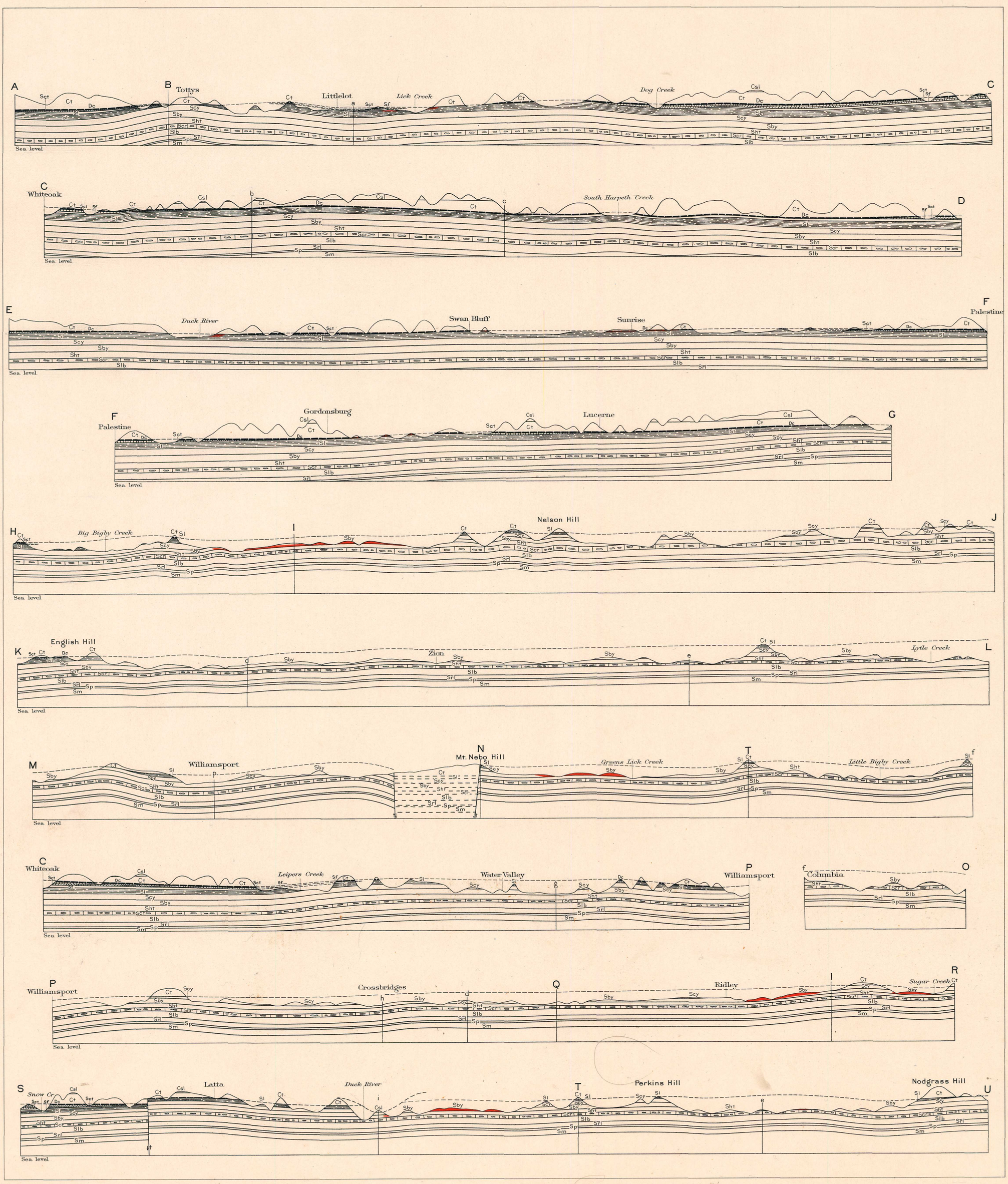
U.S. GEOLOGICAL SURVEY
CHARLES D. WALCOTT, DIRECTOR

# STRUCTURE SECTIONS

TENNESSEE
COLUMBIA QUADRANGLE




## LEGEND

*Mississippian series* — CARBONIFEROUS

- Csl — St. Louis limestone
- *UNCONFORMITY*
- Ct — Tullahoma formation

*UNCONFORMITY*

DEVONIAN

- Dc — Chattanooga shale

*UNCONFORMITY*

SILURIAN

- Sct — Clifton limestone
- *UNCONFORMITY*
- Sf — Fernvale formation
- *UNCONFORMITY*
- Sl — Leipers formation
- Scy — Catheys formation
- Sby — Bigby limestone
- Sht — Hermitage formation
- Scr — Carters limestone
- Slb — Lebanon limestone
- Srl — Ridley limestone
- Sp — Pierce limestone
- Sm — Murfreesboro limestone

*Ordovician series*

*Phosphate deposits*

*The Ordovician phosphates occur on gentle anticlines which favor the formation of residual phosphate deposits by leaching; the Devonian phosphates are restricted to the areas where the Devonian sediments rest directly on the phosphatic Ordovician limestones.*

Sections

*Section lines shown on the Sumvale and Clifton embayment map.*

*Horizontal scale: 1 inch = 1 mile.*
*Vertical scale: 1 inch = 1000 feet.*

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Geology by C. Willard Hayes and E. O. Ulrich.
Surveyed in 1899-1900.

