

FOSSILS OF THE INDIANA ROCKS.

(NO. 2.)

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INTRODUCTORY REMARKS.

In compliance with the request of Professor Collett, who desires to have his reports, as far as practicable, addressed to the general reader, and in accordance with the course pursued in the last report, I precede the more formal descriptions of the fossils, which have been selected for that purpose, by some elementary remarks concerning them, and by some general remarks concerning the material that is here described and illustrated.

It would be much more satisfactory to the writer, as well as more instructive to the reader, if at least the principal part of the known fossils of each formation in the State could be presented and illustrated at once. This would involve a large amount of work and the publication of several volumes, but in such a case the relations of the different kinds to each other and to living forms, and the relations of those of each of the formations to those of the others could be readily pointed out, and as readily understood.

The lack of sufficient funds at the disposal of the survey, however, makes it necessary to do this work, or a portion of it, by piece-meal, and in selecting the material for description and illustration we are at present obliged to be governed by what we find practicable to do, and to select such material as is at present available and suitable to be used. This explanation is deemed necessary because of the obvious lack of systematic completeness in the character and extent of the paleontological

material which is presented in these reports. It is not, however, by any means to be understood, that this material or any part of it, is unimportant. On the contrary, every form here presented is illustrative of some important fact, and each one conveys information of some characteristic of the formation from which it has been obtained.

Last year several different persons gave the use of fossils from their private collections for description and illustration, and this year others do the same, but a part of them are from the State collections. Dr. Moses N. Elrod, of Hartsville, Indiana, has sent some interesting collections from the Niagara group of that place, a part of which are figured and described in this article. Mr. William Gibson, of Newport, Indiana, also sends some interesting coal measure and other fossils.

The collections of both these gentlemen contain species that are new to science, as will be seen by reference to the descriptions on following pages.

Although several of the species herein described are new, and therefore of some especial interest, they are no more instructive than the greater part of them, which have become more or less well known. Some of the species here illustrated have also been figured in the geological reports of other States, but quite a number of them are here figured for the first time, although a part of these were originally described without illustrations. Plates 37 to 43 inclusive are illustrations of various Indiana fossils, from pen drawings by Dr. J. C. McConnell, and are reproduced by the photo-engraving process, as all of them were last year. But all the illustrations on plates 44 to 55, inclusive, are those of fossil corals which occur in the various great geological formations parts of which occupy different portions of the State of Indiana. These figures were all engraved by the late John W. Van Cleve, Esq., of Dayton, Ohio, to accompany a work on the fossil corals which he had prepared for publication as early as 1847, but delaying its publication from time to time, for the purpose of revising it, the work was stopped by his death, which occurred in 1858, and it was consequently never published. The engraved tablets of the twelve plates mentioned have been furnished to the survey by Dr. Julius S. Taylor, a life-long friend of the deceased author.

It is unfortunate that Mr. Van Cleve did not publish his

work at the time he prepared it, as it would for that time have been a very complete one, and also almost the only work on the fossil corals of North America; for it was prepared before the great and standard works of Edwards & Haime, Hall, Billings, Nicholson and others had appeared, and when that of Dana had only just been published. The consequence is that while most of his species were new to science when he did his work, almost all, if not all of them, have since been published by various authors under different names from those which he had applied. The latter being the first published names, the rules of naturalists require them to be used in preference to all others, and we can only regret that the author of that work did not live to reap the fruit of his labors, and give our testimony to the zeal and ability which the unpublished work of the dead naturalist shows that he possessed.*

Although Mr. Van Cleve obtained most of his collections from the adjoining State of Ohio they are from geological formations which also occur in different parts of Indiana; and the illustrations which have been selected for this report are those of species which are either well known in those formations, or which are likely to be found in them within the limits of the State.

Referring to these figures from a rigidly scientific and artistic point of view, it is but just to say that while they betray the most painstaking care, and extensive knowledge of the subject on the part of their author, the expert student of fossil corals of the present day will detect certain inaccuracies of detail in some of them; and in others a close resemblance of outward form with certain of the figures in the great work of Goldfuss. But as a whole, compared with the work that had been published at the time these figures were prepared, and with a large proportion of the illustrations of fossil corals that have been published since, they are really superior, and they will be very valuable to the numerous students of geology in the schools of the State in assisting them to identify the fossil corals of the various formations.

In the brief description of each of the species of these fossil corals which I have given on the following pages, I have class-

*See a letter on page 401, from Dr. Julius S. Taylor, giving some account of the life of Mr. Van Cleve.

ified them according to their structural relations, and also according to the formations which they help to characterize; but in the arrangement of the figures upon the plates, I have not followed the order of arrangement which is adopted for the first seven plates, but I have considered only the convenient filling up of the spaces. Consequently species not closely related to each other, and also species from different geological formations will be found on the same plate. But these corals will be further discussed in some general remarks which are to follow, and full descriptions of the species, with references, will also be given.

In last year's report I gave some general account of the order and distribution of the different geological formations in the State, and showed that each of them is characterized by its own peculiar fossils, a few species from each of which were illustrated and described in that report. Referring to the remarks there made, it is only necessary now to say that of the few fossils which have been selected for illustration in this report, those represented on plates 37 and 38, are from the Upper Silurian; those on 39, 40 and 41 are from the Subcarboniferous, and those on 42 and 43 are from the coal measures. The fossil corals represented on plates 44 to 55, inclusive, are from the Lower Silurian, Upper Silurian, Devonian and Carboniferous formations.

The two species which are described on following pages, under the names respectively of *Gyroceras elrodi* and *Orthoceras annulatum*, and illustrated on plates 37 and 38, are both fossil shells which are related to the *Nautilus* of existing seas, the latter being a shell which is as well known in literature as it is in science. In the case of the *Nautilus* the shell is closely coiled upon itself so that its whorls are in close contact with each other; but the whorls of the *Gyroceras* are a little separated from each other, as shown in the figure upon plate 37, while the shell still preserves the spiral form as perfectly as that of *Nautilus*.

There are still other genera of this class of shells in which the coil is much more open than that of *Gyroceras*, and some are even only gently curved, while in the case of *Orthoceras* the shell is straight or sometimes very slightly bent. If, then, we imagine the shell of a *Nautilus* or *Gyroceras* to be uncoiled and drawn out until it is nearly or quite straight, we shall have an

Orthoceras; the other characteristics of all these shells being practically the same. In other words, *Nautilus* is a closely, and *Gyroceras* a loosely coiled shell, and *Orthoceras* a straight one; all three of them being what are known as chambered shells, of which there are many other generic kinds found in a fossil condition in the rocks of different geological ages. That is, these shells are divided into chambers by having partitions of shell-substance extending transversely across the cavity, at somewhat regular intervals through a considerable part of its length. As the animal grew in size it increased the size of the shell also by additions to its border; and as the portion of the shell which was previously occupied by the animal became too small for its accommodation with its increased size, it moved its body forward and built a shelly portion behind it; separating itself from the abandoned chamber, and confining itself to the "front room" of its dwelling. This process was repeated again and again until many unoccupied chambers were formed, the animal always occupying only the outer chamber, which was always the largest one.

The shell which I have named *Patella levettei*, and which is illustrated by figures 4 and 5 on plate 39, belongs to the limpet family, living representatives of which are common upon our sea coasts. The two species of shell called *Bellerophon*, which are represented by figures 5, 6 and 7 on plate 40, and figures 4, 5 and 6 on plate 41 belong to a genus which, although quite common in former geological times, is now entirely extinct; and its nearest living relations are among the rarest of living marine shells. The shell represented by figures 7 and 8 on plate 42 has living relatives among the sea snails; and shells much like that which is represented by figures 9 and 10 on plate 42 are not uncommon in existing seas. It should be borne in mind, however, that every object of every kind that is illustrated and described in this article; and every one, of organic origin, which is to be obtained from any of the geological formations of Indiana, have long since become extinct. We know what the character of those objects was when they were alive, from their greater or less similarity to living forms, but those species have long since ceased to exist; and the differences between some of them and living forms is very great.

The shells represented by figures 1 to 6 inclusive on plate 42,

and figures 6, 7 and 8 on plate 39, belong to two different species and genera of the class of bivalve shells called Brachiopoda, the general characteristics of which were explained in the report for last year.

Figure 2, on plate 41, represents a form which has living representatives among the sea urchins of the present seas, but none are now living which are very closely related to it. A considerable proportion of the figures which have been prepared for this report are those of Crinoids of different kinds. The general character of these interesting forms was explained in the report for last year, and it is, therefore, not necessary to repeat it here. None of the fossil forms that are obtained from any strata are more interesting and beautiful than these, and the strata of Indiana have furnished a great variety, and large numbers of them. Five species of Crinoids are figured on the plates accompanying this article, one of which has never before been described. They are illustrated by figures 1, 2 and 3, plate 39; 1, 2, 3 and 4, plate 40, and figure 1, of plate 41.

Figure 7, on plate 41, represents the spiral axis of one of the very many forms that belong to the class Bryozoa, or Polyzoa, both names of the class being used by different authors. Although in form they resemble mosses, lichens and other plants, they are true animal bodies, and the parts that are found in the fossil condition consist of the stony or shell-like skeletons, each one of which has been produced by hundreds or even thousands of minute animals, all grown together in a manner similar to that by which coral is produced by coral-polyps; but the structure of the minute animal which constructs the *Bryozoum* is more nearly like that of the mollusks than the polyps. The separate animals of the Bryozoa are very minute, many of them being too small to be distinguished satisfactorily by the naked eye. The figure on plate 41, shows upon the edge of the spiral portion fine crenulations, which are, in fact, portions of the inner border of a continuous spiral expansion or thin frond, from one to several inches wide, which grew out from and around the axis, giving the whole the appearance of an erect spiral plant. This thin frond-like expansion was filled with small holes passing through it like those of a fine net, the size of which holes is indicated by the crenulations before referred to. Upon the edges or sides of the threads or dissepiments which constituted the

net-like frond there are five pores to be seen by the aid of a lens, and each of these pores was the seat of a separate animal. Although each one of these minute animals was complete in its own individual organization, it was, nevertheless, connected with every other one of its kind in all the colony which formed the Bryozoan mass, by a continuation and confluence of its living soft parts, which enveloped all the hard parts, including the strong axis, which was fixed by the lower end to the bottom of the water in which it grew. The bodies which we now designate as fossil Bryozoa are therefore really the compound skeletons of colonies of minute animals. In some cases the Bryozoa constituted a thin encrusting mass upon other objects, such as shells or corals, but they very often imitated more or less completely certain vegetable forms, as do their representatives which are now found living in all seas. So close indeed is this resemblance to vegetable forms that they are often mistaken for sea weeds by those who see them upon the sea shore.

Figures 8 and 9 upon plate 41, represent a small fossil sponge. The common sponge is so well known in every household that the word has come to be used to indicate something soft, porous and pliable; and yet only a part of the true sponges of the present seas have that character; and the fossil sponges were quite as variable in their characteristics as the living ones are. Sponges were long believed to belong to the vegetable kingdom, and to be related to the sea weeds; but they are now regarded as properly of animal origin, belonging to the Protozoa, or lowest forms of animal life. The sponge with which we are most familiar, like all others, is really the skeletal support of the gelatinous envelope which is in fact the compound animal substance that forms the sponge, as an ordinary animal forms its own skeleton; and which as completely covers it in the living state, as the skeleton of any animal is covered. The animal substance of the sponge is rotted away in the process of preparing the sponge for the market. The substance of a common sponge much resembles that of horn, but other sponges, both fossil and living, are composed of other substances. Some of them are of stony character, and the beautiful "glass sponge," which has within a few years become somewhat common in museums and cabinets, is made up of a delicate network of fibers which have the composition of flint.

The sponge which is represented on plate 41 was probably of a calcareous, stony character when living, but it is now changed to a silicious substance.

The large figure 1, on plate 43, is that of the imprint on shaley sandstone of a sea-weed-like plant, from the coalmeasure strata of Fountain county, Indiana; and figures 2 and 3 of the same plate are impressions in shale of fragments of two species of land plants from the same formation. These two last named plants had a slender stem, with whorls of small leaflets placed at intervals along its entire length.

