
Bactrites clavus *Hall*. c
Tornoceras discoideum *Conrad*. . . . c
Styliolina fissurella *Hall*. c
Pleurotomaria rugulata *Hall*. c
Nuculites oblongatus *Conrad*. c
Buchiola stuprosa *Clarke*. . . . . r
Pterochaenia fragilis *Hall*. . . . . . . r
Strophalosia truncata *Hall*. c

Skaneateles shale

The fauna of these beds is very sparse, a few species characteristic of the black beds intermingled with some from the more calcareous beds above. As the mass represents essentially a phase of transition from the condition of the black sediments to those of shallower and clearer water deposit, the fauna is also mixed and transitional. It contains:

Phacops rana *Green*............	rr	Chonetes setiger *Hall*..........	c
Styliolina fissurella *Hall*........	c	Spirifer mucronatus *Conrad*.....	r
Pleurotomaria rugulata *Hall*....	c	Ambocoelia umbonata *Conrad*....	c
Lunulicardium curtum *Hall*.....	r	Liorhynchus limitaris *Vanuxem*.	c
Nuculites oblongatus *Conrad*....	c	L. multicosta *Hall*.............	c

Canandaigua shale and limestone

With these beds begins the profuse development of the calcareous Hamilton shales. Though the rocks of this stage are treated as a unit on the map their faunas may be here considered in two divisions, that of (1) the Centerfield limestones or the calcareous beds at the base, (2) the upper division or the Canandaigua shales.

1 In the Centerfield limestones, best developed on Shaffer creek and underlying all the northern part of the village of Canandaigua, the following species have been noted:

Worms

Arabellites .... r
Oenonites .... r
Eunicites .... r
Spirorbis angulatus *Hall*........ c
Cornulites tribulis *Hall*......... r

Crustaceans

Phacops rana *Green*............ cc
Dalmanites boothi *Green*........ cc
D. boothi *var.* calliteles *Green*... cc
Proetus rowi *Green*............. cc
P. macrocephalus *Hall*
Cyphaspis ornata *Hall*
C. ornata *var.* baccata *Hall & Clarke*
C. craspedota *Hall & Clarke*
Turrilepas devonica *Clarke*
T. squama *Hall & Clarke*
T. nitidula *Hall & Clarke*
T. foliata *Hall & Clarke*
T. tenera *Hall & Clarke*
Schizodiscus capsa *Clarke*

Gastropods

Bellerophon pelops *Hall*
Cyrtolites mitella *Hall*
Platyceras auriculatum *Hall*.... c
P. symmetricum *Hall*........... c
P. thetis *Hall*.................. c
P. subspinosum *Hall*
Pleurotomaria itys *Hall*
P. lucina *Hall*
P. disjuncta *Hall*............... r
Loxonema delphicola *Hall*
L. hamiltoniae *Hall*

Lamellibranchs

Mytilarca oviformis *Conrad*..... c
Microdon bellistriatus *Conrad*
Conocardium crassifrons *Conrad*
Cypricardinia indenta *Conrad*... c
Actinopteria decussata *Conrad*.. c
Aviculopecten princeps *Conrad*.. c̄
Lingula leana *Hall*............. r
L. densa *Hall*
Crania crenistria *Hall*
Craniella hamiltoniae *Hall*...... c
Rhipidomella penelope *Hall*..... c

Brachiopods

R. vanuxemi *Hall*............... c

Orthothetes arctostriatus *Hall*	c
Stropheodonta concava *Hall*	
S. demissa *Conrad*	c
S. inequistriata *Conrad*	c
Pholidostrophia nacrea *Hall*	c
Leptostrophia perplana *Conrad*	
Chonetes coronatus *Conrad*	c
C. deflectus *Hall*	
Productella navicella *Hall*	
P. spinulicosta *Hall*	
Spirifer angustus *Hall*	r
S. divaricatus *Hall*	
S. fimbriatus *Conrad*	c
S. audaculus *Conrad*	c
S. mucronatus *Conrad*	
S. consobrinus *d'Orbigny*	
Ambocoelia umbonata *Conrad*	c
Nucleospira concinna *Hall*	cc
Trematospira hirsuta *Hall*	
Meristella haskinsi *Hall*	cc
Atrypa reticularis *Linné*	
Camarotoechia dotis *Hall*	
C. horsfordi *Hall*	c
C. prolifica *Hall*	
C. sappho *Hall*	
Pentamerella pavilionensis *Hall*	
Cryptonella planirostris *Hall*	
C. rectirostris *Hall*	c

Crinoids

Platycrinus eboraceus *Hall*	r
Megistocrinus ontario *Hall*	r

Corals

Zaphrentis halli *Edwards & Haime*	c
Z. simplex *Hall*	
Cystiphyllum varians *Hall*	
C. conifollis *Hall*	
C. americanum *Edwards & Haime*	cc
Cyathophyllum robustum *Hall*	c
C. nanum *Hall*	
C. conatum *Hall*	c
Amplexus hamiltoniae *Hall*	
Heliophyllum halli *Edwards & Haime*	cc
H. halli *var.* irregulare *Hall*	c
H. halli *var.* reflexum *Hall*	
H. obconicum *Hall*	
H. confluens *Hall*	r
Favosites placenta *Rominger*	cc
F. arbusculus *Hall*	
F. argus *Hall*	c
Alveolites goldfussi *Billings*	c
Pleurodictyum stylopora *Eaton*	
Striatopora limbata *Eaton*	c

Canandaigua shales proper

The beds above the "basal limestones" as they were originally termed by the writer, carry a less profuse fauna. The species assembled in the following list are from more numerous outcrops than the foregoing but, save at the very top of the formation just beneath the Tichenor limestone, they are seldom if ever as abundant in any single locality. There are some noteworthy differences in the composition of the faunas of these two parts of the Canandaigua beds, which are below singled out in special lists. The fossils herein are:

Crustaceans

Phacops rana *Green*	
Dalmanites boothi *Green*	
Proetus macrocephalus *Hall*	
Ostracodes of the genera Beyrichia, Entomis, Primitia and Bollia in the lower shales	cc
Estheria pulex *Clarke*	r

Worms

Spirorbis angulatus *Hall*	

Cephalopods

Orthoceras exile *Hall*	
O. nuntium *Hall*	c
O. crotalus *Hall*	r
Gyroceras liratum *Hall*	
Tornoceras uniangulare *Conrad*	r
Bactrites tenuicinctus *Hall*	

Pteropods

Styliolina fissurella *Hall*	c
Hyolithus aclis *Hall*	r

Gastropods

Bellerophon leda *Hall*	c
B. lyra *Hall*	r
B. acutilira *Hall*	r
Cyrtolites mitella *Hall*	r
Platyceras symmetricum *Hall*	c
P. erectum *Hall*	
P. conicum *Hall*	
P. attenuatum *Hall*	
P. thetis *Hall*	
P. bucculentum *Hall*	c
P. carinatum *Hall*	c
P. echinatum *Hall*	
Pleurotomaria capillaria *Conrad*	c
P. itys *Hall*	c
P. trilix *Hall*	
Loxonema delphicola *Hall*	
Diaphorostoma lineatum *Conrad*	cc
Cyclonema hamiltoniae *Hall*	
C. multilira *Hall*	
Euomphalus rudis *Hall*	
Murchisonia turricula *Hall*	r
Macrocheilus hebe *Hall*	

Lamellibranchs

Mytilarca oviformis *Conrad*	
Macrodon hamiltoniae *Hall*	
Microdon bellistriatus *Conrad*	
Buchiola halli *Clarke*	
Cypricardinia indenta *Conrad*	
C. pygmaea *Hall*	
Grammysia arcuata *Hall*	
Goniophora acuta *Hall*	
Modiomorpha complanata *Hall*	
M. concentrica *Conrad*	
M. macilenta *Hall*	
Nuculites oblongatus *Conrad*	
Aviculopecten princeps *Conrad*	
Palaeoneilo constricta *Conrad*	
P. emarginata *Conrad*	
P. fecunda *Hall*	
P. plana *Hall*	
P. tenuistriata *Hall*	

Brachiopods

Craniella hamiltoniae *Hall*	
Rhipidomella penelope *Hall*	c
R. vanuxemi *Hall*	cc
Orthothetes pandora *Billings*	
Stropheodonta concava *Hall*	
S. inequistriata *Conrad*	cc
S. junia *Hall*	c
Pholidostrophia nacrea *Hall*	
Leptostrophia perplana *Conrad*	cc
Chonetes coronatus *Conrad*	c
C. lepidus *Hall*	
C. deflectus *Hall*	
C. scitulus *Hall*	
Productella navicella *Hall*	
P. tullia *Hall*	
Spirifer angustus *Hall*	
S. fimbriatus *Conrad*	c
S. granulosus *Conrad*	c
S. audaculus *Conrad*	
S. marcyi *Hall*	
S. mucronatus *Conrad*	c
S. consobrinus *d'Orbigny*	
Ambocoelia umbonata *Conrad*	cc
A. praeumbona *Hall*	
Cyrtina hamiltonensis *Hall*	
Nucleospira concinna *Hall*	cc
Trematospira hirsuta *Hall*	c
T. nobilis *Hall*	
Trigeria lepida *Hall*	
Meristella haskinsi *Hall*	
Athyris spiriferoides *Eaton*	c
Camarotoechia congregata *Conrad*	
C. sappho *Hall*	
Liorhynchus multicosta *Hall*	r
L. quadricostatus *Vanuxem*	r
Pentamerella pavilionensis *Hall*	c
Cryptonella rectirostris *Hall*	
Terebratula lincklaeni *Hall*	
Tropidoleptus carinatus *Conrad*	cc

Crinoids

Nucleocrinus lucina *Hall*	
Dolatocrinus glyptus *Hall*	
D. liratus *Hall*	

On comparing these lists of species we find that while they are essentially homogeneous there are certain characteristic differences.

