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The HUNTON FORMATION of OKLAHOMA.

Abstract of a Thesis prepared for the Degree of Doctor of Philosophy in Yale University.

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(Contributions from the Paleontological Laboratory, Peabody Museum, Yale University, New Haven, Conn., U. S. A.)

Art. XXXI.—*The Hunton Formation of Oklahoma;* by Chester A. Reeds, Bryn Mawr College.

[Contributions from the Paleontological Laboratory of Yale University.]

Introduction.

The Hunton formation of the Arbuckle Mountains, Oklahoma, was briefly described by Mr. J. A. Taff in the Atoka Folio, 1902, Tishomingo Folio, 1903, and Professional Paper No. 31, 1904, of the U. S. Geological Survey. Drs. G. H. Girty and E. O. Ulrich collected and studied fossils in connection with the stratigraphic work of Taff.

Since 1905 the writer has examined with care all of the widely scattered outcrops of the Hunton. He has made, furthermore, three large collections of fossils from these beds, and has measured as many as 35 sections across the exposed edges of these tilted strata. After the completion of a comprehensive study of the collections and sections under the direction of Professor Charles Schuchert of Yale University, the writer prepared a paper entitled "The Stratigraphy of the Hunton Formation, with introductory chapters on the Physiography and Structure of the Arbuckle Mountains, Oklahoma." This report was submitted May 1, 1910, to the Faculty of the Graduate School of Yale University as a thesis, in partial fulfilment of the requirements for the degree of Doctor of Philosophy. The introductory chapters on the Physiography and Structure together with chapters on the Stratigraphy and Mineral Resources of the Arbuckle Mountains have since been published as Bulletin No. 3, 1910, of the Oklahoma Geological Survey.

In the following pages the writer proposes to submit only a summary of his stratigraphic and paleontologic studies of the Hunton, since the text and illustrations of the complete report will be published later as one of the U. S. Geological Survey publications.

As no maps accompany this article the writer refers the reader to the Ardmore, Tishomingo, Atoka and Stonewall topographic sheets, the Atoka and Tishomingo Folios, the map of the Arbuckle Mountains in Professional Paper No. 31 of the U. S. Geological Survey, and to the maps accompanying Bulletin No. 3 of the Oklahoma Geological Survey.

Problem stated.—As mentioned in the Tishomingo Folio, page 4, and Professional Paper No. 31, pages 29 to 30, the Hunton limestone may be divided into two categories: (1) lithologically, into 3 members: a basal limestone, a middle shale and an upper limestone; (2) paleontologically, into 4 faunal

horizons: Clinton, Niagara, Helderberg and Lower Oriskany, the first and second assigned to the basal member, the third and fourth to the middle and upper members, respectively.

The writer does not accept this threefold lithologic and fourfold paleontologic subdivision of the Hunton. Instead, he proposes both a fourfold lithologic and paleontologic arrangement, the new units to have the rank of formations. From bottom to top they are (1) the Chimneyhill limestone (Silurian), (2) the Henryhouse shale (Silurian), (3) the Haragan shale (Devonian) and (4) the Bois d'Arc limestone (Devonian). These four formation names are new terms and have been approved by the Committee on Geologic Names of the U. S. Geological Survey. As may be seen from the correlation table, Table 1, the limits of the new subdivisions do not correspond exactly with those proposed by Taff, Ulrich and Girty.

This difference in the grouping of the beds has arisen, no doubt, from the unrealized very variable thickness of the Chimneyhill, Henryhouse, Haragan and Bois d'Arc formations from place to place, and also because the characteristic fossils which definitely define the limits of each had not then been determined. In Taff's type area at Hunton only three of the new formations here proposed, the Chimneyhill, Haragan and Bois d'Arc, are present, the Henryhouse having been eroded previous to the deposition of the Haragan. In the Lawrence anticline, however, some 15 to 20 miles northwest from Hunton the Henryhouse formation attains its greatest thickness, 223 feet, while the Haragan formation is wanting. There the Bois d'Arc rests disconformably on the Henryhouse while the latter is disposed similarly on top of the Chimneyhill. In the "White Mound" region 3 to 4 miles southeast of Dougherty, and many places elsewhere, the four formations are present, but varying in thickness from locality to locality. No two of the 35 sections made across the Hunton are alike. Not only are the entire sections of different thickness but also the amount of each formation present is variable. The cause for this variability is assigned to unequal rate and time of deposition from place to place, and also to differential erosion during and following sedimentation.