All the figures on plates 44 to 55, inclusive, are those of fossil corals, with the exception of the species represented by figures 4 and 5 on plate 53, which is regarded as being related to the sponges; and that represented by figure 3 on plate 55, which belongs to the Bryozoa, the general characteristics of both of which have just been described.

Fossil corals, like their living representatives in the present seas, are of great variety of form and structure. Some of them are much like the living kinds, but many of them possess interesting and important differences. Some of them, for example those that are represented on plate 45 and parts of plates 51 and 55, are in shape so much like the horns of some animal, that those who are unacquainted with their character often call them "petrified horns." Such corals were each formed by one large polyp, and the coral constituted its internal stony skeleton, for the coral was wholly enveloped in the soft tissues of the polyp which formed it, as all corals are.

The greater part of all corals, however, are compound. That is, they are formed by an aggregated mass of polyps, all grown together more or less compactly, which originated from a common parent polyp by a process of budding similar to the budding of plants, or of splitting spontaneously into two or more nearly separate parts, which all became separate polyps with growth. Each polyp is a separately organized individual, but all of those which form a compound mass or corallum are connected together by living tissue, the mass of coral which they form, being the compound skeleton for the whole colony.

In the case of some of these compound fossil corals, as seen represented upon our plates, the parts, or corallites, each of which was formed by an individual polyp, are not in close con-

tact with each other; in which case they resemble a mass of roots of some plant; such for example as those represented by figure 3 of plate 47, figure 1 of plate 48, figures 1 and 3 of plate 49 and figure 1 of plate 51. In other cases the corallites are a little closer together, and yet not in close contact, as those of figure 1 of plate 50. In many cases the corallites are in such close contact that they necessarily assume a many sided form like the cells in honeycomb. Indeed so closely do some of these coral masses resemble that object that the people often speak of them as "petrified honeycomb;" and the scientific name of one genus of these corals *Favosites* is derived from the Latin word signifying the same thing. The cells or corallites of these honeycomb-like corals varied greatly in size, many of them being even much larger than those of figure 2, plate 49, and figure 3, plate 52. Others are much smaller, as for example those of plates 44 and 54; and still others are minute, almost as small as hairs, such for example as that which is represented by figure 2 on plate 48. In some cases the corallites were in the form of tubes more or less completely filled up by small transverse and radiating partitions, the latter often not well developed. Specimens showing the surface of such corals with the open mouths of the corallites are represented by figures 1 and 2 of plate 44, figures 4 to 7 of plate 46, figure 1 of plate 52, and others. Those represented on plate 46 are joined together by only two sides of each corallite, which gives their open mouths the appearance of a chain when viewed from above; and this coral has therefore received the name of "chain coral."

These hints may serve to interest the beginner in the study of fossil corals, but to gain any real knowledge of these interesting forms one must give long and patient study to the objects themselves.

DESCRIPTIONS OF FOSSILS.

The fossils which are described on following pages and figured on plates 37 to 43 inclusive, are in large part of species which have been described by different authors, and at various times; but a part of these species have never before been figured. Four of the species are new, and are here described and figured for the first time.

All the figures on plates 44 to 55 inclusive, were engraved many years ago by the late J. W. Van Cleve, as has already been stated. The species represented by these figures have been identified by aid of the descriptions and figures which the various authors have published who have written upon American fossil corals; and the descriptions which are here given of these species have been mainly copied or derived from this source. In short, I claim no authorship in this portion of the work, and I have only attempted to identify the species which are illustrated by the figures, and to make them available to those who may desire to study the fossil corals of the State.

UPPER SILURIAN.

MOLLUSCA.

CEPHALOPODA.

Genus *GYROCERAS*, *Meyer*.

GYROCERAS ELRODI (sp. nov.)

Plate 37, Fig. 1, and Plate 38, Figs. 2, 3 and 4.

Shell moderately large, composed of about two and half whorls, all separate except perhaps the first one, which is very small, and mostly obscured in our examples by the inbedding rock; the transverse section of the whorls having a nearly regular outline, except that the peripheral side is a little flat-

tened, or its convexity is somewhat less than that of the umbilical side; the long diameter of the whorls lies in the plane of the coil, and increases in proportion to the short diameter with the growth of the shell, the small inner volution being nearly circular in cross section, while the longer diameter of the outer portion is about one-third greater than the shorter. Septa comparatively few, or not crowded, moderately concave, plain; the sutures extending nearly straight across the peripheral portion, and across the sides with gentle sinuosity, which is scarcely apparent in the case of the inner septa, but upon the outer ones the sinuosity is somewhat distinctly marked. Body chamber large, constituting more than half the bulk of the shell. Siphuncle rather small, placed subcentrally, or a little nearer to the umbilical than to the peripheral side.

The coil of the shell, in the case of the example figured, seems to be slightly irregular, the separation of the whorls being a little greater in some parts than in others; and the outer portion of the body chamber, while not losing the primary curved character of the shell, diverges at its outer portion considerably away from the more regular curve of the inner portion. This feature is an apparent approach to the chief distinguishing characteristic of *Lituites*, but it is evident that in our shell it was a comparatively slight feature and confined to the outer portion only of the body chamber, and that this slight divergence of the coil never involved any of the septate portion.

The surface is marked by numerous revolving lines which are apparently distributed over the whole surface; and these are crossed by similar transverse lines, which evidently correspond with the lines of increase which were formed upon the borders of the aperture of the growing shell. The latter lines extend across the whorls from the umbilical to the peripheral side, in an outward and backward direction, and with a curve, the convexity of which is forward.

The distinct separation of the whorls in this shell together with its other characteristics, distinguish it as a true *Gyroceras*; and its specific characters are such as to separate it clearly from every other published form that it is likely to be confounded with upon casual examination. It bears some resemblance to both *G. ohioense* and *G. inelegans*, Meek, from the Devonian strata of Ohio. From the former, it differs in the absence of any transverse ridges, and from both in the distinct separateness of the whorls and their less rapid increase in size.

Diameter of the coil, measured from the outer side of the aperture to the opposite periphery, 210 millimeters.

Position and locality. Niagara Group; limestone layers beneath the shales, Hartsville, Indiana, where it was collected by Dr. Moses N. Elrod, in whose honor the specific name is given.

Genus, ORTHOCERAS, *Breynius*.

ORTHOCEROS ANNULATUM, *Sowerby*.

Plate 38, Fig. 1.

Orthoceras annulatum, SOWERBY, 1818. Mineral Conchology, Tab. 133.

Orthoceras annulatum, HALL, 1868. 20th Rep. Reg. Univ., N. York, p. 351.

Orthoceras laphangi, MCCHESENEY, 1860. New Pal. Fossils, p. 91.

Orthoceras nodocostatum, MCCHESENEY, 1860. New Pal. Fossils, p. 94.

Orthoceras nodocostatum, MCCHESENEY, 1867. Tran. Chi. Acad. Sci., vol. i, p. 53, pl. 9, fig. 5.

The collections contain a single, somewhat imperfect example of an annulated *Orthoceras*, which seems to possess the outward characteristics of the species which has been found in the Upper Silurian rocks of various parts of the United States, and which has been generally referred to *O. annulatum*, Sowerby. The shell is conspicuously marked by strongly raised annulations, and when perfect it was long and slender, or very gently tapering. In the case of our example the surface, both upon, and between the annulations is seen to be marked by numerous slightly raised longitudinal lines, which are quite distinct when viewed by cross-light. These longitudinal lines are crossed by numerous somewhat regular, finely undulating lamellose concentric striæ, which, although not so distinct as the longitudinal lines, together with them give the surface a rugose cancellated appearance. This surface characteristic, together with the strong annulations, is correctly shown in the figure on plate 38, except that the artist has given it a little stronger appearance than it naturally has in ordinary light. The septa of *O. annulatum* are described as being strongly concave, and the siphuncle small. Our example agrees with this description in regard to the septa, but the character of the siphuncle is not clearly made out. There is, however, a comparatively large cylindrical body, occupying nearly the position of a siphuncle, and which may really be of that character; but it resembles a small, slender, smooth *Orthoceras* which has reached that position by accident. The end of this body is represented at the lower end of the figure.

Position and locality. This specimen, like those of the preceding species, was collected by Dr. Moses N. Elrod from the limestone strata of the Niagara Group, beneath the Niagara shales, at Hartsville, Indiana.

SUBCARBONIFEROUS.

GASTEROPODA.

Genus *PATELLA*, *Linnæus*.*PATELLA LEVETTEI* (sp. nov.)

Plate 39, Figs. 4, 5.

Shell suboval in marginal outline, broader in front than behind; both anterior and posterior margins regularly rounded, but the latter margin more narrowly rounded than the former; lateral margins very gently convex and regularly rounded to both the posterior and anterior margins; apex placed at about two-fifths the full length of the shell from the front, turned strongly forward; the sides and front sloping at a nearly uniform angle from the apex to the margins, the slope being gently convex; the posterior slope longer and more strongly convex than either the sides or front. Surface marked with concentric lines and somewhat numerous stronger marks of growth, but otherwise plain.

Length, 26 millimeters; breadth, 14 mm; height, 9 mm.

A single example of this shell was obtained by myself at Spergen Hill. It seems to possess all the characteristics of true *Patella*, although it comes from paleozoic strata, and the genus to which it is referred is a common one among living mollusca. This shell bears some resemblance to a *Crania*, but it is much more elongate in marginal outline than any known species of that genus, and it is also much more elevated. The specific name is given in honor of Dr. G. M. Levette, formerly of the Geological Survey of Indiana.

Position and locality. Warsaw Division of the St. Louis group of the Subcarboniferous series, at Spergen Hill, Washington county, Indiana.

Genus *BELLEROPHON*, *Montfort*.*BELLEROPHON SUBLEVIS*, *Hall*.

Plate 40, Figs. 5, 6 and 7.

Bellerophon sublevis, HALL. 1858. Trans. Albany Inst., vol. iv, p. 32.

Shell subglobose, having a compact, somewhat inflated aspect; aperture expanded a little at the sides, but not in front,

its lateral diameter greater than the median, having an arcuate appearance when viewed in front, because of the projection into it of the rounded dorsum of the preceding whorl; umbilicus none, the umbilical spaces being covered by the thickened and expanded lateral edges of the lip; dorsal keel narrow, inconspicuous; lip thin in front, thickened and reflected at the sides; the front margin rounded upon each side into a deep median notch. Surface nearly smooth, but marked by faint lines and undulations of growth, the direction of which agrees with the borders of the lip.

Length, 19 millimeters; extreme breadth of aperture, 18 mm.

Position and locality. This species was first described from the Warsaw division, St. Louis group, of the Subcarboniferous series at Spergen Hill, and Bloomington, Indiana, but the specimens here described come from strata of the same formation at Ellettsville, Monroe county, Indiana.

BELLEROPHON GIBSONI (sp. nov.)

Plate 41, Figs. 4, 5 and 6.

Shell very large for a species of this genus; whorls gradually increasing in size, broadly rounded upon the outer side, especially of the outer portion of the last one; aperture large, expanding by reflexion of the lip at the sides, but apparently not so expanding in front.

The larger examples, when perfect, had a length of at least 65 millimeters, and a breadth of aperture of 50 mm.

This is one of the largest species of *Bellerophon* that is yet known in North American rocks, but unfortunately the condition of the only specimens of it which have yet been obtained will not admit of a full description, they being in fact only natural casts of the interior of the shell. The space between the whorls as shown in figure 5 is without doubt an indication of the thickness of the test, since the whorls were, of course, in contact. This indicates that the test was strong and massive. No indication has been obtained as to the character of the surface markings of the shell, but that of the cast is, of course, smooth. Ordinarily the description and naming of a species ought not to be attempted from such imperfect material as these examples afford; but the few characteristics which are here described and illustrated on plate 41, together with its remarkably large size, will make the identification of the species an easy matter.