# COLUMNAR SECTIONS

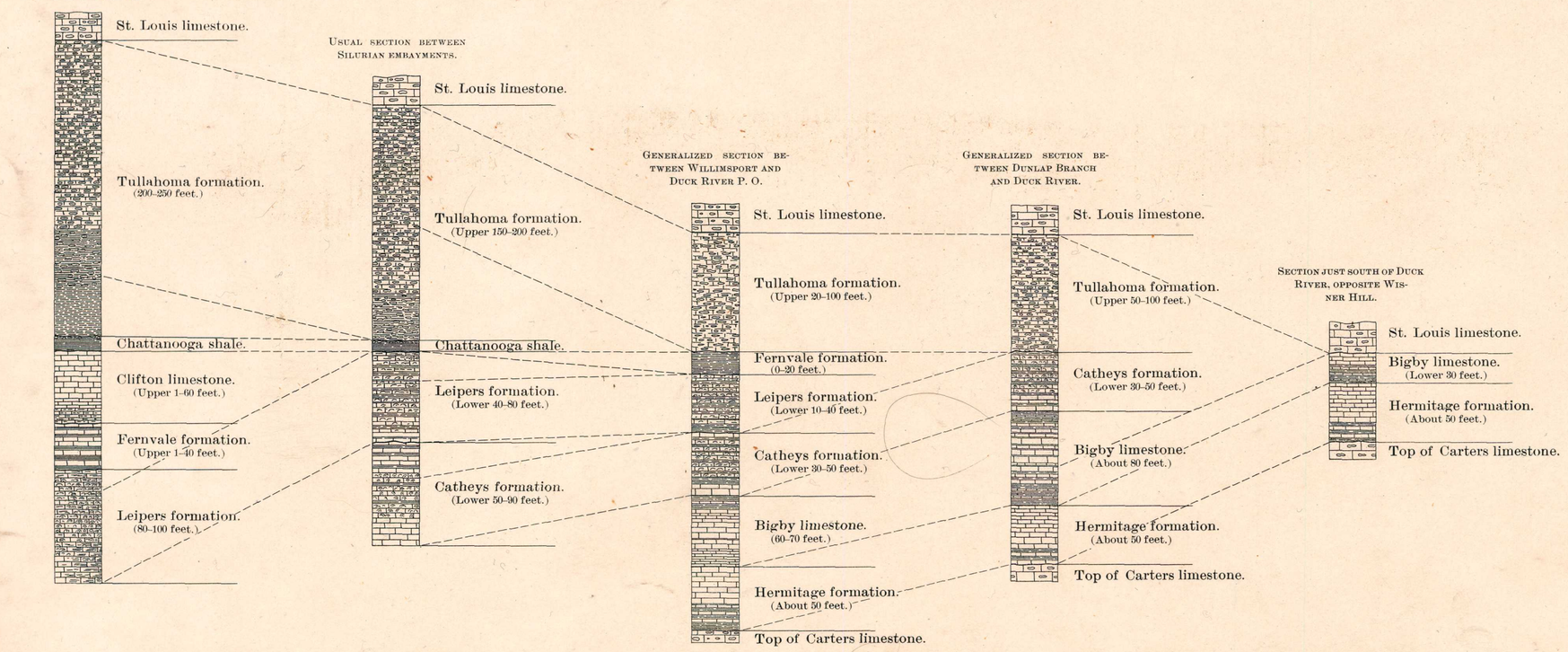
## GENERALIZED SECTION OF THE ROCKS OF THE COLUMBIA QUADRANGLE.

SCALE: 1 INCH=100 FEET.

| Period. | Formation Name. | Symbol. | Columnar Section. | Thickness in Feet. | Character of Rocks. | Character of Topography and Soil. |
|---|---|---|---|---|---|---|
| CARBONIFEROUS (MISSISSIPPIAN) | St. Louis limestone. | Csl | | 250 | Gray and blue, thick-bedded, fossiliferous limestone, generally very cherty; chert in large pieces and solid except in the basal part, where it is cellular. | Rolling or hilly land, with cliffs along streams. Residual chert of this formation covers nearly all of the northeast quarter of the quadrangle and caps the higher ridges in the northwest and southwest quarters.<br>Soil good where slopes are not too steep. |
| | UNCONFORMITY | | | | | |
| | Tullahoma formation. | Ct | | 0–250 | Greenish clay shale at the bottom, followed by extremely cherty shale and cherty limestone above; chert clayey and in small pieces. | Hilly lands and very steep slopes.<br>Soil generally very poor. |
| | UNCONFORMITY | | | | | |
| DEV. | Chattanooga shale. | Dc | | 0–10 | Black carbonaceous shale, generally with a phosphatic band at the base and a glauconitic green shale, containing phosphatic nodules, at the top. | Rarely seen except in cliffs or on steep slopes. |
| | UNCONFORMITY | | | | | |
| SILURIAN — UPPER SILURIAN | Clifton limestone. | Sct | | 0–60 | Even bedded, dense, light-gray or bluish limestone, often thin-bedded and occasionally shaly in the lower part. | Cliffs and steep slopes.<br>Very little soil. |
| | UNCONFORMITY | | | | | |
| SILURIAN — ORDOVICIAN | Fernvale formation. | Sf | | 0–40 | Soft, green and chocolate shales, and red, ferruginous, crystalline limestone, often containing greenish specks, and occasionally conglomeratic and phosphatic. | Little effect on topography and soil. |
| | UNCONFORMITY | | | | | |
| | Leipers formation. | Sl | | 0–100 | In eastern half of quadrangle, knotty, earthy limestone at the top, with similar but more shaly and highly fossiliferous beds below.<br>In western half, nearly uniform granular crystalline limestone, the more granular portions highly phosphatic. | Generally hilly, with steep slopes.<br>Soil very good but inclined to wash. |
| | UNCONFORMITY | | | | | |
| | Catheys formation. | Scy | | 0–100 | Shales and knotty limestones, usually underlain by heavy-bedded suberystalline limestone and overlain by fine-grained, blue, and earthy limestones separated by thin seams of shale; all more or less highly fossiliferous. Basal part occasionally includes some granular phosphatic layers. | Rather hilly lands and generally steep slopes.<br>Excellent soil in the larger tracts. |
| | Bigby limestone. | Sby | | 30–100 | Generally nearly uniform granular, crystalline, laminated, phosphatic limestone; the upper part often shaly or arenaceous, the lower part frequently having beds of shales but never sandy. | Gently undulating surface.<br>Soil durable and highly productive; "blue grass" lands. |
| | Hermitage formation. | Sht | | 40–70 | Even-bedded, alternating thin layers of argillaceous or siliceous limestone and shale in lower third, and siliceous subgranular limestone more or less strongly phosphatic in the middle and upper parts. | Lower part of formation rather steep slopes and poor soil; upper part, nearly level lands and very good soil. |
| | UNCONFORMITY | | | | | |
| | Carters limestone. | Scr | | 40–60 | Heavy-bedded, fine-grained, white or light-blue limestone, often containing chert and silicified fossils. | Generally cliffs along streams.<br>Soil good where slopes are not too steep. |
| | Lebanon limestone. | Slb | | 70–100 | Thin-bedded, often shaly, fine-grained, bluish or dove-colored limestone, frequently weathering yellow. | Along larger streams, steep slopes and bluffs, but elsewhere nearly level lands.<br>Soil rather shallow; good where not too rocky. |

## SECTIONS SHOWING LOCAL VARIATIONS IN THE SEQUENCE OF THE STRATA.

SCALE: 1 INCH=100 FEET.





