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IN ASSEMBLY,

February 17, 1841.

COMMUNICATION

From the Governor, transmitting several reports relative to the Geological Survey of the State.

EXECUTIVE CHAMBER,
Albany, February 16, 1841.

TO THE ASSEMBLY.

I transmit the annexed reports of the persons employed in the Geological Survey of the State.

WILLIAM H. SEWARD.

FIFTH ANNUAL REPORT

On the Palæontology of the State of New-York, by T. A. Conrad.

In order to give a clear exposition of some of the geological phenomena connected with the Palæontology of the Silurian system, which embraces nearly all the rocks of the State of New-York, it is necessary to furnish a slight sketch of the various formations of more recent date which occur within the limits of the Union.

In this general and brief review of formations, I will commence with the earliest fossilliferous strata, or those which collectively constitute the Silurian system of Murchison, a very extensive series of rocks, formerly termed the Grauwacke group by De la Bêche, and by others classed with the Old Red Sandstone and carboniferous or mountain limestone, to which vast series the name of Transition was applied. Mr. Murchison has happily been able by means of Palæontology, or the study of organic remains, to give a more natural and definite classification of the various strata below the Old Red Sandstone or Devonian system, and accordingly we now follow his arrangement, separating the Silurian strata from the Old Red Sandstone and carboniferous limestone. Nature has probably enabled the geologist to apply this classification in a more clear and satisfactory manner to the rocks of this country than to those of Europe, since the series is certainly more complete and the organic remains more abundant in species. The horizontality and undisturbed condition of the strata have enabled us to trace their sequence or order of superposition with comparative ease, and greater accuracy than can always be obtained in regions where the formations have been much inclined or distorted. These divisions or series are usually composed of various layers, as compact limestone associated with friable shale, sandstone alternating with argillaceous shale, &c. and these modifications of their mineral constituents are generally accompanied by

some variation of the organic contents; new species have been introduced, or more ancient ones have disappeared. But it is only at the junction of two formations, that each *group* of organic remains is not perfectly distinct and characteristic, a mixture of species sometimes occurring which proves a gradual transition from one era to another, and gives rise to some uncertainty where the exact line of demarcation should be drawn. This fact opposes the idea sometimes indulged by speculative geologists, that sudden convulsions of the earth's surface have been the cause of exterminating forms of life, and the introduction of others to supply their place. The change seems rather due to alteration of temperature in the water, whatever new physical conditions of the earth resulted at the same time. Such phenomena, however, do not interfere with the general distinctive characters of the stratagraphical divisions adopted in this work. It is now, I believe, an undisputed point in geology, that certain groups of organic remains belong exclusively to certain formations, and that these strata, in a general way, may be known and compared by the same groups of genera, if not species, in every region of the earth. It is also established, that whilst some genera and many species are restricted to a single formation, others have originated at an early period and continued to exist throughout a large portion of the time occupied in the deposition of a system or series of formations. Although this may appear a stumbling block in the way of stratagraphical arrangement, I believe that a skilful palæontologist will find by patient investigation, that it is a difficulty more in imagination than reality, and will therefore be considered an objection only by those who are deficient in an industrious and minute observation and comparison of the various groups of organic exuviæ.

In the Silurian system, which is composed of the oldest fossilliferous rocks yet discovered in North America, we observe a variety of formations, consisting of siliceous and argillaceous limestones and shales, of various colors, as black, blue, gray and drab; sandstones, either red or olive, coarse or fine grained, though the latter variety predominates; conglomerates and breccia are comparatively very rare. Nearly all these strata appear to have been deposited in the bed of an ocean, undisturbed by violent currents or greatly agitated waters, because the general condition of the most fragile shells is so perfect as to preclude the idea of attrition. Even in the coarse grained sandstone at the falls of Oswego river, the fucoides exhibit no trace of a violent commotion in the waters of that period. One stratum only in the whole system

can be cited as an exception to this rule, where the shells are in a fragmentary condition. It is true that the valves of bivalves are generally found apart; but their most delicate characters, their angles and ornamental striæ, are beautifully preserved; and, indeed, shells with unseparated valves are common enough in almost every formation. Many of the testacea in the shales have lost their original form, by pressure from the superincumbent rocks, and are difficult in consequence to be determined with accuracy.

Shells, chiefly bivalve, for the univalves are comparatively rare, and multivalves are unknown, form the great bulk of the organic exuviæ, and by their immense accumulation have materially added to the thickness of many of the limestones and shales. Some strata, like the limestone at Lockport, are chiefly made up of the columns of crinoidea in a fragmentary condition. Some of these formations thin out and finally disappear when traced continuously, but reappear at a distance as if they had been deposited in extensive basins, and a change in the component materials of rocks is always accompanied by some variation, however slight, in the groups of fossil remains, although these sometimes vary where the difference of mineral character is not very obvious between two rocks in juxtaposition; hence the difficulty in many parts of Ohio and other western States, where the strata, though geologically distinct, are similar in color and composition, and thin and broken up, or detrital, at their *outcrops*, of procuring a section clearly illustrated by the succession of characteristic fossils; and thus several distinct formations have not unfrequently been comprehended under the same term.

The color, and even mineral character, of a formation, usually varies greatly over an extended region; but it may be recognized by its fossil contents; for example, the black slate of the Mohawk, characterized by a peculiar trilobite, Triarthrus, which has never been known to occur in any other geological position, is represented by a drab colored shale in the vicinity of Cincinnati, Ohio. There also the equivalent or continuation of the black limestone of Trenton-Falls, is of a gray or pale hue, and could be known as the same rock only by its organic reliquiæ. The Caradoc sandstone series of Wales is represented in New-York by limestone and slate in proportion equal to the arenaceous strata. The red sandstone and red marl with which the rock salt of Cardona is associated, are referred to the period of the chalk and green-sand of England, by Dufrénoy and Lyell. The green-sand of New-Jersey

passes into limestone in the Carolinas and in Alabama. It becomes therefore a point of great interest and importance to collect and compare the various groups of organic remains from all the different States of the Union, that a uniform system of classification may be finally constructed, applicable to the whole region; otherwise the usefulness of the science will be much restricted by a multiplicity of local appellations and want of connexion between rocks of the same geological date.

The stratagraphical distribution of the various genera and species of fossils is a subject replete with interest, but much time, labor and research are necessarily required clearly to decipher these ancient records of the earth's history, and guard against erroneous inferences. The following remarks, therefore, must be understood to apply to a subject not yet as fully investigated as we could desire, our opinions of which may be modified by subsequent discoveries.

The most distinguishing features in the palæontology of the system, are the trilobites in nearly all the strata, the vast proportion of brachiopodous bivalve shells in the lower and middle divisions, consisting chiefly of the genera Delthyris, Strophomena and Atrypa in the limestones; the large quadrangular fucoids in the sandstones; the linear Graptolites in the slates, and the abundance of bivalve shells of the genus Avicula in the upper division.

It is an interesting subject of inquiry what were the first created forms of animal life, and whether marine vegetation was introduced before, contemporary with, or after the earliest types of animal organization. Professor Phillips remarks that "the classes of mollusca are more ancient than those of zoophyta, if we trust our present knowledge, and both older than marine or land plants—a seeming paradox, since the preëxistence of vegetables seems capable of being sustained by strong arguments, drawn from the relations of animal and vegetable life." In this country, the oldest fossilliferous rock hitherto known to geologists is the calciferous sandstone first named, and described by Professor Eaton, which has yielded as yet no other fossil than two species of Lingula;* a small univalve, and something resembling fucoidal remains. Should future observation be disappointed in finding other remains, we must conclude that the first created genus of animal life was one of the very few of the Silurian system which was continued in

* One species occupies a lower position in this rock than the univalve alluded to.

nearly all the subsequent formations and yet exists in the ocean, a remarkable fact, since so many genera of plants, mollusca and zoophyta were subsequently created and exterminated anterior to the Tertiary eras. In the succeeding formation, a compact gray limestone with veins of spar, a well characterized fucoid is very abundant, (F. demissus) obscure traces of trilobites of the genus Isotelus, and a species of polyparia occur, but other fossil remains are unknown. In the rock next in order of sequence, the Mohawk limestone or breccia, a few of the fossil shells of the superincumbent Trenton limestone appear, and a new genus of Brachiopoda is introduced, (Strophomena.) The Trenton limestone succeeds, and now for the first time we find various species of trilobites, a profusion of shells and corals, and the genera Delthyris, Orthis, and Stenoscisma of the Brachiopodous bivalves. From our present knowledge, therefore, we must conclude the Testacea and marine plants to be the most ancient organized forms, and that the polyparia or corals were next in the order of creation.

