CHAPTER IX.

THE NIAGARA AND LOWER HELDERBERG GROUPS; FORMATIONS V AND VI; UPPER SILURIAN.

742. In this chapter, the *Upper Silurian* beds, as developed in Tennessee, are described. These, taken together, form a group which is very heterogeneous in lithological and other characters, and which, moreover, is of limited volume compared with what it becomes when followed northward into the States of Pennsylvania and New York. It is a collection, to some extent, of the feather-edges and the outlying patches, or of the odds and ends of disappearing, or reappearing, formations. (§ 372.)

743. The *Upper Silurian* group, as here treated, embraces sandstones, limestones, shales, all of many colors, and beds of iron-ore. The minor formations composing it, have always occupied areas more or less local, never having been continuous, and State-wide, as we have reason to think the great limestone formations already described, once were.

744. In some parts of the State, in horizons in which we would naturally look for these rocks, and where underlying and overlying formations are present, not a bed is found to represent the group. In the belt of country skirting the western base of the Cumberland Table-land, this is notably the case, and in every ravine deep enough, the outcropping rocks show it to be so. Along the eastern escarpment of the Central Basin, (p. 98,) from the Kentucky nearly to the Alabama line, the Black Shale, as seen in the Snow's Hill section, (§ 729,) and in the sections of the Basin on the Map, and in chapter X, rests on the Nashville Formation, without any intervening rock.

745. On the western escarpment, this is also the case at a few points, but generally a Niagara bed has appeared to separate the two, bearing above it, here and there, a *trace*

Lower Helderberg. The Niagara and Helderberg strata are *unconformable* to the Nashville, and never covered the dome of the Basin. (§ 367.)

The two groups—the Niagara and the Lower Helderberg—will be considered respectively, in separate sections.

SECTION 1.

THE NIAGARA GROUP, OR PERIOD; FORMATION V.

746. The subdivisions of this group are, in descending order, as follows:

5,*d. The Meniscus Limestone;* uppermost.
5,*c. The Dyestone Group, or Subgroup.*
5,*b. White Oak Mountain Sandstone.*
5,*a. Clinch Mountain Sandstone,* at the base.

The lowest three are East Tennessee formations. The *Meniscus Limestone* is represented in this division of the State, but it is preëminently a formation of the Western Valley, (§ 104.) These formations represent the *Medina, Clinton,* and *Niagara epochs* of the New York nomenclature, and are all embraced in Dana's *Niagara Period.*

(5,*a.*) THE CLINCH MOUNTAIN SANDSTONE.

747. The characteristic rock of this formation, is a white, or grayish-white, hard *sandstone,* having a maximum thickness of at least 400 feet.* It is typically presented in *Clinch Mountain,* the boldest and greatest mountain within the limits of the East Tennessee Valley. (§ 97.) The sandstone lies in a great sheet, on the eastern slope of the mountain. It is a heavy-bedded rock; contains rarely a layer of shale; frequently presents on its exposed surfaces multitudes of fucoids; and has some of its beds profusely pierced with rods, filling the holes of a species of *Scolithus.* Layers, twenty inches thick, have

* In the Table of Formations, on page 161, the thickness of this sandstone is given doubtfully at 300 feet. Its maximum is, however, more than this, and may even exceed considerably that given above. No opportunity has been presented of measuring it where present in greatest volume.

been observed, with rods in abundance, running through them.* The surfaces of the layers are also often ripple-marked. The rock is generally fine grained, but sometimes coarse enough to constitute a conglomerate, with pebbles as large as peas.

748. In its more western presentation, as in Powell's Mountain, in Hancock and Claiborne Counties, it graduates upward into brown and red sandstones, some of which are highly ferruginous. These red sandstone, however, will be referred to the *White Oak Mountain Group.*

749. But, in addition to the white sandstone, the Clinch Mountain Formation is made to include, *provisionally,* an underlying heavy stratum of *red calcareous shale.* The sandstone, at all points, rests upon this shale. In one section, that of the *Nose,* in Hawkins, the shale measured 400 feet. This stratum has already been incidentally referred to in the Bull's Gap and White Horn section, on page 249.

750. Below are presented several sections, which will enable the reader to understand the relations the Clinch Mountain Group sustains to the other Niagara divisions, as well as the relations the Niagara, as a whole, sustains to the other great formations. The sections will also be of service for future reference.

751. The *Nose* referred to above, is the short isolated mountain known as the *Devil's Nose,* and mentioned on page 43. The *white sandstone* caps the mountain; the *red shale,* and the underlying Nashville beds, outcrop around its slopes. The following is a section taken on its eastern slope:

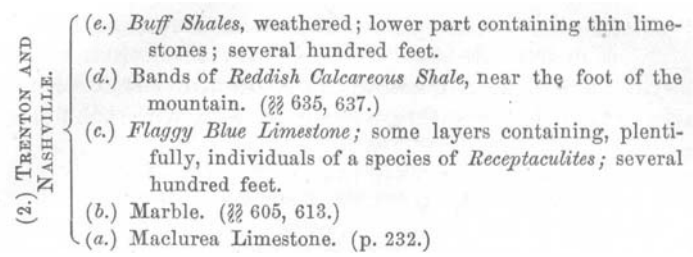
(3.) Clinch Mountain Group.

(*b.*) *Sandstone;* white, or whitish-gray; mostly fine-grained and hard; some layers fine conglomerate; about 200 feet thick.

This rock caps the Nose, and is a remnant of the base of a synclinal fold.

(*a.*) *Shale;* brownish-red calcareous rock, weathering into shale; upper part inclined to be sandy; thickness, 400 feet.

* The species concerned, is most likely Hall's *Scolithus verticalis* of the Medina Sandstone. The rods are much like those of *S. linearis* of the Chilhowee (*Potsdam* Sandstone, (§ 481,) and if the two formations were brought together by a fault and displacement, it would be difficult to distinguish between them by means of these fossils.



(1.) KNOX GROUP.

752. The diagram on page 208 represents a section which intersects many of the formations, and among them, all the members of the Niagara Group, if we regard the red sandstone referred to in § 748, as belonging to the White Oak Mountain division. The Niagara divisions are not separated in the diagram, the group being represented as a whole.

The places of the occurrence of the group are indicated by the dotted belts, and, also, by being numbered 5, either with or without letters.*

753. The points C, D, and E, of the diagram, are ridges of the *Powell's Mountain Group,* (p.42.) The following section, commencing at a gap in D, (*Mulberry Gap,*) and extending through Sneedville, to H, the east end of the diagram, presents the formations of two of them. It may be observed here, that the dip given to the strata in the part of diagram, from C to F, is too great. It is generally considerably less than 45°.

(15) *Knox Sandstone,* making *Comby Ridge.* (§§ 108, 520.)

— *Fault* .....

(14) *Mountain Limestone,* in ridge a short distance east of Sneedville.

(13) *Siliceous Group,* in same ridge, as above.

(12) *Black Shale;* heavy presentation; Sneedville is located upon it.

(11) *Meniscus Limestone,* with shale, contains *Halysites catenulata* and other fossils. Not as heavy as at the eastern base of Powell's Mountain.

(10) *Dyestone Group,* repetition of 5 below, and commencing a new *series.* (p. 146.) This forms the eastern slope of *Newman's Ridge.* It must be noted, however, that at some points sandstones of 4, below, and even of 3, occur, cut off with the Dyestone rocks by the fault.

— *Fault* .....

(9) *Mountain Limestone,* on Newman's Ridge, and upper part of western slope.

* There is an error as to one figure; the first 5 at the west end of the diagram should be 7.

(8) *Siliceous Group*, heavy, much shale, lower part of west slope of Newman's Ridge.

(7) *Black Shale*, heavy presentation, outcrops in a narrow trough or valley, between the two mountains. Big Sycamore Creek runs in the southwestern part of this trough.

(6) *Meniscus Limestone*, bluish; upper part light gray; lower part inclined to be sandy; all fossiliferous. Thickness, 145 feet.

(5) *Dyestone Group*, Shales and thin sandstones, brown; red, gray and greenish, with a band of Dyestone ore. Some layers ripple-marked. The group quite fossiliferous; contains *Bellerophon trilobata, Strophomena corrugata, Calymene Clintoni? Beyrichia lata, etc*. Thickness, 325 feet.

(4) *White Oak Mountain Sandstone;* brown and red sandstones, with some fine conglomerate, much of both very ferruginous. This, and the white sandstone below, make the eastern slope, and the crest of Powell's Mountain. Thickness uncertain, say 100 feet.

(3) *Clinch Sandstone*, light gray; contains some fine conglomerate. Thickness doubtful, but much below maximum, say 100 feet.

(2) *Clinch Shale*, reddish argillaceous limestone or calcareous shale, beneath the last, under the crest of the mountain on west side.

(1) *Trenton and Nashville Series;* outcrops on the lower part of western slope of Powell's Mountain, and makes the valley west of the mountain, in the southwest part of which flows Little Sycamore. The entire valley may be called *Little Sycamore Valley.*

754. A section will be given below, illustrating the occurrence of formations in the region of *Cumberland Gap*, the region to which the west end of the diagram on page 208 pertains; and, in order to have an *entire section* from the Gap to Comby Ridge, it may be well to introduce here a section supplying the intermediate part. These sections, taken in connection with the diagram, will illustrate, not only features belonging to the Niagara beds, but, also, the geological character of much of the country in Hancock and Claiborne counties.

(6) *Knox Dolomite*, forming a heavy, cherty ridge, becoming very wide and high east of Tazewell, (Wallin's Ridge.) This formation follows in order, the Trenton and Nashville Series (1) of the last section and the ridge mentioned lies next west of the valley in which the rocks of that series outcrop.

— *Fault* .....

(5) *Dyestone Group,* as in last section; contains a layer of iron-ore one foot thick.

(4) *White Oak Mountain Sandstone,* not as heavy as in last section.

(3) *Clinch Mountain Group,* including the Sandstone and the Shale; the former becoming thin and losing its importance.