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# THE CORRELATION TABLE.

The first column at the left shows the major geologic time divisions, and on the right, the principal and generally accepted geologic subdivisions of the Paleozoic rocks of the region between the Appalachian Mountains and the Mississippi River. The units of the column are believed to represent consecutive periods of time and are distinguished by more or less well-marked breaks in the continuity of the faunal and physical history of the continent.

The second column contains the formations that are distinguished in the Columbia quadrangle and shows their respective positions in the geologic scale. Stratigraphic unconformities, determined chiefly by paleontologic evidence, are indicated by wavy divisional lines. When the wavy line extends only half across the column it indicates that the unconformity is not general throughout the quadrangle. The first unconformity or stratigraphic hiatus occurs between the Carters limestone and the Hermitage formation, the top of the former having been reduced by erosion during the deposition elsewhere of the Black River rocks and the basal portion of the overlapping Hermitage formation. The unconformity between the Bigby and Catheys formations is a local occurrence. The third, fourth, fifth and sixth unconformities, however, seem to be general for the quadrangle. In each case one or more formations known in more complete sections have no stratigraphic representation here. In the third case the Utica and Frankfort shales are absent, in the fourth case the lower three-fourths of the Richmond group seems not to have been deposited, and in the fifth case the Clinton is wanting, while the sixth unconformity represents the long time during which in other areas the formations intervening between the Niagara and the Portage were deposited. Further, the Chattanooga formation, despite its very limited volume here, seems to represent the whole of, and perhaps more than, the upper Devonian deposits of Pennsylvania and New York. Locally a seventh and an eighth unconformity, due like the preceding ones to erosion and non-deposition, occur respectively between the Chattanooga and Tullahoma formations and between the latter and the St. Louis limestone.

In the third column, which is devoted to Safford and Killebrew's section of the rocks of middle Tennessee, the formations and parts of formations wanting in the Columbia quadrangle, but occurring in other parts of the State, are inserted in their proper positions. The Maury green shale they place at the base of the Carboniferous instead of at the top of the Devonian Chattanooga shale, the latter being the position assigned to the bed in this folio. Their Carters limestone embraces higher beds, and the Clifton limestone both lower and higher members that are wanting in this quadrangle. The earlier sections by Safford, given in the fourth and fifth columns, are not so exactly correlated, the principal reason for their insertion here being the wish to show the changes in nomenclature and classification that the formations in middle Tennessee have undergone since 1851.

In the section taken from the Richmond and London (Ky.) folios the Clifton limestone of the Columbia quadrangle represents only a part (probably the middle) of the Panola formation, while the Richmond formation in the Kentucky section does not include the Fernvale formation, but, on the contrary, is made up of lower Richmond deposits wanting in the Columbia quadrangle. The statements that Cayuga, Helderberg, Oriskany, Hamilton, upper Richmond, lower Frankfort, and Utica deposits are absent in this section are inserted by the authors.

In the last column, representing the section in Ohio, the St. Louis limestone is wanting, while the Maxville limestone is correlated with the middle part of the Chester. Further noteworthy features shown in this column are the absence of Oriskany, Helderberg, and upper Trenton deposits in Ohio, the early Trenton age of the Point Pleasant beds, and the lower position of the "Trenton oil horizon" than is generally supposed.

| | Generalized time scale for central North America. | Mapable lithologic equivalents in the Columbia quadrangle. | Safford and Killebrew: Elements of the Geology of Tennessee, 1900. Middle Tennessee. | Safford: Geology of Tennessee, 1869. Middle Tennessee. | Safford: American Journal of Science, second series, vol. xii, 1851. Geological reconnaissance, 1856. | Marius R. Campbell: Richmond and London (Ky.) Folios, U. S. Geological Survey, 1898. | Geological Survey of Ohio, 1873–93. |
|---|---|---|---|---|---|---|---|
| Carboniferous (Mississippian) | Chester. | (*Not present.*) | Mountain limestone. | Mountain limestone. | Pentremital or Mountain limestone. | Pennington shale. | (*Wanting.*) |
| | | | | | | | Maxville limestone. |
| | St. Louis. | St. Louis limestone. | St. Louis limestone. | Lithostrotion bed or St. Louis limestone. } Siliceous group. | Cherty limestone. } Siliceous group. | Newman limestone. | (*Wanting.*) |
| | Keokuk. | Tullahoma formation. | Tullahoma formation. | Lower or Protean member. } Siliceous group. | Siliceous beds. } Siliceous group. | Waverly formation. | Waverly formation. |
| | Burlington. | | | | | | |
| | Kinderhook. | | | | | | |
| Devonian | Chemung. | Chattanooga formation. | Maury green shale. | Black shale. | Black slate. | Chattanooga shale. | Black or Ohio shale (1893). (Including Cleveland shale, Erie shale, and Huron shale.) |
| | Portage. (Including Genesee.) | | Black shale (Chattanooga shale), Swan Creek phosphate, and Hardin sandstone. | | | | |
| | Hamilton. | (*If present, are represented in the phosphatic beds at the base of the Chattanooga formation.*) | | | | Panola formation. (*Cayuga, Helderberg, Oriskany, and Hamilton not represented by sediments in this area.*) | Olentangy shale and Delaware limestone. (Hamilton.) |
| | Onondaga. (Corniferous.) | | | | | | Columbus limestone. (Corniferous.) |
| | Oriskany. | | Camden chert (Oriskany). | Lower Helderberg. | Harpeth and Tennessee River group. (Gray limestone; Dyestone.) | | (*Wanting.*) |
| Upper Silurian | Helderberg. | (*Wanting.*) | Linden limestone. (Lower Helderberg.) | | | | Waterlime. (Lower Helderberg, 1893.) |
| | Cayuga. | | Clifton limestone. (Niagara.) | Meniscus limestone. (Niagara group.) | | | Niagara. |
| | Niagara. (Including Guelph.) | Clifton limestone. | | | | | |
| | Clinton. | (*Wanting.*) | | | | | Clinton. |
| Silurian / Ordovician | Richmond. | Fernvale formation. (*Wanting.*) | Hudson (College Hill; Cincinnati). Includes Hudson phosphate. | Upper Nashville. } Nashville. | Upper Nashville. } Nashville group. | (*Wanting.*) Richmond formation. | Lebanon beds. } Hudson River series. |
| | Lorraine. | Leipers formation. | | | | Winchester limestone, including Garrard sandstone lentil. (*Lower Frankfort and Utica wanting in this area.*) | Hill Quarry beds. } Hudson River series. |
| | Frankfort. | (*Wanting.*) | | Middle Nashville. } Nashville. | Lower Nashville. } Nashville group. | | Eden shale. } Hudson River series. |
| | Utica. | | | | | | Utica shale. } Hudson River series. |
| | Trenton. | Catheys limestone. | (*f*) (*g*) Cyrtodonta and Stromatopora beds. (*d*) (*e*) Dove and Ward limestones. (*c*) Capital limestone or Mount Pleasant phosphate. } Nashville (Trenton). | Lower Nashville. (Orthis bed.) } Nashville. | Siliceous or sandy limestone. } Nashville group. | Flanagan chert. | (*Wanting.*) |
| | | Bigby limestone. | | | | | |
| | | Hermitage formation. | (*b*) Orthis bed. | | | Lexington limestone. | River Quarry and Point Pleasant beds. } Trenton ? |
| | Black River. | (*Wanting.*) | (*Not classified.*) | Carters Creek limestone. } Trenton or Lebanon. | Upper Lebanon limestone. } Stones River group. | | "Hard cap of Trenton." |
| | Stones River. | Carters limestone. | (*a*) Carters limestone. | | | High Bridge limestone. | "Trenton oil horizon." |
| | | Lebanon limestone. | Lebanon limestone. | Glade limestone. | Lower Lebanon limestone. | | Trenton, Birdseye, and Chazy. |
| | | (*Not exposed.*) | Ridley limestone. } Stones River (Chazy). | Ridley limestone. | Stones River beds | (*Not exposed.*) | |
| | | | Pierce limestone. | Pierce limestone. | | | |
| | | | Murfreesboro limestone. | Central limestone. | | | |