It is acknowledged by geologists that organic remains imbedded in the earth are least analogous to existing species in proportion to their antiquity and therefore in the Silurian system we are not surprised to discover few even of the genera now in existence among the organic exuviæ. Such genera are restricted to the polyparia, radiaria, crustacea and testacea, for the Echinodermata, fishes and plants are all of extinct genera. Of the polyparia only three or four genera are known among recent corals. Of the radiaria, but two existing genera, (Asterias and Euryale.) Of testacea nine or ten recent genera are known, and among the crustacea not more than one, so that it is not probable that more than twenty genera of animals and plants of the Silurian rocks will be found by future observers referable to any of the thousands of types now existent upon the surface of the globe. The genera of shells which outlived the Silurian and carboniferous periods consists of Lingula and Orbicula among the Brachiopoda, Avicula of the division Mesomyona, and Corbula of the division Plagymyona. I have seen one species only of the latter genus. Among the univalves, all the genera of Cephalapoda are extinct; but a few of the Gasteropoda are apparently referable to existent genera; these are Trochus, Turritella and perhaps Natica, whilst in the higher strata of the system impressions resembling Solarium occur. Of the Annulosa we find a genus resembling Spirorbis. Of the crustacea, there are several species undistinguishable from the recent genera Cypris or Cytherina, to the latter of which I

have referred them as they are invariably associated with groups of marine shells, but all the other forms are very remote from living types, except the general resemblance in outline between Acidapsis of the middle division of the system and the living Limulus or king crab of the Atlantic coast.

The oldest rock in which fossils occur in profusion and considerable variety, the Trenton limestone, has hitherto yielded only four genera of recent shells, all very rare in comparison with the extinct Brachiopoda, which, although restricted to very few species, are so vastly abundant, that many of the limestone layers seem to be little more than an aggregate of bivalve shells.

In a division of the Silurian system into three large groups, for the sake of convenience, if not a strictly natural arrangement, I should propose to class all the formations below the Rochester shale in one group, designated by the term lower Silurian series, characterized by six genera of trilobites, which as yet are not known to occupy a higher stratagraphical position. Three genera of Cephalapoda are also limited to this division, and a new genus of Plagymyona.

The middle division of the system, if taking the Rochester shale and superincumbent rocks to the Onondaga limestone inclusive, will be characterized by seven genera of Crustacea, two of bivalve shells, one of plants and three of Crinoidea.

The third or highest division would embrace all the rocks above the Onondaga limestone and below the Old Red Sandstone, or that series on the borders of Pennsylvania and New-York, termed the Chemung group, together with a red sandstone which has been ascertained to hold the remains of the Holoptychus, a fish restricted to the Devonian system of Europe. This division will be characterized by two genera of trilobites.

The following table will show the limits of certain genera, as well as the relation of the strata to those described in Murchison's "Silurian System."

Formations.	Silurian formations in Wales.	Characteristic genera.
UPPER SILURIAN SERIES.		
26. Oneonta group.		*Crustacea.*
25. Cazenovia group.		Cryphæus.
24. Tully limestone.....	Aymestry limestone*	Dipleura.
23. Sherburne group.		
22. Shales near Apulia.		
21. Black slate.		
MIDDLE SILURIAN SERIES.		
20. Onondaga limestone.		*Crustacea.*
19. Corniferous limestone.		Odontocephalus.
18. Grit slate, (Eaton,)	Lower Ludlow rock.	Acidapsis.
17. Fucoidal sandstone.		Acantholoma.
16. Oriskany sandstone.		Platynotus.
15. Crinoideal sandstone,		Eurypterus,
14. Limestone and shale,		*Crinoidea.*
13. Pentamerus galeatus limestone,	Wenlock limestone.	Astrocrinites.
		Lepocrinites.
12. Hydraulic limestone.		Caryocrinites.
11. Gypseous shales.		*Testacea.*
10. Rochester shale, ...	Wenlock shale.	Phragmoceras.
LOWER SILURIAN SERIES.		
9. Pentamerus oblongus limestone,	Caradoc sandstone.	*Crustacea.*
		Triarthrus.
8. Iron ore and green slate,		Isotelus.
7. Red sandstone,		Ceraurus.
6. Shales of Salmon river.		Cryptolithus.
5. Trenton limestone,	Caradoc sandstone.	Illænus.
4. Breccia,		*Testacea.*
3. Sparry limestone,		Orthostoma.
2. Calciferous sandstone,		Cyrtolites.
1. Potsdam sandstone,		Phragmolites.
		Lyrodesma.

* It was conjectured that the Tully limestone might prove to be the equivalent of the Aymestry limestone, but a comparison of the fossil of both formations did not warrant this conclusion. Last summer, I was fortunate enough to find two species of shells which characterize the Aymestry limestone, and they occurred in the Tully limestone in Onondaga county. These are the Avicula reticulata and Atrypa didyma.

In the highest division, the whole assemblage of testaceous remains is so unlike those of either the inferior groups that the dissimilarity would be obvious to a superficial observer. The strata composing this division are many of them crowded with remains or impressions of bivalve shells, consisting chiefly of Delthyris, Strophomena and Avicula, and seem to be more completely developed than the Upper Ludlow rocks of Wales. Though a comparison of the fossils of this division with those of the Upper Ludlow has resulted in the identification of very few species, yet all the strata of which it is composed are clearly above the Lower Ludlow rocks and below the Old Red Sandstone, whilst the natural affinities of the organic remains bring them within the scope of the Silurian system.

Geographical distribution.—The general outlines of these three divisions, as they appear on the surface or in quarries, in ravines, beds, and walls of streams, and the scarps of hills, may be said to correspond with the northern, middle, and southern districts of the State of New-York; the first, or oldest, lying north of the Mohawk river and Erie canal, which, together, constitute a tolerably correct southern boundary. It reappears at Bedford Springs, and in the vicinity of Cincinnati, Ohio, judging from fossils that I have examined. The middle division occupies the central portion of the State, and beginning some distance east of the Hudson, is continued without interruption to Lake Erie. Rocks referable to this section, occur at the Muncey hills, and near Lewisburg, Northumberland county, Pennsylvania; at Richmond, Indiana; Garrard county, Kentucky, and near Florence, Alabama. To this section belong the interesting limestones and grits of the Helderberg mountain, and of the hills around Schoharie court-house; which latter localities have yielded to the untiring exertions of my friend John Gebhard, Jr. a rich harvest of the most curious and rare shells, crinoids and trilobites, highly characteristic of the strata of this division. The third or highest series, runs parallel to the latter, through the southern counties, bounded on the south by the Old Red Sandstone, and in many places extending in the adjoining counties of Pennsylvania.

Remains of Plants.—I have not met with impressions of land plants in the rocks of the system, but marine vegetation, on the contrary, was remarkably prevalent in all the periods, nearly all the arenaceous strata, exhibiting various forms of fucoids or plants allied to sea weed, and some of the sandstone and argillaceous shales, remarkable for the extreme abundance of very singular forms. One of the most prominent

characters of the larger species, is the quadrangular form of the fronds, and the terminations sometimes rudely resemble a human hand; whilst others are not unlike the foot-marks of birds, and led me into an error with respect to the impressions of feet in the New Red Sandstone. These fucoidal remains are most abundant and remarkable in the upper portion of the lower series of strata, or the Red Sandstone of Niagara and Genesee rivers. From the entire absence of land plants in the rocks of the lower and middle series, we may infer that little dry land, and that consisting of barren islands of primary rocks, interrupted the monotony of the shoreless expanse of ocean in those remote periods of the earth's history.