This group, with the Dyestone and the White Oak Mountain groups above, forms a sharp ridge along this line of section, which is separated from that of the Knox Dolomite above, by a very narrow valley, and which, too, with the formations which make it, runs out before reaching a point opposite Tazewell.

(2) *Trenton and Nashville Series,* follows the Shale of the Clinch Group, and the sharp ridge mentioned, just as the same rocks (1) in the last section follow the Shale and Powell's Mountain.

The series, moreover, presents a valley similar to the Little Sycamore Valley. Tazewell is located in it. East of the latter place, this Series follows the Knox Dolomite of Wallin's Ridge, the fault separating the two.

(1) *Knox Dolomite;* this succeeds the last in the great anticlinal of Claiborne, Union and Campbell. (§ 513.)

755. Passing the axis of the anticlinal just mentioned, the order in which the formations occur is reversed. From this axis *eastward,* we pass from older formations to newer, until a fault is met with, which throws us abruptly back to some one of the lower formations as a new starting point. Advancing, however, the formations we meet with occur in the same succession as before, until a second fault is encountered, and another starting point presented, and so on. (See page 146.) To meet with the formations of Cumberland Gap, in ascending order, our course from the axis of the anticlinal must be *westward.*

756. The following is a section of the rocks in the vicinity of *Cumberland Gap.* The point A, in the diagram on page 208, is a bold, conspicuous cliff of sandstone, called the *Pinnacle.* The elevation of this is given on page 73. Its rocks are the uppermost of the section.

The formations are presented as in the foregoing sections, in their natural order, and numbered in accordance, that is, from below, upward. The lowest formation rests directly upon No.1 of the last section.

(7) *Base of Coal Measures;* hard sandstone forming the Pinnacle.

(6) *Mountain Limestone;* a heavy bed, but not measured.

(5) *Siliceous Group;* a heavy stratum of bluish, or greenish, more or less calcareous, shale; 15 or 20 feet of which, at top, contains characteristic layers of chert. Some iron-nodules and a few unimportant layers of brown shale are seen. Thickness, 520 feet.

(4) *Black Shale;* at the base of the mountain.

(3) *Dyestone Group;* in upper part shales with thin sandstones, the shales mostly greenish, followed below by a valuable bed of ore from 24 to 30 inches thick. Below this, shales with some heavy layers of fine-grained sandstone, which may represent the Clinch Mountain sandstone; if so, the latter formation has not quite disappeared.

This group makes *Poor Valley Ridge,* a low ridge skirting the base of the mountain for many miles to the southwest.

(2) *Clinch Red Shale,* not exposed.

(1) *Trenton and Nashville Series,* making the long and interesting *Powell's Valley,* and resting upon the Knox Dolomite, No. 1, of the preceding section.

757. In the sections given, the Clinch Sandstone is either on the top, or, as a great tilted plate, forms one of the slopes of a mountain. It makes the cap of the Nose, (§ 751.) In connection with some of the red sandstones of overlying formations, it makes the eastern slopes, and the crests of Newman's Ridge, and of Powell's Mountain. In fact, the mountains mentioned owe their existence, as such, to these sandstones. Had the latter been shales, or limestones, like those of Little Sycamore Valley, the whole region, long since, would have been without mountains.

How hard plates of rock, like these sandstones, are mountain-making and mountain-saving, has been explained. (See §§ 362 and 628.)

758. The Clinch Sandstone has given us, either alone or with other formations, three distinct groups of mountains, as follows:

1. *The Powell's Mountain Group,* the geology of which we have just considered. (See also § 96.)

   In this group ought to be included the *Lone Mountain,* of Claiborne* and Union Counties, which is in a line with Powell's Mountain, the opposing ends of the two being about four miles apart. These mountains are the same geologically. The White Oak red sandstones, however, are prominent, and the Clinch Sandstone less so, in Lone Mountain, than in Powell's.

2. *The Clinch Group,* (See § 97.) I have spoken of the occurrence of the *Sandstone* in the main *Clinch Mountain* itself, in § 747, and of its presentation on the *Nose,* in § 751. It also makes, in part, *Stone Mountain* of this group. *House Mountain*

* *Claiborne* and Union, not *Grainger* and Union, as appears on pages 251 and 252.

is an outlier, and very much, in all respects, like the Nose. It is capped in the same manner, and the slopes of the two present the same formations.

Pine Mountain is made by the hard rocks of the *Siliceous Group*, and so is *Stone Mountain*, in part.

In this region, the red sandstones of the *White Oak Mountain Group* do not occur in any noteworthy force.

2. *The Bay's Mountain Group.* (See § 99, and also § 643.) In this group, the Clinch Sandstone alone is the mountain-making layer. In a section across the middle of the group, the strata are seen to be arranged in a series of synclinal and anticlinal waves. The first range met with on the southeast side is broken, and includes the prominent points, *Chimney Top* and *Fodder Stack*, both of which are capped off with sandstone like the Nose, in Hawkins. The next range has also a high point, *Stone Mountain*, capped as the others. Then follows a pair of mountains, with a smaller ridge between, and in the double valley thus formed, rests a low double-synclinal trough of sandstone, a section of which is like the letter **W**, with the inner part reduced in size. After this, come four or five synclinals and anticlinals of sandstone, forming ridges that are not as high as those on the eastern side.

759. The last presentation of the *Clinch Sandstone*, going southward, is in House Mountain. This is about thirteen miles northeast of Knoxville. The greatest development of the Sandstone is in Clinch Mountain. West of this, it loses volume, and is much reduced in the Powell's Mountain Group. It does not reach the Cumberland Table-land, unless, indeed, the sandstone which helps to form Poor Valley Ridge, (§ 756, (3,)) near Cumberland Gap, and southward, in Claiborne, is its feather-edge. Eastward, it is last seen in the Bay's Mountain Group, on the summits of Chimney Top and Fodder Stack. It passes to the northeast out of the State, and extends through Virginia and Pennsylvania into New York, where it has long been known as a part of the *Medina Sandstone.*

760. The *Clinch Red Shale* is prominently seen involved with the Sandstone in the anticlinals and synclinals of the Bay's Mountain Group. Its place is below the Sandstone. The beds of the latter, at some points, however, have been observed to contain some shale, but in small quantity.

The Shale has a wider extension eastward and southward than the Sandstone. It occurs beneath the Dyestone Group, at

the base of Poor Valley Ridge, in Claiborne, and of Walden's Ridge, in Campbell.

In the southern part of the State, it has not been made out satisfactorily as a distinct bed.

761. At many localities, the Clinch Sandstone could supply excellent building material. It is often well bedded for quarrying, and its light gray color, and its texture, would make it popular. As yet, no railroad touches it at any point.

(5,*b*.) WHITE OAK MOUNTAIN SANDSTONE.

762. Starting up south of the Hiwassee River, and running in a southwesterly course, the line of which is east of Chattanooga about fourteen miles, is a nearly straight ridge, that reaches far into Georgia. This, in Tennessee, is called *White Oak Mountain,* and in Georgia, *Taylor's Ridge.* (§ 102.) It is, for the most part, made up of a heavy group of variegated alternating sandstones and shales, to which I have given the name above.

763. The *sandstones* are mostly fine-grained, thin, and even-bedded, sometimes thick-bedded, fossiliferous, generally, reddish-brown, but also greenish gray, buff, and of other colors. Their surfaces often abound in crinoidal buttons. Some of the layers are highly ferruginous, making an iron-rock, to which the remarks in § 618 are applicable. Many beds can be used for building purposes with advantage. The depot at Ringgold, in Georgia, is built of this rock, as well as certain culverts on the line of the railroad.

764. The *shales,* of reddish-brown, pale green, and other colors, alternate in beds of various thicknesses with the sandstones, and generally constitute the greater part of the volume of the group.

765. The rocks of this group resemble, more or less, those of the two lower divisions of the Knox Group. (§§ 499, 519 and 523.) At certain points, the rocks of the two groups are thrown together. In such cases, the fossils of the White Oak beds enable the observer to separate them without difficulty.

765. It is in White Oak Mountain, and Taylor's Ridge, that this formation appears in greatest volume. It must be, at

least, 600 feet thick in the gap at Ringgold, and, perhaps, considerably more. In Tennessee, its maximum may be placed at 500.

The lateral extent of the formation, at least in Tennessee, is very limited. It is not observed, either east or west of the belt, including White Oak and its spurs.

766. In the northern part of the State, certain beds of ferruginous brown-red sandstone and fine conglomerate have been referred to this formation. These occur in the Powell's Mountain Group, and are presented in the sections in §§ 753 and 754. The occurrence of the formation in Lone Mountain is also spoken of in § 758. As in the White Oak Mountain region, so here, these rocks are confined to a comparatively narrow belt, not appearing outside of the area including the ridges of the Powell's Mountain Group.

767. Along the line from Lone Mountain to the north end of White Oak, there are no especial presentations of the rocks of this formation. Traces occur at intervals, in the Dyestone ridge, which lies in this range. There is a considerable ridge in the line, just north of the Hiwassee River, which may contain some of the lowest layers, and a curious amphitheatre of hills just south of this river, the highest points of which may show them.

768. This amphitheatre, or circle of hills, is isolated, and more than a mile in diameter. It rests in a wide area of rocks, belonging to the Trenton and Nashville Series. This area is due to the lateral extension of Savannah Valley caused by the running out of White Oak Mountain. The amphitheatre is an outlier of the latter mountain, and is separated from it by an interval of from three to four miles. In the area around it the rocks are nearly horizontal.

769. Just south of Georgetown, which is located in the area mentioned, the north end of White Oak appears, not as a sharp ridge, but more as the end of a long plateau. This end is nearly two miles wide; its strata outcrops in nearly horizontal layers, and the rocks of the formation under consideration, appear at the top in very feeble force. But southward, the rocks of the mountain become tilted, with dips of from 25° to 35°. The sandstones and shales increase rapidly in volume, and

the mountain becomes a well defined ridge, highest and boldest in Georgia.

770. This formation presents another example of a stratum following, for long distances, the trend of the valley, with but little lateral extension, (See §§ 582 and 583.)