Central limestone and shale group. — Cincinnati group.

NOTE.—Italics in the last two columns are insertions by the authors

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## GENERALIZED FAUNAL CHART.

Only a few of the more striking species of some of the formations exposed within the Columbia quadrangle are figured on the Illustration sheet. There are many other fossils equally characteristic of the formations, and these are listed in the generalized faunal chart opposite, which aims to show their first occurrence and their vertical range by the letters a (signifiying abundant), c (common), or r (rare), in spaces each representing approximately 20 feet of the stratigraphic column. As the chart is intended to serve for the whole of the Central Basin of Tennessee, it includes the species occurring in the Ridley, Pierce, and Murfreesboro limestones, which do not outcrop within this quadrangle.

# GENERALIZED FAUNAL CHART
## FOR THE WESTERN SIDE OF THE MIDDLE TENNESSEE BASIN

Names of species arranged in groups under tne formation in which they first appear.

Vertical range of species indicated by horizontal spaces, each representing approximately 20 feet of thickness.

a=abundant; c=common; r=rare.

| Names of species arranged in groups under tne formation in which they first appear. | St. Louis limestone. | Tullahoma formation. | Chatta-nooga. | Clifton limestone. | Fern-vale. | Leipers formation. | Catheys formation. |
|---|---|---|---|---|---|---|---|
| ST. LOUIS FORMATION — Lithostrotion proliferum | c c | | | | | | |
| L. canadense | c c | | | | | | |
| Melonites sp. | c c | | | | | | |
| Cystodictya st. ludovici | c c | | | | | | |
| Worthenopora spinosa | c | | | | | | |
| Hemitrypa proutana | c | | | | | | |
| Fenestella tenax | c | | | | | | |
| Spirifer leidyi | c c c | | | | | | |
| S. tenuicostatus | c c | | | | | | |
| Productus punctatus | r r r | | | | | | |
| TULLAHOMA FORMATION. — Productella concentrica | | r | | | | | |
| P. (very small species) | | c | | | | | |
| Camarotœchia sageriana | | r | | | | | |
| Lingula subspatulata ? | | c | | | | | |
| Pleurotomaria hickmanensis | | r | | | | | |
| Ctenobolbina loculata and other small Ostracoda | | c | | | | | |
| Columns and plates of many crinoids | | c c c r | | | | | |
| CHATTANOOGA — Lingula spatulata ? | | | a | | | | |
| Dinichthys and other fish remains | | | c | | | | |
| Conodonts | | | a | | | | |
| Athyris incrassata | | | | | | | |
| CLIFTON LIMESTONE — Duncanella borealis ? | | | | c | | | |
| Heliolites interstinctus | | | | c r | | | |
| Thecia minor | | | | c r | | | |
| Halysites catenulatus | | | | c r | | | |
| Favosites favosus | | | | c r | | | |
| F. niagarensis | | | | c r | | | |
| Holocystites sp. undet. | | | | r | | | |
| Haplocrinus hemisphæricus | | | | c | | | |
| FERNVALE FORMATION — Bythotrypa epidermata | | | | | c | | |
| Anolotichia ponderosa | | | | | c | | |
| Monotrypella quadrata | | | | | c | | |
| Crepipora hemisphærica | | | | | c | | |
| Pachydictya grandis | | | | | c | | |
| Ptilotrypa obliquata | | | | | c | | |
| Goniotrypa bilateralis | | | | | c | | |
| Leptæna unicostata | | | | | c | | |
| Strophomena planodorsata | | | | | c | | |
| Dalmanella tersa | | | | | c | | |
| Dinorthis subquadrata | | | | | c | | |
| Hebertella insculpta | | | | | r | | |
| Rhynchotrema capax | | | | | r | | |
| Parastrophia divergens | | | | | r | | |
| LEIPERS FORMATION — Dystactospongia insolens | | | | | | c | |
| Labechia scabra | | | | | | c | |
| Glyptocrinus decadactylus | | | | | | r | |
| G. subglobosus | | | | | | r | |
| Lepidodiscus cincinnatiensis | | | | | | r | |
| Crepipora simulans | | | | | | a | c |
| Monticulipora mammulata | | | | | | r | |
| M. molesta | | | | | | c | |
| Atactoporella mundula | | | | | | c | |
| Peronopora compressa | | | | | | a | |
| Homotrypella nodosa | | | | | | a | |
| Bythopora minuta ? | | | | | | | c |
| B. graciliis | | | | | | c c | |
| Heterotrypa frondosa | | | | | | a | |
| H. solitaria | | | | | | a | |
| Dekayella grandis | | | | | | a | |
| Callopora dalei | | | | | | a r | c |
| Constellaria florida | | | | | | a | c |
| Amplexopora columbiana | | | | | | c a | |
| Escharopora pavonia | | | | | | c | |
| E. falciformis | | | | | | r | |
| Phylloporina clathrata | | | | | | r r | |
| Crania scabiosa | | | | | | c | |
| Platystrophia laticosta | | | | | | c | a |
| P. lynx | | | | | | a | |
| Hebertella sinuata | | | | | | c a | r |
| Rafinesquina alternata ponderosa | | | | | | c c | |
| Strophomena sinuata | | | | | | r | |
| S. planoconvexa | | | | | | c | |
| Bucania n. sp. | | | | | | | r |
| Cyclonema mediale | | | | | | c | |
| Byssonychia radiata | | | | | | | |
| Pterinea cincinnatiensis | | | | | | c | |
| Modiolopsis modiolaris | | | | | | r | |
| Modiolodon truncatus | | | | | | r r | |
| Calymene senaria | | | | | | r | |
| Ceraurus milleranus | | | | | | r | |
| Lichas halli | | | | | | c | |
| CATHEYS FORMATION — Pattersonia aurita | | | | | | | r a |
| Columnaria alveolata | | | | | | c c r a | |
| Stromatocerium pustulosum | | | | | | rc c c a r | |
| Tetradium fibratum | | | | | | rc c a r | |
| T. apertum | | | | | | c c | |
| Heterotrypa parvulipora | | | | | | a | c |
| H. sp. undescr., nodose | | | | | | a | c |
| Escharopora, tuberculated species near pavonia | | | | | | a | c |
| Hebertella sinuata, var. | | | | | | ?r a a c | r |
| Platystrophia lynx, small var. | | | | | | | a |
| P. laticosta, var. | | | | | | c | |
| P. n. sp. with bifurcating plications | | | | | | r | |
| Orthorhynchula linneyi | | | | | | c c a | c |
| Oxydiscus cristatus | | | | | | | c |
| Bucania lindsleyi | | | | | | r c | |
| B. frankfortensis | | | | | | r c | |
| Cyclonema varicosum | | | | | | c a | |
| Leperditia linneyi | | | | | | c c | |
| L. n. sp. with ventral spine | | | | | | c c | |
| Isochilina saffordi | | | | | | c c | |
| I. ampla | | | | | | c c | |