The characteristic forms are as follows:

MIDDLE SERIES.

Fucoides cauda-galli.

LOWER SERIES.

Fucoides Harlani, Dictuolites Beckii, Fucoides demissus,

which are imbedded in the order here given, the lowest being the first creation. No fucoids have yet been named as characteristic of the upper term of the system.

Remains of Polyparia.—Coralline remains are most abundant in the limestones of the middle series; they are less numerous in the shales, and the sandstones are comparatively almost destitute of them. They generally occur in detached masses, never of a large size compared with those of existing species, and they frequently lie in thin layers. Nothing resembling the coral reefs of the present ocean existed in this ancient era of the globe, for dwarfish indeed were the stony dwellings of the Silurian Polyparia, in comparison with the colossal structures of existing species in tropical seas. Nor do we find any very large masses of coral in the later formations of this country, except in the Medial Tertiary sands of Virginia. The genera which most abound in Silurian limestones, are Favosites and Cyathophyllum, and the former are the largest coralline remains of the system.

MIDDLE SERIES.

Species characteristic of the Series.

Favosites gothlandica.
——— fibrosa.
——— spongites.
Aulopora serpens.
Catenipora labyrinthica.
Cyathohyllum turbinatum.
——— lamellosum.
——— vermiculare.
——— helianthoides.
Syringipora vermiculare.

LOWER SERIES.

Columnaria, allied to C. sulcata. Favosites, 2 species.

Remains of Crinoidea.—Some of the limestones are composed almost wholly of the fragments of crinoidal columns and yet the globose or conical terminal portion is among the rarest of organic exuviæ in New-York, except in the shale at Lockport; whilst near Huntsville, Alabama, they are very numerous. This condition of the crinoidea is owing chiefly to the loss of gelatinous matter which connected the articulations, a very slight current being sufficient to scatter them in the bed of the sea. In the shales many of these columns may be traced unbroken the space of a foot or more, whilst in one very thin layer of shale at Schoharie the Astrocrinites occurs several feet in length, always lying in regular curves and occasionally with the terminal plates and fingers. Owing to the disjointed state of most of the columns, and the variety of forms appertaining to a single species, they are difficult to determine and are consequently much less known to geologists than the other classes of fossil remains. Most of the crinoidea were attached to such bodies in the sea as could give them a firm support; thus we behold their root-like bases upon the valves of the larger shells in the shales of Livingston county; and I have seen only one species which was apparently free, as the whole column has been frequently found and the base is always without any means or mark of attachment. The presence of Ambulacra in the plates of this genus, Lepocrinites (*nob.*) resembling those of the Echinida would seem to constitute this fossil a connecting link between the Crinoidea and the Echinodermata.

MIDDLE SERIES.

Species characteristic of the Series.

Lepocrinites Gebhardi. Caryocrinites loricatus.
Astrocrinites pachydactylus.

The species of the other series are undetermined.

Remains of Echinodermata.—When we consider the variety of delicate species of this fragile class of animal envelopes, which are preserved in various strata less suited to their perfect preservation than the Silurian limestones and shales, and at the same time remark their almost total absence from the latter, we are forced to conclude that they

did not exist in the periods of the lower and middle series of the system, where none have been discovered. One species only is known in the upper series, and the impression of this, although in sandstone, is very distinct.

Remains of Radiaria.—There is one species of Asterias in the Trenton limestone which I found in a quarry between Herkimer and Little-Falls, and is remarkably well preserved. No other species of Radiaria is known in the system, except an Euryale in the upper division.

Species characteristic of the Series.

UPPER SERIES,.... Euryale annulatum, (De Kay.)
MIDDLE SERIES,... None.
LOWER SERIES, ... Asterias primigenuis, (Con.)

Remains of Testacea.—Shells are the most important class of fossils in the estimation of geologists, because they are far more perfect and abundant, more generally distributed, and more satisfactorily determined and compared than remains of other classes of animals; and such is the similarity of groups in all the grand divisions of rocks throughout the earth, as the Silurian and Carboniferous systems, Old Red Sandstone, New Red Sandstone, Oolite, chalk, &c. that they alone furnish the clew to identity of time or periods of deposition between strata, the continuity of which cannot be traced in consequence of intervening seas or other obstructions. Testaceous remains of the Silurian system consist chiefly of bivalve shells of the division Brachiopoda, in the lower and middle divisions, and are almost entirely of extinct genera, the species of Lingula and Orbicula, recent genera, being comparatively extremely few, and are rarely abundant in specimens in their limited localities. All the various bivalves formerly referred to the genus Terebratula belong to the extinct genera, Atrypa and Stenoscisma. In the upper division, bivalves of the division Mesomyona are very abundant, chiefly of the genera Avicula and Inoceramus; but the generic relations of some others of the bivalves have not been accurately determined in consequence of the character of the hinge being concealed in the matrix or in casts of the external surfaces of the valves. Among the Cephalapoda, or univalves of the Nautilus kind, we find not one of the Ammonite genus, which in the Oolitic and Cretaceous periods flourished in vast abundance and variety of forms. Nor do we find the kindred genus Goniatites, so common in the Carboniferous limestone,

in any but the upper division of the Silurian system, and in that they are exceedingly rare. Among the multitude of shells, we are surprised to find but one species which is known to have outlived the Silurian period, and been continued in the Carboniferous; so that there is absolutely a greater amount of difference in this respect between the two systems than between the Secondary and Tertiary formations. The species marked with an asterisk are common to Europe and America.

UPPER SERIES.

Species characteristic of the Series.

BIVALVES.

* Avicula, (Pterinea) fasciculata.
——— subrecta.
——— bella.
Nuculites oblongata.
——— triqueter.
——— bellastriata.
——— cuneiformis.
——— rostellata.
Cypricardites elongata.
Cypricardites recta.
——— concentrica.
——— mytiloides.
——— alta.
——— oblonga.
——— carinata.
——— rugosa.
——— radiata.
——— subulata.

UNIVALVES.

* Bellerophon expansus.

MIDDLE SERIES.

Species characteristic of the Series.

BIVALVES.

* Strophomena rugosa.
——— costellata.
——— indenta.
* ——— euglypha.
* ——— lævigata.
——— corrugata.
Delthyris macropleura.
——— acuminata.
* ——— sulcata.
Delthyris arenosa.
* ——— lineata.
Atrypa elongata.
* ——— lacunosa.
——— unguiformis.
——— nasuta.
——— naviculoides.
* Pentamerus (Atrypa) galeatus.

UNIVALVES.

* Tentaculites ornatus.
Calceola indenta.
Euomphalus profundus.
Maclurites magna.
* Phragmoceras arcuatum.
* Lituites Biddulphii.
Cyrtoceras trivolvis.
Cyrtoceras Matheri.
* Conularia quadrisulcata.
Platyceras dumosum.
———— cirriformis.
———— Gebhardii.
Littorina pervetusta.
* Spirorbis tenuis.

LOWER SERIES.

BIVALVES.

Strophomena sericea.
———— alternata.
———— deltoidea.
———— compressa.
———— subtenta.
———— corrugata.
* Strophomena transversalis.
* Orthis testudinaria.
* ——— callactis.
* ——— flabellulum.
* ——— hemispherica.
* Pentamerus oblongus.

UNIVALVES.

* Bellerophron trilobatus.
* ———— bilobatus.
* Trochus lenticularis.
Phragmolites compressus.
Cyrtolites ornatus.