Centerfield limestone	Canandaigua shale
Profusion of Trilobites representing all species of the Hamilton fauna except *Homalonotus dekayi*. Cirripedes and Schizodiscus	Trilobites relatively rare, the only common species *Phacops rana*, *Dalmanites boothi*, *Proetus macrocephalus*, *H. dekayi*. Other crustacea, except ostracodes rare or absent
Cephalopods rare or absent	Orthoceras, Gyroceras, Bactrites, Tornoceras
	....
Bellerophon pelops	B. leda
....	B. lyra
....	B. acutilira
Platyceras c	Platyceras cc
Pleurotomaria lucina	....
P. disjuncta	....
....	Diaphorostoma lineatum c
....	Murchisonia
....	Macrochilus
....	Cyclonema
Actinopteria decussata	....
....	Modiomorpha complanata
....	M. concentrica
....	M. macilenta
....	Goniophora acuta
....	Grammysia arcuata
....	Palaeoneilo constricta, emarginata, fecunda, plana, tenuistriata
....	
Lingulas c	....
Pholidostrophia nacrea cc	P. nacrea .... r
Leptostrophia perplana .... r	L. perplana cc
Spirifer divaricatus	....
....	Trematospira nobilis
....	Athyris spiriferoides
....	Trigeria lepida
....	Tropidoleptus carinatus
Corals very abundant forming a well marked plantation	Corals quite rare

Future investigations may obliterate some of these differences yet there will doubtless remain a distinction in the upper and lower elements of this fauna though these are bound together by a multitude of identities.

Tichenor limestone

Fossils are extremely few in this layer of semicrystalline gray limestone. They are frequently replaced wholly or in part by celestite and hence at times make very striking specimens. They are:

Phacops rana *Green*
Orthoceras caelamen *Hall*
O. exile *Hall*
Lyriopecten orbiculatus *Hall*
Spirifer mucronatus *Conrad*
Spirophyton typus *Hall*

The last named object covers surfaces of the rock when inclined to be shaly.

Moscow shales

Lower division

The Moscow shales are well divided into subequal parts by the Menteth limestone and as there is a lithologic difference in the two on account of the gradual loss of calcareous content, we may contrast the faunas of these divisions. Lower beds:

Crustaceans

Phacops rana *Green*............ccc
Dalmanites boothi *Green*..........c
Proetus macrocephalus *Hall*
Homalonotus dekayi *Hall*

Worms

Spirorbis angulatus *Hall*

Cephalopods

Orthoceras nuntium *Hall*
Gyroceras liratum *Hall*
Tornoceras uniangulare *Conrad*
Bactrites tenuicinctus *Hall*

Pteropods

Tentaculites bellulus *Hall*
Hyolithus aclis *Hall*

Gastropods

Bellerophon leda *Hall*
B. patulus *Conrad*
B. thalia *Hall*
Platyceras carinatum *Hall*
P. conicum *Hall*
P. thetis *Hall*
Pleurotomaria itys *Hall*
Loxonema delphicola *Hall*
Diaphorostoma lineatum *Conrad*.ccc
Cyclonema trilix *Hall*

Lamellibranchs

Mytilarca oviformis *Conrad*
Macrodon hamiltoniae *Hall*
Microdon bellistriatus *Conrad*
Cypricardinia indenta *Conrad*
C. pygmaea *Hall*
Grammysia arcuata *Conrad*
G. bisulcata *Conrad*
Goniophora acuta *Hall*
Modiomorpha concentrica *Conrad*
Aviculopecten parilis *Conrad*
Palaeoneilo fecunda *Hall*
P. muta *Hall*
P. plana *Hall*
P. tenuistriata *Hall*
Actinopteria decussata *Hall*.......c

Brachiopods

Craniella hamiltoniae *Hall*
Crania crenistria *Hall*
Pholidops hamiltoniae *Hall*
Rhipidomella penelope *Hall*
R. vanuxemi *Hall*................c
Stropheodonta concava *Hall*.......c
S. inequistriata *Hall*..............c
S. junia *Hall*.....................c
Leptostrophia perplana *Conrad*...cc
Chonetes coronatus *Conrad*
C. deflectus *Hall*
Productella papulata *Hall*
P. spinulicosta *Hall*
Spirifer marcyi *Hall*
S. mucronatus *Conrad*............c
S. consobrinus *d'Orbigny*
Ambocoelia umbonata *Conrad*
Nucleospira concinna *Hall*
Trematospira gibbosa *Hall*
Meristella haskinsi *Hall*
Athyris spiriferoides *Eaton*.......c

Atrypa reticularis *Linné*..........c
Camarotoechia congregata *Conrad*
C. prolifica *Hall*
Pentamerella pavilionensis *Hall*..cc
Cryptonella planirostris *Hall*
C. rectirostris *Hall*
Tropidoleptus carinatus *Conrad*..cc

Crinoids

Platycrinus *sp.*
Megistocrinus depressus *Hall*
M. ontario *Hall*
Thylacocrinus clarkei *W. & S.*
Ancyrocrinus bulbosus *Hall*
Dolatocrinus liratus *Hall*
D. intermedius *Hall*
D. glyptus *Hall*
D. troosti *Hall*
Aorocrinus cauliculus *Hall*
A. pocillum *Hall*
A. praecursor *Hall*
Eleutherocrinus whitfieldi *Hall*
Gennaeocrinus eucharis *Hall*
G. nyssa *Hall*
Gilbertsocrinus spinigerus *Hall*
Melocrinus gracilis *W. & S.*
Poteriocrinus diffusus *Hall*
P. nereus *Hall*
P. nycteus *Hall*
Poteriocrinus *sp.*
Rhodocrinus gracilis *Hall*
R. spinosus *Hall*
R. nodulosus *Hall*
Nucleocrinus lucina *Hall*
Pentremites leda *Hall*

Menteth limestone

In this thin layer the species of the fauna are crowded together in great numbers. Several years ago the late Prof. Charles E. Beecher of Yale University collected at the localities of this interesting formation, and the etchings from the material thus gathered have been studied and identified by Percy E. Raymond of the Carnegie Museum, Pittsburg. Mr Raymond is about to publish some account of the fauna and he has permitted me to give here his list of species determined to which I have added a few not recognized by him.

Worms

Spirorbis angulatus *Hall*
S. spinuliferus *Nich.*
Cornulites tribulis *Hall*
Cornulites *sp. nov.*
Autodetus lindstroemi *Clarke*
Autodetus *sp. nov.*
Proetus rowi *Green*
P. macrocephalus *Hall*
Cyphaspis ornata *Hall*
Homalonotus dekayi *Green*
Phacops rana *Green*
Cryphaeus boothi *Green*

Crustaceans

Primitiopsis punctilifera *Hall*
Kirkbya parallela *Ulrich*
Strepula sigmoidalis *Jones*
Isochilina lineata *Jones*
I. (?) fabacea *Jones*
Primitia seminulus *Jones*
Octonaria stigmata *Ulrich*
Ctenobolina papillosa *Ulrich*
Beyrichia kolmodini *Jones*
Halliella retifera *Ulrich*
Moorea bicornuta *Ulrich*
Ostracoda—several unidentified species

Cephalopods

Orthoceras *sp. ind.*

Pteropods

Styliola *sp. und.*
Tentaculites bellulus *Hall*
Hyolithes aclis *Hall*

Gastropods

Loxonema hamiltoniae *Hall*
Pleurotomaria capillaria *Conrad*
Cyclonema hamiltoniae (?) *Hall*
Bellerophon leda *Hall*
Platyceras bucculentum *Hall*
P. carinatum *Hall*
P. symmetricum *Hall*
P. thetis *Hall*
Diaphorostoma lineatum *Conrad*

Lamellibranchs

Nuculites oblongatus *Conrad*
N. triqueter *Conrad*
Nucula corbuliformis *Hall*
Palaeoneilo contricta *Conrad*
Conocardium eboraceum *Hall*
Actinopteria decussata *Hall*
Aviculopecten exacutus *Hall*
A. princeps *Conrad*
A. scabridus *Hall*
Pterinopecten intermedius *Hall*
P. hermes *Hall*
P. regularis *Hall*
P. conspectus *Hall*
Lyriopecten orbiculatus *Hall*
Modiomorpha alata *Conrad*
Cypricardella bellistriata *Conrad*
Cypricardinia indenta *Conrad*
Nyassa arguta *Hall*