771. The northern presentation of the group in the Powell's Mountain region is of minor importance, so far as volume is concerned. The relations, however, of these rocks to the Clinch Sandstone, are there seen. The two groups in this region overlap, the red White Oak sandstones being on top. In the southern part of the State the Clinch Sandstone, as we have stated, is wanting.

772. The *White Oak Mountain Sandstone*, as I have described it, ought, perhaps, to be regarded as a *provisional* group. Its ferruginous, variegated rocks naturally associate it with the *Dyestone Group* next above it, and doubtless its paleontological characters unite it with that. I have, however, thought best for the present, mostly on account of its great and special development in White Oak Mountain and in Taylor's Ridge, to keep it separate.

773. Below is a section of the formations as they are presented in the gap of White Oak Mountain, through which the Chattanooga and Cleveland Railroad runs. It may be well to state that, in approaching White Oak Mountain from the east, along the line of the railroad, a *fault* is met with at a point about two and a third miles from the foot of the main mountain. Passing this, the road intersects, at once, an *outlying and local ridge*, made up of the sandstones and shales of both the White Oak and Dyestone formations, and in which, too, a band of iron-ore occurs of from one to three feet thick. The rocks of this ridge dip to the southeast, and are the overturned southeastern side of a synclinal trough, of which White Oak Mountain, itself, is the greater northwestern side. Between the ridge and the mountain is a *cove*, into which outcrops *Carboniferous limestones*, (*Mountain Limestone*,) the beds of which, at many points, are horizontal.

It may be added here, that, to the southeast of the *fault* spoken of, the country, for many miles, is underlaid by strata of the Knox Group.

774. The section is arranged in ascending order, the formations being so numbered. The topmost bed is on the cove side of the mountain, the lowest on the western. The strata dip to the southeast at an average rate of about 28°.

(5) *Siliceous Group.* At top, rough, cherty layers running beneath the *Carboniferous* limestones of the cove, about 20 feet seen, upper part concealed.
Greenish shale, 30 feet.
Gray crinoidal limestone, crinoidal buttons, large, 15 feet.
Greenish shale, 8 feet.
Thickness in all, ... 73 feet.

(4) *Black Shale*..... 20 feet.

(3) *Dyestone Group.* Red and greenish shales mostly, alternating with thin, even-bedded, fine-grained sandstones, and containing dyestone ore, ... 200 feet.

(2) *White Oak Mountain Sandstone.* A heavy series of shales and sandstones, of reddish-brown, green, gray and buff colors, the reddish-brown and green most common. The sandstone, thick and thin-bedded; one hard brown layer near the base, eight feet thick. This series graduates into that above.
Thickness in all, ... 420 feet.

(1) *Transition Beds*, passing down into Nashville rocks.
Alternating greenish shale and shaly, blue, fossiliferous limestone, 130 feet. Below this, reddish, argillaceous limestone, weathering into shale; variegated with greenish bands, 152 feet.
Thickness in all. ..... 282 feet.

(5,*c*.) THE DYESTONE GROUP.

775. This group is neither great in volume, nor of much importance, as to topographical or agricultural relations. Nevertheless, it is highly interesting as a repository, or matrix, of iron-ore. The group is confined to East Tennessee. It is a series of variegated shales and thin sandstones, for the most part, the rocks presenting a variety of colors, among which, red, brown and green, are predominant. It holds from one to three or more layers of fossiliferous iron-rock, which is generally available as an iron-ore. Much of the mass either is, or

has been, quite calcareous. At some points thin beds of limestone occur with the shales; at others, the mass is pretty thoroughly leached so far as its outcrop is concerned, and, indeed, for many feet within.

776. The sandstones are generally fine-grained, thin, and smoothly bedded. Sometimes thick, heavy layers occur. Occasionally they appear to be wholly absent. This is especially the case at some points in the southern part of the State, in Hamilton County, and in Sequatchee Valley, the group being mostly shales and limestone, with but little sandstone.

777. The *iron-ore* (often called *dyestone*, being sometimes used as such, and hence the name of the group) is in stratified layers. It is highly fossiliferous, abounding in casts of crinoidal buttons, small corals and *bryozoa.* It contains, also, shells and fragments of trilobites. In addition, the ore abounds in small, flattened, *oolitic* bodies, in consequence of which it is called both *oolitic* and *lenticular* ore. Fragments long exposed on the surface, have, externally, a dark brown, or reddish-brown, appearance, but the ore when freshly quarried, has a more or less bright reddish, and at certain points, nearly a scarlet, color. At some localities it is more or less calcareous, while at others it appears to be thoroughly leached. It is highly esteemed as an iron-ore, and is the main dependence of all the furnaces and forges in the western part of the Valley.

778. A number of sections have been given, in which the Dyestone Group is represented, and from which its characters and its relations to other formations can be learned.

See paragraphs 753, 754, 756 and 774. The cuts on pages 139, 142, 190 and 208, may also be referred to. In those on pages 142 and 190, the place of the group is indicated by the figure 5, and in that on page 208, by 5,*c.*

779. Below is a section taken on the Nashville and Chattanooga Railroad, above Lookout Station. The locality is on or very near the Tennessee and Georgia line, and embraces the places known as Love's and Cross's Hollows. In this region the *Siliceous Group*, the *Black Shale*, and the *Dyestone Group* outcrop, from beneath overlying strata, near the base of one of the spurs of Raccoon Mountain. The strata dip to the northwest at a low angle, running under the mountain. This local-

ity corresponds to a point near the right hand base of the mountain, E, in the diagram on page 139. The range of formations intersected, skirts, for a long distance, the eastern base, not only of Raccoon Mountain, but also of Walden's Ridge, north of Tennessee River. (§§ 141, 142.)

The formations are numbered in ascending order.

(4) *Siliceous Group.* Gray crinoidal limestone charged with layers of chert. Contains *Agaricocrinus.* Seen at base about ..... 100 feet.

(3) *Black Shale,* with a bituminous sandstone at base, averaging about one foot in thickness.
In all. ..... 12 feet.

(2) *Dyestone Group.*

i. Greenish shale, 22 feet.

h. Dyestone ore, with shale interstratified; one foot and a half.

g. Fine sandstone, somewhat ferruginous, in part inclining to be shaly. Contains individuals of *Pentamerus oblongus;* six feet.

f. Greenish shale, with occasionally thin seams of ferruginous layers, approaching dyestone; some layers more or less calcareous; 67 feet.

e. Calcareous dyestone, alternating with shale; fresh, the dyestone has the aspect of deep red limestone, is fossiliferous, and much of it oolitic, weathers into a rather open iron-ore; one layer, 12 inches thick. In all, 4 feet.

d. Greenish shale, much like *f,* above; contains one or two thin seams of calcareous dyestone; in its lower part, are *Strophomena profunda? S. depressa, Orthis elegantula?* &c.; 21 feet.

c. Dyestone, calcareous; 6 inches.

b. Shale and thin limestones alternating; 14 feet.

a. Dyestone, like *c,* above; contains *Leptæna sericea, Strophomena depressa, Orthocerata,* &c.; three to six inches.

Thickness of entire group ..... 136½ ft.

(1) *Transition Beds.* An alternation of thin limestones and shales; freshly quarried, the whole mass is blue, thin limestones predominating.

This, together with the corresponding mass in section § 774, ought perhaps, to be included in the *Upper Silurian,* although Nashville fossils begin to appear. The bed has been referred to in § 654, and some of the

fossils given. *Strophomena tenuistriata* of that list, is doubtless *S. depressa, Atrypa marginalis* is quite common.

Thickness ..... 112 feet.

Below this reddish limestones come in, and well marked Nashville rocks are met with.

780. The entire absence in the above section, of the red sandstones of the White Oak Mountain Formation, is to be noted. The Dyestone Group itself, lacks its thin sandstones, only one bed of the latter appearing, and that near the top. The group is seen, moreover, to be quite calcareous at this point, as it is pretty generally in this portion of the State.

781. In the section, in § 753, the thickness of the Dyestone Group, on the east side of Powell's Mountain, is 325 feet; in the White Oak Mountain section, (§ 774,) it is placed at 200 feet, and in the section above, at 136½. The *transition beds,* however, in the last section, might very well be included in the group, as well as about 100 feet of layers below them, making in all nearly 350. But these so-called transition beds occur in the section of § 774, with the great White Oak Group of red sandstones interpolated between them and division 3, of the section. Including, then, divisions 1, 2, and 3, in the Dyestone Group, the latter becomes, in White Oak Mountain, 900 feet thick—a great development of *Clinton (Medina,* in part?) rocks. (See also § 772.)

In addition to the fossils enumerated in § 753, and the section above, as pertaining to this group, *Atrypa hemispherica,* (Sowerby,) has been observed on the east side of Powell's Mountain, in abundance.

782. *The Outcrops of the Dyestone Group; the Dyestone Ridges.*—The Dyestone Group, (the rocks dipping more or less,) outcrops, in the western portion of the Valley—that next to the Table-land—in quite a number of long narrow belts, which, like the belts of the other formations, run in northeasterly and southwesterly courses. These outcrops, or belts, are generally found either on one or the other slope of long, narrow, characteristic ridges, which the hard layers of the group help to make, and which we designate as *Dyestone Ridges.* Sometimes, the ridge is wanting on a portion of a bed of outcrop, but such instances are exceptional.

783. In a few instances, the ridge is wholly made up of the rocks of the Dyestone Group, but generally, the heavy cherty layers of the *Siliceous Group* constitute the most important element in their structure. In fact, we have a *trio* of forma-

tions, ordinarily going together, and making up these ridges. These are, the *Dyestone Group,* the *Black Shale,* and the *Siliceous Group,* the latter occurring as a heavy bed of hard cherty layers. The first and last are the weathering-resisting formations, and the *Black Shale* between is protected, more or less, by one or the other, as the case may be. The hard rocks of the trio, taken together, form no very great volume, and make usually nothing more than a moderate ridge.

When a heavy sandstone formation is interpolated beneath the Dyestone Group, like the Clinch Sandstone, or the White Oak red group, then a Mountain results, and both Dyestone and Siliceous Formations are subordinate. Thus it is, for the most part, in the Powell's Mountain Group, and in White Oak.