Remains of Crustacea.—The trilobites have excited more interest among naturalists than any other class of Silurian remains. They consist of the impressions, and not unfrequently of the shelly coverings of crustaceous animals of various genera and species, essentially different from existing types, and restricted to the Silurian and Carboniferous system. In the latter, few and imperfect specimens occur, never the same in species with those of the inferior system, which these curious remains peculiarly characterize by their abundance and variety of forms. Nearly all the species are quite limited in their stratagraphical positions, but Calymene bufo, the most common trilobite, is imbedded in a variety of formations, both in the middle and upper series of the system, but is not known to occur in the lower series or Caradoc sandstone equivalents. The trilobites are usually found in fragments, except in the shale at Lockport, where whole specimens of Asaphus limulurus,* are not uncommon. In some parts of the shale accompanying the Trenton limestone, I have found several entire Calymenes, of the species usually referred to C. Blumenbachii, by naturalists. One specimen of shale

* A. Wetherilli, (Green.) A. longicandatus, (Murch.)

has as many as ten whole trilobites of this species upon it, and two or three imperfect individuals of the Ceraurus of Green. The Calymenes must have lived upon the spot where they were finally imbedded in a colony like many species of shells. I have ascertained that this species is not the same with C. Blumenbachii of Europe, nor does it correspond in geological position; whilst the Calymene platys of Green agrees with the Blumenbachii in every essential particular; it is associated with the same group of shells at Schoharie, which characterize the lower Ludlow rock of Murchison, and consequently its stratagraphical position is identical with that of the Blumenbachii. I propose, therefore, to name the Trenton species Calymene senaria; and I may remark that it has never been found in a rock above the shale at Rochester where it is not common, whilst the Blumenbachii has not been discovered so low in the series, nor indeed has a trace of it been observed in any of the equivalent strata of the Wenlock limestone, except a single fragment of a buckler, which Mr. Gebhard obtained from the Hydraulic limestone at Schoharie. Two entire specimens and several fragments have been met with in the grit slate of Eaton, at Schoharie, and a fine mould from which the model was taken, described by Dr. Green, occurred in the same rock on the Helderberg mountain. I have seen another specimen in the same geological position at Col. Clarke's, near Saugerties. These are all of larger size than the Trenton species ever attains, and in this respect are equal to the C. Blumenbachii major figured in Murchison's "Silurian system." Among the crustaceous remains, the most rare and curious is the Eurypterus, of which genus only two species are known, one peculiar to the Hydraulic limestone of New-York, and the other to a limestone at Burdie-House, in Scotland. When perfect, the E. remipes of Dekay has a long spiniform tail like Limulus, but more obtuse at the extremity, and finely serrated. It has been suggested that this genus was of fresh water origin, but the presence of fucoids in the same stratum where the Eurypterus occurs, and the absence of the slightest evidence of a fresh water deposit in any part of the Silurian system, leave no room to doubt that this singular crustacean inhabited the sea. The same remarks apply to the small fossils, resembling beans, usually referred to the genus Cypris; and as they were evidently tenants of the ocean, being associated with marine shells in abundance, they may with more propriety be placed in the recent genus Cytherina, which is restricted to the sea, but scarcely differs from the fresh water Cypris in the external character of the crust, the only part of the animal known among species imbedded in the earth.

The monograph of the trilobites, published by Dr. Green, has greatly facilitated our inquiries into their geological history, and if some errors occurred in his classification of the species, they were the unavoidable result of imperfect specimens, and no skill and care could reconstruct a species from the bucklers and tails and fragments so frequently associated in the same locality. Time and industry are gradually condensing them into a more tangible form, and while the discovery of whole specimens has reduced in some instances two nominal species into one, it has occasionally led us ro separate others, as in the case of the Calamene Blumenbachii and C. senaria.

Nothing is yet known of the internal organization, nor of the habits of trilobites, and it is not probable that any other guide than analogy will ever point out their relations to existing animals. They are generally divided, like the recent Serolis, into three distinct lobes, and have a body composed of articulations varying from seven to fourteen in number in the different genera; but there have lately been discovered some singular forms of crustaceans allied to, if not properly classed among trilobites, one of which is similar to Limulus, (Acidapsis;) another has a buckler like that of an eyeless genus, but with a short body destitute of lobes or dividing sulci, and with two long curved spines in place of the pygydium of other genera. The whole surface is without a single articulation.

UPPER SERIES.

Species characteristic of the Series.

Cryphæus calliteles.	Cryphæus Greenii.
——— Boothii.	Dipleura Dekayii.

MIDDLE SERIES.

Calymene Blumenbachii.	Trimerus delphinocephalus.
Asaphus laticostatus.	Platynotus boltoni.
——— pleuroptyx.	Acidapsis tuberculatus.
——— micrurus.	Acantholoma spinosa.
——— nasutus.	Bumastus Barriensis.
——— limulurus.*	Dicranurus hamatus.
——— myrmecophorus.	Aspidolites Gebhardii.
Odontocephalus selenurus.†	

* A. longicaudatus, (Mucr.)

† Asaphus Selenurus, (Eaton.) Calymene odontocephalus, (Green.)

LOWER SERIES.

Isoletus gigas.	Illænus.
——— cyclops.	Agnostus latus.
Ceraurus pleurexanthemus.	Asaphus micropleurus.
Triarthrus Beckii.	Calymene senaria.
Cryptolithus tessellatus.	

State of conservation of organic remains.—Of the plants of the Silurian system little more is preserved than the impressions, and among the fucoids, frequently the fronds in bold relief, but not distinguishable to the eye, in mineral structure, from the rocks on which we behold them. The corals are generally silicified, often forming layers of hornstone in the limestone strata. The crinoidea are universally converted into calcareous spar in every formation, either limestone or sandstone, in which they are enclosed; and in consequence of this law I have referred to the crinoidea some fossils with the same mineral character which are so remote from the usual forms, that otherwise mineralized they would hardly suggest the idea of affinity to crinoidal remains. Shells are either silicified, or converted into calcareous spar, and sometimes the only change they have undergone is the loss of their gelatinous matter, in which case they are chalky and friable. In this condition we find numerous specimens of Delthyris speciosa and other bivalves in the shales of the southern part of Onondaga county, where they have the appearance and perfection of recent shells. In some of the sandstones seldom more than the impression or casts remain; in others, as in the Oriskany sandstone, the mineralized shells of various species are abundant. Brongniart has remarked that different shells have different kinds of petrifaction, and that he has known instances where the shell was replaced by carbonate of lime and the ligament of silex. Small annular ridges are seen in many bivalves, which he thinks were occasioned by gelatinous silex taking the place of the shell, a process analogous to the formation of chalcedony. The rings are entirely siliceous, ordinarily opaque and not crystalline. Sometimes they are dispersed in the shell, at others, they are so numerous as to have entirely displaced the calcareous matter. It is remarkable, that whilst this is a frequent condition in bivalves, especially in the Green sand formation, univalves replaced by siliceous matter are hardly ever in a similar condition, but are composed of compact silex. I have, however, occasionally met with the annular structure in univalves.

Fresh Water Formations.—Throughout the Silurian system we never find any evidence of fresh water streams or lakes, doubtless owing to the very small proportion of dry land coeval with those remote periods of the watery surface of our planet. I formerly thought that such evidence was satisfactory in the Red sandstone at Medina, in Orleans county, where I found impressions of bivalve shells with the cardinal and lateral teeth of their hinges moulded into the exact form of the corresponding part of Unio on the fresh water mussel. The coexistence of numerous univalves, not to be distinguished from the fresh water genus Cyclostoma, completed the deception. Further research, however, has enabled me to detect among the marine bivalves of other strata, shells with a hinge so similar to that of the supposed Unio, but with characters essentially different from the fresh water genus, and which were probably concealed in the matrix of the Medina specimens, that I now believe the latter to be of marine origin. The univalve I believed to be a Planorbis is probably a Bellerophron, and if so, the shell resembling Cyclostoma can be considered only as an allied genus. They are also associated with two marine genera, Lingula and Orthocera. If this conclusion be correct, we are unacquainted with a single fossil of fresh water origin in any rock of earlier date than the Carboniferous limestone, in which Uniones occur in Pennsylvania; and it is remarkable that we do not find any which existed after this period, when there was so great an extent of dry land, especially in the Tertiary epochs, except those which Dr. Hildreth discovered in Ohio. These consist of ferruginous casts of Unio, approximating the existing species of that region in their general outlines, and have every appearance of appertaining to a Tertiary deposit.