Brachiopods

Lingula punctata *Hall*
Lingula *sp. ind.*
Pholidops oblata *Hall*
P. hamiltoniae *Hall*
Crania crenistriata *Hall*
Craniella hamiltoniae *Hall*
Camarotoechia congregata *Conrad*
C. horsfordi *Hall*
C. sappho *Hall*
Trigeria lepida *Hall*
Eunella lincklaeni *Hall*
Tropidoleptus carinatus *Conrad*
Atrypa reticularis *Linn.*
Cyrtina hamiltonensis *Hall*
Spirifer mucronatus *Conrad*
S. audaculus *Conrad*
S. granulosus *Conrad*
S. consobrinus *d'Orb.*
S. sculptis *Hall*
S. fimbriatus *Conrad*
Ambocoelia umbonata *Conrad*
Nucleospira concinna *Hall*
Athyris spiriferoides *Eaton*
Stropheodonta concava *Hall*
S. demissa *Conrad*
S. inequistriata *Conrad*
S. junia *Hall*
Leptostrophia perplana *Conrad*
Pholidostrophia iowensis *Owen.*
Orthothetes chemungensis pectinaceus *Hall*
O. chemungensis arctistriatus *Hall*
O. bellulus *Clarke*
Chonetes coronatus *Conrad*
C. mucronatus *Hall*
C. scitulus *Hall*
C. deflectus *Hall*
C. robustus *Raymond*
Strophalosia truncata *Hall*
Productella spinulicosta *Hall*
Rhipidomella penelope *Hall*
R. vanuxemi *Hall*

Bryozoans

Ascodictyum stellatum *N. & E.*
Pinacotrypa plana *Hall*
Monotrypa fruticosa *Hall*
Monotrypa *sp. und.*
Fenestella emaciata *Hall*
Reteporina striata *Hall*
Isotrypa *sp. und.*
Hemitrypa cribosa *Hall*
Polypora fistulata *Hall*
P. multiplex *Hall*
Rhombopora tortalinea *Hall*
Streblotrypa hamiltonensis *Nich.*
Ptilodictya plumea *Hall*
Cystodicta incisurata *Hall*
Taeniopora exigua *Nich.*
Acrogenia prolifera *Hall*
Lichenalia stellata *Hall*
Paleschara reticulata *Hall*

Corals

Heliophyllum halli *E. & H.*
Michelinia stylopora *Eaton*
Aulopora serpens *Goldf.*
Ceratopora dichotoma *Grabau*
C. jacksoni *Grabau*

Moscow shales

Upper division

Fossils in these beds are less profuse though more numerous in species. They are quite uniformly distributed through the lower portion but farther up become arranged in thin beds separated by more or less wide intervals of barren shales.

Thin layers of limestone in these upper shales carry agglomerated masses of fossils.

Crustaceans

Phacops rana *Green*..............c
Cryphaeus boothi *Green*
Proetus macrocephalus *Hall*
Homalonotus dekayi *Green*

Worms

Spirorbis angulatus *Hall*

Cephalopods

Orthoceras exile *Hall*
O. emaceratum *Hall*
O. nuntium *Hall*
O. crotalus *Hall*
Gyroceras liratum *Hall*
Bactrites tenuicinctus *Hall*

Pteropods

Styliolina fissurella *Hall*
Hyolithus aclis *Hall*

Gastropods

Bellerophon leda *Hall*
Platyceras carinatum *Hall*
P. echinatum *Hall*
P. erectum *Hall*
P. rectum *Hall*
P. symmetricum *Hall*
Pleurotomaria capillaria *Conrad*
P. itys *Hall*
P. lucina *Hall*
P. rotalia *Hall*
Loxonema delphicola *Hall*
Diaphorostoma lineatum *Conrad*

Lamellibranchs

Macrodon hamiltoniae *Hall*
Microdon bellistriatus *Conrad*
Cypricardinia indenta *Conrad*
Grammysia arcuata *Hall*
G. bisulcata *Conrad*
Goniophora hamiltonensis *Hall*
Modiomorpha macilenta *Hall*
Nucula corbuliformis *Hall*
N. lirata *Conrad*
Nuculites oblongatus *Conrad*
Orthonota carinata *Conrad*
O. parvula *Hall*
O. undulata *Conrad*..............cc
Palaeoneilo constricta *Conrad*
P. tenuistriata *Hall*
Pholadella radiata *Hall*
Phthonia nodocostata *Hall*
Sanguinolites solenoides *Hall*
Tellinopsis subemarginata *Conrad*

Brachiopods

Lingula punctata *Hall*...........cc
Dignomia alveata *Hall*
Craniella hamiltoniae *Hall*
Crania crenistriata *Hall*
Pholidops hamiltoniae *Hall*.......c
P. oblata *Hall*
Rhipidomella penelope *Hall*
R. vanuxemi *Hall*................c
Orthothetes pandora *Billings*
O. arctostriatus *Hall*
Stropheodonta concava *Hall*
S. demissa *Conrad*...............rr
S. inequistriata *Conrad*
S. junia *Hall*
Pholidostrophia nacrea *Hall*
Chonetes aurora *Hall*
C. coronatus *Conrad*..............c
C. deflectus *Hall*................c
C. lepidus *Hall*..................c
C. scitulus *Hall*.................c
Spirifer granulosus *Conrad*
S. marcyi *Hall*
S. audaculus *Conrad*

S. tullius *Hall*.....................c
S. eatoni *Hall*
Cyrtina hamiltonensis *Hall*
Ambocoelia umbonata *Conrad*....cc
Nucleospira concinna *Hall*........c
Trematospira hirsuta *Hall*
Meristella haskinsi *Hall*
Athyris spiriferoides *Eaton*.......cc
Atrypa reticularis *Linné*.........cc
A. spinosa *Hall*..................c
Camarotoechia congregata *Conrad*
C. dotis *Hall*
C. sappho *Hall*
Cryptonella rectirostris *Hall*
Eunella lincklaeni *Hall*
Tropidoleptus carinatus *Conrad*

Crinoids

Nucleocrinus lucina *Hall*
Forbesciocrinus lobatus *Hall*
Calceocrinus clarus *Hall*
Platycrinus eboraceus *Hall*

The contrasts in the faunas of these upper and lower beds are not deep seated. There is in the former as a most striking feature the profuse development of the crinoids associated with an almost equal profusion of Phacops rana, Diaphorostoma lineatum and Pentamerella pavilionensis with Productella papulata; in the upper beds lamellibranch species such as Orthonota undulata, parvula, carinata, Phthonia nodocostata, Pholadella radiata and specially Tellinopsis subemarginata which are rare or absent below. There are also here thin beds wholly composed of Ambocoelia umbonata but on the whole the distribution of the fauna throughout the Moscow shales is quite uniform.

The Moscow shales are exposed in detail in the ravine at Tichenor point where the succession from the bottom up is essentially as follows:

At the base the uppermost beds of the Canandaigua shales with Eridophyllum archiaci, Heliophyllum and other cyathophylloids in abundance.

Tichenor limestone

1 Blue calcareous shale with crinoids, Pentamerella pavilionensis, Diaphorostoma lineatum, Phacops rana, 2 feet, passing into a thin limestone 8 inches

2 Bluish shale with Tropidoleptus carinatus, 30 feet

3 Menteth limestone, 1 to 1½ feet

4 Bluish shale with Tropidoleptus carinatus

5 Olive shales with Cryphaeus boothi

6 Arenaceous shale with Homalonotus dekayi, Orthonota, abounding in grotesque calcareous concretions and passing into a thin limestone above, 12 feet

7 Olive shale

8 Very soft light gray shales with Ambocoelia, Chonetes, Athyris and Phacops in distant thin layers

9 Olive shale

Tully pyrite

Genesee shale

Tully limestone and pyrite

What little Tully limestone is here represented carries the indicial species Hypothyris cuboides Sowerby (sp.) identified originally by Conrad with Sowerby's Rhynchonella cuboides and subsequently described by Hall as R. venustula.

The species R. cuboides was long ago referred by King to the genus Hypothyris. This world-wide species is here a newcomer into the Devonic faunas and is associated throughout the exposures of the Tully with an assemblage essentially consisting of Hamilton species, though slight variations from Hamilton types are indicated and there are a few additional species present like the very characteristic trilobite Bronteus tullius Hall & Clarke. For at least a half century Hypothyris cuboides has been recognized as indicative of lowest upper Devonic age and the Bronteus associated with it is likewise of early Devonic type (*Thysanopeltis*). The fact that these species accompany an essentially unmodified fauna of earlier age does not argue that age for the limestone but serves to emphasize if anything the introduction of new types indicative of fundamental change.

The fauna of the pyrite layer is a parvifauna with affinities wholly or essentially with that of the Hamilton shales. It is in fact a series of forms which have as a whole suffered an arrest of development, and its species are immature stages of those preceding though they are actually in adult condition. The conditions of growth while this pyrite was being precipitated, were so unfavorable that the organisms were able to advance but a little in the line of species development and yet they apparently acquired the power of reproduction and manifested themselves in these arrested conditions probably for several generations. These fossils were studied by the writer some years ago, and have been more exhaustively examined of late by Dr F. B. Loomis from material collected all along the line of outcrop of the layer.