| Names of species arranged in groups under the formation in which they first appear. | Leipers formation. | Catheys formation. | Bigby limestone. | Hermit-age. | Carters limestone. | Lebanon limestone. | Ridley limestone. | Pierce. | Murfreesboro limestone. |
|---|---|---|---|---|---|---|---|---|---|
| BIGBY LIMESTONE — Solenopora compacta | | a | c | | r | r | | | |
| Constellaria teres | | c r | a | | | | | | |
| C. florida emaciata | | c c | a | | | | | | |
| C. grandis | | | c | | | | | | |
| Eridotrypa briareus | | c r c | c r | | | | | | |
| Escharopora ponderosa | | | r | | | | | | |
| Lingulops norwoodi | | | c | | | | | | |
| Dalmanella testudinaria, var. | | | c | | | | | | |
| Hebertella borealis | | | c | | | | | | |
| Rafinesquina alternata | c c c r r | | r a c r | | | | | | |
| Rhynchotrema inæquivalve | | | a | | | | | | |
| Ctenodonta subrotunda | | | a | | | | | | |
| Clidophorus fabula | c c c c c | | c a | | | | | | |
| Ctenodonta obliqua | c c c c c | | c a | | | | | | |
| Byssonchia intermedia | | r | r | | | | | | |
| Archinacella patelliformis | | | c | | | | | | |
| Cyrtolites retrorsus | | | c | | | | | | |
| Bellerophon clausus | | | a | | | | | | |
| Lophospira oweni | | | a | | | | | | |
| Hormotoma gracilis | | | c | | | | | | |
| Cyclora minuta | c c c c c | r r r r r | r c a | | | | | | |
| C. parvula | r r r r r | | r a | | | | | | |
| Microceras inornatum | c c c c c | | a | | | | | | |
| Ormoceras capitolinum | | | c | | | | | | |
| Cyrtoceras macrostomum | | ?c | c | | | | | | |
| C. constrictum | | c | ?c | | | | | | |
| C. n. sp. | | | c | | | | | | |
| HERMITAGE — Prasopora patera | | | | a | | | | | |
| P. simulatrix | | | | c | | | | | |
| Leptobolus lepis | | | | c | | | | | |
| Dalmanella testudinaria, var. | | | | c c c | | | | | |
| Ctenodonta, small, circular species | | | | a | | | | | |
| Whiteavesia cincinnatiensis | | | | r | | | | | |
| Lophospira abnormis | | | | c | | | | | |
| CARTERS — Dystactospongia minor | | | | | a r c | | | | |
| Tetradium columnare | | | | | a c | | | | |
| Columnaria halli | | | | | a a | | c | | |
| Rhinidictya nicholsoni | | | | a | | | | | |
| Phyllodictya frondosa | | | | a | | | | | |
| Stromatocerium rugosum | | | | r a c | | | | | |
| LEBANON LIMESTONE — Bythotrephis cæspitosa | | | | | | c c r c | | | |
| Tetradium cellulosum | | | | c | | a r | | | |
| Streptelasma profundum | | | | r c r | | r r | | | |
| Ciliocrinus n. sp. | | | | | | r c | | | |
| Amygdalocystites n. sp. | | | | | | r r | | | |
| Rhinidictya trentonensis | | | | | | c c | | | |
| Escharopora ramosa | | | | | | c | | | |
| E. libana | | | | | | c | | | |
| E. briareus | | | | | | c | | | |
| Helopora spiniformis | | | | | | c | | | |
| Batostoma libana (Saff.) | | | | | | a c | | | ?c |
| 10 undescribed Bryozoa | | | | | | c | | | |
| Diplograptus | | | | | | a | | | |
| Plectambonites n. sp., obliquely wrinkled | | | | | | c a | | | |
| Orthis deflecta | | | | | | c c | | | |
| O. tricenaria | | | | r | | c c | | | |
| Skenidium halli | | | | | | c | | | |
| Rhynchotrema minnesotensis | | | | | | a a | | | |
| Zygospira recurvirostra | c c r c | r | c | a | | c | | | |
| Z. (Hallina) saffordi | | | | | | a | | | |
| Conradella grandis | | | | | | c | | | |
| Helicotoma planulatoides | | | | c | | r | | | |
| Lophospira peracuta | | | | | | r | | | |
| Subulites | | | | | | r | | | |
| Pterotheca saffordi | | | | ? | | c | | | |
| Lituites undatus ? | | | | | | r | | | |
| Eurychilina subradiata | | | | | | c | | | |
| Drepanella macra | | | | | | c | | | |
| Encrinurus excedrinus | | | | | | c | | | |
| Pterygometopus callicephalus | r | | | c | | r | | | |
| Thaleops ovatus | | | | | | c | | | |
| RIDLEY — Orthis bellarugosa | | | | | | | c r r a | | |
| Rhynchotrema ottawaensis ? | | | | | | | a | | |
| Liospira convexa | | | | | | | c | | |
| PIERCE LIMESTONE — Nicholsonella pulchra | | | | | | | | a | |
| Phylloporina sublaxa | | | | | | c c | | c | |
| Rhinidictya nashvillensis | | | | | | | | a | |
| Escharopora symmetrica | | | | | | | | a | |
| 20 undescribed Bryozoa | | | | | | | | a | |
| Rafinesquina minnesotensis | | | | | | a a | r | c r c | |
| Strophomena incurvata | | | | | a | a a | | c | |
| Dalmanella subæquata | | | | | | a a | | c | |
| D. stonensis | | | | | | | | c | |
| Protorhyncha ridleyana | | | | | | | a | r | |
| Rhynchotrema n. sp. | | | | | | | | c | |
| MURFREESBORO LIMESTONE — Anthaspidella sp. undet. | | | | | | | | | r |
| Ctenodonta gibberula | | | | | | | | | c |
| C. n. sp. | | | | | | | | | c |
| Orthodesma saffordi | | | | | | | | | c |
| Holopea sp. undet. | | | | | | | | | r |
| Solenospira prisca-extenuata | | | | | | | | | c |
| Helicotoma tennesseensis | | | | | | | | | a |
| H. declivis | | | | | | | | | a |
| Trochonema bellulum | | | | | | | | | c |
| Lophospira perangulata | | | | | | | | | a |
| L. bicincta | | | | | | | | | c |
| L. centralis | | | | | | | | | c |
| L. procera | | | | | | | | | r |
| Liospira abrupta | | | | | | | | | a |
| L. decipiens | | | | | | | c | | c |
| L. progne | | | | | | c | c | | c |
| L. subconcava | | | | | | | | | c |
| L. vitruvia | | | | | | c | c | | c |
| Salterella billingsi | | | | | | | | | a |
| Hyolithus baconi | | | | | | | | | r |
| Actinoceras bigsbyi | | | | | | | | | r |
| Cyrtoceras bondi | | | | | | | | | r |
| C. stonense | | | | | | | | | c |
| Leperditia fabulites | c c | | c c c | | | r | r | r a | a |