Old Red Sandstone, or Devonian System.

This system, as I understand it, is largely developed in some of the contiguous counties of Pennsylvania and New-York. A part of the series may be recognized in the Chemung group of the annual reports, and another term in the red sandstone near Blossburg, Pennsylvania, which holds the remains of Holoptychus nobillissimus, a fish restricted to the old red sandstone, and by which I was enabled, in connexion with the geological position of the rock, to identify the formation with that member of the Devonian system, which this singular fish characterizes. Since I announced that important discovery, my attention has been directed to a group of shells quite distinct from those of the Upper Silurian division, and resting upon them. They are, however, more

analogous to Silurian than to Carboniferous types, and I was led to infer a correspondence between them and the Devonian species. It was therefore with deep interest that I referred to the figures of the latter, in the Geological Transactions, in which I found sufficient confirmation of my view. Not only does the group I allude to meet the conditions on which the Devonian system has been founded, that the fossils are of "a type intermediate between the types of the Carboniferous and Silurian systems;" but of the limited number of specimens in my cabinet, six appear to be identical with species figured in the Geological Transactions. These consist of Avicula pectinoides, Terebra nexiles, Strophomena (Leptæna) rugosa.* Atrypa decussata, A. desquamata, and A. squamosa. The Delthyris calcarata I have not seen in this group, but Mr. Hall found it in the Upper Silurian division, near Moscow, Livingston county. When my collection is more complete, I expect to be able to extend the list of corresponding species. It is remarkable that a Producta does not occur in this group of fossils, although it is the prevailing bivalve in the Carboniferous system. Two shells of the upper Silurian strata, which I formerly referred to this genus, prove to be Strophomenæ.†

The Devonian group consists chiefly of arenaceous strata, but there is a band of limestone associated with them which is replete with shells. The shale is remarkable for the abundance of a very large Delthyris, with a greatly extended hinge. (D. perlatus, *nob.*) The Chemung group of fossils belongs to the lower portion of the Devonian system, and the Holoptychus to the upper term. Great tracts of this system lie between Carbondale in Pennsylvania, and the Upper Silurian district of New-York, nearly all of which is quite destitute of distinct organic remains, except those of vegetables. It consists chiefly of a micaceous sandstone, either of a red or olive colour, and sometimes variegated, and is very remarkable for the universal occurrence of diagonal lines, apparently of deposition, in all those picturesque weathered masses which are so frequently met with in travelling along the roads of this wooded and hilly region.

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* This is a new species, and not the S. rugosa of Rafinesque.

† This genus is generally confounded with Producta, although its character is very different, and I believe the fact is still unnoticed by geologists that Producta is unknown in deposits more ancient than the Carboniferous system.

Carboniferous System.

This system is not known to be represented within the limits of New-York, unless it be on the summit of the Catskill mountain. Besides the anthracite and bituminous coal of Pennsylvania, it embraces blue subcrystalline limestone, replete with Producta and Delthyris; also clay ironstone nodules, black or bituminous shale, full of shells, and cherty beds with the common and most characteristic bivalve, Delthyris trigonalis. All these rocks are characterized by the same group of fossils which occur in Europe in a similar geological position. Some members of the system may be seen near Blossburg, Tioga county, Pennsylvania, from whence I have received characteristic fossils in iron stone nodules. The black shale occurs overlying coal at one of the inclined planes of the Alleghany mountain. It also occurs near Pittsburg. The cherty beds compose Flint ridge in Ohio. Very fine fossil shells of this system were obtained at Engineer cantonment, on the Missouri river. The limestone occurs in Guernsey county, Ohio, and contains a Producta resembling P. punctata, and a Delthyris which I believe to be D. duplicostata, of Phillips. I have seen no remains of Trilobites from the Carboniferous strata. No fossil species of this system is known to occur in the Silurian rocks. The shells common to the European and American Carboniferous strata, are the following:

Delthyris trigonalis.
——— duplicostata.
——— cuspidatus.
Producta punctata.
——— scabricula.
——— scotica.
Producta hemisphærica.
——— sulcata.
Goniatites Henslowi.
——— minuta.
Amplexus coralloides.

New Red Sandstone or Saliferous System.

The system which succeeds the Devonian is the New Red Sandstone, which is known to occur in Massachusetts, Connecticut and New-Jersey, and was first described and classified by Professor Hitchcock, who has ably elucidated it, and accurately described the curious foot-marks which peculiarly characterize this system. No other distinct fossil impressions occur, except of fishes, which, as Professor Hitchcock remarks, having heterocercal tails, must be older than the Oolite, and as the rock which contains them is certainly above the coal, it holds exactly the same relative stratagraphical position as the New Red Sandstone of Great Britain. No brine springs or rock salt accompany this

sandstone, and hence the name of Saliferous would not be appropriate to the system as it occurs in North America.

Oolitic System.

No rock answering to the Lias of Europe has yet been discovered, but I now for the first time announce the occurrence of well chracterized and undoubted oolite, in the State of Ohio. At present I will merely observe that it contains two European species of Trigonia, T. costata, and another, both of which are restricted to the Oolitic system. Shells of this genus are unknown in more ancient rocks is this country, whilst they are abundant in the Oolitic and not very rare in the Cretaceous, but they are absolutely unknown in any tertiary deposit. In the Oolitic system we lose sight of the genera Producta, Strophmena, Atrypa, Pentamerus, and other bivalves, which are prevailing types of the Silurian, Devonian and Carboniferous systems. All the rocks of this country, hitherto described as Oolite, belong to very different systems, particularly the Silurian and Carboniferous. No geological oolite occurs in the State of New-York. The extinct genus Ammonites which contains such a vast assemblage of species, makes its first appearance in this system.

Cretaceous System.

This widely extended series, was first referred to the chalk of Europe by Vanuxem and Morton; and the latter author has amply illustrated the organic remains. He divides the system into three sections, upper, middle and lower. The latter consists chiefly of green sand in New-Jersey and Delaware, and in limited localities in Maryland, South-Carolina and Georgia, but it is generally an impure limestone in the southern States, with the same organic remains as those of the green sand. It is the substratum of all the prairie land of Alabama. Here we behold a new creation of genera of shells, saurians and fishes. The genera Baculites, Hamites, Crioceratites, Cirrolites, (nob.) Scaphites, all cephalapodous univalves, appear for the first time in the cretaceous series. Dr. Morton has referred this division to the Green-sand of Europe; and indicates one shell as identical with a British species, Pecten quinquecostatus, which occurs both in chalk and green sand. The following fossils I believe to be common to the European and American Lower Cretaceous strata:

Shells.

1. Pecten quinquecostatus—Chalk and Green sand.
2. Ostrea vesicularis—Chalk.
3. ——— falcata (O. larva, Nillson.)
4. Gryphœa vomer (Ostrea lateralis, Nillson)—Chalk,
5. Trigonia aliformis (T. thoracica, Morton)—Green sand.
6. Ammonites Conradi (A. sussexiensis, Mantell)—Chalk marl.
7. Nautilus expansus (N. Dekayi, Morton)—Chalk marl.

Fishes.

8. Galens pristodontus—Chalk.
9. Lamna acuminata—Ib.
10. ——— Mantelli—Ib.

Saurians.

11. Mosasaurus—Maestricht strata.

The middle division of this system was first discovered and described by Dr. Morton. It consists of gray marl, alternating with a limestone which appears to be of a kind of oolitic or granular texture, but when examined with a glass, this structure is found to be due to innumerable minute Nummites and small corallines. A band of this limestone runs through the Green-sand district of southern New-Jersey, from New-Egypt to Salem. It contains several of the fossils of the lower division, but others which are peculiar to it. It is remarkable that no trace of Ammonites has been discovered in this limestone, the Green-sand seeming to be the highest limit of the genus. I discovered this formation at Wilmington in North-Carolina.