The specimens are to be extracted from the rock only with great labor but it is to be expected that forms present at one place will appear at others and hence the entire list of the known species is here appended. It will be observed that the designations used in Dr Loomis's list here given indicate *mutations* only from the types of Hamilton species and not deep seated specific differences.

Crustaceans

Beyrichia dagon *Clarke*
Entomis prosephina *Loomis*
Cryphaeus boothi *var.* calliteles *Green*

Cephalopods

Bactrites (*sp.*) ? *mut.* parvus *Loomis*
B. (*sp.*) *mut.* pygmaeus *Loomis*
Orthoceras nuntium *Hall*
O. scintilla (?) *mut.* mephisto *Clarke*
O. subulatum *mut.* pygmaeum *Loomis*
Tornoceras uniangulare *mut.* astarte *Clarke*
T. uniangulare *Conrad*

Pteropods

Tentaculites bellulus? *mut.* stebos *Clarke*
T. gracilistriatus *mut.* asmodeus *Clarke*

Gastropods

Loxonema delphicola *mut.* moloch *Clarke*
Pleurotomaria
P. itys *mut.* pygmaea *Loomis*
P. capillaria *mut.* pygmaea *Loomis*
Macrochilina hamiltoniae *mut.* pygmaea *Loomis*
M. hebe *mut.* pygmaea *Loomis*
Diaphorostoma lineatum *mut.* belial *Clarke*

Lamellibranchs

Conocardium eboraceum *mut.* pygmaeum *Loomis*
Buchiola retrostriata *mut.* pygmaea *Loomis*
Grammysia constricta *mut.* pygmaea *Loomis*
Paracyclas lirata *mut.* pygmaea *Loomis*
Palaeoneilo constricta *mut.* pygmaea *Loomis*
P. plana *mut.* pygmaea *Loomis*
Leda rostellata *mut.* pygmaea *Loomis*
Nuculites oblongatus *mut.* pygmaeus *Loomis*
N. triqueter *mut.* pygmaeus *Loomis*
Nucula varicosa *mut.* pygmaea *Loomis*
N. corbuliformis *mut.* pygmaea *Loomis*
N. lirata *mut.* pygmaea *Loomis*

Brachiopods

Trigeria lepida *mut.* pygmaea *Loomis*
Productella spinulicosta *mut.* pygmaea *Loomis*
Strophalosia truncata *mut.* pygmaea *Loomis*
Tropidoleptus carinatus *mut.* pygmaeus *Loomis*
Ambocoelia umbonata *mut.* pluto *Loomis*
A. umbonata *mut.* pygmaea *Loomis*
Nucleospira concinna *mut.* pygmaea *Loomis*
Cyrtina hamiltonensis *mut.* pygmaea *Loomis*
Spirifer marcyi *mut.* pygmaeus *Loomis*
S. granulosus *mut.* pluto *Clarke*
S. tullius *mut.* belphegor *Clarke*
S. medialis *mut.* pygmaeus *Loomis*
S. mucronatus *mut.* hecate *Clarke*
S. fimbriatus *mut.* pygmaeus *Loomis*
S. fimbriatus *mut.* simplicissimus *Loomis*
Crinoid stems
Pentremites leda *Hall*

Genesee shale

This shale carries only a sparse fauna and its fossils are not well preserved. In the densely black layers there is rarely anything to be obtained, but lignites sometimes of considerable length, occasionally Lepidodendron and conodont teeth have also been found herein.

The less bituminous shales contain:

Pleurotomaria rugulata *Hall*
Styliolina fissurella *Hall*
Pterochaenia fragilis *Hall*
Lingula spatulata *Hall*
Orbiculoidea lodensis *Hall*
Liorhynchus quadricostatus *Hall*
Probeloceras lutheri *Clarke* (occasionally)
Bactrites aciculum *Hall*

Genundewa limestone

The fauna here appearing is, as we have explained on previous occasions, the first appearance in this district of the Portage or Naples fauna of the beds overlying. It is thus a prenuncial fauna announcing the invasion and occupancy of the field by a congeries of species not before known in New York. It is evident that this fauna came in from the west and covered for a short time only, the whole area from here westward to Lake Erie. We have shown elsewhere the probability that the rock itself, which is largely composed of the pteropod Styliolina, represents a deep water deposit of pteropod ooze and its associated organisms are also those of deep water habit. The fauna and flora of this limestone are as follows and in this list the names in roman are of species reappearing in the higher faunas (Cashaqua); those in antique not occurring elsewhere.

Dinicthys newberryi *Clarke*
Echinocaris? longicauda *Hall*
Spathiocaris emersoni *Clarke*
Cardiocaris
Manticoceras pattersoni *Hall* var. **styliophilum** *Clarke*
M. contractum *Clarke*
M. fasciculatum *Clarke*
M. nodifer *Clarke*
Gephyroceras genundewa *Clarke*
Tornoceras uniangulare *Conrad* var. **compressum** *Clarke*
Orthoceras atreus *Hall*
Styliolina fissurella *Hall*
Tentaculites gracilistriatus *Hall*
Pleurotomaria genundewa *Clarke*
Bellerophon koeneni *Clarke*
B. denckmanni *Clarke*
Phragmostoma natator *Hall*
P. incisum *Clarke*
Loxonema noe *Clarke*
Macrochilina pygmaea *Clarke*
M. seneca *Clarke*
Diaphorostoma pugnus *Clarke*
Protocalyptraea styliophila *Clarke*
Lunulicardium hemicardioides *Clarke*
L. encrinitum *Clarke*
Pterochaenia fragilis *Hall*
P. sinuosa *Clarke*
Honeoyea styliophila *Clarke*
H. simplex *Clarke*
Ontaria suborbicularis *Hall*
Buchiola retrostriata v. *Buch*
B. livoniae *Clarke*
B. scabrosa *Clarke*
Paracardium doris *Hall*
P. delicatulum *Clarke*
Lingula spatulata *Vanuxem*
Lingulipora williamsana *Girty*
Aulopora annectens *Clarke*
Cordaeoxylon clarkei *Dawson*
Cladoxylon mirabile *Unger*
Cyclostigma affine *Dawson*
Lepidodendron gaspianum *Dawson*
L. primaevum *Rogers*

Taken as a whole the assemblage is rich and interesting and there are not more favorable opportunities for its examination than are afforded on Canandaigua lake. Specially noteworthy are the remains of plants of genera and species which have been found elsewhere only in corresponding horizons of Europe.

West River shale

In these beds we find a return of the shale fauna beneath (Genesee) with a few additional species. The distinctive characters of the division are essentially lithologic. Its fossils are:

Bactrites aciculum *Hall* (?)
Gephyroceras *sp.*?
Pleurotomaria rugulata *Hall*
Buchiola retrostriata *v. Buch*
Panenka *sp.*
Pterochaenia fragilis *Hall*. c
Lunulicardium curtum *Hall*
Lingula spatulata *Vanuxem*
Orbiculoidea lodensis *Vanuxem*

Embedded in these shales not far above the Genundewa limestone is a thin and, over the region of this map, continuous limestone which is a mass of the crinoid Melocrinus c l a r k e i Hall. Over this surface for a brief period flourished a plantation of these crinoids and their substance has largely contributed to the lime content of the rock containing them.

Standish shales and flags

Fauna very sparse and chiefly that of the beds below.

Bactrites aciculum *Hall?*
Gephyroceras *sp.*
Pleurotomaria cognata *Clarke*
Pterochaenia fragilis *Hall*
Ontaria suborbicularis *Hall*

Middlesex shale

These densely bituminous deposits, similar in all respects to the Genesee shale bear only the most meager evidences of organic life. Indeterminable plant remains occasionally appear and with them are:

Conodonts
Sandbergeroceras syngonum *Clarke*
Ontaria suborbicularis *Hall*

The affinity of the fauna with that of the Cashaqua shales is herein evident.

Cashaqua shale

In these soft shale beds, with their accompanying flags and sands, the peculiar western Portage fauna attains its culmination. This interesting congeries of fossils has been termed the *Naples fauna* for it is here that it attains its best development. The term has been employed because of the indefiniteness of the term Portage as applied to the fauna, for the faunas existing in Portage time are known to differ highly according to their geographic location; brackish in eastern New York (Oneonta), a profuse brachiopod fauna in central New York (Ithaca) and in western New York a fauna essentially devoid of brachiopods but characterized by its abundance of cephalopods and lamellibranchs. In our latest studies of this fauna in its extent throughout western New York it has become evident that, in this western Portage province covering the field occupied by the fauna from Cayuga lake west to Lake Erie, the Genesee province as it has been designated, there are actually two subprovinces, an eastern (Naples subprovince) into which only the advance guard penetrated on its invasion from the west, and a western or Chautauqua subprovince. These two subfaunas of the Genesee provinces are knit together by unity of generic and to some extent of specific characters, but differ more in respect to predominant species.

We have then in the rocks before us the typical development of the fauna of this Naples subprovince or the Naples fauna in its proper sense.