Position and locality. St. Louis group of the Subcarboniferous limestone series; Greencastle, Putnam county, Indiana. The specific name is given in honor of Mr. Wm. Gibson, of Newport, Indiana, who has furnished to the survey many interesting fossils for study.

BRACHIOPODA.

Genus *TEREBRATULA*, *Llhwyl.*

TEREBRATULA FORMOSA, *Hall.*

Plate 39, Figs. 6, 7 and 8.

Terebratula formosa, HALL. 1858. Trans. Albany Inst., vol. iv, p. 6.

Shell elongate, subovate in marginal outline; ventral valve strongly convex from beak to front, beak prominent and strongly curved; dorsal valve less convex than the ventral; the borders of the two valves meeting at the sides and in front somewhat acutely; the front margin usually somewhat truncated, but there is no proper sinus in either valve. Surface smooth, or marked only by the ordinary lines of growth.

Length of the largest example in the collection, 25 millimeters; breadth of the same, 16 mm.

The examples from which the foregoing descriptions are drawn are considerably larger than those which were originally described by Prof. Hall, and yet they seem to be specifically identical with them, and were found at the same locality. Still larger examples were found associated with these, which are also believed to be of the same species.

Position and locality. Warsaw division of the Subcarboniferous series, Spergen Hill, Washington county, Indiana.

BRYOZOA.

Genus *ARCHIMEDES*, *Lesueur.*

ARCHIMEDES LAXA, *Hall.*

Plate 41, Fig. 7.

Archimedes swallowiana, HALL. 1857. Proc. Am. Asso. Adv. Sci., vol. x., part 2, p. 178.

The collections contain some examples of the axes of a species of *Archimedes*, one of which is represented by figure 7, plate 41, and which appears to agree with Prof. Hall's descrip-

tion of *A. swallovia*. It is very doubtful whether the axes alone of any *Archimedes* possesses distinguishing characteristics which ought to be relied upon for the determination of species. At least it seems certain that considerable differences exist in the axes of different examples of the same species; and also that the character and arrangement of the fenestrules and pores in some cases show specific differences which the axes alone do not reveal. Therefore as these axes, which are contained in this collection, are not accompanied by any portions of the frond, no specific description is here attempted.

RADIATA.

ECHINODERMATA.

Genus LEPIDESTHES, *Meek & Worthen*.

LEPIDESTHES COLLETTI, *White*.

Plate 41, Figs. 2 and 3.

Lepidesthes colletti, WHITE. 1878. Proc. Acad. Nat. Sci. Philad., p. 33.

Lepidesthes colletti, WHITE. 1880. An. Rep. U. S. Geol. Sur. Ter. for 1878. Part i., p. 163, pl. 40, fig. 2.

General form apparently ovate. Interambulacral areas very narrow, linear, slightly convex from side to side, composed of four or five rows of small pieces, which rows do not apparently decrease in number, except perhaps near each extremity. Ambulacral areas broad, partaking of the convexity of the body, lance-oval in outline, and five or six times as broad as the interambulacral areas are. Ambulacral areas made up of very numerous small rhombic pieces, the transverse diameter of which is a little greater than the vertical; their lateral angles moderately acute, and interlocking so that they appear to be arranged in oblique rows; size of the pieces nearly uniform throughout the field, except that they all become a little smaller near both the upper and lower extremities. The number of vertical rows of pieces in each field is apparently 18 or 20. Each ambulacral piece has two distinct round pores, near each other, and near the upper angle of the piece, but they are sometimes obscured by the overlapping of adjacent pieces. Surface granules small, more distinct upon the interambulacral than upon the ambulacral pieces.

Two examples of this species have been discovered, both of which are crushed and otherwise in a much damaged condition. The original height of the larger one was about 45 millimeters, and its transverse diameter apparently considerably less.

The crushed condition of the specimen causes some doubt as to the true number of longitudinal rows of interambulacral pieces, but they evidently do not exceed five. There seems to be only four rows to each area, one row of comparatively large pieces, with two rows of smaller ones on the right-hand side of it, and one similar row on the left. This want of bilateral symmetry in the visible rows of pieces suggests the possibility, that one row of smaller pieces on the left-hand side of the row of larger ones, has been forced beneath the others and out of sight, by pressure, but a careful examination fails to reveal any evidence of it.

This species is clearly distinguished from *L. coreyi*, MEEK & WORTHEN, the only other known species of the genus, by the very much narrower interambulacral areas, the different and varying proportions of the pieces which compose those areas as well as some other important but less conspicuous differences. The specific name is given in honor of Prof. John Collett.

Position and locality. Keokuk division of the subcarboniferous series, Salem, Washington county, Indiana.

Genus AGARICOCRINUS, *Troost*.

AGARICOCRINUS SPRINGERI (sp. nov.)

Plate 40, Figs. 2, 3 and 4.

Body of medium size, the portion below the arms shallow, convex; base truncate but not depressed; column moderately large, the cicatrix for its attachment concave, the last joint almost completely covering the basal pieces; first radial pieces wider than long, and they are the largest of the radial series; second radial pieces very short, more than twice as broad as long; third radial pieces triangular, and so small, in some of the rays at least, that the first piece of the secondary radial or brachial series rests in part upon the second principal radial piece as well as the third; above or beyond each third radial piece there are for each ray two pairs of pieces wider than long, the distal ones of which extend around the base of the pairs of arms, reaching up to the border of the brachial apertures; interradial pieces one for each space, rudely ovate in shape,

longer than wide, the upper end narrow and terminating near the mid-height of the arm bases, and bearing upon the upper end of each a small narrow piece between each pair of arms; anal pieces four, the first one ranging, with, but somewhat smaller than the first radials; the next articulating with the first and with the adjacent radials and brachials, and separated from each other by the fourth anal piece, which is higher than wide, and rests by its lower end upon the first; all the pieces of the body tumid, or having a somewhat abruptly raised transverse ridge upon each. Dome considerably elevated, and composed of numerous moderately small tumid pieces, the three which are placed immediately above the bases of each pair of arms being larger and more tumid than the others or even subspinous; the anal area of the dome being also surrounded by a row of similar pieces which bear prominent tubercles; anal area of the dome prominent composed of minute pieces, inflated, almost proboscis-like, the aperture at top directed upward and projecting above the summit of the dome.

Height from base to top of dome, twenty-seven millimeters; height from base to top of arm-bases, 12 mm.; diameter of body including arm-bases, 28 mm.

This differs from all other species of *Agaricocrinus* in the peculiar shape of the anal area of the dome, which is tumid, as just stated, almost proboscis-like, and has its aperture directed upward. It also differs from most of them in the convexity of the lower side, a character which has hitherto been observed only in species of the lower Burlington group.

Position and locality. The only known example of this species was found in the "terrace drift, west bank of the Wabash, at Clinton, Vermillion county, Indiana," owned by Mr. William Gibson. Its exact geological horizon is, therefore, not accurately known, but it probably comes from that of the Keokuk, or lower Burlington division of the Subcarboniferous series. The specific name is given in honor of Frank Springer, Esq., joint author with Mr. Charles Wachsmuth in their able Revision of the Palæocrinoidea.

Genus ONYCHOCRINUS, *Lyon & Casseday.*ONYCHOCRINUS EXSCULPTUS, *Lyon & Casseday.**Plate 40, Fig. 1.*

Onychocrinus exsculptus, LYON & CASSADY. 1860. *Am. Jour. Sci.*, vol. xxix, (2), p. 78.

The following is the substance of the original description of this species as given by Lyon & Casseday, which is copied here because our example is not perfect enough for full description. Calyx vasiform, spreading to the base of the free arms; surface ornamented with minute granules. Basal pieces three, their under surfaces concave, forming a saucer-shaped depression, which was wholly filled by the column. Four of the subradial pieces pentagonal, two of them being larger than the other two, all being distinctly angular at top; the fifth one is hexagonal and somewhat smaller than the other four. Radial pieces generally five to each ray; the first row are large, heptagonal, except in the postero-lateral rays where they are hexagonal; their superior margins are horizontal, on which are imposed the second row of radial pieces; these are smaller than the first, hexagonal, nearly twice as wide as high. The third and fourth rows are similar in form, but become gradually smaller; the fifth row are heptagonal, and support on each beveled edge a row of two or three brachial pieces, which are smaller than the radials. Upon the last brachial pieces rest two arms, which are as long as the body, and composed of stout pieces. These arms have short, stout pinnulæ alternately disposed at their sides.

The interrarial pieces vary from twenty to twenty-five; the first being quite large and situated between the rays opposite the first and second radials respectively; the others are smaller, and decrease in size upward.

The foregoing is condensed from the original description of Lyon & Casseday, and to it may be added the following: At the bases of the arms above the third secondary radial pieces, and between each pair of arms there are from one to three small pieces. The sutures between the principal radial pieces are straight, and those between the secondary radial pieces in our example are only slightly sinuate, but the sutures between the joints of the arms are distinctly and somewhat deeply sin-

uous. The stem is long, round, and rather strong, composed of very numerous pieces of nearly uniform size, but near the body the joints are very thin, and the stem is there a little larger than elsewhere.

The figure on plate 40 is of natural size, and gives a good idea of its size and shape, as well as many of the details of its structure.

Position and locality. Keokuk division of the Subcarboniferous group, Crawfordsville, Indiana.

ONYCHOCRINUS RAMULOSUS, *Lyon & Casseday.*

Plate 39, Figs. 2 and 3.

Forbesiocrinus ramulosus, LYON & CASSEDAY. 1859. Am. Jour. Sci., vol. xviii., (2.) p. 237.

Column moderately large but short, composed of thin pieces of equal size, its upper end entirely concealing the basal pieces of the body or allowing only their edges to appear; subradial pieces comparatively small, much wider than high; primary radial pieces comparatively large, four to each ray, not differing greatly in size; the first one of each ray articulating with each other at their sides and with the subradials below; the second and third pieces of nearly the same size and shape; the fourth piece of similar size and shape with the others, except that it has a sharp projection at the middle of its upper border which partially separates the two secondary radial pieces which rest upon it. The secondary rays are not divided into two equal parts, as the primary rays are, but they give off moderately strong branches at considerable intervals along their sides, there being about four secondary radial pieces of nearly equal, or gradually diminishing size between the fourth piece of the principal ray and the first side branch of the secondary ray, and the intervals between the branches becoming less towards the upper ends of the branching arms in which the secondary rays terminate. The sutures between all the pieces of both the primary and secondary rays are sinuous, being concave at the middle and elevated or convex at the sides; those of the secondary rays a little more deeply sinuous than those of the primary rays. Between the primary rays, adjoining the first, second and sometimes the third radial pieces, there are from one to three or four interradian pieces, all of which are small, but the lower one being much larger than any of the others. There is

also a similar set of secondary interradial pieces between the lower portions of each pair of secondary rays. Anal space moderately large, said by Lyon & Casseday to contain from four to six pieces, but they are not satisfactorily discernable in our example. Outer surface of the rays and arms moderately convex and finely granular.

Our example has been somewhat flattened by pressure, and its proportionate width is therefore not satisfactorily determined. Height from the base to the top of the fourth primary ray 19 millimeters; extent of the secondary rays and arms above the latter point about 50 mm.

Position and locality. Keokuk division of the Subcarboniferous series, at Crawfordsville, Indiana.

Genus CYATHOCRINUS, *Miller*.

CYATHOCRINUS MULTIBRACHIATUS, *Lyon & Casseday*.

Plate 39, Fig. 1.

Cyathocrinus multibrachiatus, LYON & CASSEDAY. 1859. Am. Jour. Sci., vol. xxviii., p. 245.

Our example, which is well represented by figure 1 on plate 39, is probably identical with the *C. multibrachiatus* of Lyon & Casseday, but as a large part of it is embedded in shale, and the portion which is visible presents some differences from the type of the species according to the original description given by those authors, I am not without some doubt as to its specific identity. Our example seems to have four principal radial pieces to each ray, instead of from three to eight, as stated by Lyon & Casseday. The subradial pieces seem also to be simply convex and entirely free from the broad, faint radiating plications mentioned by those authors; but in other respects our example seems to agree well with their description. Our figure gives so correct a representation of the visible portion of the example that no formal description is attempted, because it would be incomplete at best. Its long, slender, numerous arms, cup-shaped body and moderately strong, round stem will serve for its ready identification.