The upper division of the Cretaceous system is composed of a chalky limestone which I was the first to trace in the southern States, and to collect the group of its organic remains which have been described by Dr. Morton. These, as a group, were ascertained to be unlike any observed in Europe, and to point to a passage or connecting link between secondary and tertiary deposits. The only extinct genus of shells found in it is Plagiostoma, but not one recent species occurs, and which are found in the overlying Lower Tertiary strata. This limestone contains those enormous vertebra of the Zeuglodon (Basilosaurus, Harlan,) which are not uncommon in Alabama, and characterize the formation. This division occupies a portion of South-Carolina, near the sea board, and of Georgia south of Augusta, but its great development is in the southern counties of Alabama and in Florida. There is a belt of prairie land

passes through central Alabama, based on the lower division or Green-sand, and where this terminates on the south, the upper cretaceous limestone commences, and is continued through Florida nearly to the Gulf of Mexico.

Tertiary Formations.

This class of strata I have investigated with sufficient care to enable me to separate them into three divisions, Upper, Medial and Lower, the last being certainly identical with the London clay or Eocene formation, to which I was not only the first to refer it, but to notice the formation at all. I was led to the comparison in the first place by finding the Cardita planicosta, a well known shell of the European Eocene period; and thus even a single fossil will sometimes truly inform us of the geological relations of a particular stratum. In some places the Green-sand derived from the Cretaceous strata enters largely into the composition of the Lower Tertiary marls. In Georgia, and more rarely in Alabama, a portion of the formation assumes the character of burr stone, and the shells which abound in it are beautifully silicified. Near Fort Washington, on the Potomac river, the Lower Tertiary is very similar in aspect to the Bognor rocks of Great Britain, and contains the Panopea (Mya) intermedia and Ostrea Bellovicina of that locality. In this formation we meet with the first creation of testacea which have a near resemblance to recent shells, but yet, in this country, all the species appear to be distinct from existing types. But two or three genera among the minute shells occur which are unknown in a recent state. A very interesting section of the Lower Tertiary is presented at Claiborne, Alabama; where I collected about two hundred species of shells and corallines, many of which are identical with Eocene species of Europe. Among these are Cardita planicosta, Corbis lamellosa, Cytherea erycinoides, Bulimus terebellatus, Pyrula tricarinata, Solarium patulum, &c.

Medial Tertiary.—An extensive formation of sand and clay, abounding in finely preserved shells, follows the preceding strata in the ascending order, and contains only one species which is not widely different from the fossils of the latter formation. There are about 170 species at present collected, and of these I have ascertained about 23 to be recent, nearly all of which inhabit the Atlantic coast and that of the Gulf of Mexico. Whatever the per centage of recent species may ultimately prove to be, I have no doubt the period of this formation was

contemporaneous with that of the Older Pliocene strata of Europe, a belief founded on the great similarity of their respective groups of shells and remote analogy of the American group to the Miocene of Europe, which I have long believed, has no representative in North America, at least among the known tertiary deposits. The Medial Tertiary formation occurs along the Atlantic border from New-Jersey, inclusive, to the Santee river in South Carolina.

Upper Tertiary.—This group of fossils is found in Maryland, Virginia and North-Carolina, in the same tract with the preceding, but is not so extensively distributed. Very few of the species of the Medial Tertiary occur, but the mass consists chiefly of recent shells, many of which inhabit the same parallels of latitude on the Atlantic coast of the Union, and the others chiefly the southern coast. There are, however, enough extinct species to bring the group within the limits of the Newer Pliocene.

Post Tertiary.—By this term Mr. Lyell designates a group of organic remains which not only embraces a less per centage of extinct species than the Newer Pliocene, but they are of a more *arctic* character than the recent group of the same parallels of latitude. In this series must be included the tertiary deposits on the borders of Lake Champlain, described by Professor Emmons, as they are identical with those of the St. Lawrence, described by Capt. Bayfield, and which Lyell refers to his Post Tertiary. The shells of the St. Lawrence are the same with those of the Champlain beds, and not only so, but Lyell has found them to be nearly all the same with the Post Tertiary species of Scotland, Denmark, Norway and Sweden, and there is less than one per cent of species unknown in a living state. This is the only described formation of the Tertiary character within the limits of the State of New-York, and the other systems also wanting are the following: Carboniferous, New Red Sandstone, Oolitic and Cretaceous. The Post Tertiary in New-York always reposes on strata of the Lower Silurian series.

Note. Since the above was written, I have read an article on the geology of New-York, in the New-York Review for Jan. 1841, in which I am opposed in the opinion that the Llandeilo flags are not represented in New-York; but more accurate observations have proved to my satisfaction that the Llandeilo trilobites do not occur in the Trenton limstone, but can be considered only as allied species. On the

other hand the respective groups of the Caradoc sandstone and Trenton limestone are so similar, that I could not resist the evidence and retain my first position. The reviewer censures me for regarding the Niagara sandstone as a Caradoc equivalent on the evidence of one shell, Bellerophon trilobatus; this I have not done, for the occurrence of the Pentamerus oblongus above the sandstone, a shell which marks the upper part of the Caradoc in Wales, led to the inference that the Niagara sandstone may be a portion of the great Caradoc group. With respect to the suggestion of the reviewer that the Caradoc series should terminate with the gray band of Eaton, I should have no other objection than its variation from Murchison's classification. The question is, should that be strictly adhered to or not?

Descriptions of New Genera and Species of Organic Remains.

CRUSTACEA.

GENUS DICRANURUS. No articulations; body short, without lobes; pygidium consisting of two long incurved spines. *Locality.*—Helderberg mountain, Albany county.

GENUS ASPIDOLITES. Buckler? trigonal, subrostrated, not lobed, but a depression along the margin; in place of eyes there are two rather deep impressions, above which the marginal sinus continues across the disk; surface tuberculated. *Localities.*—Schoharie, where Mr. Gebhard found it in the limestone which contains Asaphus micrurus; Helderberg, in shale, No. 14 of the table. It is doubtful whether the specimens described may not be entire; no trace of articulations has yet been found.

Asaphus? acantholeurus. Pygidium very wide at base; margin lunate, but projecting in the middle; a broad space between the ends of the ribs and the margin, on which are 9 thick, erect spines, the central one largest; surface of the lobes with coarse tubercles. *Locality.*—Near Schoharie, in limestone with Odontocephalus, (Onondaga limestone.) Found by John Gebhard, Jr.

A.? denticulatus. Pygidium with a lunate margin denticulated at the terminations of the ribs; ribs simple, with two rows of minute tubercles on each. *Locality.*—Schoharie, in grit, No. 18. Found by Mr. Gebhard.

A. nasutus. Buckler rostrated; ribs with a wide, shallow sulcus; a few of the ribs each with a large tubercle; two rows of tubercles on the middle lobe; obsolete on some of the ribs; tail consisting of a long, round, finely tuberculated spine. *Localities.* —Schoharie and Helderberg, in shale, No. 14, this trilobite attained a length of at least 6 inches.

A. aspectans. A small portion of the buckler and one eye only is visible, but the eye is of an extraordinary height; the margins parallel, and the lens arranged in parallel longitudinal lines; small and very numerous. *Locality.*—Near Schoharie. Found by Mr. Gebhard in Onondaga limestone.

Calymene senaria. This name is proposed for the trilobite of the Trenton limestone, usually confounded with C. Blumenbachii; it differs in having no tubercle between the eye and the middle tubercle of the central lobe; the front, anterior to the first tubercle, is much smaller and the margin more acutely rounded; there is also no tubercle on the margin of the middle lobe, between the second and third large tubercles; these latter are oblique, which is not the case in C. Blumenbachii; the granules of the surface are more minute and less unequal in size than those of the latter species. Its geological position is widely different. The specific name has allusion to the six tubercles of the buckler.