The species are:

Crustaceans

Eleutherocaris whitfieldi *Clarke*
Stylonurus? wrightianus *Dawson*
Spathiocaris emersoni *Clarke*
Dipterocaris

Cephalopods

Manticoceras pattersoni *Hall*
M. apprimatum *Clarke*
M. tardum *Clarke*
M. accelerans *Clarke*
M. vagans *Clarke*
Probeloceras lutheri *Clarke*
P.? naplesense *Clarke*
Beloceras iynx *Clarke*
Tornoceras uniangulare *Conrad*
T. uniangulare *var.* obesum *Clarke*
Cyrtoclymenia neapolitana *Clarke*
Bactrites gracilior *Clarke*
B. aciculum *Hall*
Orthoceras pacator *Hall*
O. ontario *Clarke*
O. filosum *Clarke*

Pteropods

Hyolithus neapolis *Clarke*
Tentaculites gracilistriatus *Hall*
T. tenuicinctus *Roemer*
Styliolina fissurella *Hall*
Protospirialis minutissima *Clarke*

Gastropods

Loxonema noe *Clarke*
Macrochilina pygmaea *Clarke*
Palaeotrochus praecursor *Clarke*
Diaphorostoma rotundatum *Clarke*
Pleurotomaria cognata *Clarke*
P. ciliata *Clarke*
Protocalyptraea marshalli *Clarke*
Phragmostoma natator *Hall*
P. incisum *Clarke*
P. *cf.* triliratum *Hall*
Tropidocyclus hyalinus *Clarke*
Bellerophon koeneni *Clarke*

Lamellibranchs

Lunulicardium acutirostrum *Hall*
L. ornatum *Hall*
L. clymeniae *Clarke*
L. hemicardioides *Clarke*
L. velatum *Clarke*
L. finitimum *Clarke*
L. sodale *Clarke*
L. pilosum *Clarke*
L. paruncnlus *Clarke*
Pterochaenia fragilis *Hall*
P. fragilis *var.* orbicularis *Clarke*
P. perissa *Clarke*
Honeoyea erinacea *Clarke*
H. majora *Clarke*
Paraptyx ontario *Clarke*
Ontaria suborbicularis *Hall*
O. clarkei *Beushausen*
O. affiliata *Clarke*
O. halli *Clarke*
Buchiola retrostriata *v. Buch*
B. scabrosa *Hall*
B. conversa *Hall*
Paracardium doris *Hall*
Palaeoneilo petila *Clarke*
P. muricata *Clarke*

Brachiopods

Productella speciosa *Hall*
Chonetes scitulus *Hall*
Lingula triquetra *Clarke*
L. ligea *Hall*

Corals

Aulopora annectens *Clarke*

Crinoids

Melocrinus clarkei *Hall*

Plants

Cordaeoxylon clarkei *Dawson*
Lepidodendron gaspianum *Dawson*
L. primaevum *Rogers*

In the midst of these Cashaqua beds is the

Parrish limestone

which has frequently been referred to in our publications because, first, of its singular composition of greenish and reddish calcareous nodules, which are usually fused into a continuous mass and resemble the kramenzel so characteristic of some of the European Devonic beds of equivalent age, and again because the abundance of Goniatites which it contains chiefly of the species Manticoceras pattersoni, Tornoceras uniangulare and Probeloceras lutheri, together with Orthoceras pacator, some singular and undetermined fish remains and myriads of the pteropods Styliolina and Protospirialis. The rock is continuous nearly across the map and beyond it to the east.

Rhinestreet shale

In these recurrent beds of black shale the fauna is again very much curtailed. Only the following have been obtained from it:

Polygnathus dubius *Hinde*
Prioniodus spicatus *Hinde*
P. erraticus *Hinde*
Palaeoniscus devonicus *Clarke*
Acanthodes pristis *Clarke*
Spathiocaris emersoni *Clarke*
Lunulicardium velatum *Clarke*
Pterochaenia fragilis *Hall*
Leptodomus multiplex *Clarke*

Hatch flags and shales

The fossils in these arenaceous beds are all representatives of the Cashaqua shale fauna but in very much decreased quantity. Goniatites, specially Manticoceras pattersoni and Probeloceras lutheri occur in the flagstones, also occasional specimens of Lunulicardium ornatum and L.

acutirostrum, Honeoyea desmata and Buchiola retrostriata, Palaeotrochus praecursor and Bactrites. In certain layers fragments of plants abound, chiefly of Lepidodendron.

Grimes sandstone

The Portage or Naples fauna has now disappeared except for a few straggling and modified representatives in the higher rocks and with the Grimes sandstone appears a well defined though somewhat sparse brachiopod fauna. We originally regarded this small fauna of the Grimes sandstone as a representative of the Chemung fauna but have subsequently expressed the view that it is rather the invading Ithaca fauna from the east. The distinction is a refined one; it would be extremely difficult to indicate at what time or horizon in the succession the term Chemung is to be applied to the homogeneous fauna occupying the field of central New York during the upper Devonic.

The fauna of the Grimes sandstone is as follows:

Protonympha devonica *Clarke*
Palaeochaeta salicifolia *Clarke*
Conularia *cf.* continens *Hall*
Paracyclas *sp.*
Grammysia subarcuata *Hall*
Aviculopecten *cf.* cancellatus *Hall*
Sphenotus *sp.*
Orbiculoidea
Schizophoria impressa *Hall*
Leptostrophia mucronata *Vanuxem*
Chonetes lepidus *Hall*
Liorhynchus mesacostalis *Hall*
L. globuliformis *Vanuxem*
Productella lachrymosa *Hall*
Ambocoelia umbonata *Conrad*
Atrypa spinosa *Hall*
Paropsonema cryptophyum *Clarke*
Dictyospongia haplea *Hall & Clarke*

West Hill flags and sandstone

The fauna of these beds is a continuation of the brachiopod fauna of the Grimes sandstone with some interesting additions. Nowhere are the fossils abundant and none are specially distinctive of the Chemung fauna so that we may regard these beds also as a continuation of the Ithaca invasion from the east. The fossils recorded are as follows:

Manticoceras oxy *Clarke*
Palaeotrochus praecursor *Clarke*
Aviculopecten cancellatus *Hall*
Grammysia elliptica *Hall*
Pholadella *cf.* parallela *Hall*
Leptodesma robustum *Hall*

Stropheodonta cayuta *Hall*
Leptostrophia perplana *Conrad* var. nervosa *Hall*
Orthothetes chemungensis *Conrad*
Productella lachrymosa *Hall*
Spirifer mucronatus *Conrad* mut.
S. mesacostalis *Hall*
Atrypa hystrix *Hall*
Ambocoelia umbonata *Conrad*
Cyrtina hamiltonensis *Hall*
Liorhynchus mesacostalis *Hall*
Hydnoceras tuberosum *Conrad*
H. variabile *Hall & Clarke*
H. legatum *Hall & Clarke*
Ceratodictya annulata *Hall*
Hydriodictya cylix *Hall & Clarke*

High Point sandstone

The interesting fauna of the calcareous or firestone layer of this formation was studied some years ago by the writer and its species have not been increased by later observations. These occur in the beds on High point, Naples:

Rhynchodus *sp.*
Cladodus *sp.*
Pterinea *sp.*
Orthis infera *Calvin*
Schizophoria iowensis *Hall*
Stropheodonta cayuta *Hall*
S. arcuata *Hall*
S. canace *Hall & Whitfield*
S. variabilis *Calvin*
S. exilis *Calvin*
Strophonella reversa *Whitfield* (?)
Orthothetes chemungensis *Hall*
Chonetes setiger *Hall*
Productella speciosa *Hall*
P. dissimilis *Hall*
Spirifer disjunctus *Sowerby*
S. orestes *Hall & Whitfield*
S. subattenuatus *Hall*
S. mesacostalis *Hall*
S. bimesialis *Hall*
Ambocoelia umbonata *Conrad*
Atrypa aspera *Hall*
A. hystrix *Hall*
A. reticularis *Linné*
Camarotoechia contracta *Hall*
Hypothyris pugnus *Martin*
Fistulipora occidens *Hall & Whitfield*
Polypora *sp.*
Fenestella *sp.*
Zaphrentis *sp.*
Receptaculites *sp.*
Dadoxylon clarkei *Dawson*

In this unusual congeries we find the earliest appearance of S p i r i f e r d i s j u n c t u s, which may be taken as indicating the advent of the true Chemung fauna. It is also important to note the very marked representation of species which were originally described from the upper Devonic of Iowa and have been observed nowhere else in the Appalachian region except spasmodically.

Exact correlation of the stages of the Iowan Devonic with that of New York is not practicable as the Siluric continental barrier between was the cause of great differences in sedimentation and fauna on its east and west sides, but this invading western fauna intercalated in the normal Chemung fauna of this district may be regarded as an indication of the fact that the continental barrier was temporarily down and the western fauna migrated to the east.

Prattsburg sandstone

In these beds the fauna, which is fairly profuse in certain layers, does not materially differ from that of the West Hill beds. The Iowan species occurring in the High Point fauna are not present or if so are of extremely rare occurrence and certain species are abundant such as

Spirifer mesastrialis *Hall*
S. mucronatus *Conrad* var. posterus *Hall & Clarke*
Atrypa hystrix *Hall*
A. reticularis *Linné*
Stropheodonta cayuta *Hall*

In certain of the beds from the upper part of the division occurs the trilobite Bronteus senescens Clarke, which has also been found as far south as Avoca, Steuben co. in the continuation of the same formation. Associated with it is the spiny crinoid Hystricrinus depressus Wachsmuth & Springer which is known only from these beds.