C. WILLARD HAYES,
E. O. ULRICH,
*Geologists.*

# THE ILLUSTRATION SHEET.

On the Illustration sheet are figured some of the more striking species of fossils found in the quadrangle, grouped according to their respective formations, as follows:

### ST. LOUIS LIMESTONE.

FIG. 2. Upper surface of *Lonsdaleia* (or *Lithostrotion*) *canadense* (Castlenau), a coral growing, as in the figure, into compact masses reaching a foot in diameter. In the associated *L. prolifera* the individual corallites do not touch each other and therefore are cylindrical instead of prismatic. The latter variety is the more common in this region and probably occurs alone in the lower beds of the formation.

FIGS. 3 and 4. Highly magnified views of the front and back of one of the delicate "lace Bryozoa," the species figured being *Fenestella tenax* Ulrich. The broken remains of these beautiful Bryozoa often cover the heavy layers of chert at the base of the formation.

### CLIFTON LIMESTONE.

FIG. 5. Upper surface of *Favosites favosus*, one of the honey-comb corals. Other species of *Favosites*, having much smaller cells, are often found with this.

FIG. 6. One of the varieties of *Halysites catenulatus*—the chain-coral—which in this region is highly characteristic of the Clifton limestone.

### FERNVALE FORMATION.

FIGS. 7 and 8. Views of the exterior and interior of the ventral (in this case the flatter) valve of *Dinorthis subquadrata* (Hall).

FIGS. 9 and 10. A group of three specimens of *Monotrypella quadrata* (Rominger), and the surface of one of them magnified five diameters. At the ends of the branches the cells are rhombic in shape.

### LEIPERS FORMATION.

FIGS. 11 and 12. A sub-globular bryozoan, *Amplexopora columbiana* Ulrich and Bassler, composed of small radiating prismatic tubes. Fig. 12 shows the openings of these tubes magnified five diameters.

FIG. 13. A frond of the strongly pustulose bryozoan *Monticulipora molesta* Nicholson. This fossil is highly characteristic of the upper middle part of the formation and its empty molds were frequently observed in the phosphate of this horizon in the Swan Creek region. (An outwardly similar but structurally quite different species occurs in the underlying Catheys formation.)

FIGS. 14 and 15. *Homotrypella nodosa* Ulrich and Bassler. A group of three specimens and the surface of a fourth magnified five times. The cells are very small and the walls granulose.

FIG. 16. *Glyptocrinus decadactylus* Hall. This fine crinoid occurs about the middle of the formation. Fragments of the annulated stem or column, which in life was attached to the lower end of the portion shown in the illustration, are common and heads even are not rare where the strata are shaly.

FIG. 17. The dorsal side of *Hebertella sinuata* Hall, a common brachiopod of this and the underlying Catheys formation. In the latter the plications are usually a little coarser than in the Leipers formation variety.

FIGS 18 and 19. *Strophomena planoconvexa* Hall. The first shows the convex or dorsal side of an entire specimen; the second the interior of the flat ventral valve.