The writer's classification is based on both faunal and lithologic grounds but primarily on the faunal evidence. In localities where the Haragan shale rests on the Henryhouse shale, as in the exposures about Dougherty, it will be difficult, without a knowledge of the fossils, to separate one formation from the other. In localities where only one of these shale members is present, as near Lawrence and Hunton, there will be no difficulty in distinguishing three formations, lithologically as well as faunally. The fossils, however, are the only criteria that may

be relied upon to determine which of the two shale formations is represented.

That the writer's conclusions may be substantiated and that the formations may be more completely defined, each formation, with its characteristic fauna, will be treated separately in the following pages.

Chimneyhill limestone (Silurian).

This formation corresponds to Taff's lower Hunton limestone. It varies in thickness from 0 to 53 feet, but it is persistent throughout all of the widely scattered exposures of the Hunton. It is named after Chimneyhill creek, which crosses

TABLE I.—*Correlation table of the Siluro-Devonian Rocks, Arbuckle Mountains, Oklahoma.*

<table>
<tr><th>Period</th><th>Series</th><th>Stage</th><th>Reeds 1911</th><th colspan="2">Taff, Ulrich and Girty 1903–1904</th></tr>
<tr><td rowspan="5">Devonian</td><td rowspan="2">Helderbergian</td><td>Becraft</td><td>Bois d'Arc limestone
0–90 feet, average 60 feet</td><td>Upper Hunton</td><td>Oriskany</td></tr>
<tr><td>New Scotland</td><td>Haragan shale
0–166 feet, average 100 feet</td><td rowspan="3">Middle Hunton</td><td rowspan="3">Helderbergian</td></tr>
<tr><td rowspan="3">Silurian</td><td rowspan="2">Niagaran</td><td>Break</td></tr>
<tr><td>Bob & Lobleville</td><td>Henryhouse shale
0–223 feet, average 90 feet</td></tr>
<tr><td>Break</td><td></td><td></td></tr>
<tr><td>Alexandrian</td><td>Ohio Clinton</td><td>Chimneyhill limestone 0–53 feet av. 35 feet
Pink-crinoidal member, 0–39 ft., av. 15 ft.
Glauconitic member, 0–25 ft., av. 15 ft.
Oölitic member, 0–12 ft., av. 5 ft.</td><td>Lower Hunton</td><td>Niagara
Clinton</td></tr>
</table>

the formation in the northeast corner of the Mountains. The type locality is at the confluence of three small creeks, Sec. 4, T. 2N., R. 6E. Since there were no geographic names in this region suitable for formation names it was necessary to change "South Fork of Jack Fork" creek to Chimneyhill creek. The Chimneyhill limestone rests unconformably on a blue, green or yellowish shale which Taff has named the Sylvan. Above, in most places, it is in contact with the Henryhouse formation, which rests unconformably on it. In other places, as at Hunton, it is in contact with the Haragan shale, the second shale formation, since erosion removed in that region all of the Henryhouse before the Haragan was deposited on the uneven surfaces of the Chimneyhill.

Lithology.—From a lithologic standpoint the Chimneyhill formation is divisible into three members: an oölitic limestone, a glauconitic limestone and a pink crinoidal limestone. Each member has a variable thickness and extent throughout the mountains. They will be considered in the order named, which was also their order of deposition.