INDEX

University of the State of New York

New York State Museum

PUBLICATIONS

Postage or express to places outside of New York State must be paid in addition to the price given. On 10 or more copies of any one publication 20% discount will be given, the buyer to pay transportation. Editions printed are only large enough to meet special claims and probable sales. When the sale copies are exhausted, the price for the few reserve copies is advanced to that charged by secondhand booksellers, in order to limit their distribution to cases of special need. Such prices are inclosed in [ ]. All publications are in paper covers, unless binding is specified.

Museum annual reports 1847-date. *All in print to 1892, 50c a volume, 75c in cloth; 1892-date, 75c, cloth.*

These reports are made up of the reports of the director, geologist, paleontologist, botanist and entomologist, and museum bulletins and memoirs, issued as advance sections of the reports.

Geologist's annual reports 1881-date. Rep'ts 1, 3-13, 17-date, O; 2, 14-16, Q.

The annual reports of the early natural history survey, 1837-41, are out of print.

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

Separate volumes of the following only are available.

Report	*Price*	*Report*	*Price*	*Report*	*Price*
12 (1892)	$.50	16	$1	19	$.40
14	.75	17	.75	20	.50
15, 2v.	2	18	.75	21	.40
				22	.40

In 1898 the paleontologic work of the State was made distinct from the geologic and will hereafter be reported separately.

Paleontologist's annual reports 1899-date.

See fourth note under Geologist's annual reports.

Bound also with museum reports of which they form a part. Reports for 1899 and 1900 may be had for 20c each. Since 1901 these reports have been issued as bulletins.

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

Reports 3-17 bound also with museum reports 40-46, 48-55 of which they form a part. Since 1898 these reports have been issued as bulletins. Reports 3-4 are out of print, other reports with prices are:

Report	*Price*	*Report*	*Price*	*Report*	*Price*
1	$.50	9	$.25	14 (Ent. 5)	$.20
2	.30	10	.35	15 (" 9)	.15
5	.25	11	.25	16 (" 10)	.25
6	.15	12	.25	17 (" 14)	.30
7	.20	13	.10	18 (" 17)	.20
8	.25			19	*In press*

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

Botanist's annual reports 1867-date.

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

Separate reports 25-28, 30, 42-50 and 52 (Botany bulletin 3), are out of print. Report 51 may be had for 40c; 53 for 20c; 54 for 50c. Since the 55th these reports have been issued as bulletins.

Descriptions and illustrations of edible, poisonous and unwholesome fungi of New York have been published in volumes 1 and 3 of the 48th museum report and in volume 1 of the 49th, 51st, 52d, 54th and 55th 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. O. *To advance subscribers, $2 a year or 50c a year for those of any one division:* (1) *geology, economic geology, mineralogy, general zoology, archeology and miscellaneous,* (2) *paleontology,* (3) *botany,* (4) *entomology.*

Bulletins are also found with the annual reports of the museum as follows:

Bulletin	*Report*	*Bulletin*	*Report*	*Bulletin*	*Report*
12-15	48, v. 1	20-25	52, v. 1	35-36	54, v. 2
16-17	50 "	26-31	53 "	37-44	" v. 3
18-19	51 "	32-34	54 "	45-48	" v. 4
				49-54	55, v. 1

The figures in parenthesis indicate the bulletin's number as a New York State Museum bulletin.

Geology. G1 (14) Kemp, J. F. Geology of Moriah and Westport Townships, Essex Co. N. Y., with notes on the iron mines. 38p. 7pl. 2 maps. Sep. 1895. *10c.*

G2 **(19)** Merrill, F: J. H. Guide to the Study of the Geological Collections of the New York State Museum. 162p. 119pl. map. Nov. 1898. [*50c*] *New edition in preparation.*

G3 **(21)** Kemp, J. F. Geology of the Lake Placid Region. 24p. 1pl. map. Sep. 1898. *5c.*

G4 **(48)** Woodworth, J. B. Pleistocene Geology of Nassau County and Borough of Queens. 58p. il. 9pl. map. Dec. 1901. *25c.*

G5 **(56)** Merrill, F: J. H. Description of the State Geologic Map of 1901. 42p. 2 maps, tab. Oct. 1902. *10c.*

G6 Cushing, H. P. Geology of the Vicinity of Little Falls, Herkimer Co. *In press.*

——— Crystalline Rocks of the Northeastern Adirondacks. *In press.*

Kemp, J. F. Crystalline Rocks of Warren and Washington Counties. *In preparation.*

Woodworth, J. B. Glacial Geology of New York. *In preparation.*

Economic geology. **Eg1** **(3)** Smock, J: C. Building Stone in the State of New York. 152p. Mar. 1888. *Out of print.*

Eg2 **(7)** —— First Report on the Iron Mines and Iron Ore Districts in the State of New York. 6+70p. map. June 1889. *Out of print.*

Eg3 **(10)** —— Building Stone in New York. 210p. map, tab. Sep. 1890. *40c.*

Eg4 **(11)** Merrill, F: J. H. Salt and Gypsum Industries of New York. 92p. 12pl. 2 maps, 11 tab. Ap. 1893. *40c.*

Eg5 **(12)** Ries, Heinrich. Clay Industries of New York. 174p. 2pl. map. Mar. 1895. *30c.*

Eg6 **(15)** Merrill, F: J. H. Mineral Resources of New York. 224p. 2 maps. Sep. 1895. *50c.*

Eg7 **(17)** —— Road Materials and Road Building in New York. 52p. 14pl. 2 maps 34x45, 68x92 cm. Oct. 1897. *15c.*

Maps separate *10c each, two for 15c.*

Eg8 **(30)** Orton, Edward. Petroleum and Natural Gas in New York. 136p. il. 3 maps. Nov. 1899. *15c.*

Eg9 **(35)** Ries, Heinrich. Clays of New York; their Properties and Uses. 456p. 140pl. map. June 1900. *$1, cloth.*

Eg10 **(44)** —— Lime and Cement Industries of New York; Eckel, E. C. Chapters on the Cement Industry. 332p. 101pl. 2 maps. Dec. 1901. *85c, cloth.*

Eg11 **(61)** Dickinson, H. T. Quarries of Bluestone and other Sandstones in New York. 108p. 18pl. 2 maps. Mar. 1903. *35c.*

Mineralogy. **M1** **(4)** Nason, F. L. Some New York Minerals and their Localities. 20p. 1pl. Aug. 1888. [*10c*]

M2 **(58)** Whitlock, H. P. Guide to the Mineralogic Collections of the New York State Museum. 150p. il. 39pl. 11 models. Sep. 1902. *40c.*

M3 **(70)** —— New York Mineral Localities. 110p. Sep. 1903. *20c.*

Paleontology. **Pa1** **(34)** Cumings, E. R. Lower Silurian System of Eastern Montgomery County; Prosser, C: S. Notes on the Stratigraphy of Mohawk Valley and Saratoga County, N. Y. 74p. 10pl. map. May 1900. *15c.*

Pa2 **(39)** Clarke, J: M.; Simpson, G: B. & Loomis, F: B. Paleontologic Papers 1. 72p. il. 16pl. Oct. 1900. *15c.*

Contents: Clarke, J: M. A Remarkable Occurrence of Orthoceras in the Oneonta Beds of the Chenango Valley, N. Y.

——Paropsonema cryptophya; a Peculiar Echinoderm from the Intumescens-zone (Portage Beds) of Western New York.

——Dictyonine Hexactinellid Sponges from the Upper Devonic of New York.

——The Water Biscuit of Squaw Island, Canandaigua Lake, N. Y.

Simpson, G: B. Preliminary Descriptions of New Genera of Paleozoic Rugose Corals.

Loomis, F: B. Siluric Fungi from Western New York.

Pa3 **(42)** Ruedemann, Rudolf. Hudson River Beds near Albany and their Taxonomic Equivalents. 114p. 2pl. map. Ap. 1901. *25c.*

Pa4 **(45)** Grabau, A. W. Geology and Paleontology of Niagara Falls and Vicinity. 286p. il. 18pl. map. Ap. 1901. *65c; cloth 90c.*

Pa5 **(49)** Ruedemann, Rudolf; Clarke, J: M. & Wood, Elvira. Paleontologic Papers 2. 240p. 13pl. Dec. 1901. *40c.*

Contents: Ruedemann, Rudolf. Trenton Conglomerate of Rysedorph Hill.
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.
——Value of Amnigenia as an Indicator of Fresh-water Deposits during the Devonic of New York, Ireland and the Rhineland.