784. Below, the Dyestone Ridges, or ranges, are enumerated. The iron-ore outcrops usually on the sides of these, but is sometimes found at the summits. It ought to be observed, also, that these ridges not only give us the outcropping ranges of the Dyestone Group, but also many of those of the *Black Shale,* and of the *Siliceous Group.*

We commence with the ridge which lies at the foot of the eastern slope of the Cumberland Table-land.

785. (1) *The Mountain Dyestone Ridge and Range.*—On page 251, in the table of *valley-ranges* in which Trenton and Nashville rocks outcrop, I have there mentioned the *Mountain Range.* This valley-range, as stated, skirts the base of the Table-land almost continuously from Virginia to Georgia. It is also stated, on page 49, that this range does not come in direct contact with the base of the Table-land, being generally separated therefrom by a low, sharp ridge, and by a very narrow, curious trough, often called "*Back Valley,*" the latter lying back of the sharp ridge. This sharp ridge is the Dyestone Ridge under consideration. It is formed by the outcropping of the trio of formations spoken of above, the *Dyestone, Black Shale* and *Siliceous,* as they rise to the surface from beneath the Carboniferous strata of the Table-land.

The west end of the diagram on page 208, illustrates how these formations outcrop on the surface. At B is the *Dyestone Ridge,* the Black Shale (erroneously numbered 5 instead of 7) and the Siliceous Group at this point being no part of it. The diagrams on pages 139 and 190 give sections of the formations occurring in the range, or along the line of this Dyestone Ridge, although the ridge being at these points small, is not represented. In that on page 139, its place is near the eastern base of the spur E. (See, also, § 779.) In the one on page 190 it is near the base of the eastern slope of Walden's Ridge.

786. The Mountain Dyestone Ridge comes into Tennessee from Virginia. From the vicinity of Cumberland Gap, where it is called *Poor Valley Ridge*, (the Back Valley being here, *"Poor Valley,")* it reaches southwestward, skirting the Table-land closely, with but few interruptions, to the Georgia line, a distance of nearly 160 miles. (See Map.) Its best defined portions have usually local names. One of these I have mentioned; another in Rhea County is *Shin-bone Ridge.*

In some parts of its line, as in the southern portion of Campbell County, and along the eastern base of Walden's Ridge, in Anderson, it is poorly developed, yet traceable, and the formations present. At a few points, the principal one being the vicinity of the Salt-works, in Anderson, the range, including both ridge and formations, is ingulfed in local faults, and thus interrupted. At other points, and especially in the vicinity of the Little Emery, in Roane County, it is duplicated by local folds or faults.

787. One or more beds of iron-ore outcrop in this ridge, or in the range when the former is not well developed, throughout its whole length. Generally there is but one important bed which varies in thickness from a few inches to two or three feet, swelling out occasionally, however, to six or eight feet. At some localities several different beds occur. In § 756 the bed of ore as found at Cumberland Gap, is mentioned.

788. (2) *Lookout Dyestone Ridges*.—Lookout Mountain, which starts up so boldly near Chattanooga, and runs southwestward, into Georgia and Alabama, (§ 189,) rests in a synclinal trough. Its position and geological relations are seen in the diagram on page 139 at L. The trio of formations, the Dyestone, Black Shale, and Siliceous, (VI, VII, and VIII of the diagram,) are seen to outcrop on both sides of the mountain, near its base, and their outcrops, though not thus represented in the figure, make skirting ridges. Lookout, nearly throughout, from Chattanooga to Gadsden, Alabama, is bordered on each side by a Dyestone ridge.

789. These ridges extend northward, some distance beyond the end of Lookout Mountain, and are intersected in passing from Chattanooga to Walden's Ridge. Traces of one or both of them, may be observed nearly as far up as the Rhea County line.

North of Chattanooga, in addition to the two Lookout ridges spoken of, are two or three short dyestone ridges, made by local folds. The lower end of one of these forms the high hill on the West side of Chattanooga, a fine section of which is seen in the bluff at the brewery.

Layers of ore are found in all of these ridges. The Lookout ridges in Georgia and Alabama are especially interesting as depositories of ore.

790. (3) *Half-moon Island Range*.—Lying in Roane, Rhea, and Meigs, and a little east of the mouth of White's Creek, is a local synclinal several miles in length, made up of the trio of formations, the Dyestone, Black Shale and Siliceous. (See Map.) The Siliceous Group occupies the axis, the other formations outcropping on each side. This synclinal supplies excellent and extensive beds of ore.

The ore outcrops in two lines, which, across the middle part of the

synclinal, are nearly a mile apart. The western line runs through *Half-moon Island*, in the Tennessee River, at one end of which is an ore quarry, which, for years, supplied Eagle Furnace, as well as other furnaces, and several forges. For a mile, running through this island, the ore will average four feet, and at a point or two, swells out to twenty feet in direct thickness. The ore is highly esteemed, and makes excellent soft iron.

Immediately west of this ore belt is a strip of Trenton and Nashville rocks, appertaining to the Washington Valley range. (p. 251.)

791. It may be mentioned here, that, at Post Oak Springs, in Roane County, a limited patch of the Dyestone Group, showing some iron-ore, occurs. This point is in an interesting little cove surrounded by ridges, which may be called *Brown's Cove.* It contains an isolated patch of Nashville, Dyestone, and Black shale rocks. On the west of it is a Knox Dolomite cherty ridge, and on the east, Knox Sandstone ranges.

792. *Big Valley, and White Oak Mountain Dyestone Range.*—This is an important, though broken range. The line of it runs from Virginia to Georgia. It lies immediately on the eastern side of the equally long *valley-range* to which I have given the name, on page 251, of Big Valley range. In the range under consideration, the Dyestone Group appears in a ridge or mountain, generally associated with the Black Shale and Siliceous Group.

To the east of this ridge or mountain, as the case may be, follows one of the great faults of East Tennessee. This sometimes cuts off the Siliceous Group, and with it, occasionally, the Black Shale, and even the Dyestone Group itself. (§ 510.)

793. Commencing at the Virginia line, the first portion of the range is in Wallin's Ridge, in Hancock and Claiborne counties. Its place in the diagram on page 208 is at C. It is also seen in the section in § 754, and at the point represented, it contains a bed of ore one foot thick. This portion is, perhaps, about ten miles long, being cut off by the fault before reaching a point opposite Tazewell.

794. The second portion begins with the re-appearance of the range near the mouth of Big Barren Creek, in the southern part of Claiborne, and extends through Union and Anderson, passing east of Clinton, into Roane. In this portion, the ore outcrops at numerous points, ranging from a few inches to three or four feet in thickness. It has also been worked extensively, especially that of Union and Claiborne counties, both in furnaces and forges. In this part, the ore-bed at some points, is multiplied and greatly increased in quantity, by local folds in the rocks, there being, sometimes, three or four parallel bands in the place of one.

795. East, or southeast, of Kingston, a few miles, and near the Tennessee River, a third portion of this range begins. Near the river, on both sides, it shows considerable ore. On the south side of' the river, back of Col. Welcker's, on the ridge, are outcrops several feet thick. From this region the range extends, with more or less interruption, in a southeasterly direction, towards White Oak Mountain.

796. The Dyestone Group, bearing with it considerable ore, is found on the eastern slope of White Oak Mountain, as far as the Georgia line, and I might add, much beyond. It is also found in the outlying ridge east of the mountain, to which reference has been made in § 773. In this outlier, as stated, is a bed of ore from one to three feet thick.

The section in § 774 embraces the Dyestone Group of White Oak Mountain.

797. (5) The Dyestone Formation in Wallin's Ridge has been noticed as a portion of the last described range. It remains to mention the other belts of this formation in the Powell's Mountain Group. (§ 96.)

798. The first in order, is that of Powell's Mountain and of Lone Mountain, the two being in the same line. They both have the Dyestone Formation on their eastern sides, the formation in each case containing beds of iron-ore. The place of the formation in Powell's Mountain, is at the eastern base of D, in the diagram, page 208. It is also (5) in the section in § 753.

799. The second, following, is the belt on the eastern side of Newman's Ridge, and seen at (10) in the section of paragraph of 753. There is some dyestone ore in this belt, but its presentation is not equal to what it is generally, in the more western ranges.

800. East of range (4)—the Big Valley and White Oak range—the Dyestone Formation, excepting the belts in the Powell's Mountain Group just mentioned, is rarely seen. Some traces of it appear to exist on the east side of Clinch Mountain, but they appertain, doubtless, to the feather edge of the formation; moreover, they are often absent, the Black Shale resting directly on the Clinch Sandstone.

In the southern part of the State, east of the range, not only the Dyestone Formation, but the Black Shale and the Siliceous Group, as well, are cut off by the great faults. (See diagram on page 190.)

801. There is, however, at least one interesting exception to this remark, and that occurs in front of Chilhowee Mountain. Along a good part of the western base of this mountain, is a great fault, by means of which the *Carboniferous Limestone* is brought in immediate contact with the lower part of the *Chilhowee* (*Potsdam*) *Sandstone,* or even the upper part of the *Ocoee Conglomerate,* involving a vertical displacement of the strata of more than 10,000 feet. In the diagram on page 190, the place of the fault is shown by the location of Montvale Springs, which are nearly upon it. A section at this place, from the fault westward, through the ridge *a,* is as follows:

— *Fault.*

(3) *Carboniferous Limestone.*

(*b*) *Mountain Limestone.* First a stratum of shaly limestone, containing many characteristic fossils.
Then, thin-bedded and soft sandstones. Followed by a space in which the rocks are not seen.
The above rocks form a narrow valley in which the Hotel and Springs are located.

(*a*) *Siliceous Group.* Thin-bedded, dark-gray sandstones, with some sandy shale, several hundred feet. Forms in the main, the ridge *a,* of the diagram.

(2) *Black Shale,* well characterized; 25 or 30 feet thick; underlaid with whitish and reddish clay, mixed with more or less sand, 8 or 10 feet thick.