Oölitic member.—This member forms a bed of oölitic limestone ranging in thickness from 0 to 12 feet, at the base of the formation. Its best outcrop is in the northeast corner of the mountains in the vicinity of Lawrence. There it has an average thickness of 9 feet, and is well exposed for a distance of 5 miles as the cap-rock to the escarpment of the Sylvan shale. Although this member is generally present with the other members of this formation it is absent in 10 of the 35 measured sections and only 1 foot thick in 4 of them. Where it is only 1 foot thick the lower half is composed chiefly of crinoidal fragments while the upper 6 inches consists wholly of oölite. Where the member has an average thickness of 5 feet or more the lower 1·5 feet consist chiefly of crinoidal fragments. Other fossils are sometimes present. This narrow lower zone is often of the same color as the overlying oölite beds, but perhaps it is more frequently a brownish earthy crinoidal limestone. On fresh exposures the oölitic limestone in the upper zone is light gray to white in color, but where weathered it takes on a darker tone. In hand specimens the oölites themselves may be more or less uniform in grain, that is, fine, medium, or coarse, or, those varying from a pinhead to a pea in size may be associated together. This upper oölitic zone is chiefly unfossiliferous except for a few small specimens of *Favosites niagarensis*, and occasionally lentils of white limestone which contain a new species of *Clorinda*. In the Coal creek section a 6-foot yellowish shale bed, resembling the Sylvan, occurs between 3·5 feet of oölite below and 1 foot of oölite above. This is the only locality observed where a lentil of

shale was intercalated in this member. Its presence indicates that the muddy water conditions of the Sylvan were resumed at this time and place. The presence of limestone lentils at other localities foreshadows the deposition of the overlying white glauconitic limestone or middle member.

Glauconitic member.—This member was found in all of the numerous exposures examined except one near Sheep creek where the pink-crinoidal member rests on the oölitic member. The 35 sections made across the Hunton show that it varies in thickness from 0 to 25 feet. It is a white to gray, granular to crystalline, generally massive bedded limestone, disseminated with green glauconitic grains. The presence of the green glauconite, white color and granularity readily distinguish it from the oölitic and pink-crinoidal members, between which it is intercalated.

Pink-crinoidal member.—This limestone constitutes the uppermost member of the Chimneyhill formation. Typical exposures are to be found in the Lawrence and Hunton anticlines and Franks syncline along the northeast border of the mountains between Lawrence and Bromide. The exposures in the vicinity of Dougherty in the west central part of the mountains are not so characteristic. Typically the member is a thin bedded, compact earthy to crystalline limestone containing numerous crinoidal fragments which have been stained pink by infiltrated iron and manganese. The member varies in thickness from 0 to 39 feet, with an average thickness of approximately 15 feet. This variation in thickness is accounted for chiefly by the differential erosion which affected the member previous to the deposition of the Henryhouse shale, and, in places where it has been completely carried away, by a second period of erosion, the one just previous to the deposition of the Haragan shale.

Fauna.—The fauna of the Chimneyhill limestone is roughly equivalent to that of the Ohio Clinton and Brassfield formations east of the Cincinnati axis in Ohio and Kentucky. It is still more closely related, however, to the Ohio Clinton west of this axis in Indiana, southern Illinois, Kentucky and Tennessee. In fact, as at present understood, the Chimneyhill was deposited in the same marine waters but near the opposite shore of a rather restricted geographical province, the Indiana basin.* It would thus be expected that the faunas are somewhat alike but not necessarily the same in every particular. The names and stratigraphic range of the characteristic species of the Chimneyhill formation are as follows:

* Schuchert, C., Paleogeography of North America, Bull. Geol. Soc. Am., vol. xx, pp. 532–538, pl. 64.

CHARACTERISTIC SPECIES OF THE CHIMNEYHILL FORMATION (SILURIAN).

Oölitic member.

Atrypa n. sp., *Schuchertella* sp., *Rhipidomella* n. sp., *Cyclonema daytonensis.*

Glauconitic member.