FIG. 20. The convex side (ventral valve) of an entire shell of *Rafinesquina alternata* var. *ponderosa*. The opposite valve is concave. This species is even more abundant in the Catheys and Bigby formations, but in those lower horizons it scarcely reaches half the size of the *ponderosa* variety which characterizes the upper middle part of the Leipers formation.

FIGS. 21 and 22. *Platystrophia lynx* Von Buch. Dorsal and cardinal views of two specimens of the large variety of this species which is so abundant in and characteristic of the uppermost bed of the formation.

### CATHEYS FORMATION.

FIGS. 23 and 24. *Stromatocerium pustulosum* Safford. Portions of a silicified mass of this common hydro-coralline, the first showing the upper surface, the second the laminar structure of the edge and bottom. Masses of this coral vary from a few inches to 2 or 3 feet in diameter. A variety of the species reappears in the upper part of the Leipers formation, while along the northern margin of the basin it occurs in rocks that are equivalent to the Bigby limestone of this quadrangle. Almost invariably the matrix is an earthy, fine-grained limestone.

FIG. 25. Portion of the weathered upper surface of a mass of *Columnaria alveolata* Goldfuss, showing the strongly septate corallites. This coral and the preceding pustulose *Stromatocerium* are nearly always found associated and generally in company with one or another of the species of *Tetradium*.

FIG. 26. *Heterotrypa parvulipora* Ulrich and Bassler, a frondescent or palmate bryozoan found very abundantly in the shaly lower third or half of the formation. The entire surface is covered with the angular apertures of very small tubes.

FIG. 27. *Oxydiscus cristatus* Safford, a symmetrically involuted, disciform gastropod shell, highly characteristic of the lower part of the formation. The keel is very thin and sharp.

FIGS. 28 and 29. A very large and small specimen of *Cyclonema varicosum* Hall. The species is distinguished by its strong revolving lines, is very common, and restricted to the Catheys formation.

### BIGBY LIMESTONE.

FIG. 30. A group of eight specimens of *Constellaria florida* var. *emaciata* Ulrich and Bassler.

FIG. 31. A group of five specimens of *Constellaria teres* Ulrich and Bassler. These two species of *Constellaria* are often extremely abundant in the upper part of the Bigby limestone. In this quadrangle *Constellaria teres* appears to be restricted to the Bigby, but in the vicinity of Nashville it seems to pass over into the Catheys formation. *Constellaria florida* is very common in the shaly parts of the Leipers formation, and the variety *emaciata* is not infrequently found also in the Catheys formation.

FIGS. 32 to 34. Dorsal, lateral and apertural views of two specimens of *Bellerophon clausus* Ulrich. This species is generally associated with another gasteropod, a variety of *Lophospira oweni* Ulrich, and these, together with *Ctenodonta subrotunda* Ulrich, *Hebertella borealis* (Billings), and *Rhynchotrema inæquivalve* (Hall), may be regarded as reliable indications of a horizon lying between the middle of the formation and the *Constellaria* bed at the top—in other words, to the horizon intervening between Bigby phosphates Nos. 2 and 3.

FIG. 35. *Lingulops norwoodi* (James), a small, strongly convex linguloid brachiopod, of the natural size and magnified, found in the unleached limestone horses of Bigby phosphate No. 2.

FIGS. 36 and 37. Opposite view of two specimens of *Hebertella borealis* (Billings).

FIGS. 38 and 39. Opposite views of two specimens of *Rhynchotrema increbescens* (Hall).

FIGS. 40 and 41. Exterior and interior views of a valve of *Ctenodonta subrotunda* Ulrich. A much smaller undescribed species of this type occurs sometimes very abundantly in the Hermitage formation in the region between Mount Pleasant and McCains.

### HERMITAGE FORMATION.

FIGS. 42 and 43. Portions of a slab of chert almost made up of silicified valves of a variety of *Orthis* (*Dalmanella*) *testudinaria*.

FIGS. 44 to 46. A thin, concavo-convex bryozoan, *Prasopora patera* Ulrich and Bassler. It is common and highly characteristic of the shaly lower third of the formation. Fig. 44 represents the celluliferous upper surface; fig. 45 a portion of same magnified five diameters, and fig. 46 the concentrically striated under surface. Often the cells are more angular and the walls thinner than in fig. 45.

### CARTERS LIMESTONE.

FIG. 47. *Columnaria halli* Nicholson. Comparing figs. 47 and 25 it will be noticed that the radiating septa are much shorter in this species than in *C. alveolata* which marks the Catheys and Leipers formations.

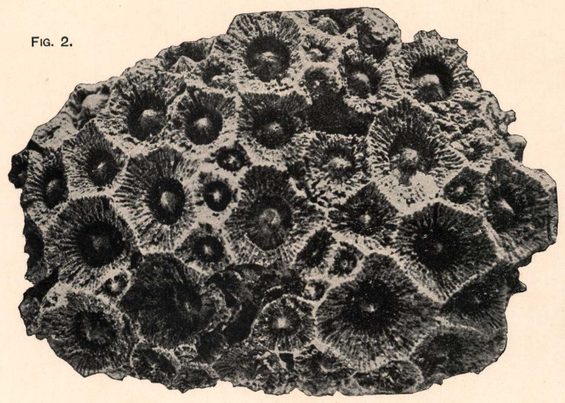
FIGS. 48 and 49. Side and top views of two specimens of a fine sponge that is often found in the upper part of the Carters limestone. The specimens are silicified and were freed from the limestone matrix by means of hydrochloric acid. The species is provisionally identified with *Dystactopongia minor* Ulrich. It usually occurs in association with *Columnaria halli* and *Stromatocerium rugosum* Hall, which differs from *Stromatocerium pustulosum* (see figs. 23 and 24) in wanting the regularly disposed pustules on the upper surface.

U. S. GEOLOGICAL SURVEY
CHARLES D. WALCOTT, DIRECTOR

# ILLUSTRATION SHEET

TENNESSEE
COLUMBIA QUADRANGLE

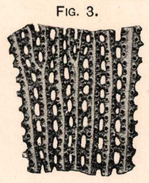
Fig. 2.



ST. LOUIS LIMESTONE.

Fig. 7.

Fig. 3.



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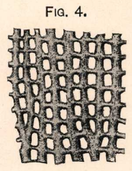


FERNVALE FORMATION.