(1) *Dyestone Group?* Reddish-brown, sandy shale, at least 100 feet, and followed below by the shales of the Trenton and Nashville Series.

802. This section is interesting not only on account of its relations to the fault, but as affording the most southeasterly presentations we have of several of the higher formations.

As to the Dyestone Group, it is not altogether certain that the reddish sandy shales belong to this group. I was informed, however, that dyestone iron-ore occurs at a few points along the range. The fact did not come under my own observation.

803. The Fossil Ore mentioned in § 657, may be placed in this enumeration, as it may prove to be a member of the Dyestone Formation. It is an important range. The ore from it has been used on a small scale, for making iron. The ore is abundant, and will doubtless be extensively worked some day.

804. The enumeration of the Dyestone ridges and ranges, was commenced with the *Mountain Range,* that skirting the eastern base of the Table-land, (§ 785,) and from this we proceeded eastward. But west of this, also, in both Elk Fork (§ 144) and Sequatchee (§ 140) Valleys, the Dyestone Group outcrops.

The diagram on page 142 illustrates the geological structure of the Valley of the Elk Fork. Formation 5 is the Dyestone Group, and the figure explains how it is brought to the surface. Its outcrop extends longitudinally through a good part of the valley, and presents an excellent bed of ore, having a nearly

uniform thickness of three feet. The dip of this ore-bed at some points, is much less than that indicated in the diagram, thus making the ore easily accessible over wide belts. In addition, by local folding the outcrop of ore in some parts of the valley is multiplied, several parallel bands appearing at the surface.

805. In Sequatchee Valley the Dyestone Group appears in place near the base of the mountain all around, excepting in certain parts on the west side, where this, with other formations, are cut off by a fault. The diagram on page 139 gives a section of the Valley between A and C, and illustrates how the formations, and among them the one under consideration, outcrop. The fault, however, does not appear in this figure. (Compare § 600 and note.) The Dyestone Group is not heavily presented in Sequatchee Valley. At the head of the Valley, above Pikeville, considerable dyestone ore is found, and it is presented in limited quantity at all points between this and the Alabama line, wherever the formation to which it belongs outcrops.

806. In the Elk Fork and Sequatchee Valleys are the last presentations of the Dyestone Group, as we have limited it.

On the west side of the Table-land, this, and all the Niagara divisions, are absent at the first re-appearance of the Black Shale. (§ 744.)

(5,*d*.) THE MENISCUS LIMESTONE.

807. The *Meniscus Limestone* is the uppermost of the formations grouped in this Report, under the name *Niagara.* As already stated, (§ 746,) it is eminently the formation of the *Western Valley,* or rather, it should be stated, of one large section of this valley. The topographical features and outlines of this area have been given in the First Part of the Report. (See pages 104-109.) In the Western Valley, the *Meniscus* Limestone presents two subdivisions, the upper one of which contains a *lens,* or *meniscus-shaped* fossil *Sponge,* to which Roemer, in a work that will be referred to hereafter, has given the name *Astræospongia meniscus,* and which also is figured on plate H, at the end of this volume. This fossil occurring abundantly, and being very characteristic, especially of the upper

member mentioned, I have given the name *Meniscus* to the formation. The bed is doubtless equivalent to rocks of the Niagara epoch in New York. It is desirable, however, when a formation is so far removed from the type, to have a local name for it.

808. In East Tennessee, the formation is represented by the the limestone, (Sneedville Limestone,) occurring in the Powell's Mountain Group, and lying next above the Dyestone shales. Several belts of this limestone are presented, two of which have already been noticed; one in the valley between Powell's Mountain and Newman's Ridge, and the other at the eastern base of the latter ridge. These are given in the section in § 753 to which the reader is referred.

In addition to these belts, there is a considerable presentation of the limestone at the south end of Newman's Ridge. Along the eastern base of Lone Mountain, in Claiborne and Union counties, a bed of limestone occurs, at least 100 feet thick, which, perhaps, is to be referred to this formation, although it is succeeded above by Dyestone layers, an arrangement, however, which may have been brought about by a local fault.

Outside of the region of the Powell's Mountain Group the formation is generally wanting in East Tennessee .

At one point about four miles southeast of the Saltworks in Anderson County, and in the line of the Big Valley Dyestone range, I have seen a local cherty bed, pretty well charged with corals, and in contact with the Black Shale. This I referred to the formation under consideration. It is the only bed of the kind I have met with.

809. We now pass westward, over a large section of the State in which no rocks of the Meniscus Limestone occur, and it is not until we reach the western slopes of the Central Basin (p. 97) that they are met with again. (See §§ 732, 733, also 744, 745.)

Here the formation is generally seen in place between the Black Shale and the Nashville rocks, but not in full force. Passing, however, still further to the west or southwest, it reappears from beneath overlying rocks in its maximum development, and outcrops over wide areas in the southern part of the Western Valley, in Perry, Decatur, Wayne and Hardin counties.

810. Upon entering the Central Basin from the east, the feather-edge of the Meniscus Limestone is met with on the northern side, in Macon County, and on the southern, in Lincoln, and in the southwestern part of Bedford. In the western part of Lincoln, and in Giles, the ridges usually present the formation on their slopes in a bed occupying a place between the Black Shale and the Nashville rocks, and from two or three to fifty, or occasionally more, feet in thickness. In the high hills which immediately encircle Pulaski, and which are capped with rocks of the Siliceous Group, neither the Meniscus Limestone nor the Black Shale are usually well presented. But a few miles east, on the Fayetteville road, are good exposures.

It is not proposed, however, to mention specially the outcrops of this formation and the areas it occupies. These, indeed, are best determined and appreciated by reference to the Map.

811. The formation consists of thick-bedded crystalline and fine-grained limestones, more or less argillaceous, and often weathering into shale. Most of the limestones are sparry and crinoidal. Many of them contain green points. The series is divided into two nearly equal members, the *Sponge-bearing Bed* above, and the *Variegated Bed* below, each about 100 feet in thickness. The lower bed is an alternation of gray, red, and mottled layers, the crinoidal portions sometimes making a fair marble. Much of the mass tends to crumble into shale. The limestones of the upper bed are light gray, and light-bluish gray, and, as in the lower bed, much of it weathers into shaly matter. On the hill sides layers of this limestone frequently outcrop in two or three successive ledges, separated by intervals of shale. Thin layers of chert often occur, interstratified with the limestone, or embedded in it.

812. It is the upper member of the Meniscus Formation, for the most part, that appears on the slopes of the Central Basin; the Variegated Bed presents itself mainly in the Western Valley and in its ramifications. (§ 253.)

813. On pages 106 and 107 I have spoken of the *glades* of the Western Valley. Both members of the formation help to make these glades. The *fossils,* however, come mostly from the upper, or *Sponge-bearing Bed.* The Variegated Bed is fos-

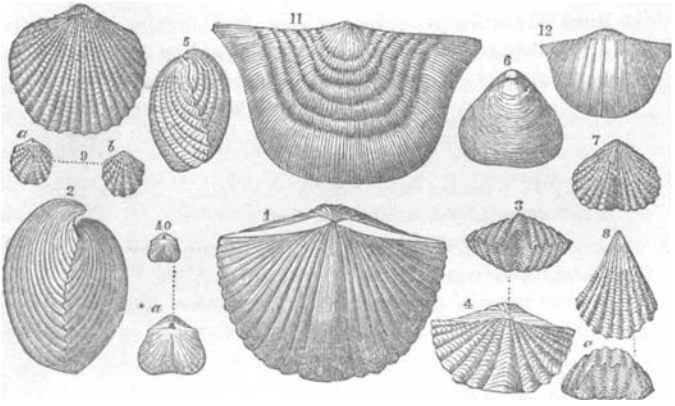
siliferous, many of its layers are crinoidal, as I have stated, and at many localities, it is very rich, especially in its lower part, in individuals of a number of species of *Orthocerata,* but it presents no such varied fossil fauna as does the bed above it.

814. Dr. Ferdinand Roemer has presented us with a Monograph on the *Silurean Fauna of Western Tennessee,** which we welcome with pleasure, as a handsome contribution to the paleontology of the State. It is really, so far as it goes, a monograph of the fauna (excepting one or two species) of the Sponge-bearing Bed mentioned above. There are, however, many species in the bed which are not given in the work, most of which are undescribed. The species of new corals, especially, are quite numerous. The crinoids collected by Troost on the glades of Perry and Decatur counties, are nearly all, in fact all, that I have seen, from this bed. It is to be regretted that the Doctor's work was not published long since. As it is, there is so much uncertainty connected with his names that they cannot, in most cases, be used with any satisfaction.

815. At the end of this section is appended a catalogue of fossils occurring in the Meniscus Limestone. It includes the described species, or, at least, such as I have had the means of identifying. The most of these occur in all the counties in which the formation outcrops, in Hardin, Wayne, Perry, Decatur, Benton, Henry, Hickman, Lewis, etc. Some of them are almost always present, and very characteristic. Among such are *Caryocrinus ornatus, Pentatrematites Reinwardtii* and a minute crinoid, which has never been properly made out and figured, that I am aware of, named by Troost *Haplocrinus hemisphericus.* I have rarely failed to find this in the outcrops of the formation in the counties mentioned. It is alone sufficient to fix the horizon of a layer. The sponges are also of common occurrence, especially the one from which the formations takes its name. This is quite as useful as the little crinoid. *Cya- thophyllum Shumardi, Petraia Waynensis,* species of *Eucalyptocrinus, Calceola Tennesseensis,* and *Lampterocrinus Tennesseensis,* are common and characteristic forms.

* Die Silurische Fauna Des Westlichen Tennessee; Eine Palæontologische Monographie von Dr. Ferdinand Roemer; Breslau, 1860.

816. Below is presented a group of figures* representing some of the fossils, which, in the State of New York, are found in the Niagara Formation, the equivalent of our Meniscus Bed. Most of these have not been, as yet, observed in Tennessee. *Strophomena rugosa* (Fig. 11) is quite a common species, and what is unusual, is found in several geological horizons outside of the one we are considering.