SHELLS.

Genus Nuculites. Equivalved; hinge with cardinal teeth as in Nucula, but apparently uninterrupted beneath the apex; an interior rib like that of Solecurtus, but narrower, extends from the apex, either direct or slightly oblique, towards the base, never passing much beyond the middle of the valve.

These shells have much the exterior aspect of Nucula, but the deep sinus in casts of some of the species, left by the interior rib, constitutes about the same amount of difference between the two genera, as between Solen and Solecurtus, especially, as I believe to be the case, that the series of cardinal teeth is uninterrupted by a fosset which in Nucula is a prominent character. This genus, so constituted, is restricted to the Silurian (and perhaps to the Carboniferous) system.

1. *N. lamellosa.* Ovate oblong; with regular concentric rather distant lamellar lines; umbonial slope not distinctly defined; posterior slope flattened; extremity obliquely truncated.

2. *N. emarginata.* Oblong, with concentric lamellar lines; umbonial slope profoundly angulated; posterior margin obliquely and profoundly emarginate. *Locality.*—With the preceding species, near Smyrna.

3. *N. triqueter.* Trigonal, umbo elevated; umbonial slope terminal and acutely angulated in consquence of the profound depression of the posterior margin; disk flattened; interior rib curved. *Locality.*—Cazenovia.

4 *N. oblongata.* Oblong, compressed; anterior margin acutely rounded; rib slightly oblique, nearly rectilinear. *Locality.*—Near Smyrna, Chenango co. tab. No. 23.

5. *N. rostellata.* Small, ovate-acute; posterior end rostrated and slightly recurved; disk with regular prominent concentric striæ. *Locality.*—Same with the preceding.

6. *N. bellastriata.* Subtrigonal; anterior and posterior margins rounded; disk with numerous fine, regular striæ; basal margin arched. *Locality.*—Same with the preceding.

7. *N. cuneiformis.* Cuneiform; umbo prominent; umbonial slope marginal, acutely angulated, rectilinear; posterior extremity narrow, obliquely truncated. *Locality.*—Near Oneonta, table No. 26.

8. *N. maxima.* Ovate-acute, compressed; posterior side cuneiform, extremity rounded; basal margin profoundly arched, except on the posterior side, where it is straight. *Locality.*—Oneonta, table No. 26.

9. *N. planulata.* Compressed; ovate-acute; posterior dorsal margin oblique, rectilinear, extremity acutely rounded; basal margin regularly arched; rib oblique. *Locality.*—Pulaski, Oswego county, table No. 6.

GENUS ORTHONOTA. Equivalved, profoundly elongated; hinge and basal margins straight and parallel; beaks near the anterior extremity; posterior extremity truncated.

The hinge of this singular group of shells is yet unknown, but as the external characters are remarkably prominent, I have ventured to pro-

pose a generic term to include the few shells of this peculiar form yet known to us. The genus appears to be restricted to the Silurian system. The first species appears in the Salmon river shale at Pulaski.

1. *Orthonota pholadis.* (Pterinea pholadis, *nob.*)
2. *O. undulata.* Posterior side with three oblique furrows, crossed by deep slightly waved sulci, which terminate at the furrow nearest the anterior side; anterior side with concentric angular sulci; an oblique furrow from beak to base, obsolete on the inferior half of the valve; posterior dorsal margin carinated. *Locality.*—Near Smyrna, Chenango county, tab. No. 23.
3. *O. carinata.* Destitute of undulations and with 4 prominent oblique carinæ on the posterior side; dorsal margin carinated *Locality.*—Near Apulia, at Labrador or Tinker's-Falls, tab. No. 23.

Genus Lyrodesma. Equivalved, inequilateral; hinge with about 8 diverging prominent cardinal teeth, transversely striated.

I was fortunate enough to obtain two fine casts of the hinge of this bivalve, with the teeth remarkably well represented. Occur in sandstone of Salmon river series near Rome, Oneida co.

L. Plana. Subrhomboidal, compressed; posterior margin widely and obtusely truncated; posterior basal margin rectilinear, extremity rounded.

Genus Cypricardites. Equivalved, profoundly inequilateral; hinge with 4 or 5 uncqual cardinal teeth; anterior one largest and most prominent, oblique; lateral teeth short and very remote from the cardinal teeth.

This genus is allied to Pterinea of Goldfuss, but it is never properly alated, nor has it the very large muscular impressions of that genus; the cardinal and lateral teeth are also different; the anterior cicatrix is often deeply impressed; the posterior one not visible in casts of the interior. This genus abounds in the Silurian rocks, but I have not seen a species from any more recent formation.

1. *Cypricardites elongatus.* Subensiform, contracted from beak to base; concentric lines strong and irregular; anterior margin rounded, posterior margin obliquely truncated, slightly emarginate. *Locality.*—Smyrna.

2. *C. recta.* Oblong; dorsal and basal margins parallel; basal margin slightly and widely contracted; posterior margin very oblique and slightly arched, extremity acutely rounded; surface with distinct concentric lines; umbo prominent. *Locality.*—Same with the preceding.

3. *C. concentrica.* (Pterinea concentrica, *nob.*)

4. *C. bisulcata.* (Pterinea bisulcata, *nob.*)

5. *C. mytiloides.* Ovate, slightly ventricose; lines of growth prominent; umbo prominent; dorsal margin elevated; anterior basal margin very oblique and slightly contracted; posterior side profoundly dilated and the margins regularly rounded. *Locality.*—Near Ogden's ferry, tab. of form. No. 23.

6. *C. alta.* Subovate, rounded and inflated over the umbonial slope; concentric lines prominent, acute; disk slightly depressed from beak to base; posterior side dilated, margin obliquely truncated above; obtusely rounded inferiorly; basal margin oblique, slightly concave or contracted; hinge margin elevated, slightly arched. *Locality.*—Ogden's ferry, tab. No. 23.

7. *C. oblonga.* Proportionately longer than the preceding, much less dilated posteriorly and with coarser concentric sulci. *Locality.* Near Smyrna, tab. No. 23.

8. *C. modiolaris.* (Pterinea modiolaris, *nob.*) tab. No. 6.

9. *C. angustifrons.* Trapezoidal; dorsal and basal margins parallel; anterior side narrowed, somewhat produced; end margin angulated above, rounded inferiorly; posterior margin truncated, nearly direct; basal margin nearly straight, or slightly contracted; posterior extremity angulated. *Locality.*—Near Rome, Oneida co. tab. No. 6.

10. *C. nasuta.* Narrow subelliptical; anterior side rostrated, acute; posterior margin very obliquely truncated. *Locality.*—Same with the preceding.

11. *C. ovata.* Ovate, oblong; posterior side dilated; the posterior dorsal and posterior margin regularly rounded or arched, the curve more abrupt where it joins the base; basal margin slightly contracted anteriorly; hinge margin much elevated. *Locality.*—Pulaski, Oswego co. tab. No. 6.

12. *C. curta.* Suborbicular, compressed; hinge margin elevated; posterior margin obtusely rounded. *Localities.*—Near Rome, Oneida co. Richmond, Indiana, tab. No. 6.

13. *C. carinata.* Trapezoidal, compressed, contracted from beak to base; beaks distant from the anterior extremity; disk with distant prominent slightly waved concentric lines; umbonial slope profoundly carinated; posterior margin obliquely truncated; extremity angulated; basal margin sinuous. *Locality.*—Near Oneonta, tab. No. 26.

14. *C. rugosa.* Subrhomboidal; disk flattened, slightly contracted with numerous concentric prominent wrinkled striæ; umbonial slope elevated, carinated; posterior margin oblique and straight above, truncated and direct inferiorly; hinge margin elevated. *Locality.*—Near Smyrna, Chenango co. tab. No. 23.

15. *C. radiata.* Oblong, much compressed, with narrow radiating striæ, most crowded near the umbonial slope, rather distant towards the anterior and posterior extremities and crossed by fine wrinkles; basal margin nearly rectilinear; posterior margin obliquely truncated above, extremity rounded. *Locality.*—Same with the preceding.