Fig. 10.

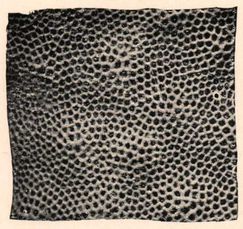
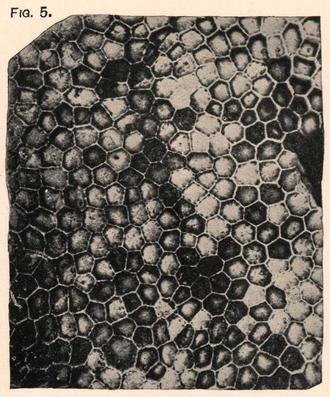


Fig. 8.

Fig. 5.



CLIFTON LIMESTONE.

Fig. 6.

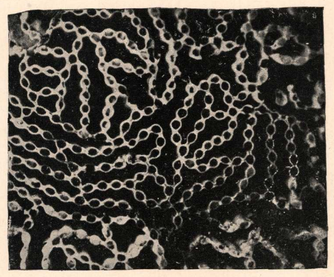


Fig. 9.

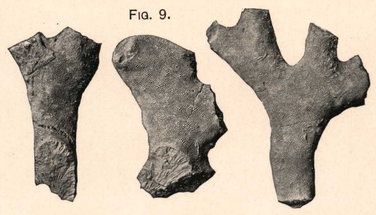


Fig. 11.

Fig. 13.

LEIPERS FORMATION.

Fig. 14.

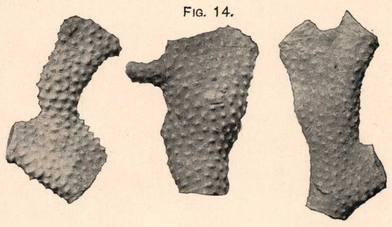


Fig. 12.

Fig. 17.

Fig. 15.

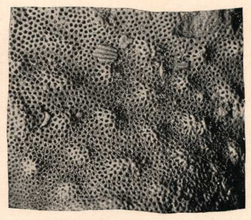


Fig. 18.

Fig. 19.

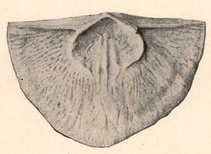


Fig. 16.

Fig. 20.

Fig. 21.

Fig. 22.

Fig. 23.

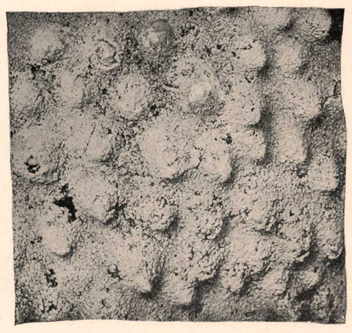


Fig. 25.

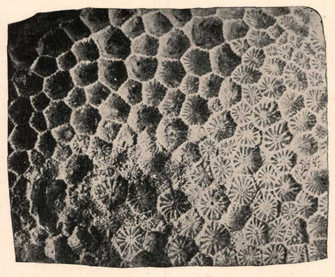


Fig. 27.

CATHEYS FORMATION.

Fig. 28.

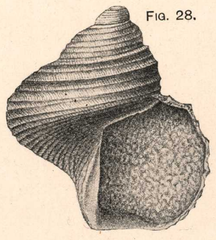


Fig. 24.

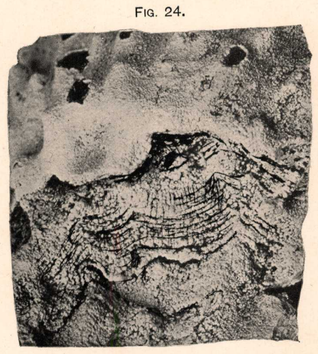


Fig. 26.

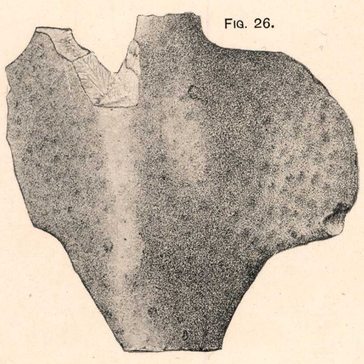


Fig. 29.

Fig. 42.

Fig. 45.

HERMITAGE FORMATION.

Fig. 43.

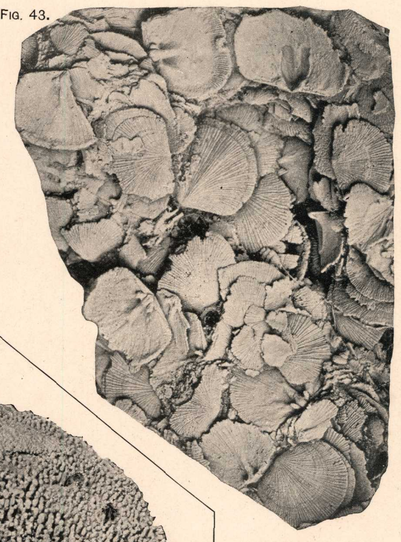


Fig. 48.

Fig. 44.

Fig. 46.

Fig. 30.

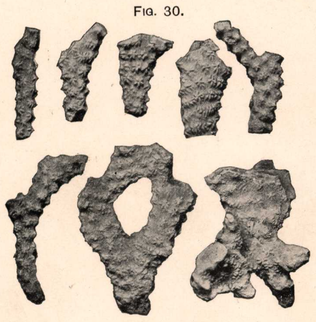


Fig. 35.

Fig. 31.

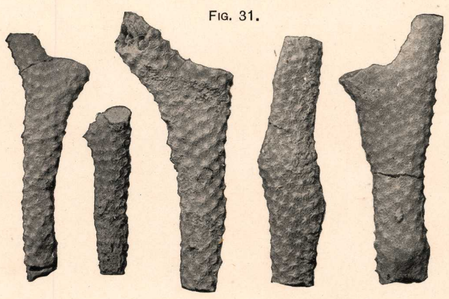


Fig. 36.

Fig. 38.

Fig. 39.

BIGBY LIMESTONE.

Fig. 32.



Fig. 33.



Fig. 34.



Fig. 37.



Fig. 40.



Fig. 41.



Fig. 47.



CARTERS LIMESTONE.

Fig. 49.