Figs. 1,2, *Spirifer Niagarensis.*
" 3, 4, " *sulcatus.*
Fig. 5, *Atrypa nodostriata.*
" 6, *Merista nitida.*
" 7, *Pentamerus interplicatus.*
Fig. 8, *Rhynchonella cuneata.*
" 9, *Leptocœlia disparilis.*
" 10, *Orthis biloba.*
" 11, *Strophomena rugosa.*
" 12, *Leptæna transversalis.*

817. I have, on a previous page, (see § 711,) given a section of the rocks seen in the bluff at and above Clifton, on the Tennessee River, in the northwestern part of Wayne County. The base of the Meniscus Limestone in this section, rests upon strata of the Nashville Formation. The junction is well seen, not only at Clifton, but for several miles below that place, along the eastern bank of the Tennessee River.

Below I give a general section of the formations in this part of Wayne County. The successive beds outcrop along a line commencing at the level of low water at Clifton, and terminating nearly four miles back, at the top and on the end of one of the spurs that jut out from the high lands further east. (§ 252.) This region is the most favorable for studying the entire Meniscus Formation that has come under my observa-

* Taken from Dana's Manual of Geology, page 241.

tion. The strata are presented in the section in their natural order, and are to be read from the bottom, upward.

(5) *Siliceous Group.* (Form. 8,*a*.)

Caps the ridge overlooking the valley of Eagle Creek; strata mostly concealed; loose, cherty masses scattered over the surface, and containing Carboniferous fossils..... 53 feet.

(4) *Black Shale Group.* (Form. 7.)

(*b*.) Proper *black shale,* mostly replaced by *bluish and greenish siliceous shale,* (weathered) Eight feet at the base, interstratified with thin, smooth, fine-grained sandstones, containing individuals of *Lingula subspatulata?* 42 feet.

(*a*.) *Fine-grained sandstone,* highly charged with the same *Lingula* as above, 8 feet.

Entire thickness of the group ..... 50 feet.

(3) *Lower Helderberg.* (Form. 6.)

Gray crinoidal limestone, fossils obscure at this point. This particular bed may belong below; it occupies, however, the horizon of well-marked Lower Helderberg rocks in the vicinity..... 25 feet.

(2) *Meniscus Limestone.* (Form. 5,*d*.)

(*b*.) *Sponge-bearing Bed;* gray, crinoidal, and argillaceous limestones, many of them glade-forming, highly fossiliferous, containing sparsely thin layers of chert. 90 feet.

(*a*.) *Variegated Bed;* gray, red, and mottled limestones, interstratified; many layers argillaceous; Orthoceratа abundant in its lower part. Clifton is located in part upon it. 96 feet.

Entire thickness of the formation, ... 186 feet.

(1) *Nashville Formation.* (Form. 4.)

See section in paragraph 711.

818. Sections similar to this, but rarely showing the base of Nashville rocks, may be found in the northern part of Hardin County, near the Tennessee River, and also on Hardin's, Indian, and Horse Creeks, and on some of their principal tributaries. There are many good exposures of the formation on these large creeks. At many of them the Helderberg rocks are absent, and the Black Shale Group rests directly on the Meniscus Limestone.

819. On the upper part of Birdsong Creek, in Benton, and also on Big Sandy, in the southeastern part of Henry, sections

including the Variegated Bed, can be obtained. Good presentations occur on Duck River, in Hickman, as well as on Cane and other creeks of the same county. The upper part of the valley of Buffalo River, in Lewis and Wayne, afford many good sections.

820. In the northern part of Sumner County, at the point where the Gallatin and Glasgow Turnpike ascends the ridge and leaves the Basin, the *Meniscus Limestone* is present in considerable volume, there being about 120 feet of it. The rocks are gray, and bluish-gray, crinoidal and argillaceous limestones. The middle portion and the lower part of the upper portion, abounds in individuals of *Pentamerus oblongus* associated with *Caryocrinus ornatus,* and other Niagara forms.

821. Below is a section of the formations as they are presented in the bluff at Montgomery's Mill, in Hickman County, on Piney River, near its mouth.

(4) *Gravel-bed* on top of the ridge.

(3) *Siliceous Group.*

(*b.*) A heavy bed of compact, gray, metal-ringing limestone; some of its upper and lower layers contain flinty burs, averaging size of filberts; rarely showing cherty bands. This mass is wholly made up of *finely* comminuted crinoidal remains. It is mostly concealed at the top of the ridge above the mill, but at Esquire Curl's, about a mile distant, (where it is 125 feet thick, is capped with alternating layers of shale and chert, and rests directly upon the Black Shale,) it is well exposed. 135 feet.

(*a.*) A group of heavy cherty layers with shales and limestone. 45 feet.

Thickness in all, ... 177 feet.

(2) *Black Shale Group.*

(*c.*) Layer of "kidneys" (§ 732) half a foot.

(*b.*) Black Shale, very fetid, 8 feet.

(*a.*) Fine-grained sandstone, 6 to 12 inches.

Entire thickness,..... 9 feet.

(1) *Meniscus Formation.*

(*c.*) Mostly compact, gray, sparry limestone, with a few feet of shaly limestone at top. Some bands are tinged with red, 30 feet.

(*b.*) Marly limestone, loaded with fossils and yielding them readily. Contains several species of *Eucalyptocrinus, Caryocrinus ornatus, Platyostoma Niagarensis, Rhynchonella Tennesseensis, Spirijer macropleurus,* etc., 4 feet.

(*a.*) Gray limestones, inclining to be marly; at base thin, gray, sparry layers, some few with red tinge; runs down to water. 44 feet.

Thickness of entire formation, ... 78 feet.

822. *Rocks of Special Use, Minerals, and Agricultural Features of the Meniscus Limestone.*—As already stated, some of the variegated crinoidal layers of this formation are a fair *marble,* and, indeed, they have been worked as such, at a number of points. Quarries have been opened on Big Sandy, in the southern part of Henry County, in a region where a local but wide dome or swell in the strata, brings the Variegated Bed to the surface. Localities of the same rock occur on Birdsong Creek, in Benton County. In the more southern counties, Perry, Decatur, Wayne and Hardin, where the Variegated Bed has its greatest presentation, numerous localities occur, and many of them immediately on the Tennessee River. This rock, though a fair marble, is not equal to the best of Hawkins County.

Building material of good quality, is found at many points in this formation, and frequently on the river, thus admitting of easy transportation.

823. After passing the solid rocks of the Western Valley, and getting upon the sands and clays of West Tennessee, it becomes an important object to find material for making *lime.* The Meniscus and Lower Helderberg limestones are the ones drawn upon for this purpose. Along the line of their last appearance, are many points where the rock is burnt into lime to be sold and carried westward.

824. *Galenite* (lead-ore) is found occasionally within the area of this formation in small veins, but I know of no locality worthy of special notice. A small vein is said to cross Cane Creek, in the southwestern part of Hickman County. It could not be seen at the time of my visit. Near Montgomery's Mill, the locality of the section just given, pieces of galenite have been picked up, but no vein found.

825. On the glades of the Meniscus Limestone are very generally found isolated cubes, and cubo-octahedrons of *pyrite* (iron-pyrites.) The specimens are often interesting. Compound forms, and symmetrical groups of crystals, from the size of a walnut to that of one's fist, are often met with.

826. The limestone of this formation, like the Trenton and Nashville limestones in the Basin, afford, occasionally, cavities containing *petroleum.* At Montgomery's Mill, on Piney River, and from rocks at the very base of the section given above, is a crevice, from which a black looking petroleum has been oozing ever since 1830. It was first observed in blasting out the foundation for the mill. Since that time it has frequently been gathered for medicinal purposes. The oil is, perhaps, deeply seated, and may come from Nashville rocks which are not far below. A boring has recently been made at this point, but with what success I am not informed.

827. The topographical, as well as, to some extent, the agricultural features of the Western Valley have been given in the First Part of the Report. (Pages 104-110.) As a whole, the area is rough, but it contains numerous rich and well cultivated minor valleys. The large creeks in Hardin County, present long strips of good land based on the limestones of this division. So, too, with the creeks in Wayne, Decatur, Perry and Hickman. The upper part of Buffalo, with its tributaries, of Cane Creek, and of Duck River, below Centerville, the lower parts of Piney River and Beaver Dam, portions of the creeks in Benton, with many others in the counties mentioned, have lands underlaid by the Meniscus limestones, which, together with the alluvial flats along the streams, present sites for multitudes of productive and very desirable farms.

828. Below, is the catalogue referred to in § 815. No species has been admitted but such as I know, or have good reason to think, belong to the Meniscus or Niagara horizon. With the exception of a very few, I have them all in my cabinet, having collected them myself. The catalogue includes *all* of Roemer's species with but two exceptions. One of these is *Orthis biloba,* which was overlooked. The other, *Strophomena euglypha,* Hall's *Strophodonta punctulifera,* was purposely omitted, as I have never seen it outside of the Lower Helder-

berg horizon. I might add that several of the *trilobites* are doubtful as to specific relations.

1. *Astylospongia præmorsa,* Goldfuss, (sp.,) Monograph, page 8
2. *Astylospongia stellatim-sulcata,* Roemer, " " 11
3. *Astylospongia inciso-lobata,* " " " 11
4. *Palæomanon cratera,* " " " 13
5. *Astylospongia imbricato-articulata* " " " 12
6. *Astræospongia meniscus,* " " " 14
7. *Stenopora fibrosa,* Goldfuss, (sp.,) (calamopora fibrosa) " " 20
8. *Thecostegites hemisphæricus* Roemer, " " 25
9. *Thecia Swinderenana,* Goldfuss, " " 26
10. *Heliolites interstincta,* Linn., (sp.,) " " 23
11. *Plasmopora follis,* Edwards and Haime, " " 24
12. *Halysites catenularia,* Linn., (sp.,) " " 25
13. *Favosites favosa,* Goldfuss, (sp.,) (calamopora favosa.) " " 18
14. *Favosites Gothlandica,* Goldfuss, (sp.,) Calamopora Gothlandica.) " " 18
15. *Favosites Forbesi,* Ed. and H., var. *discoidea,* (Calamopora Gothlandicavar. discoidea) " " 19
16. *Favosites Niagarensis,* Hall, (Calamopora Gothlandica var., etc.,) " " 19
17. *Favosites cristata,* Edwards and Haime, (Calamopora cristata) " " 20
18. *Cyathophyllum Shumardi,* Ed wards & Haime, " " 27
19. *Petraia Waynensis,* Safford. This Volume, pl. H., Fig. 2
20. *Petraia Fanningana,* " " " " " " 3
21. *Aulopora repens,* Walch and Knorr, Monograph, page 28
22. *Alveolites repens,* Hisinger, " " 22
23. *Cladopora reticulata,* Hall, Pal. N. Y. Vol. II, p. 141.
24. *Fenestella acuticosta,* Roemer, Monograph, page 30
25. *Caryocrinus ornatus,* Say " " 33
26. *Apiocystites Anna,* Safford,

    Much like Hall's *A. elegans,* (Pal. Vol. II, p. 243,) but the pectinated apertures are on the edges of the plates, and those of each pair close together. The markings on the body plates mostly fine sharp ridges.