Pa6 **(52)** Clarke, J: M. Report of the State Paleontologist 1901. 280p. il. 9pl. map, 1 tab. July 1902. *40c.*
Pa7 **(63)** —— Stratigraphy of Canandaigua and Naples Quadrangles. 2 maps. 78p. map. June 1904. *25c.*
Pa8 **(65)** —— Catalogue of Type Specimens of Paleozoic Fossils in the New York State Museum. 848p. May 1903. *$1.20, cloth.*
Pa9 **(69)** —— Report of the State Paleontologist 1902. 464p. 52pl. 8 maps. Nov. 1903. *$1, cloth.*
Pa10 —— Report of the State Paleontologist 1903. *In press.*

Zoology. **Z1** **(1)** Marshall, W: B. Preliminary List of New York Unionidae. 20p. Mar. 1892. *5c.*
Z2 **(9)** —— Beaks of Unionidae Inhabiting the Vicinity of Albany, N. Y. 24p. 1pl. Aug. 1890. *10c.*
Z3 **(29)** Miller, G. S. jr. Preliminary List of New York Mammals. 124p. Oct. 1899. *15c.*
Z4 **(33)** Farr, M. S. Check List of New York Birds. 224p. Ap. 1900. *25c.*
Z5 **(38)** Miller, G. S. jr. Key to the Land Mammals of Northeastern North America. 106p. Oct. 1900. *15c.*
Z6 **(40)** Simpson, G: B. Anatomy and Physiology of Polygyra albolabris and Limax maximus and Embryology of Limax maximus. 82p. 28pl. Oct. 1901. *25c.*
Z7 **(43)** Kellogg, J. L. Clam and Scallop Industries of New York. 36p. 2pl. map. Ap. 1901. *10c.*
Z8 **(51)** Eckel, E. C. & Paulmier, F. C. Catalogue of Reptiles and Batrachians of New York. 64p. il. 1pl. Ap. 1902. *15c.*

Eckel, E. C. Serpents of Northeastern United States.
Paulmier, F. C. Lizards, Tortoises and Batrachians of New York.

Z9 **(60)** Bean, T. H. Catalogue of the Fishes of New York. 784p. Feb. 1903. *$1, cloth.*
Z10 **(71)** Kellogg, J. L. Feeding Habits and Growth of Venus mercenaria. 30p. 4pl. Sep. 1903. *10c.*
Farr, M. S. Birds of New York. *In preparation.*
Letson, Elizabeth J. Catalogue of New York Mollusca. *In preparation.*

Entomology. **En1** **(5)** Lintner, J. A. White Grub of the May Beetle. 32p. il. Nov. 1888. *10c.*
En2 **(6)** —— Cut-worms. 36p. il. Nov. 1888. *10c.*
En3 **(13)** —— San José Scale and Some Destructive Insects of New York State. 54p. 7pl. Ap. 1895. *15c.*
En4 **(20)** Felt, E. P. Elm-leaf Beetle in New York State. 46p. il. 5pl. June 1898. *5c.*

See En15.

En5 **(23)** —— 14th Report of the State Entomologist 1898. 150p. il. 9pl. Dec. 1898. *20c.*
En6 **(24)** —— Memorial of the Life and Entomologic work of J. A. Lintner Ph.D. State Entomologist 1874-98; Index to Entomologist's Reports 1-13. 316p. 1pl. Oct. 1899. *35c.*

Supplement to 14th report of the state entomologist.

En7 **(26)** —— Collection, Preservation and Distribution of New York Insects. 36p. il. Ap. 1899. *5c.*
En8 **(27)** —— Shade Tree Pests in New York State. 26p. il. 5pl. May 1899. *5c.*
En9 **(31)** —— 15th Report of the State Entomologist 1899. 128p. June 1900. *15c.*
En10 **(36)** —— 16th Report of the State Entomologist 1900. 118p. 16pl. Mar. 1901. *25c.*

En11 (37) —— Catalogue of Some of the More Important Injurious and Beneficial Insects of New York State. 54p. il. Sep. 1900. *10c.*

En12 (46) —— Scale Insects of Importance and a List of the Species in New York State. 94p. il. 15pl. June 1901. *25c.*

En13 (47) Needham, J. G. & Betten, Cornelius. Aquatic Insects in the Adirondacks. 234p. il. 36pl. Sep. 1901. *45c.*

En14 (53) Felt, E. P. 17th Report of the State Entomologist 1901. 232p. il. 6pl. Aug. 1902. *30c.*

En15 (57) —— Elm Leaf Beetle in New York State. 46p. il. 8pl. Aug. 1902. *15c.*

This is a revision of En4 containing the more essential facts observed since that was prepared.

En16 (59) —— Grapevine Root Worm. 40p. 6pl. Dec. 1902. *15c.*

See En19.

En17 (64) —— 18th Report of the State Entomologist 1902. 110p. 6pl. May 1903. *20c.*

En18 (68) Needham, J. G. *& others.* Aquatic Insects in New York. 322p. 52pl. Aug. 1903. *80c, cloth.*

En19 (72) Felt, E. P. Grapevine Root Worm. 58p. 13pl. Nov. 1903. *20c.*

This is a revision of En16 containing the more essential facts observed since that was prepared.

En20 (74) Felt, E. P. & Joutel, L. H. Monograph of the Genus Saperda. 88p. 14pl. June 1904. *25c.*

Felt, E. P. 19th Report of the State Entomologist 1903. *In press.*

—— Mosquitos or Culicidae of New York. *In press.*

Botany. Bo1 (2) Peck, C: H. Contributions to the Botany of the State of New York. 66p. 2pl. May 1887. *Out of print.*

Bo2 (8) —— Boleti of the United States. 96p. Sep. 1889. [*50c*]

Bo3 (25) —— Report of the State Botanist 1898. 76p. 5pl. Oct. 1899. *Out of print.*

Bo4 (28) —— Plants of North Elba. 206p. map. June 1899. *20c.*

Bo5 (54) —— Report of the State Botanist 1901. 58p. 7pl. Nov. 1902. *40c.*

Bo6 (67) —— Report of the State Botanist 1902. 196p. 5pl. May 1903. *50c.*

Bo7 (75) —— Report of the State Botanist 1903. 70p. 4pl. 1904. *40c.*

Archeology. Ar1 (16) Beauchamp, W: M. Aboriginal Chipped Stone Implements of New York. 86p. 23pl. Oct. 1897. *25c.*

Ar2 (18) —— Polished Stone Articles used by the New York Aborigines. 104p. 35pl. Nov. 1897. *25c.*

Ar3 (22) —— Earthenware of the New York Aborigines. 78p. 33pl. Oct. 1898. *25c.*

Ar4 (32) —— Aboriginal Occupation of New York. 190p. 16pl. 2 maps. Mar. 1900. *30c.*

Ar5 (41) —— Wampum and Shell Articles used by New York Indians. 166p. 28pl. Mar. 1901. *30c.*

Ar6 (50) —— Horn and Bone Implements of the New York Indians. 112p. 43pl. Mar. 1902. *30c.*

Ar7 (55) ——Metallic Implements of the New York Indians. 94p. 38pl. June 1902. *25c.*

Ar8 (73) —— Metallic Ornaments of the New York Indians. 122p. 37pl. Dec. 1903. *30c.*

Ar9 —— History of the New York Iroquois. *In press.*

—— Perch Lake Mounds. *In press.*

—— Aboriginal Use of Wood in New York. *In press.*

Miscellaneous. Ms1 (62) Merrill, F: J. H. Directory of Natural History Museums in United States and Canada. 236p. Ap. 1903. *30c.*

Ms2 (66) Ellis, Mary. Index to Publications of the New York State Natural History Survey and New York State Museum 1837-1902. 418p. June 1903. *75c, cloth.*

Museum memoirs 1889-date. Q.

1 Beecher, C: E. & Clarke, J: M. Development of some Silurian Brachiopoda. 96p. 8pl. Oct. 1889. *Out of print.*

2 Hall, James & Clarke, J: M. Paleozoic Reticulate Sponges. 350p. il. 70pl. 1898. *$1, cloth.*

3 Clarke, J: M. The Oriskany Fauna of Becraft Mountain, Columbia Co. N. Y. 128p. 9pl. Oct. 1900. *80c.*

4 Peck, C: H. N. Y. Edible Fungi, 1895-99. 106p. 25pl. Nov. 1900. *75c.*
This includes revised descriptions and illustrations of fungi reported in the 49th, 51st and 52d reports of the state botanist.

5 Clarke, J: M. & Ruedemann, Rudolf. Guelph Formation and Fauna of New York State. 196p. 21pl. July 1903. *$1.50, cloth.*
6 —— Naples Fauna in Western New York. 268p. 26pl. map. *$2, cloth.*
7 Ruedemann, Rudolf. Graptolites of New York. Pt 1 Graptolites of the Lower Beds. *In press.*

Felt, E. P. Insects Affecting Park and Woodland Trees. *In preparation.*

Natural history of New York. 30v. il. pl. maps. Q. Albany 1842-94.

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. Q. Albany 1842-44. *Out of print.*
Historical introduction to the series by Gov. W: H. Seward. 178p.

v. 1 pt1 Mammalia. 13+146p. 33pl. 1842.
300 copies with hand-colored plates.

v. 2 pt2 Birds. 12+380p. 141pl. 1844.
Colored plates.

v. 3 pt3 Reptiles and Amphibia. 7+98p. pt4 Fishes. 15+415p. 1842.
pt3-4 bound together.

v. 4 Plates to accompany v. 3. Reptiles and Amphibia 23pl. Fishes 79pl. 1842.
300 copies with hand-colored plates.

v. 5 pt5 Mollusca. 4+271p. 40pl. pt6 Crustacea. 70p. 13pl. 1843-44.
Hand-colored plates: pt5-6 bound together.