Position and locality. Keokuk division of the Subcarboniferous series, Crawfordsville, Ind.

Genus *PLATYCRINUS*, *Miller*.*PLATYCRINUS HEMISPHERICUS*, *Meek & Worthen*.*Plate 41, Fig. 1.*

Platycrinus hemisphericus, MEEK & WORTHEN. 1865. Proc. Acad. Nat. Sci., Phila., p. 162.

Platycrinus hemisphericus, MEEK & WORTHEN. 1868. Illinois Geol. Rep., vol. iii, p. 511.

"Body rather above medium size, hemispherical, being rounded below, and about twice as wide as high; base broad, basin-shaped, and forming about one-third the entire height of the cup, with a pentagonal outline, as seen from below; facet for the attachment of the column between one-third and one-fourth the diameter of the base and subelliptical in outline. First radial pieces larger than the basal, wider than high, nearly quadrangular, and widening moderately from below upwards; facet for the reception of the second radial one-third as wide as the summit and extending down nearly one-fourth the length of the plates, concave and sloping outward, with a deep notch within. Second radial pieces very small, but filling the cavity in each of the first radials, from which they extend out nearly horizontally; pentagonal in outline, and each supporting on its superior lateral sloping margins the first divisions of the arms, which are comparatively small and bifurcate again on the second piece; beyond this the two outer divisions remain simple, but the two inner divide again on the second piece, making six arms to each ray, or thirty to the entire series.

"Arms after the last divisions, long, slender, cylindrical and composed at first of a series of quadrangular pieces, but passing gradually upward into interlocking triangular pieces, and still further up forming a double series of small, alternating, cuneiform pieces, supporting closely arranged, long-jointed tentacles. Anal, interrarial and vault pieces unknown; sutures, except between the basal pieces, distinctly but not widely or deeply channeled.

"Surface ornamented with rather small, but well defined, prominent nodes. On the base, these nodes are arranged in ten rows, five of which radiate from the facet for the reception of the column, one to each of the corners, while those between each of these form intermediate radiating rows, consisting at

first of a single range, but becoming a double or triple range near the margin, when the three sometimes coalesce laterally. On the first radial pieces two rows pass from just beneath the facet for the reception of the second radials to each of the inferior lateral angles, while between these there is, at first, a single node, but further down two or three rows, consisting of nodes which show a disposition to become elongated, or coalesce laterally, so as to form little transverse ridges; above there is also a row extending horizontally to each superior lateral angle, with a few less regularly arranged nodes on the side below these. A single transversely elongated node sometimes also occurs on the little radials, and one less distinctly defined also sometimes on each of the pieces between this and the next bifurcation.

"Breadth of body at the summit of first radial pieces, 1.07 inches, height of the same 0.60 inch; breadth of base, 0.67 inch; breadth of first radial pieces at the summit, 0.54 inch; breadth of second radials, 0.19 inch."

Position and locality. Keokuk division of the Subcarboniferous series, Crawfordsville, Indiana.

PROTISTA.

PORIFERA.

Genus *PALÆACIS*, *Haime*.

PALÆACIS CUNEATUS, *Meek & Worthen*.

Plate 41, Figs. 8 and 9.

Sphenopoterium cuneatum, MEEK & WORTHEN. October, 1860. Proc. Acad. Nat. Sci. Phila., p. 448.

Sphenopoterium cuneatum, MEEK & WORTHEN. 1866. Geol. Sur. Illinois, vol. ii., p. 263, pl. 19, fig. 1, a, b, c and d.

Meek & Worthen described this species together with three others of the same genus in the works above cited, under the generic name of *Sphenopoterium*, which they had proposed for them. In the same year, but a few months previously Haime proposed the generic name of *Palæacis* for the same generic

forms, and that name therefore takes precedence. The following is a copy of the specific description of the form which is illustrated on plate 5.

“Compressed, cunate, longer than wide; base sharp, a little rounded at the lateral edges; cells from two or three to about five, rather distant, deep, conical, or a little compressed below, and arranged alternately on each lateral edge; rounded or slightly oval at the aperture, and directed obliquely outward and upward; often having one or two slightly prominent ridges extending part of the way up the inside; perforations of the walls numerous and distinct. Surface striæ fine, closely arranged, rather regularly and minutely crenulated, directed obliquely inward and downward from the apertures of the cells, and passing more or less nearly parallel to each other, to the base, on the lower flattened portion. Length, 0.75 inch; breadth, 0.50 inch; thickness, 0.22 inch.”

Position and locality. Warsaw division of the Subcarboniferous series, Spergen Hill, Washington county, Indiana.

COAL MEASURES.

MOLLUSCA.

GASTEROPODA.

Genus POLYPHEMOPSIS, *Portlock*.

POLYPHEMOPSIS NITIDULA, *Meek & Worthen*.

Plate 42, Figs. 7 and 8.

Polyphemopsis nitidula, MEEK & WORTHEN. Geol. Surv. Illinois, vol. ii, p. 374, pl. 31. figs. 9 a and b.

The shell figured on plate 42 is referred, with some doubt, to *P. nitidula*, Meek & Worthen. One shell seems to have much the same form and general characteristics of their type, but is a little more elongate, and the volutions are a little less convex. These differences, however, seem only to be varietal, and therefore the description of the species as given by those authors is here copied.

"Shell of medium size, subfusiform, spire elongated, conical, rather attenuate and acutely pointed above. Volutions eight to eight and a half, rather convex, last one comparatively large, composing less than two-thirds the entire length, somewhat contracted and produced below. Suture well defined, especially between the lower whorls. Aperture narrow, subovate, a little oblique and acutely angular above, rather narrow, and apparently provided with a small rounded sinus at the base of the columella below. Outer lip thin and sharp, with a slightly prominent margin. Columella arcuate, and somewhat twisted below; inner lip nearly or quite obsolete above. Surface smooth, but showing under a magnifier extremely fine, obscure lines of growth. Length 1.10 inches; breadth, 0.43 inch; apical angle regular, divergence 30° ; length of aperture, 0.47 inch; breadth, 0.20 inch."

Position and locality. Coal measure strata, Eugene, Vermillion county, Indiana.

CONCHIFERA.

Genus NUCULA, *Lamarck*.

NUCULA VENTRICOSA, *Hall*.

Plate 42, Figs. 9 and 10.

Nucula ventricosa, HALL. 1858. Geology of Iowa, part ii, p. 716, pl. 29, figs. 4, 5.

There is no room for doubt that the species which is represented by figures 9 and 10, on plate 42, is identical with the *N. ventricosa* of Hall, and it is not improbable that the latter is really a synonym of *N. tumida*, Phillips; but as I have no means at hand for satisfactory comparison, I prefer to use the name which has been proposed by Professor Hall. The following is a copy of his description of the species as given in the work cited.

"Shell ovoid, gibbous or subventricose on the middle and upper part of the shell; outline regularly curving to the base and posterior extremity; beaks near the anterior extremity incurved and inclining forward, with a cordiform depression beneath them. Surface marked by fine concentric striæ and some stronger lines of growth. Hinge line, marked on the posterior side of the beak, by thirteen or fourteen small, prominent teeth,

which increase in strength as they recede from the beak; anterior side with several small teeth, and two others much stronger, with a deep pit between; muscular impressions strongly marked; shell thickened just within the margin."

Position and locality. Coal measure strata, Sullivan county, Indiana.

BRACHIOPODA.

Genus SPIRIFER, *Sowerby*.

Sub-genus MARTINIA, *McCoy*.

SPIRIFER (MARTINIA) LINEATUS, *Martin*.

Plate 42, Figs. 4, 5 and 6.

The shell which is here figured is one which has usually been referred to *Spirifer lineatus* Martin, but which McChesney described under the name of *S. perplexa*. Although it very closely resembles *S. lineata*, one can hardly be satisfied that it is really specifically identical, and it is probable that we shall be justified in adopting McChesney's name. Not having the means for direct comparison with the European form at hand, however, I prefer to leave our shell for the present with *S. lineatus*, where it has been placed by the majority of paleontologists who have noticed it; making the following brief description:

Shell moderately gibbous, transversely subelliptical in marginal outline, the front and sides regularly rounded; hinge much shorter than the width of the shell; cardinal extremities rounded; cardinal area distinct, arched and moderately high. Ventral valve convex; umbonal portion prominent; beak prominent, incurved; area small; without median sinus, but there is a slight flattening of the valve at the front which gives the front margin a very slight sinuosity. Dorsal valve regularly convex, both transversely and longitudinally; umbonal portion prominent, but not so much so as that of the other valve; beak moderately prominent and projecting a little beyond the hinge line. Surface marked by numerous very faint radiating lines and somewhat stronger concentric lines; the latter being impressed and finely crenulate, the minute crenulations apparently marking the bases of hair-like spines when the surface of the shell was perfect.

Length from ventral beak to front, 17 millimeters; breadth, 18 mm.; greatest thickness, both valves together, 13 mm.

Position and locality. Coal measure strata, Eugene, Indiana.

Genus *PRODUCTUS*, *Sowerby*.

PRODUCTUS PUNCTATUS, *Martin*.

Plate 42, Figs. 1, 2 and 3.

This is one of the best known species of characteristic coal-measure fossils, and one the specific identity of which with the European form of that name has never been seriously questioned. The following description applies to the species as it exists in widely separated localities in the United States.

Shell large, test thin; marginal outline varying from imperfectly four sided, the narrowest side being the posterior one, to subovate, sometimes being wider than long, but sometimes longer than wide; cardinal margin almost invariably shorter than the width of the shell at any part in front of it; anterior border broadly rounded but usually a little emarginate at the middle; sides flattened, by which means the lateral margins are somewhat straightened; ears small. Ventral valve broadly arcuate from front to rear, in which direction there is also a broad mesial flattening of the valve, with usually a shallow but somewhat distinct mesial sinus along its middle; umbo prominent, narrow; beak small, incurved and projecting slightly over the cardinal border. Dorsal valve moderately concave; beak as such wanting, its place being concave; mesial fold ill defined, there being only a slight mesial elevation of the valve extending along the visceral and anterior portions.

Surface of both valves marked by rather numerous and regular concentric folds, which are smaller at the beak and borders than elsewhere, upon adult shells, and smaller and more distinct upon the dorsal than upon the ventral valve; interspaces between the concentric folds plain; folds supporting numerous spines of varying size, but all minute and more or less appressed against the shell.

Length of the example figured, which is of adult size, 67 millimeters; breadth of the same at the broadest part, about the same as the length.

Position and locality. Coal measure strata, Newport, Indiana.

24—GEOL.

FOSSIL PLANTS.

Genus TAONURUS.

TAONURUS COLLETTI, *Lesquereux*.*Plate 43, Fig. 1.**Chondrites colletti*, LESQUEREUX. 1870. Ills. Geol. Rep., vol. iv, p. 379.*Taonurus colletti*, LESQUEREUX. Vol. P., Atlas Coal Flora, 2d Geol. Sur. Penna., pl. A, fig. 7.

The following is a copy of the description of this species as given by Professor Lesquereux:

“Fronde large, dividing fan-like into numerous crowded branches, dichotomous, either diverging on both sides of the main axis or arched on one side; ultimate divisions simple, linear, cylindrical, with irregular borders.

“This species is not as yet satisfactorily known. I have received from Mr. John Collett, of Eugene, Indiana, some specimens of a black fossiliferous limestone, whose surfaces are marked with the remains of these plants, true *Fucoides*. The species distantly resembles, by the curving of its branches, *Fucoides cauda-galli*, Vanuxem. But it is evidently a compound of separate branches, dichotomous from near the base of the frond (the base is broken from the specimen), the branches in dividing and ascending, forming fan-like or flabellate fronds. The branches, which are ultimately simple, leave upon the stone a half-cylindrical impression and are distinct from each other.”