27. *Pentatrematites Reinwardtii,* Troost, (sp.,) Monograph, p. 60

28. *Saccocrinus speciosus,* Hall, Monograph, page 42
29. *Platycrinus Tennesseensis,* Roemer, " " 35
30. *Lampterocrinus Tennesseensis,* Roemer, " " 37
31. *Cytocrinus lævis* "'," 46
32. *Eucalyptocrinus cælatus,* Hall ;
I doubt as to this being Hall's species " " 48
33. *Eucalyptocrinus ramifer,* Roemer, " " 51
34. *Coccocrinus bacca,* " " " 51
35. *Synbathocrinus Tennesseensis,* Roemer, " " 55
36. *Porteriocrinus pisiformis,* " " " 54
37. *Cystocrinus Tennesseensis,* " " " 56
38. *Haplocrinus hemisphericus,* Troost ;
(See § 815.)
39. *Calceola Tennesseensis,* Roemer,
(The same as *C. Americana,* Safford, Amer. Jour. Sci. II, Vol. XXIX, p. 248.) Monograph, page 73
40. *Strophomena rugosa,* Dalman, (sp.,)
(S. depressa,) " " 65
41. *Streptorhyncus subplanus,* Conrad,
(Strophomena pecten,) " " 67
42. *Orthis fissiplica,* Roemer, " " 64
43. *Orthis hybrida,* Sowerby, " " 63
44. *Orthis elegantula,* Dalman, " " 62
45. *Spirifer crispus,* Hisinger, Pal. N. Y., Vol. II, p. 262
46. *Spirifer macropleurus,* Conrad.
(S. Niagarensis var. oligoptycha,) Monograph, page 68
47. *Atrypa reticularis,* Linn., " " 69
48. *Atrypa marginalis,* Dalman, " " 69
49. *Pentamerus oblongus,* Murchison, (§ 820,) Silurian System.
50. *Pentamerus Littoni?* Hall.
Hall refers this to the *Lower Helderberg,* but if it be the species I think it is, its horizon is in the upper part of the *Meniscus* (*Niagara*) *Formation.* I have seen it at a number of localities; Pal. N. Y., Val. III, page 262.
51. *Pentamerus galeatus,* Dalm.
This is a Lower Helderberg species; but it also occurs in the topmost part of the *Meniscus*
Limestone, Monograph, page 73
52. *Athyris tumida,* Dalman, " " 70

53. *Rhynchonella Wilsoni,* Sowerby,	"	"	71
54. *Rhynchonella Tenneeseensis,* Roemer,	"	"	72
55. *Platyostoma Niagarensis,* Hall,	"	"	75
56. *Platyceras Niagarensis,* Hall, (Acroculia Niagarensis)	"	"	76
57. *Cyclonema Tennesseensis,* Roemer; (Turbo Tennesseensis)	"	"	77
58. *Orthoceras annulatum,* Sowerby,	"	"	78
59. *Ceraurus bimucronatus,* Murchison,	"	"	80
60. *Sphærexochus mirus,* Beyrich,	"	"	81
61. *Dalmania caudata,* Brongniart,	"	"	82
62. *Calymene Blumenbachii,* Brongniart,	"	"	79
63. *Bumastus Barriensis,* Murchison,	"	"	83

SECTION II.

LOWER HELDERBERG; FORMATION VI.

829. This formation does not appear to occur in East Tennessee. The portion of the State to which it appertains is the Western Valley, (§ 250,) and a narrow belt of country adjoining this on the east.

830. It is a series of light-blue limestones, often shaly, highly fossiliferous, frequently containing cherty layers, especially in its upper part, and having a maximum thickness, so far as yet observed, of 70 feet.

831. The formation has been met with in greatest volume, for the most part, in its most westerly exposures, as, for instance, in the vicinity of the White Sulphur Springs, in the southern part of Hardin County, and within a considerable area in Henry County, commencing at the mouth of Big Sandy, and extending up the valley of that stream five or six miles. In the southern part of Benton, as well as in Decatur, it is also seen well developed at a number of points.

832. The areas and points referred to, lie in a narrow strip of country, running across the State, and contiguous to the Tennessee River on its west side, in which the strata of all the older formations, from the *Nash-*

ville to the *Siliceous*, inclusive, are, as a single group, suddenly beveled off, and made to give place to the sand, clay, and gravel beds of West Tennessee, the latter overlapping and abutting against the former. (See §§ 272 and 326.)

In this belt any one of the older formations may come in contact with the later and unconsolidated beds of the west, a circumstance depending upon the comparative elevation of the formation, and its local topography.

833. In the strip mentioned, many clear exposures have been observed, presenting sections of the Helderberg Limestone from 50 to 70 feet thick, and in some cases without either the top or the bottom of the formation being seen. It will be safe to place its maximum thickness at 100 feet.

834. Passing eastward from the Tennessee River, the formation is found (by the study of the sections exposed in the deep valleys cut in the Highlands by the streams,) to grow thinner, and to become more or less fragmentary until it disappears, for the most part, before reaching the Central Basin. Doubtful traces exist in the sections on the west side of the Basin, (§ 744,) but they are rare and hardly note-worthy.

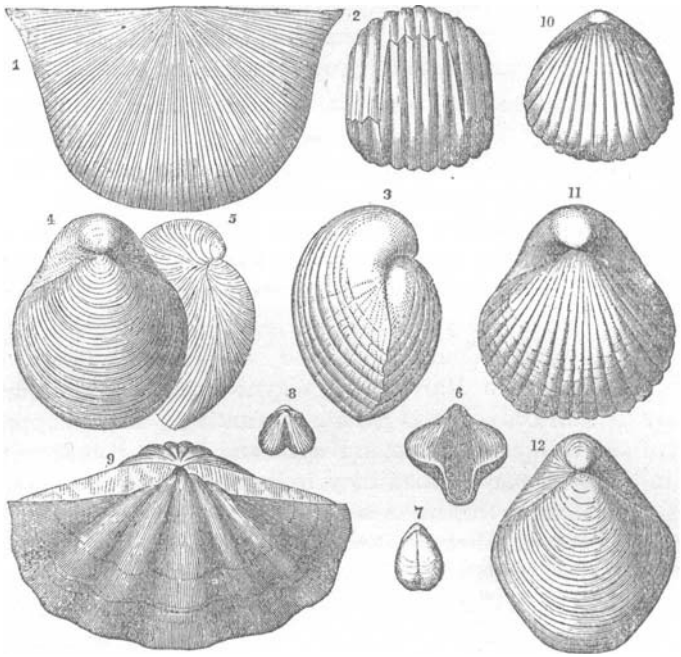
835. Along the valley of Duck River, the formation scarcely reaches Hickman County. In the valleys of Indian and Hardin's creeks, in Hardin and Wayne counties, it occurs locally in thin beds, but is generally wanting. In the upper part of the valley of Buffalo, in Wayne and Lewis, it is absent; but in the lower part of this valley, in Perry, and at a few points in Humphreys, the formation is well presented, and loaded with fossils. It is seen below the Black Shale at the foot of the hill at Linden. Three miles below Beardstown, on Buffalo, it measured 30 feet in a section showing both the Black Shale above and the Meniscus Bed below. Two miles above the mouth of Buffalo, by a local swell in the strata, it is brought up, and is exposed in a bluff, showing a thickness of 50 feet.

There is also a good presentation of Helderberg rocks in the Wells Creek Basin, in Stewart County. (§§ 364, 553.)

836. The formation at most points, is rich in fossils. A group of some of those commonly occurring is figured on the next page. All the species represented are found in the rocks of the formation in the State of New York,* and most of them in the same

* The formation is well developed in the *Helderberg* Mountains, south of Albany, in New York, and hence the name given to it.

horizon in Tennessee. Two, *Spirifer macropleurus and Pentamerus galeatus,* occur with us, both in the Helderberg and Meniscus formations. In the latter, *Pentamerus galeatus* is found at the top of the group, while *S. macropleurus* occurs sometimes at a lower level. (§ 821.) The individuals of both species are usually of a smaller size in the Meniscus Formation than in the Helderberg. *Merista? sulcata, Strophomena radiata,* and *Pentamerus pseudo-galeatus* have not, as yet, been identified as Tennessee forms.



1. *Strophomena radiata.*
2, 10. *Rhynchonella ventricosa.*
3,11. Pentamerusgaleatus.
4, 5. *Pentamerus pseudo-galeatus.*
6. *Eatonia singularis.*
7. *Merista? sulcata.*
8. *Orthis varica,*
9. *Spirifer macropleurus.*
12. Merista lævis.

837. Below is given a list of such species, from among those collected by the author from the Helderberg rocks of Tennessee, as have been identified with described forms. Before presenting this list, however, it will be well to call attention to some of the principal localities, and to their character.