DIVISION 2 BOTANY. Torrey, John. Flora of the State of New York; comprising full descriptions of all the indigenous and naturalized plants hitherto discovered in the State, with remarks on their economical and medical properties. 2v. il. pl. sq. Q. Albany 1843. *Out of print.*
v. 1 Flora of the State of New York. 12+484p. 72pl. 1843.
300 copies with hand-colored plates.

v. 2 Flora of the State of New York. 572p. 89pl. 1843.
300 copies with hand-colored plates.

DIVISION 3 MINERALOGY. Beck, Lewis C. Mineralogy of New York; comprising detailed descriptions of the minerals hitherto found in the State of New York, and notices of their uses in the arts and agriculture. il. pl. sq. Q. Albany 1842. *Out of print.*
v. 1 pt1 Economical Mineralogy. pt2 Descriptive Mineralogy. 24+536p. 1842.
8 plates additional to those printed as part of the text.

DIVISION 4 GEOLOGY. Mather, W: W.; Emmons, Ebenezer; Vanuxem, Lardner & Hall, James. Geology of New York. 4v. il. pl. sq. Q. Albany 1842-43. *Out of print.*
v. 1 pt1 Mather, W: W. First Geological District. 37+653p. 46pl. 1843.
v. 2 pt2 Emmons, Ebenezer. Second Geological District. 10+437p. 17pl. 1842.
v. 3 pt3 Vanuxem, Lardner. Third Geological District. 306p. 1842.
v. 4 pt4 Hall, James. Fourth Geological District. 22+683p. 19pl. map. 1843.

DIVISION 5 AGRICULTURE. Emmons, Ebenezer. Agriculture of New York; comprising an account of the classification, composition and distribution of the soils and rocks and the natural waters of the different geological formations, together with a condensed view of the meteorology and agricultural productions of the State. 5v. il. pl. sq. Q. Albany 1846-54. *Out of print.*
v. 1 Soils of the State, their Composition and Distribution. 11+371p. 21pl. 1846.
v. 2 Analysis of Soils, Plants, Cereals, etc. 8+343+46p. 42pl. 1849.
With hand-colored plates.

v. 3 Fruits, etc. 8+340p. 1851.

v. 4 Plates to accompany v. 3. 95pl. 1851.
Hand-colored.

v. 5 Insects Injurious to Agriculture. 8+272p. 50pl. 1854.
With hand-colored plates.

DIVISION 6 PALEONTOLOGY. Hall, James. Palaeontology of New York. 8v. il. pl. sq. Q. Albany 1847-94. *Bound in cloth.*

v. 1 Organic Remains of the Lower Division of the New York System. 23+338p. 99pl. 1847. *Out of print.*

v. 2 Organic Remains of Lower Middle Division of the New York System. 8+362p. 104pl. 1852. *Out of print.*

v. 3 Organic Remains of the Lower Helderberg Group and the Oriskany Sandstone. pt1, text. 12+532p. 1859. [*$3.50*]

—— pt2, 143pl. 1861. [*$2.50*]

v. 4 Fossil Brachiopoda of the Upper Helderberg, Hamilton, Portage and Chemung Groups. 11+1+428p. 99pl. 1867. *$2.50.*

v. 5 pt1 Lamellibranchiata 1. Monomyaria of the Upper Helderberg, Hamilton and Chemung Groups. 18+268p. 45pl. 1884. *$2.50.*

—— —— Lamellibranchiata 2. Dimyaria of the Upper Helderberg, Hamilton, Portage and Chemung Groups. 62+293p. 51pl. 1885. *$2.50.*

—— pt2 Gasteropoda, Pteropoda and Cephalopoda of the Upper Helderberg, Hamilton, Portage and Chemung Groups. 2v. 1879. v. 1, text. 15+492p. v. 2, 120pl. *$2.50 for 2 v.*

v. 6 Corals and Bryozoa of the Lower and Upper Helderberg and Hamilton Groups. 24+298p. 67pl. 1887. *$2.50.*

v. 7 Trilobites and other Crustacea of the Oriskany, Upper Helderberg, Hamilton, Portage, Chemung and Catskill Groups. 64+236p. 46pl. 1888. Cont. supplement to v. 5, pt2. Pteropoda, Cephalopoda and Annelida. 42p. 18pl. 1888. *$2.50.*

v. 8 pt1 Introduction to the Study of the Genera of the Paleozoic Brachiopoda. 16+367p. 44pl. 1892. *$2.50.*

—— pt2 Paleozoic Brachiopoda. 16+394p. 84pl. 1894. *$2.50.*

Catalogue of the Cabinet of Natural History of the State of New York and of the Historical and Antiquarian Collection annexed thereto. 242p. O. 1853.

Handbooks 1893-date. 7½x12½ cm.
In quantities, 1 cent for each 16 pages or less. Single copies postpaid as below.

H5 New York State Museum. 52p. il. *4c.*
Outlines history and work of the museum with list of staff 1902.

H13 Paleontology. 12p. *2c.*
Brief outline of State Museum work in paleontology under heads: Definition; Relation to biology; Relation to stratigraphy; History of paleontology in New York.

H15 Guide to Excursions in the Fossiliferous Rocks of New York. 124p. *8c.*
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.

H16 Entomology. 16p. *2c.*

H17 Economic Geology. *In press.*

H18 Insecticides and Fungicides. 20p. *3c.*

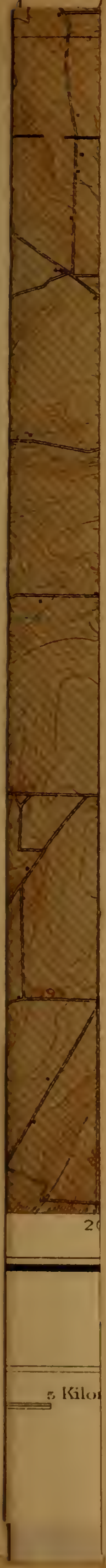
H19 Classification of New York Series of Geologic Formations. 32p. *3c.*

Maps. Merrill, F: J. H. Economic and Geologic Map of the State of New York; issued as part of Museum bulletin 15 and the 48th Museum Report, v. 1. 59x67 cm. 1894. Scale 14 miles to 1 inch. *Separate edition out of print.*

—— Geologic Map of New York. 1901. Scale 5 miles to 1 inch. *In atlas form $3; mounted on rollers $5. Lower Hudson sheet 60c.*
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.*

Clarke, J: M. & Luther, D. D. Geologic Map of Canandaigua and Naples Quadrangles. 1904. *20c.*
Issued as part of Paleontology 7.


5 Kilo

JOHN M. CLARKE
STATE PALEONTOLOGIST

UNIVERSITY OF THE STATE OF NEW YORK
STATE MUSEUM

BULLETIN 63

H. M. Wilson, Geographer in charge.
Control by W. T. Griswold and W. W. Gilbert.
Topography by J. H. Jennings.
Surveyed in 1900 in cooperation with the State of New York.

Scale 1/62500

Contour interval 20 feet.

Geology by John M. Clarke and D. D. Luther

University of the State of New York

New York State Museum

The New York State Museum as at present organized is the outgrowth of the Natural History Survey of the State commenced in 1836. This was established at the expressed wish of the people to have some definite and positive knowledge of the mineral resources and of the vegetable and animal forms of the State. This wish was stated in memorials presented to the Legislature in 1834 by the Albany Institute and in 1835 by the American Institute of New York city and as a result of these and other influences the Legislature of 1835 passed a resolution requesting the secretary of state to report to that body a plan for "a complete geological survey of the State, which shall furnish a scientific and perfect account of its rocks, soils and materials and of their localities; a list of its mineralogical, botanical and zoological productions and provide for procuring and preserving specimens of the same; etc."

Pursuant to this request, Hon. John A. Dix, then secretary of state, presented to the Legislature of 1836 a report proposing a plan for a complete geologic, botanic and zoologic survey of the State. This report was adopted by the Legislature then in session and the governor was authorized to employ competent persons to carry out the plan which was at once put into effect.

The scientific staff of the Natural History Survey of 1836 consisted o John Torrey, botanist; James E. DeKay, zoologist; Lewis C. Beck mineralogist; W. W. Mather, Ebenezer Emmons, Lardner Vanuxem and Timothy A. Conrad, geologists. In 1837 Mr Conrad was made paleontologist and James Hall, who had been an assistant to Professor Emmons was appointed geologist to succeed Mr Vanuxem, who then took charg of Mr Conrad's geological district.

The heads of the several departments reported annually to the gover nor the results of their investigations, and these constituted the annu octavo reports which were published from 1837 to 1841. The fin reports were published in quarto form, beginning at the close of the fiel work in 1841, and 3000 sets have been distributed, comprising four vol umes of geology, one of mineralogy, two of botany, five of zoology, fiv of agriculture, and eight of paleontology.