Position and locality. Coal measure strata, falls of Mill creek, Fountain county, Indiana.

Genus SPHENOPHYLLUM, *Brongniart*.SPHENOPHYLLUM SCHLOTHEIMI, *Brongniart*.*Plate 43, Fig. 2.*

The following is a copy of the description given of this plant by Professor Lesquereux, in his coal flora of Pennsylvania:

“Verticils of five to nine leaves; leaves broadly cuneate, rounded and crenulate at the upper border; veins free at the base, much divided; spikes thick, cylindrical.

"This species, the most common and most beautiful of the genus, is easily known by the undivided rounded upper borders of the leaves, which often appear entire or very slightly crenulate, but are sometimes acutely dentate. The whorls vary much in diameter, the leaves being from one-half to nearly two centimeters long and equally as variable in width. The spikes are rarely found attached to stems bearing leaves, and therefore it is rarely possible to refer them to their species."

Position and locality. This species ranges throughout the whole thickness of the coal measures, and is found from Pennsylvania to the Mississippi valley. The specimen figured on plate 43 is from Shelburn, Sullivan county, Indiana.

SPHENOPHYLLUM EMARGINATUM, *Brongniart*.

Plate 43, Fig. 3.

This species, like the last, is described by Prof. Lesquereux in his admirable Coal Flora of Pennsylvania, of which description the following is a copy:

"Leaves narrower [than those of *S. schlotheimi*], truncate at the top, obtusely dentate, primary nerves confluent at the base.

"This species differs from the former merely by proportionately longer, narrower leaves, cut horizontally (not rounded) at the upper margin, and the primary veins joined at the base and less divided. The species is easily confounded with the former."

Position and locality. The specimen figured on plate 43 is from Lebanon, Warren county, Indiana.

VAN CLEVE'S FOSSIL CORALS.

The fossil corals which are represented on plates 44 to 55, inclusive, as has before been stated, were many years ago studied by Mr. J. W. Van Cleve, with the view to their publication, and the figures referred to were all engraved by his own hands. His death prevented the publication of his work, and the names he had applied to the species have all been superseded by those of subsequent authors. I have, therefore, made no use of his manuscript, but identifying his figures from the published descriptions of other authors, I have either copied those descriptions, or have given the substance of them in other words. This portion of the present article is, therefore, wholly one of compilation, and one in which I claim no proper authorship.

LOWER SILURIAN.

Genus *STREPTELASMA*, *Hall*.

STREPTELASMA CORNICULUM, *Hall*.

Plate 51, Figs. 2, 3 and 4.

The following is Prof. Hall's original description of this species, Vol. I, Paleontology of New York, p. 69:

"Turbinate, curved near the base, which terminates in an acute point, somewhat rapidly expanding above; cup profound; lamellæ about sixty; surface marked by strong longitudinal lines indicating the lamellæ, which are crossed by fine concentric wrinkled lines. Length varying from three-fourths to one and a half inches."

The foregoing description was made from specimens collected from the Trenton group of New York. It occurs abundantly in the lower Silurian strata of Ohio and Indiana, specimens of which are often found several inches in length, being much larger than those mentioned by Prof. Hall. It is likely to be found in those counties of Indiana which adjoin Ohio, from Wayne county southward. This species has frequently been published under the generic name of *Petraia*, but Munster's generic description of *Petraia* will not apply to the structure of the coral here described and figured.

Genus PALÆOPHYLLUM, *Billings*.PALÆOPHYLLUM DIVARICANS, *Nicholson*.

Plate 52, Fig. 4.

The species represented by figure 4, on plate 52, seems to be identical with that which was described by Dr. Nicholson in Vol. II, Paleontology of Ohio, p. 220, under the name of *Palæophyllum divaricans*. The following is a copy of his description:

"Corallum usually free, sometimes apparently attached, compound, formed of conical turbinate corallites, which are produced by lateral gemmation, or rarely by fission, and which are directed outward from the parent, usually at a more or less open angle, and are never in actual contact with each other.

The number of corallites in a corallum, so far as observed, varies from two to six. Septa from fifty-eight to sixty-two, alternately large and small, the large ones becoming twisted as they approach the center of the visceral chamber, where they unite with one another laterally and form a more or less developed central mass of vesicular tissue. No dissepiments nor columella. Tabulæ unknown. Wall with a well developed epitheca, with longitudinal ridges corresponding with the septa within, and also with faint encircling striæ and a few shallow annulations of growth. Calices deep, with a flattened space at the bottom. Free edges of the septa not furnished with spines or denticulations. Apparently no fossette.

"The best preserved specimen which has come under my notice consists of two corallites, one budded from the side of the other nearly at right angles. The largest corallite has a length of nearly ten lines, a diameter of calice of seven lines and a depth of calice of four lines. Another specimen consists of six nearly equally sized corallites, apparently produced by parietal gemmation, and having a length of five or six lines, and a diameter at the calice of about five lines. Another specimen consists of two large corallites which appear to have been produced by fission, being attached only by their pointed bases, and being nearly in contact with one another. The length of the largest of these corallites is more than an inch and a half, and its diameter at the calice is ten lines. Another specimen, precisely similar in its mode of growth, is attached to the dorsal valve of *Rhynchonella dentata*, Hall, the length of the largest corallite being only three lines and the diameter of the calice of the same.

"The specimens from which the above description was taken, in most respects closely resemble *Streptelasma corniculum*, Hall, especially as concerns their twisted septa; but they possess a much smaller number of septa (if specimens of the same size be compared) and they are always rendered composite by the production of lateral buds or by cleavage."

Position and locality. Professor Nicholson's specimens were obtained from the Cincinnati Group at Cincinnati, and Mr. Van Cleve obtained his specimens from near Dayton, Ohio. The species is likely to be discovered in those counties of Indiana which border upon Ohio, from Wayne county, southward.

Genus FAVISTELLA, *Hall.*

FAVISTELLA STELLATA, *Hall.*

Plate 44, Figs. 1 and 2.

Corallum forming an irregular compact or sub-hemispherical mass; corallites prismatic, varying in diameter from 2 to 4 millimeters, the average being about 3 millimeters; the number of sides of each corallite varying from three to seven, according to the number of other corallites with which it is in contact, but the number of sides is usually six; radiating septa unequally developed, alternately large and small; the larger septa from twelve to fifteen in number, reaching to the center of the corallite or nearly so; small septa rudimentary, projecting but slightly from the margin; tabulae numerous, complete, no columella.

Position and locality. This coral, like the two preceding species, is characteristic of the Lower Silurian strata, and has been found at various widely separated localities in the United States and Canada. It may be looked for in Wayne, Union, Franklin, Dearborn, Ohio and Switzerland counties of Indiana.

Genus PROTAREA, *Edwards & Haime.*

PROTAREA VETUSTA, *Edwards & Haime.*

Plate 49, Fig. 4.

Corallum forming a thin encrustation upon shells, other corals, or upon some foreign body, of less than a millimeter in thickness; calyces shallow, of nearly uniform size, usually hex-

agonal, from one to two millimeters in diameter; radiating septa twelve in number, nearly equal, not extending to the center of the calyx, the bottom of which is tuberculated; separating walls of the calyces comparatively thick.

Position and locality. This handsome little coral is also widely distributed in the lower Silurian rocks of North America. It is likely to be discovered in the strata of the counties of southeastern Indiana, which have been mentioned in connection with the preceding species.

Genus CONSTELLARIA, *Dana*.

CONSTELLARIA ANTHELOIDEA, *Hall*.

Plate 46, Figs. 1, 2 and 3.

The following is a copy of Prof. Nicholson's description of this species as given in Vol. II, of the Paleontology of Ohio, p. 214:

"Corallum composed of palmate or sub-palmate expanded fronds, or flattened stems, which must have grown in an erect position, attaining a height of two inches or more, and having a thickness of from one and a half to two lines. Surface poly-piferous on all sides, the corallites cylindrical, radiating in all directions from an imaginary central plane or axis. Scattered over the entire surface are numerous conspicuous, more or less prominent stars, each of which has a diameter of one line or a little less, and is composed of a central, sometimes depressed, smooth area, and of generally from six to eight prominently elevated ridges, which radiate from the central space, and occasionally have smaller rays intercalated between them. The stars are usually circular in shape, sometimes elongated or elliptical, and generally arranged in irregular oblique or transverse rows, two stars usually occupying a space of two lines and a half. The central area of each star is minutely pitted or porous, being apparently composed of very minute tubuli, but appears to be solid, unless examined with a sufficiently high magnifying power.

The elevated rays of the stars, and all the comparatively depressed portions of the surface between the stars are covered with small circular calices, of which ten or twelve occupy the

space of one line. The calices are sometimes in contact, but they are more usually separated from one another by half their own width or more. The spaces between the calices appear to be sometimes solid, but they are more commonly minutely tubular, this latter condition almost certainly representing the true structure of the coral. The corallites exhibit no traces of septa, but well developed, though delicate tabulæ."

Professor Nicholson has described another species of the same genus under the name of *C. polystomella*, which he found associated with the former species in the lower Silurian rocks of Ohio. It is probable that figure 2 on plate 10 was drawn from an example of that species, but this is not certain. Figures 1 and 3, however, will enable any one to recognize the species here described, without hesitation.

Position and locality. This species, like the preceding ones, has a wide distribution in the lower Silurian rocks of North America, and it may be looked for in the strata of those counties of Southeastern Indiana, which have been named in connection with the description of *Favistella stellata*, on a previous page.

Genus MONTICULIPORA, d'Orbigny.

MONTICULIPORA FRONDOSA, d'Orbigny

Plate 48, Figs. 2 and 3.

This, together with numerous other species which are associated with it, and many others that are found in other formations, have, until lately, all been referred to the genus *Chaetetes*. This species has accordingly long been known as *Chaetetes frondosus*. As shown by Professor Nicholson and others, however, it clearly belongs to the genus *Monticulipora* of d'Orbigny. The following is Professor Nicholson's description of the species as given in Paleontology of Ohio, Vol. II, p. 208:

"Corallum forming erect, flattened, undulating expansions, polypiferous on both sides, of unknown, but considerable height, and varying from less than one line to three lines in thickness. Calices sub-circular, from eight to ten in one line, almost or quite half their diameter apart, separated by numerous very small cylindrical tubuli, which render the spaces between the corallites minutely porous. Surface with stellate or sub-circular spaces, which may either not project at all, or may be elevated in the form of low, rounded tubercles, and which are

occupied by minute tubuli similar to those which separate the ordinary tubuli. Often the corallites immediately surrounding these spaces are larger than the average, the tubercles being usually arranged in irregular diagonal lines and placed at distances of about one line apart.

"I am not at all satisfied that the specimens from which the above description is drawn, are really referable to the form described by d'Orbigny under the name of *Monticulipora frondosa*; but not having at this moment access to this author's description, I provisionally describe our examples under this name. Should they prove to be distinct the specific name of *ohioensis* might be applied to them.

"Many of the examples of this species appear to have attained a large size, and are now only to be found in a broken condition. Mr. U. P. James, however, has furnished me with a number of nearly perfect specimens, which have the form of small flattened fronds, about an inch or an inch and a half in height, and three-quarters of a line in thickness, which would appear to be young examples of this form."

Position and locality. This is a very common fossil in the lower Silurian series of Ohio, and it is also common at some points in Southeastern Indiana; and it is likely to be found at numerous places in those counties which border upon Ohio, which have already been mentioned in connection with the description of the five preceding species, all of which species belong to strata of lower Silurian age.

UPPER SILURIAN.

Genus *LYELLIA*, *Edwards & Haime*.

LYELLIA AMERICANA, *Edwards & Haime*.

Plate 47, Fig. 5.

The following is a free translation of the original description as given by Edwards & Haime in their *Monographie des Polypiers Fossiles des Terrains Palaeozoïques*, p. 226.