Callopora magnopora, Pachydictya bifurcata, Phenopora fimbriata, Phenopora magna, Rhinopora verrucosa, Plectambonites transversalis n. var., *Strophomena* (?) *antiquata, Cyclonema ventricosa, Orthoceras* cf. *latanummulatum, Illœnus ambiguas, Illœnus* cf. *armatus.*

Pink-crinoidal member.

Pisocrinus sp., *Homœospira* n. sp., *Plectambonites tennesseensis* (cf. *quinquecostata* McCoy), *Spirifer radiatus, Stropheodonta corrugata, Triplecia* n. sp. (cf. *waldronensis*), *Whitfieldella* sp., *Delthyris* n. sp., *Conocardium* sp., *Hyolithes* n. sp., *Lophospira* sp., *Calymene* sp., *Cyphaspis clintonensis, Dalmanites arkansus, Illœnus* 2 sp., *Lichas* n. sp., *Odontopleura arkansana, Prœtus corrugatus* ?, *Prœtus determinatus* ?, *Sphærexochus* sp.

Oölitic and glauconitic members.

Orthis flabellites.

Glauconitic and pink-crinoidal members.

Stephanocrinus elongatus, Conocardium sp., *Strophostylus cyclostomus, Orthoceras rectum, Dalmanites* sp.

Oölitic, glauconitic and pink-crinoidal members.

Streptelasma cf. *bilateralis, Clorinda* n. sp., *Dalmanella elegantula, Hebertella fausta, Platystrophia biforata, Triplecia* cf. *ortoni, Hormotoma* sp., *Dalmanites werthneri, Illœnus* cf. *daytonensis.*

Henryhouse shale (Silurian).

This formation varies from 0 to 223 feet in thickness. The thickest exposures occur in the Lawrence anticline on Chimneyhill creek in the northeast corner of the Arbuckles and again in the south limb of the Arbuckle anticline along the southwest border of the mountains from Springer to Poolville (Elk). Good outcrops may be seen on Henryhouse creek 3 miles east of Woodford. The formation takes its name from this creek. In the central part of the mountains in the vicinity of Dougherty the formation is not so thick and on the eastern side of the Arbuckles from Canyon creek south to Bromide (Sulphur Springs) it is altogether wanting.

Lithology.—Along Chimneyhill creek this formation is composed of bluish to yellowish, thin to moderately thick bedded earthy limestone and intercalated shale beds in the lower 180 feet, while the upper 43 feet is of white marly beds. In the type area, and also in the vicinity of Dougherty, alternating yellowish shales, shaly limestones and bands of reddish earthy limestone occur. The lower 180 feet of the Chimneyhill section is represented thus in the Henryhouse creek section. Faunally, it contains many of the same species but is less prolific in the number of individuals. The white marly beds and their coral fauna are not present at the top of the Henryhouse creek section. As may be seen the beds of the two sections are thus somewhat variable in character as well as in thickness. The sediments were evidently deposited in shallow oscillating seas which bordered an irregular coast-line of slightly uplifted land, or, possibly in a sea containing scattered islands.

Fauna.—The fauna of the Henryhouse shale is more prolific than that of the Chimneyhill formation below, although fossils are scant in the lower 120 feet. They may be collected, too, with greater ease from the weathered shale slopes of the Henryhouse than from the hard limestone ledges of the Chimneyhill. The contact between these two formations is sharper in the northeast part of the mountains in the Lawrence anticline, than in the vicinity of Dougherty and along the south side of the mountains, west of the Washita river. The fossils from the lower 120 feet of this formation correspond more closely to those of the Bob formation of Tennessee and this division may be known as the Lower Henryhouse. The fossils from the remaining 102 feet correspond most closely to the Lobleville beds and these beds represent the Upper Henryhouse. It may thus be seen that the unconformity between the Chimneyhill and Henryhouse formations is denoted by the absence of the Osgood, Laurel, Waldron, Lego, Dixon and Beech river formations as defined by Pate and Bassler.* The names and stratigraphic range of the diagnostic species of the Henryhouse formation are as follows :

CHARACTERISTIC SPECIES OF HENRYHOUSE FORMATION (SILURIAN).