16. *C. subalata.* Trapezoidal; hinge margin obliquely elevated or subalated; posterior margin widely and slightly arched; extremity rounded; disk contracted from beak to base. *Locality.*—Near Apulia, Onondaga county, tab. No. 22. Ithaca.

Posidonia? alveata. Subrhomboidal, with concentric furrows, forming angular ridges, becoming obsolete towards the umbonial slope which is angular; posterior margin long, oblique, rectilinear; extremity obtusely angulated; length $3\frac{1}{2}$ inches. *Locality.*—Near Hamilton, tab. No. 25.

P? arcuata. Differs from the preceding in having a rounded posterior margin, and the umbonial slope not angulated; length $1\frac{3}{4}$ inches. *Locality.*—Same with the preceding.

1. *Avicula subrecta.* Slightly oblique, with wrinkled radii; anterior margin projecting beyond the extremity of anterior wing; posterior wing dilated, not produced; posterior margin from extremity of hinge line to about one-third its length from base, nearly rectilinear and direct. *Locality.*—Cazenovia, Madison county, tab. No. 25.

2. *A. bella.* Slightly oblique, wider than high, ears large; inferior valve convex, and with about 20 acute ribs and an intermediate striæ, and in some of the interstices, two or three; concentric lines not numerous nor crowded, regular; anterior ear obliquely angulated; basal margin forming a nearly regular curve or arch. *Locality.*—Tinker's-Falls, tab. No. 23.

3. *A. Gebhardi.* Suborbicular, left valve convex, with about 15 slightly impressed radiating grooves, forming wide convex, obsolete ribs; ears equal, not produced; height 5 inches. *Locality.*—Schoharie, in Oriskany sandstone. The description is from a fine specimen found by the most industrious of naturalists, John Gebhard, Esq. of Schoharie.

4. *A. cruciformis.* Elevated, with both ears greatly elongated. *Locality.*—Near Oneonta: this species is remarkable for the great proportional height; very little oblique. Height 3½ inches.

1. *Delthyris perlatus.* Hinge margin profoundly elongated; valves with numerous not very prominent ribs; sides flattened; mesial elevation profound, expanded at base, rounded with 12 to 14 slender ribs or striæ. *Locality.*—Near Blossburg, Tioga county, Penn. in the Devonian group.

2. *D. mucronatus.* Trigonal, compressed, with numerous angular ribs, crossed by prominent lines; cardinal line extremely elongated and mucronate at the extremities; mesial elevation flattened and divided by a longitudinal sulcus. Width 3 inches; from beak to base ¾ inch. *Localities.*—Hamilton, in No. 25. Near Apulia in No. 23. Extremely abundant.

Strophomena gibbosa. Subtrigonal; inferior valve with back and umbo very prominent, and the sides compressed; surface with numerous equal slightly undulated striæ which bifurcate on the umbo; hinge extremities prominent and angulated. *Locality.*—Helderberg, in Onondaga limestone, No. 20.

S. undulosa. Surface with irregular, profound, concentric grooves, obsolete towards the base, and with crowded radiating striæ. *Locality.*—Schoharie, in tab. of form. No. 20. Differs from S. rugosa in its simple convexity, and more numerous undulations.

1. *Atrypa acutiplicata.* Short ovate-acute, compressed, with 6 to 8 acute profound plicæ; beak of larger valve acute, concave beneath the apex in front; 3 or 4 strongly marked concentric im-

pressed lines. *Locality.*—Near Waterville, in Onondaga lime stone, No. 20.

2. *A. arata.* Trigonal, with large unequal ribs; those on the lesser valve disposed to bifurcate, and becoming obsolete on the umbo; inferior valve capacious, widely depressed, or slightly concave on the back; some of the ribs bifurcating; beak very prominent. *Locality.*—Schoharie, tab. of form. No. 18.

3. *A. octocostata.* Subovate or suborbicular, with about 8 prominent irregular angulated ribs, some of which bifurcate; inferior valve ventricose, depressed along the middle; summit prominent; superior valve slightly elevated in the middle, and depressed at the sides. *Locality.*—Schoharie, tab. No. 18.

4. *A. flabellites.* Suborbicular, compressed; ribs about 13, rounded; the two middle ribs of the flat valve largest and rectilinear rather distant at base from the others, and separated by a deep interstice which produces a sinuous margin; middle of inferior valve depressed towards the base, the three middle ribs larger than the others. *Locality.*—Near Saugerties, Oriskany sandstone, abundant.

5. *A. pleiopleura.* Subtriangular, elevated in the middle of the lesser valve, and profoundly depressed towards the base of the larger; surface with about 50 rounded costæ; about 17 of which in mature specimens are on the elevated portion of the upper valve; sides dilated and rounded on their margins. *Localities.*—Near Saugerties and Schoharie, Oriskany sandstone.

6. *A. congregata.* Suborbicular, with about 15 rounded costæ crossed by wrinkled lines; lesser valve with the central part flat, slightly elevated, except towards the base where it is more prominent, wide at base and rapidly narrowed above, with 4 flattened ribs wide at base and rapidly narrowed above, inferior valve with a regularly concave depression in the middle. *Locality.*—Conklin's-Falls, near Apulia, Onondaga county. This shell is the most abundant fossil in a formation of shale, (tab. of form. No. 22.) The lower portion of which appears to be non-fossiliferous; but the upper part in many of the layers abounds with this bivalve, and few other species of shells appears among them. Cypricardites subalata, however, is not unfrequently met with.

7. *A. semiplicata.* Small, subtriangular, upper part of valves entire, the lower deeply plicated; lesser valve with a prominent middle divided by a sulcus. *Locality.*— Schoharie, a small but highly characteristic species of the Pentamerus limestone, No. 13.

A. unisulcata. Trigonal, superior valve with a broad, prominent middle, sulcated longitudinally, the sulcus being obsolete towards the base; sides concave; the depression giving the margins a carinated appearance; inferior valve deeply concave, subangulated in the middle; umbonial slope carinated, and the area between it and the margin much depressed. *Locality.*—Schoharie, in Onondaga limestone.

8. *A. peculiaris.* Subtriangular, with obsolete, fine, radiating lines; inferior valve flat, concave at base, with a linguiform projection; superior valve with a convex, mesial elevation at base, where the margins of the valves meet above the basal margin, and are notched or serrate; submargin of the sides of the flat valve serrated. *Locality.*—Schoharie, in Oriskany sandstone.

UNIVALVES.

1. *Platyceras sulcatus.* Subfalcate, rounded with well defined sulci or ribs crossed by waved lines; beak laterally curved; margin of aperture plicated. *Locality.*—Schoharie, tab. of form, No. 18.

2. *P. expansus.* Dilated, suborbicular, spire small, not prominent with 3 volutions; aperture profoundly dilated, labium angulated. *Locality.*—Schoharie, in Oriskany sandstone. 2¼ inches in length.

3. *P. nodosus.* Subfalcate with numerous thick, obtuse nodes. *Locality.*—Occurs with the preceding species. This is a cast in sandstone, and the shell was probably covered with spines. Length 2 inches.

4. *P. cirriformis.* Smooth, with 3 or 4 subangular gyrations.

5. *P. subundata.* Subfalcate, rounded; beak prominent, incurved and free; inclined towards the back of the shell; surface with obscure nodes or irregular undulations; margin of aperture slightly undulated; aperture rounded oval transversely. *Locality.*— With the preceding, on the Helderberg mountain, tab. of form. No.

1. *Conularia undulata.* Distinguished from C. quadrisulcata by having the striæ more crowded and undulated, and by the absence of lines crossing the furrows between the striæ. *Locality.*—Helderberg and near Middlebury, in Cazenovia shales.
2. *C. laqueata.* Slender, smooth, with 8 longitudinal grooves, well defined. *Locality.*—Albion, Wayne county, in Rochester shale.