838. There are two classes of these localities. The first includes a number occurring at points where no other rocks, below the Black Shale, but those belonging to the Helderberg Formation, are present. The second includes certain localities at which the junction of the Helderberg with the underlying Meniscus (Niagara) limestones is seen, and at which, too, it is frequently difficult to point out the plane of separation. The lithological character is much the same, and the two formations, in some regions, appear to run into each other. Certain beds occupying the horizon of junction, do contain, more or less, both Helderberg and Niagara species. I have designated the localities by capital letters, and it has always been made a point to mark every specimen collected with the letter of its locality.

Below are the localities, each with its letter, which present, below the Black Shale when occurring, Helderberg rocks alone:

839. (A) A locality in Henry county, on Big Sandy, about five miles above its mouth, at Williams' Mill. About fifty feet of bluish limestone are exposed; all shaly, excepting a few layers of gray limestone at top. On the surface above the limestone, are loose, angular, flinty masses, containing the fossils of the rock below, and derived from cherty layers not seen. The bluff is capped with a bed of orange-colored sand and gravel belonging to the later formations.

840. (B) A locality similar to the last, on a tributary of Birdsong Creek, in the southern part of Benton County.

841. (W) White Sulphur Springs, near the Tennessee river, in the southern part of Hardin County. The establishment is located upon the upper part of the Helderberg rocks, and from them the sulphur water of the springs issues. Masses of chert, containing the fossils of the formation, are found abundantly on the surface. About a mile from the Springs, on the opposite side of the river, is a bluff, two or more miles in length, at the base of which the Helderberg rocks are exposed. The following is a section at a point opposite the springs:

(4) Top of hill above the bluff capped with *sand and gravel,* in good part cemented into *ferruginous conglomerate.*

(3) *Siliceous Group* (Form. 8,*a.*)

(b) A leached mass, consisting of cherty layers, with chalky-looking shale between, 10 to 12 feet.

(a) Fine-grained, sky-blue, calcareo-siliceous rock, ("water-lime" ,) weathering into siliceous shale, 65 feet.

Entire thickness, ... 75 feet.

(2) *Black Shale Group.* (Form. 7.)

Nearly wanting at this point; represented by a fetid sandstone, with slaty seams..... .....3 feet.

(1) *Helderberg Limestone.* (Form. 6.)

Bluish limestone, abounding in cherty nodules and layers, and running down to the water's edge; all fossiliferous. The limestone has, at its top and base, thick-bedded layers ..... 63 feet.

842. (F) On Buffalo river, in Perry county.

843. At the following localities both Helderberg and Meniscus (Niagara) rocks are seen, or else there is presented a bed of limestone immediately below the Black Shale horizon, and above the Meniscus layers, having, in paleontological features, a more or less mixed character.

844. (C) A locality near Esq. A. B. Gant's, on Indian Creek, in Wayne County, fourteen miles from Waynesboro, and twenty-two from Savannah.* The fossils in column C of the list, are from this locality, and from limestones within 20 feet of the Black Shale rocks. The section at the particular point is as follows:

(4) *Black Shale Group,* represented by its lowest member—the sandstone.

(3) A layer of gray limestone, containing the fossils of column C, which are silicified..... 10 feet.

(2) *Space,* rocks not seen..... 8 feet.

(1) Argillaceous limestone at the foot of the hill, which may be referable to the Meniscus Formation..... 5 feet.

845. I introduce here a general section of the formations as they occur in the valley of Indian Creek, in the vicinity of Esq. Gant's, and of Cravens' Mills, a short distance below.

(4) *Siliceous Group.*

Caps the hills on both sides of the valley; not well seen at top, but its liberated cherty fossiliferous masses are plentifully scattered over the surface; occasionally a specimen of *Lithostrotion Canadense* is met with; lower part, a bed of heavy, cherty layers, interstratified with limestone and shale.

Thickness, from a few feet to..... 250.

(3) *Black Shale Group.*

(b) Fine, blue, calcareo-siliceous rock, weathering into shale, and alternating, especially in its lower part, with thin, fine-grained sandstones; abounds in the lingulæ of the group; maximum thickness about 60 feet.

* I take this opportunity of expressing my thanks to my friend and former pupil, A. B. Gant, Jr., now living in Texas, for valuable assistance rendered me in my investigations on Indian and Eagle creeks. Mr. Gant has discovered several most interesting localities of fossils in both Wayne and Hardin counties.

(a) Fine-grained, bituminous sandstone, contains lingulæ, and generally forms a ledge, more or less prominent, along the slopes, 8 to 12 feet.

Thickness entire ..... 70 feet.

(2) *Helderberg Limestone.*

Does not differ essentially, in lithological character, from the rocks below; eastward, runs out; same as 3, in last section; thickness variable; maximum about 35 feet.

(1) *Meniscus Limestone.*

From 4 to 6 feet at top; rock compact, forming a ledge, as at Craven's Mills.

Next below, sparry, crinoidal limestone; some of it thin-bedded; all more or less inclined to crumble and form gravelly places; contains *Astræospongia meniscus, Caryocrinus ornatus, &c.* Including the rock of the ledge, it is the Sponge-bearing member, with a maximum thickness of 65 feet.

Below this, again, are about 20 feet of the Variegated Bed, red and gray limestones alternating, which takes us to the bottom of the creek. These rocks are well seen at Craven's Mill.

Thickness entire, ... 85 feet.

846. Two and a half miles west of Esq. Gant's, is a bed (m) 25 feet thick, well filled with *Niagara* corals, and separated from the base of the Black Shale Group by 10 feet of gray limestone.

847. (S) A locality in Hardin county, at Col. Smith's, nine miles from Savannah, on the Waynesboro road. The fossils come from a bed about 20 feet thick.

848. (D) Bath Springs, in the southern part of Decatur county. These fossils are from a bed twenty feet thick, followed below by a hard limestone, three feet in thickness, forming a ledge. Below the ledge are eighteen feet of shaly limestone, containing *A. meniscus, &c.* This is underlaid by variegated limestones at the bottom of the hill.

849. In the table a column is appropriated on the right, to each of the localities mentioned. The arrangement will enable the reader to see the range of the species, and the better to appreciate how they are associated. The age of the rocks at the localities C, S, and D, respectively, is debatable. It may be found desirable, upon further investigation, to refer these beds to the Niagara horizon.

I take this opportunity of acknowledging the kindness of Prof. James Hall, in aiding me, personally, in the determination of many of the fossils in the following list. And I must add here, that his great work on the

Paleontology of New York, and indeed I might say, on the Paleontology of America, has been the foundation of the most that has been done towards the making out of the Paleozoic formations of Tennessee.

HELDERBERG FOSSILS OCCURRING IN TENNESSEE.

	NAMES OF SPECIES AND REMARKS.	A	B	W	F	C	S	D
1	Anisophyllum Agassizi, Edwards and Haime,	...	...	...	...	...	*	*
2	Favosites Gothlandica, Goldfuss,	*	...	*				
3	Favosites Niagarensis, Hall,	...	...	*	*			
4	Apiocystites Anna, Safford. This is given in the catalogue of Meniscus (Niagara) species, but ought to be included here, as it occurs in D, at Bath Springs	...	...	...	...	...	...	*
5	Leptæna concava, Hall	✲						
6	Strophomena rugosa, Hisinger,	*	*	*	*	*	*	*
7	Strophodonta punctulifera, Conrad,	✲	*	*				
8	Strophodonta Beckii, Hall,	...	...	*				
9	Strophodonta varistriata, Conrad; var. arrata, Hall,	*						
10	Orthis varica, Hall,	✲						
11	Orthis oblata, Hall,	✲	✲	*	*	*		
12	Orthis subcarinata, Hall,	✲						
13	Orthis eminens, Hall,	✲						
14	Orthis elegantula, Dalman,	...	...	...	...	✲	✲	✲
15	Orthis Halli, Safford; a fine species, with prominent striæ, much like those of *O. fissiplica*, Roemer, and a form recalling the Trenton *O. deflecta*, but having a narrower cardinal area; is also like *O. fasciata*, Hall,	✲						
16	Spirifer perlamellosus, Hall,	✲	*	...	*			
17	Spirifer cyclopterus, Hall,	✲	...	*	*			
18	Spirifer macropleuris, Conrad,	✲	*	...	*			
19	Spirifer Saffordi, Hall,	...	...	...	...	✲	...	*
20	Spirifer tenuistriata, cannot locate it,							
21	Trematospira simplex, Hall,	...	...	...	...	✲		
22	Nucleospira ventricosa, Hall,	...	...	...	...	✲		
23	Nucleospira concentrica, Hall,	...	...	...	...	...	✲	*
24	Rhynchospira globosa, Hall,	*	...	...	...	...	...	*
25	Rhynchospira formosa, Hall,	*	...	...	*	*	✲	✲
26	Leptocœlia, (undes.)	*	..	..	..	✲		
28	Rhynchonella Wilsoni, Sowerby,	*	*	...	...	...	*	*
27	Rhynchonella mutabilis, Hall,	*	...	*	*	*		
29	Rhynchonella Tennesseensis, Rœmer,	...	...	...	...	*	*	✲
30	Rhynchonella ventricosa, Hall,	✲						
31	Atrypa reticularis, Linn,	*	*	*	*	✲	✲	*
32	Merista lævis, Vanuxem,	✲	*	...	*			
33	Merista (Athyris) tumida, Dalman,	...	...	...	*	...	...	✲
34	Camarium Meeki, Hall, Decatur County,							
35	Eatonia singularis, Hall,	*	...	...	✲			
36	Pentamerus galeatus, Dalman,	*	*	...	...	...	✲	*
37	Pentamerus Verneuili, Hall,	✲	...	...	*	...	✲	*
38	Platyostoma ventricosa, Conrad,	...	...	...	*			
39	Platyceras tenuiliratum, Hall,	*	...	...	...	...	...	*
40	Phacops Hudsonicus, Hall,	*						
41	Dolmania micrurus, Green,	*	..	*				
42	Dalmania nasutus, Conrad	✲						

850. There is nothing special to add with reference to the agricultural features of the formation. In connection with the Meniscus Limestone, it presents some desirable farming areas. It might have been included with the Meniscus Formation, when speaking, in a previous paragraph, of the agricultural features of the latter.

So far as I know, it does not contain any minerals of importance.