Corallum elevated, expanded; calyces separated from each other generally by one or two times their diameter, circular, prominent, the surface of the cœnenchyma finely reticulated; radiating septa twelve in number, well developed, alternately a little unequal, thinning inwardly; diameter of the calyces a little more than two millimeters. A vertical section (of parts

that have not been altered by fossilization) show a cœnenchyma composed of convex vesicles, very unequal, but generally large.

Position and locality. This species is characteristic of the Niagara group of the upper Silurian age. It is not a very abundant fossil, but it is found at somewhat widely separated localities in the United States, and is likely to be found in eastern Indiana, for example in Clark, Shelby and Decatur, counties.

Genus HALYSITES, *Fischer.*

HALYSITES CATENULATA, *Linnæus.*

Plate 46, Figs. 4, 5, 6 and 7.

This is one of the most common and one of the most readily recognizable of all the fossil corals. It has been described by various authors under different names and as different species, based mainly upon the differences in size of the corallites. Specimens showing two different sizes of corallites are illustrated on plate 46, and specimens are frequently found with corallites still smaller than the smallest of these.

It seems hardly necessary to describe this well known coral, except in a general way. The corallum is made up of vertical plates, which are joined together by their edges in such a manner as to leave between them open vertical spaces of irregular size and shape. The vertical plates are composed of the corallites, which are joined close together side by side throughout their whole length, the plate being only one corallite in thickness. So joined, the oval open mouths of the corallites, generally retaining a nearly uniform height and present the appearance of delicate chains. The tabulæ of the corallites are somewhat numerous and well developed, and the radiating lamellæ are occasionally to be seen, and are rarely found to be very distinct. The long diameter of the corallite is always in the direction of the length of the chain, and it varies in different examples from less than one millimeter to more than three millimeters.

Position and locality. This is one of the most characteristic fossils of the Upper Silurian rocks of North America, being common to both the Clinton and Niagara groups. It may be sought for in all parts of the State of Indiana in which either of these formations is present at the surface—Clark, Jefferson, Shelby, Decatur, Delaware, Wabash, etc.

Genus HELIOLITES, *Dana*.HELIOLITES ELEGANS, *Hall*.*Plate 48, Fig. 4.*

Figure 4 on plate 48 seems to have been drawn from an example of *Heliolites elegans*, Hall. It does not show the minute rays which mark the mouth of each corallite in perfect specimens; but the general aspect of the surface represented is that of ordinary examples of the species. The following is a copy of Prof. Hall's original description, from Vol. II, Paleontology of New York, p. 130:

"Coral massive or hemispheric, increasing by the lateral addition of cells more than by interstitial additions; cells small, sixteen to eighteen in an inch; openings upon the surface marked by twelve or more short rays; transverse septa numerous; interspaces apparently lamelliferous.

"The coral presents a variable surface appearance, from the different influences of weathering; when it has suffered little or nothing from such causes, the entire surface presents a series of stars having a depression in the center, and apparently confluent at the margins; where it has been slightly weathered or worn, the stars are limited, and in many cases there is a solid crystalline center with surrounding rays. A polished transverse section presents the cells with the space between them equal to the diameter of the cell. A vertical section gives the same general appearance."

Position and locality. This coral was originally described from the Niagara group of the State of New York. It is likely to be found in the strata of that group in Indiana.

Genus FAVOSITES, *Lamarck*.FAVOSITES FAVOSUS, *Goldfuss*.*Plate 52, Figs. 1 and 2.*

Figure 1 on plate 52 very accurately represents the upper surface of a corallum of this species which has been completely weathered out of the imbedding rock, and showing the open mouths of the corallites. Figure 2 represents a few of the separated corallites with the fine communicating mural pores in

their vertical walls. The following is Dr. Nicholson's description of this species as it exists in North American rocks (for it is also a European species), copied from his report on the Palæontology of Ontario (1875), page 52:

"The corallum in this species is massive and in all respects quite like *F. gothlandica*, except for the fact that the tabulæ are strongly and uniformly curved, with their convexities upwards. The corallites are prismatic, from one line to one and a half lines in diameter; the tabulæ are about six in the space of two lines; the mural pores are in two alternating rows upon the faces of the corallites, and the septa are represented by spiniform projections."

Position and locality. *Favosites favosus* is a characteristic coral of the Niagara group, and it may be sought for in strata of that age in those parts of Indiana where they are known to occur. Several other species of *Favosites*, some of them closely resembling this, may also be found in the State, but those will be likely to be found in the rocks of Devonian age, and some of them will be described on subsequent pages.

Genus CLADOPORA, *Hall*.

CLADOPORA RETICULATA, *Hall*.

Plate 47, Fig. 6.

The following is a copy of Professor Hall's original description of this handsome and delicate coral, from Paleontology of New York, Vol. II, page 141:

"Coral expanded into a broad reticulate frond; branches roundish or slightly flattened, coalescing at frequent intervals and forming meshes of various form and size, poriferous on all sides; openings of the cells upon the surface roundish or oval, distant from each other rather more than their diameter, often arranged in parallel longitudinal lines; interior showing the cells reaching to the center from all sides, and, in solid specimens, becoming prismatic. Cells distant from each other one-sixty-fourth of an inch.

"This species has the general aspect of a *Retepora*, but a slight examination proves it poriferous on all sides, having round, tubular cells, which, in perfect specimens, open upon the surface in nearly circular mouths, having a projecting lip

upon the lower side. In slightly worn branches, the openings are quite circular; and in those more worn they become somewhat angular. From unequal wearing the openings sometimes appear oval; and from other causes specimens often present a variety of appearances. The spaces between the mouths of the cells are slightly greater than the width of the openings themselves, and, in longitudinal sections, this is distinctly seen penetrating to the axis, while the cell appears like a gradually enlarging tube from the center to the surface of the branch."

Position and locality. The specimens from which Professor Hall drew this original description were obtained from strata of the Niagara group near Louisville, Kentucky, and the species is likely to be found in Indiana wherever the strata of that group occur.

Genus CLATHROPORA, *Hall*.

CLATHROPORA FRONDOSA, *Hall*.

Plate 55, Fig. 3.

This form bears, at least, some general resemblance to the one last described, but it is in reality very different, belonging to the class Polyzoa, and not like the former, to the Hydrozoa. The species was originally described from the Niagara shale at Lockport, New York, and the following is Professor Hall's description, copied from *Paleontology of New York*, Vol. II, p. 160.

"Fronde reticulate, expanded, flabellate or funnel-shaped; the two surfaces regularly and equally celluliferous; cells with rhomboidal or oblong quadrangular apertures opening obliquely upward; tubular cells reaching to the centre and gradually enlarging towards the aperture.

"This species consists of a thin, expanded frond, produced by the anastomosing of broad, flattened branches. It appears more like a perforated flabellate frond, than a reticulate structure. It has the general appearance of *Retepora*, from which it is not readily distinguished unless both sides are examined. The form of the apertures of the cells, however, is more quadrangular than in any species of *Retepora* I have seen, and this character may be of service in deciding the reference of specimens. It usually occurs in the soft shale, one side adhering to the stone from which it is necessary to remove some portions

of the coral before its real character can be ascertained. Portions of fronds, six inches or more in diameter in every direction, have been obtained, and which are imperfect on all sides, showing that the coral attained a large size. From the mode of divergence of the frond from the center, it appears that the perforations are arranged in concentric circles, each row or circle having successively been at the outer margin of the frond."

Position and locality. This species is likely to be discovered in the strata of the Niagara group where they may occur in Indiana.

DEVONIAN.

Genus ACERVULARIA, *Schweigger*.

ACERVULARIA DAVIDSONI, *Edwards & Haime*.

Plate 49, Fig. 2.

Coral forming sub-turbinate or sub-hemispherical masses, with the upper surface convex or nearly plane; corallites irregularly polygonal, unequal in size, borders of the calyces slightly zig-zag; interior wall indistinctly defined, its position indicated by a circular, slightly pronounced fold which circumscribes a calyx of moderate depth; rays from thirty-two to forty in number in the larger corallites, and less in the smaller, distinctly crenulate or even denticulate at the outer portion, but less so at the inner; a small papilliform elevation is sometimes to be seen at the bottom of the central pit of the calyx. Diameter of the corallites, 10 to 12 millimeters; diameter of the central pits, 4 or 5 mm.

The corallum of this species sometimes reaches a foot in diameter, but the masses are usually much smaller.

Position and locality. The type specimens of this species were obtained from the Devonian rocks at Jeffersonville, Ind., and the original description was published in France, in the work already quoted. It is quite a common fossil also in the Devonian strata of Michigan and Iowa.

Genus DIPHYPHYLLUM. *Lonsdale.*DIPHYPHYLLUM ARCHIACI, *Billings.**Plate 50, Fig. 1.*

The following is the original description of this coral, as given by Mr. Billings, in the Canadian Journal, new series, Vol. V, page 260 :

"Corallum forming large masses of parallel, nearly straight, cylindrical stems, in contact with each other, or nearly so and which, when full grown, are from six to eight lines in diameter. The young stems are added by lateral or marginal gemmation, and are at first two or three lines in diameter, their adult size being attained at the length of two or three inches. At the diameter of four or five lines there are between thirty and thirty-five radiating septa; at six or eight lines, usually about fifty; but occasionally in those of the larger size, from seventy-five to eighty may be seen.

"Fifty appears to be the common number. There are two or three transverse diaphragms in the length of one line. In most of the corallites there is a central area, one line or a little less in diameter into which the radiating septa do not penetrate. Others in the same mass seem to be without this central area. Surface with a somewhat thick epitheca, which, where perfectly preserved, is beautifully ornamented with fine crowded encircling striæ, from fifteen to twenty in the width of one line. In addition to these fine striæ, there are numerous, usually sharp-edged annulations, varying from less than one-fourth of a line in width and depth, to one or two lines. Some of the corallites exhibit sudden constrictions of growth, which give to them the appearance of a series of short turbinate stems inserted into each other.

"The epitheca is often entirely or partially worn away, and the fine striæ can only be seen when the surface is in a very perfect state of preservation. It is probable this coral occurs simple as well as aggregate."

Position and locality. This species is somewhat common in the strata of the Hamilton group of different parts of Canada, where it is originally described. It is found in all the Devonian strata of Indiana, which have afforded perhaps a greater variety of fine fossil corals than those of any other State.

DIPHYPHYLLUM STRAMINEUM, *Billings*.*Plate 48, Fig. 1.*

"Corallum forming large masses of cylindrical tubes, averaging two lines in diameter, and either so closely aggregated as to be nearly in contact, or separated from one another by intervals of from one to five lines, the distance varying in different clusters and in different parts of the same. Sometimes numerous single tubes occur scattered through the rock, which were probably derived from some disintegrated group. The tubes are either straight or flexuous, smooth or annulated by short encircling folds of growth, the surface striated longitudinally by the outer edges of the septa. The latter are forty in number and do not reach the center. The transverse diaphragms are well developed, slightly convex in the center, and appear to be suddenly turned down on approaching the margin. The outer vesicular area is thin, seldom exceeding one-sixth of the whole diameter. The central area altogether occupied by the transverse diaphragms; sometimes in well-preserved specimens the septa may be seen extending about half way to the center, upon the surface of some of the diaphragms, but in general they are confined to the outer area. In the more dense colonies, the corallites often inosculate, and are sometimes connected by lateral processes, as in the species of the subgenus *Eridophyllum*."

The above description is copied from Billings' description, in Canadian Journal, New Series, Vol. IV, p. 135. Prof. Nicholson, in commenting upon it, says he doubts if the distinctness of this species from *Diphyphyllum gracile*, McCoy, can be maintained. Mr. Billings also admitted the close similarity of the two species, but claimed that the slight differences observable in the American specimens, from the European ones, are of specific importance.

Position and locality. The type examples of *D. stramineum* were obtained from the Corniferous limestone of Canada, but it may be reasonably sought for in the equivalent strata of Indiana, especially in the counties of Clark, Decatur, Shelby, Bartholomew, Cass, Carroll, Jasper, etc.