Lower Henryhouse.

Glassia sp., *Scenidium insigne*, *Schuchertella* n. sp., *Strophe-odonta* n. sp., *Strophonella prolongata*, *Platyschisma* n. sp., *Orthoceras* n. sp., *Bronteus* cf. *plana*, *Ceraurus niagarensis*, *Dalmanites* n. sp., *Encrinurus* n. sp.

*Pate, W. F. and Bassler, R. S., Proc. U. S. Nat. Museum, vol. xxxiv, p. 410.

Upper Henryhouse.

Astylospongia præmorsa, Amplexus shumardi, Aulopora repens, Calceola sp., *Cladopora reticulata, Eridophyllum rugosum, Favosites niagarensis, Favosites venustus* n.var., *Heliophyllum radicula, Plasmopora folis, Thecia minor, Thecia major, Coccoseris micropora, Heliolites interstinctus, Heliolites subtubulatus, Pisocrinus milliganae, Synbathocrinus tennesseensis, Ascodictyon silurinense, Bythotrypa* cf. *distichia, Bythotrypa* cf. *squamata, Chilotrypa* 4 sp., *Crepipora* n. sp., *Fenestella* cf. *acuticosta, Fistulipora* 2 sp., *Hederella* sp., *Leptotrypa* n. sp., *Lioclema* 2 sp., *Nicholsonella* cf. *florida, Penniretepora* cf. *distichia, Rhopalonaria attenuata, Anastrophia* cf. *internascens, Anoplotheca saffordi, Atrypa* cf. *nodostriata, Camarotœchia ? neglecta, Hebertella fissiplica, Leptæna* sp. (European type), *Nucleospira* cf. *lentiformis, Pholidops* sp., *Rhynchonella* n. sp., *Rhynchospira globosa, Schuchertella subplanus, Spirifer crispus, Strophonella tenuistriata, Uncinulus* cf. *nucleolata, Uncinulus* cf. *stricklandi, Amphicœlia* sp., *Platystoma* sp., *Cyrtoceras subrectum, Orthoceras* sp., *Acaste* cf. *dowingiæ, Dalmanites* n. sp.

Lower and Upper Henryhouse.

Striatopora sp., *Lecanocrinus* n. sp., *Ceramopora* sp., *Fenestella* n. sp., *Fistulipora hemispherica, Pachydictya crassa, Anoplotheca saffordi, Bilobites saffordi, Camarotœchia whitei, Dalmanella crassa, Dictyonella gibbosa, Gypidula rœmeri, Gypidula rœmeri simplex* n. var., *Leptœnisca adnascens, Merista tennesseensis, Pholidostrophia* n. sp., *Schuchertella subplanus rœmeri, Spirifer saffordi, Stropheodonta* n. sp. (1), *Strophonella laxiplicata, Calymene* cf. *camerata.*

Haragan shale (Devonian).

The Haragan shale varies in thickness from 0 to 166 feet, with an average thickness of about 100 feet. The fossils indicate that this variation in thickness is due chiefly to the unequal rate of deposition of the beds over an uneven surface. It is absent in the Lawrence anticline and Wapanucka syncline but is represented in most of the remaining outcrops of the Hunton. Excellent exposures may be found along the northeast border of the mountains from Canyon creek south to Hunton and Bromide. The prominent escarpment at the postoffice of Hunton is of this shale. Excellent exposures containing abundant fossils are to be seen in the "White Mound" region along Haragan creek 3 to 4 miles southeast of Dougherty. This is the type area, the formation taking its name from Haragan creek which flows westward across the strike of the formation about one-fourth mile north of "White Mound." The term Haragan, which is used here as the formation name, has been applied to an unnamed creek which may be seen on the Ardmore quadrangle in Sec. 17, T. 2S., R. 3E. The

Henryhouse and Haragan shales are both exposed here and when taken together constitute Taff's middle member.