DIPHYPHYLLUM ARUNDINACEUM, *Billings*.

Plate 51, Fig. 1.

This species was also described by Mr. Billings in the same work, he having found his type specimens associated with those of *D. stramineum*. The following is his description, copied from the Canadian Journal, New Series, Vol. IV, p. 134:

"Corallum forming large masses of long cylindrical straight or flexuous stems, from three to four lines in diameter, but usually distant from one to three lines from each other; radiating septa thin, between forty and fifty in number, rarely reaching to the center; transverse diaphragms turning downward, on approaching the margin; two to four in one line. In some of the corallites the walls are so thin and closely united that no separation can be observed, but in others of the same cluster an outer area is distinctly visible. There is usually a circular space in the center of the corallites into which the radiating septa do not penetrate; often, however, they reach the center. The young corallites sometimes spring from the sides of the parent with a slender base, and curving upwards immediately become parallel with those of the whole group. In large colonies frequent instances may be seen where, instead of this lateral budding, a bifurcation takes place, both branches being of the same size. In large groups, owing to numerous additions of young, the corallites diverge slightly, as if radiating from a point. The colonies are from six inches to several feet in diameter, and large blocks of stone are of frequent occurrence which are penetrated at right angles to the stratification by the closely crowded stems."

Professor Nicholson, in commenting upon this species,* says it is distinguished from *D. stramineum*, the species last described, "chiefly by the almost uniformly greater size of the corallites, which average three or four lines in diameter when fully grown. In shape the corallites are cylindrical, with annulations and constrictions of growth; they may be straight or more or less flexuous, and they vary in their distance apart. The epitheca is marked with numerous extremely close-set and delicate encircling striæ, together with more or less conspicuous vertical

* Paleontology of Ontario, 1874, p. 32.

striæ, which mark the position of the septa within. Occasionally the corallites are united by lateral connecting processes derived from the epitheca, similar to those which characterize the genus *Eridophyllum*; but these processes are always remote and are only an occasional feature. The septa are from forty to forty-two, alternately large and small, and rarely encroaching upon the central tabulate area. The tabulæ are regularly depressed and bent downward as they pass through the outer vesicular zone on their way to reach the margin; but they are sometimes more or less flexuous. Increase of size, so far as I have observed, seems to be always by the production of lateral buds, but it is possible that calycular gemmation sometimes occurs, and Mr. Billings states that bifurcation of the corallites takes place occasionally."

Position and locality. Since *D. stramineum* and *D. arundinaceum* are associated together in the corniferous strata of Canada, it is probable that they will be found thus associated in at least some of the Devonian strata of Indiana; especially so because of the fact that the latter species has been observed in strata of that age in Iowa, showing its wide geographical distribution.

Genus ERIDOPHYLLUM, *Edwards & Haime.*

ERIDOPHYLLUM STRICTUM, *Edwards & Haime.*

Plate 49, Fig. 1.

This is another species which Edwards & Haime obtained from the Devonian strata near Jeffersonville, Ind., and published in their great work, *Monographie des Polypiers Fossiles*. The species is also known to occur at various other places in the United States and in Canada. The following description of it is copied from Dr. Nicholson's Report on the Paleontology of Ontario (1875), p. 74:

"Corallum fasciculate, of elongated cylindrical corallites, which have a diameter of from two to five lines, and are placed at intervals varying from half a line to two lines apart. The corallites are sometimes annulated by sharp epithecal projections at intervals of from one and a half to three lines, and at each of these annulations arise small processes by which the separate corallites are united to one another. At other times these periodic annulations and the processes which spring from them, are not nearly so well marked, and may hardly be devel-

oped at all. In any case, the epitheca is marked by longitudinal and fine encircling striæ, of which the latter often have an oblique direction. Increase is chiefly or entirely by calycular gemmation, three or four young being often produced simultaneously from the oral disc of the parent corallite.

"A well marked internal tabulate area is present. The septa are well developed in the external area of the corallites, where they are united by delicate dissepiments. The septa are apparently alternately developed, and rarely encroach much upon the internal tabulate area, their number seeming to be about sixty in a full-sized corallite.

"This species is somewhat variable. The specimens which I have seen from the Corniferous limestone of Ohio and Kentucky exhibit, very conspicuously, periodic annulations of growth, from which the connecting processes are developed in a whorled manner; but this feature is not marked in the Canadian specimens."

Position and locality. Devonian strata near Jeffersonville, and other parts of Indiana.

Genus CYSTIPHYLLUM, *Lonsdale*.

CYSTIPHYLLUM VESICULOSUM, *Goldfuss*.

Plate 55, Figs. 1 and 2.

This is another American form which is identified with a well known European species. It is widely distributed in the Devonian rocks of the United States and Canada. It is very variable in outward form, but the characteristic vesiculose structure is constant and easily recognized, even without making sections of the corallum. The following description, by Dr. Nicholson, is copied from his Report on the Paleontology of Ontario (1874), page 37:

"Corallum simple, elongated, turbinate or cylindro-conic, sometimes nearly cylindrical. Epitheca exceedingly strong, exhibiting numerous fine encircling striæ, along with many well-marked annulations of growth, which sometimes have the form of circular wrinkles, but which at other times are sharp-edged and imbricating. Not uncommonly the folds of the epitheca are laterally prolonged in the form of wing-like extensions. Calice very deep, its walls extraordinarily thickened in aged examples and its bottom usually occupied by a group of bullæ. Septal

striae in the interior of the calice usually very distinct, but appearing to be made up of a succession of elongated vesicles. Internal structure vesicular, the largest of the vesicles being central, and having a diameter of a line to a line and a half. Young individuals are truly simple, but older examples increase by calicular gemmation, a succession of vertically superimposed corallites being thus produced. In an individual of average size, the length is three inches; the diameter of the calice is an inch and a quarter, and the depth of the calice is an inch and a quarter. Large individuals occur, however, in which the length must have been half a foot, and a foot, whilst the diameter is nearly three inches.

"Our specimens agree exactly with those figured by Goldfuss, and there can not be the smallest doubt as to their identity.

"Our specimens show also in a most marked manner, a feature which is present in most of the examples figured by Goldfuss, viz., growth by means of calicular gemmation. In this peculiar mode of increase the coral attains a certain growth, and the calice becomes then more or less obliterated by the extension over it of the epitheca. Then a new bud is thrown up from the calice, generally directly above the old one, and this too continues to grow for a certain period. A third, fifth, or sixth may be similarly produced, until the entire corallum may consist of a series of short turbinate cups, or inverted cones, superimposed one above the other, the younger upon the older. As the direction of the new cups does not always accord with that of the old ones, the general form produced by this mode of increase is often very peculiar and irregular. Some specimens also show extraordinary lateral prolongations of the epitheca."

The figures prepared by Mr. Van Cleve, and which are given on plate 55, were no doubt taken from a specimen of *C. vesiculosum*, but it was evidently one from which all, or nearly all the epitheca had been removed by weathering or other causes. These figures, however, well represent the condition in which specimens of this species are often found; and it would require many figures to illustrate even a part of the forms and conditions in which the specimens are known to occur.

Position and locality. This is one of the most widely distributed of the Devonian corals, and it is likely to be found at various localities in Indiana, where Devonian strata are exposed.

Genus ZAPHRENTIS, *Rafinesque*.ZAPHRENTIS RAFINESQUII, *Edwards & Haime*.*Plate 45, Figs. 3, 4 and 5.*

The original specimens of this species were obtained by Edwards & Haime from near Jeffersonville, Indiana, and taken to France for study and description, together with many other American forms. The following is a free translation of their description as published in their "Monographie des Polypiers Fossiles:"

Corallum long, irregularly bent and contorted, showing numerous well-marked transverse folds. Calyx circular, thin at its borders and very deep. Septal fossett rather narrow, situated at the curved side; principal rays thirty-two, very close together at nearly the whole of their free parts, somewhat strongly denticulated, and prolonged below to the center of the calyx; or they are slightly flexuous but not elevated there. The principal rays alternate with an equal number of less developed rays. Length sixty or eighty millimeters; diameter of calyx 20 mm.; depth of calyx about 20 mm.

The three figures on plate 45 represent some of the various shapes in which specimens of this species occur, and will serve to give an approximate idea of its general aspect. It is probable that the figures 3 and 4 on plate V, of the report for last year represent a short example of this species; but the septal fossett in that case is upon the side of the convex curve of the corallum, instead of the concave.

Position and locality. Devonian strata near Jeffersonville, and other Indiana localities.

Genus AMPLEXUS *Sowerby*.AMPLEXUS YANDELLI, *Edwards & Haime*.*Plate 45, Figs. 1 and 2.*

Figures 1 and 2 on plate 45 represent somewhat satisfactorily the general characteristics of *Amplexus yandelli*; the former figure showing the outer aspect of the corallum, and the latter a longitudinal section of the same, exhibiting the broad transverse plates or tabulæ. A portion of the details of the structure

are not clearly shown by figure 2, but together, and in connection with the following description as given by Dr. Nicholson, the species may be readily identified:

“Corallum simple, cylindrical, straight or curved. Calice varying in diameter from half an inch up to an inch and a half. Epitheca marked with from forty-five to sixty-five strong and angular septal ridges, which in well preserved examples are crossed by fine encircling striæ, and a few remote and regular folds of growth. The septa do not extend more than from half a line to two lines from the wall, leaving the tabulæ exposed over a large central area. The tabulæ appear to be generally flat; and the septa have plain sides, and are alternately large and small.”

Position and locality. This is another species of which the types were obtained by Edwards & Haime from the Devonian rocks near Jeffersonville, Indiana, and published in their *Monographie des Polypiers Fossiles des Terrains Paleozoïques*. It may be sought for at the various localities in the State where the Devonian rocks are known to occur.

Genus FAVOSITES, *Lamarck*.

FAVOSITES BASALTICA, *Goldfuss*.

Plate 54, Fig. 1.

Mr. Van Cleve probably had before him an example of the species which is generally known as *Favosites basaltica*, Goldfuss, when he drew figure 1, plate 54. At least this figure gives a very fair idea of the general outward aspect of that form. Much difference of opinion exists among paleontologists as to the identity and limits of this species, which it is not necessary for me to discuss here. The following is Mr. Billings' description of the species as he identified it from specimens collected from the Devonian rocks of Canada.

“Corallum forming convex, sub-spherical or pyriform masses; corallites variable in size, and either all of nearly an equal width in the same specimen, or with many very small ones interspersed between the larger; transverse diaphragms thin, flexuous or flat, complete or incomplete; mural pores usually in one series. The width of the tubes varies from less than one line to two lines. The specimens generally referred to this

species have a pyriform or hemispherical shape, and small, well, defined, polygonal curved tubes, with one row of pores, rarely two."

Position and locality. This is one of the characteristic species of the Devonian rocks, and it may be sought for in those portions of Indiana in which rocks of that age occur.

FAVOSITES POLYMORPHA, *Goldfuss.*

Plate 50, Fig. 2, and Plate 53, Figs. 1 and 2.

This, like the preceding species, is a characteristic American Devonian coral, which has been identified with the European species of that name. It is very variable in outward form, and considerable diversity of opinion has prevailed as to the true limits of the species.

The figures referred to on plates 50 and 53 give a very good idea of its general aspect. The following is a description of the species as given by Professor Nicholson in his report on the paleontology of Ontario, (1874) p. 50.

"Corallum submassive or dendroid, often dichotomously branched, or reticulated; diameter of branches varying from a little over a line to more than an inch. Corallites radiating in all directions from an imaginary axis, nearly at right angles, or obliquely, more or less contracted internally, and widening as they approach the surface. Diameter of the corallites from half to three-quarters of a line, in branches of half an inch across, often with smaller ones intercalated. Calyces in reality more or less polygonal, but often rendered circular by the thickening of their walls. Mural pores in single series.

"The above would stand as a general definition for a number of branching species of *Favosites* which some eminent paleontologists, such as Lonsdale, McCoy and Billings, regard as belonging to a single natural group; whilst other high authorities, as De Blainville and Milne, Edwards and Haime, distribute them among several species. My own view would coincide with the former of these, namely, that the forms in question should be regarded as belonging to a single very variable specific type, the *Favosites polymorpha* of Goldfuss."

Position and locality. The discovery of this species may be expected wherever the Devonian rocks are exposed within the limits of the State.

FAVOSITES POLYMORPHA var. DUBIA.

Plate 53, Fig. 3.

This variety, which some authors regard as a distinct species, is described by Prof. Nicholson as follows, on page 51 of his report on the Paleontology of Ontario, (1874):

“Corallum dendroid, branched; branches not coalescing and inosculating as they do in *F. reticulata*; few small calices being intercalated amongst the larger ones. The diameter of the larger calices is from half a line to two-thirds of a line. The calyces are more or less rounded, and their walls thick. The diameter of the branches is mostly from three to four lines.

“In some specimens, in place of there being a few minute corallites interspersed amongst a great number of larger-sized ones, the corallites are only moderately unequal, and the number of small ones is about equal to that of the larger ones.”

Position and locality. This variety is likely to be found associated with the typical form.

FAVOSITES, ———?

Plate 54, Fig. 2.

Figure 2 on plate 54 represents a view of the flat under side of a sub-hemispherical mass of *Favosites*, probably *F. hemispherica*, which is a not uncommon species in the Devonian rocks of Southern Indiana.

Genus FISTULIPORA, McCoy.

FISTULIPORA CANADENSIS, Billings.

Plate 47, Figs. 1 and 2.

The following is Mr. Billings' description of this species, as given in the Canadian Journal, New Series, Vol. IV, p. 98:

“Corallum forming irregular, contorted masses, or wide, flat, undulating expansions or layers, from one-half of an inch to an inch in thickness, which are based upon a thin, concentrically wrinkled epitheca. Cell-tubes half a line or less in diameter, and about one line distant from each other; the mouths of

the tubes protruding a little above the general surface. Transverse diaphragms thin, horizontal, or flexuous, and sometimes very numerous, there being in some of the tubes three or four in half a line of the length of a tube. The intercellular tubules are polygonal, and about four in the diameter of the principal cells; their transverse diaphragms are well developed, usually four or five to one line of the length."

Figure 1 represents the appearance of the upper surface of this species very satisfactorily; but the section of a corallum represented by figure 2 is much thicker than the corallum of the species that usually occurs. It also fails to show satisfactorily the small secondary tubules as separate from the principal corallites.

Position and locality. *Fistulipora canadensis* is a not uncommon fossil in the Hamilton group of New York and Canada, and it is abundant in the Devonian strata of Indiana.

Genus ALVEOLITES.

ALVEOLITES GOLDFUSSI, *Billings*.

Plate 54, Fig. 3.

This figure was evidently drawn from an example of *Alveolites goldfussi*, Billings. Usually, the mouths of the corallites are somewhat larger in this species than they are represented in the figure, but they are sometimes as small as they are there represented. The following is Professor Nicholson's description of the species, as given in his report on the paleontology of Ontario, (1874) p. 56:

"Corallum forming irregular, undulated expansions, or depressed, discoidal masses, several inches in width, and from two lines up to two inches in thickness. Under surface covered with a thin, concentrically wrinkled epitheca, similar in every respect to that of a *Favosites*. The epitheca carries in young examples one, and in aged examples many, layers of corallites, which are arranged in a radiating manner around the central part of the coral, and which open very obliquely upon the surface. The calyces are of large size, in general from three-fourths of a line to one line across and half a line in height. Their shape is usually transversely oval, or three sided, the outer side being curved, and the two inner sides straight. Owing to the thinness of the walls of the corallites, the calyces

do not appear to be separated by any interspaces transversely, but overlap one another. There are no traces of teeth or grooves on the interior of the corallite."

Position and locality. Specimens of this form have been found in the Devonian rocks of Canada and the State of New York, and I have collected from rocks of the same age in Iowa some examples which I believe to belong to the same species; and is found in the counties of Clark, Decatur, Bartholomew, Shelby, Delaware, Cass, etc.

Genus STRIATOPORA, *Hall.*

STRIATOPORA LINNÆANA, *Billings.*

Plate 47, Fig. 7.

Although figure 7, on plate 47, is unsatisfactory as to some of the details of structure, it was doubtless drawn from a portion of a large corallum of *Striatopora linnæana*. The following is Mr. Billings' description of this species as given in the Canadian Journal, new series, Vol. V, p. 253:

"Stems two or three lines in diameter, branching at an angle of 75° to 80°; cells variable in size, the greater number with the expanded mouth one line wide, and the circular cavity at the bottom from one-third to one-half of a line; the smaller or younger cells of all sizes are somewhat uniformly distributed among the larger. In the perfect specimens the mouths of the cells are everywhere in contact with each other, the edges of the walls between them sharp, and the form more or less polygonal, generally five or six sided. In worn specimens the cells are more nearly circular, and the walls obtusely rounded on the edge. The striæ in the cell-mouths not observed."

Position and locality. The original examples were obtained from the strata of the Hamilton group in Canada. It occurs in the Devonian strata of Indiana.

Genus SYRINGOPORA, *Goldfuss.*

SYRINGOPORA PERELEGANS, *Billings.*

Plate 49, Fig. 3.

"Corallites one line in diameter, sometimes a little more or less, distant a little less than one line; connecting tubes half a

line in diameter, and distant from one line to one line and a half, usually projecting at right angles, but sometimes a little oblique. Epitheca with numerous annulations, generally indistinct, but under certain circumstances of growth, sharply defined and deep, so much so as to give to the corallites the appearance of the jointed stalk of a crinoid. The young individuals are produced by lateral budding, and on one specimen the whole colony appears to be based upon a broad lamellar foot-secretion like that which forms the base of a Favosite.

"The distance of the corallites is usually about a line, but like all other species this one varies a good deal in this respect. When some cause has intervened to prevent their regular growth, they are much flexed and consequently at times more distant than when they have been undisturbed. The connecting tubes on the same side of the corallite, are three or four lines distant, but generally on the other sides one or two others in the same space occur, making the average distance one line, or one line and a half."

This species is very closely allied with *Syringopora reticulata* Goldfuss, from the Carboniferous of Europe. It appears to differ only in having proportionally fewer connecting processes.

Position and locality. Originally from the Carboniferous limestone of Canada. It is found in the Devonian rocks of Indiana.

SYRINGOPORA MACLUREI, *Billings*.

Plate 47, Fig. 3.

The figure prepared by Mr. Van Cleve seems to agree well with Mr. Billings' description of *Syringopora maclurei*, but Mr. Van Cleve referred it to *S. ramulosa* of Goldfuss. The species represented by this figure is probably not identical with that European species, and it also may not belong to *S. maclurei*, but I am acquainted with no described American form with which the figure more nearly agrees. The following is a copy of Mr. Billings' description, Canadian Journal, N. Ser., Vol. IV, p. 115.

"This species is found in large masses of long, slightly flexuous corallites. These have a diameter of about a line and a half, and, owing to their flexuosity, are at times in contact, and often two or three or four lines apart. In large colonies, which

have grown luxuriantly without the interference of disturbing causes, the corallites are more regular than in the smaller or stunted groups, in which the corallites are much bent and confused. The connecting processes are very short and distant, and appear to be sometimes mere inosculation of the stems. The corallites, after growing separately for a short distance, approach each other and seem to grow together or adhere to each other for the space of a line and a half, or more, they then diverge and again unite. These points of contact occur at distances varying from three lines to six, nine or even twelve lines. Externally they exhibit numerous other indistinct annulations, and also faint indications of longitudinal striæ."

Position and locality. Mr. Billings states that *S. maclurei* is abundant in the Corniferous limestone of Canada West; and is found in the Devonian rocks of Indiana.

Genus STROMATOPORA, *Blainville*.

STROMATOPORA PUSTULIFERA, *Winchell?*

Plate 53, Figs. 4 and 5.

These figures appear to represent the species which Professor Winchell described in the appendix to his report on the Grand Traverse Region of Michigan, under the name of *Stromatopora pustulifera*. It may, however, prove to be a different species, as the pustules represented by the figure are considerably larger than those of Prof. Winchell's type specimens, and yet not so large as those of his *S. monticulifera*. The following is his description of the first named species:

"In very large spheroidal, ovoid or elongate masses, composed of arching, transverse layers, formed of laminæ of coralline substance separated by a network of minute passages which, at intervals, coalesce and turn upward through the layer, radiating and ramifying again on the upper side. The places where the layers are thus traversed are raised on the upper side into little eminences. The distinction of layers is produced by variations in the density of the coralline substance. Masses of coral several feet in diameter."

Position and locality. The species described by Professor Winchell, under the name of *S. pustulifera* is somewhat common in the Devonian rocks of Michigan and Iowa, and is likely to occur in strata of that age in Indiana.

SUBCARBONIFEROUS.

Genus LITHOSTROTION, *Fleming*.LITHOSTROTION MAMILLARE, *Castelnau*.*Plate 52, Fig. 3.*

Mr. Van Cleve's figure is a very good representation of the upper surface of a corallite of this species, showing the calyces and the elevation at the bottom of each. It is a characteristic fossil of the St. Louis division of the Subcarboniferous series; but as it was described on page 506, (138) of the report for last year, its repetition is not necessary here.

The following letter from Dr. Julius S. Taylor to Professor Collett, gives a few of the leading facts of the life of the author of the illustrations of the fossil corals which are described on the preceding pages.

KANKAKEE, ILL., June 8, 1881.

Prof. John Collett, State Geologist of Indiana:

DEAR SIR:—The engraved plates of geological specimens which I have loaned to you for publication in the Indiana State reports were the production of my friend, the late John W. Van Cleve, Esq., who drew and engraved them to accompany a work on fossil corals which he had prepared for publication, but died before accomplishing it.

Mr. Van Cleve was born in Dayton, Ohio, June 27, 1801, and lived in that city continuously until his death, which occurred September 6, 1858. He was a man of sterling integrity and marked ability, and was greatly honored and respected by his fellow-citizens for the excellencies of his character and his liberal public spirit.

I had the good fortune to become acquainted with him in 1838, and to enjoy his intimate friendship until his death. He was an ardent student of geology, and much of our intimacy consisted in our joint study of this absorbing science. His acquirements were such in that study, that if he had been ambitious of distinction, he might have stood in the foremost rank of the geologists of that day; but he was naturally of a retiring disposition, and, above all, he disliked mere notoriety. In everything he did he was careful and thorough, and in addition to his ability as a geologist, he possessed such skill as an artist and engraver, that he was able to delineate the objects he studied with great truthfulness.

After the death of Mr. Van Cleve, his nephew, Mr. Thomas Dover, presented me with these plates, because of my long friendship with his uncle; and I am especially glad that an opportunity has at last occurred to do honor to the friend I loved so well, by having at least a portion of the work published upon which he bestowed such long and patient labor.

Your friend,

JULIUS S. TAYLOR.

ERRATA.

- Page 8, Line 1—For *germs* read gems.
Page 112, Second Line from top—Range 8 should be range 9.
Page 139, Sixth Line from the bottom—"clearage" should read cleavage.
Page 142, Line 33—For *trix* read strix.
Page 151, Line 3—For *west* read east.
Page 176, Line 31—For *members* read numbers.
Page 180, Line 7—For *their* read thin.
Page 181, Line 6—Insert comma after place.
Page 192, Line 30—For *Deitricks* read Beitricks.
Page 199, Line 1—For *Noble* read Nolte.
Page 210, Line 30—For *are* read is.
Page 254, Line 19—For *fifteen to twenty-five* read .15 to .25.
Page 273, Line 33—For *aduntant* read abundant.
Page 277, Line 18—For *unknown* read unworn.
Page 277, Line 20—For 17 read 19.
Page 286, Line 33—For *liule* read line.
Page 316, Line 14—For 28 read 27.
Page 333, Line 20—For *occur* read occurs.

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