Lithology.—The formation consists of alternating blue to white shales and thin bedded earthy limestones which weather into yellowish shales on long exposure. It resembles somewhat the Henryhouse formation, but instead of a tendency toward massive bedded alternating series of yellow and pink earthy limestones and some shale beds there is here a predominance of the shale members and only occasionally thin ledges of earthy or crystalline limestone. The most typical sections were made along Coal and Haragan creeks.

Fauna.—The fossils are numerous and easily obtained close to the streams where weathered shale slopes occur. The fauna contains a considerable number of species that are to be found in the New Scotland shale of the Helderbergian series in the lower Devonian of New York. The names of the species which have been identified that are peculiar to this horizon are the following:

CHARACTERISTIC SPECIES OF THE HARAGAN SHALE (DEVONIAN).

Favosites venustus, *Striatopora issa*, *Brachiocrinus* sp., *Edriocrinus* n. sp., *Callopora perelegans*, *Anoplia helderbergæ*, *Atrypa nodostriata* n.var., *Atrypina imbricata*, *Camarotœchia bialveata*, *Chonetes* sp., *Cyrtina dalmani*, *Dalmanella* n. sp., *Dalmanella subcarinata*, *Orthostrophia strophomenoides*, *Spirifer cyclopterus* n. var., *Stropheodonta crebristriata*, *Stropheodonta varistriata*, *Stropheodonta* n. sp., *Stropheodonta* cf. *planulata*, *Strophonella* n. sp., *Trematospira* cf. *costata*, *Conocardium* sp., *Megambonia* sp., *Diaphorostoma* n. sp., *Diaphorostoma ventricosa*, *Platyceras lamellosum*, *Platyceras unguiforme*, *Pleurotomaria* n. sp., *Tentaculites gyracanthus*, *Dawsonoceras* n. sp., *Dicranurus hamatus*, *Phacops logani.*

Bois d'Arc limestone (Devonian).

This formation corresponds to Taff's upper Hunton. It is present wherever the Chimneyhill, Henryhouse and Haragan beds are found except in the northeast limb of the Arbuckle anticline in the vicinity of Honey creek near the Washita river. There it was eroded previous to the deposition of the overlying Woodford chert. It varies in thickness from 0 to 90 feet but has a general average of 60 feet. In the type area along Bois d'Arc creek, Sec. 4, T. 2N., R. 6E., in the northeast corner of the Arbuckles, it has a maximum thickness of only 64 feet. Although the thickness is not as great as that to be found in the Dougherty anticline, or along Haragan creek, the fossils indicate that it is the higher portion of the section

which is here represented. It may yet be determined that the uppermost 40 feet of the Bois d'Arc are Oriskany in age.

Lithology.—The Bois d'Arc limestone consists of thin bedded crystalline and non-crystalline limestone with occasional chert lentils and thin beds of intercalated yellowish shale. In the Coal creek and Goose creek sections a 6-foot bed of yellowish shale occurs near the middle of the formation. Where the crystalline ledges have weathered considerably the rock is readily worked for fossils, but the non-crystalline limestone instead is very hard and weathers into thin lenticular lenses.

Fauna.—The fossils indicate that for most places in the Arbuckles deposition was continuous from the Haragan shale into the Bois d'Arc limestone. The contacts, however, are sharp where the beds are gently inclined, but not always so where the beds are steeply tilted. This is due to the less effective power of the agents of weathering. In passing from the Haragan shale to the Bois d'Arc limestone, thin intercalated shale beds are to be found between the ledges of limestone in the lowermost 5 feet of the Bois d'Arc limestone. This is well illustrated in the thick sections across the Dougherty anticline and along Haragan creek. In the type area in the northeast corner of the mountains the Bois d'Arc limestone rests unconformably on the Henryhouse shale, for strangely enough the Haragan shale is not represented here. This suggests that the northeast corner of the Arbuckle Mountains was above sea level during Haragan times, and possibly that the Henryhouse was not affected much by erosion since the thickest section containing the highest horizon of the formation occurs a mile away on Chimneyhill creek. Since deposition was continuous in various places from the Haragan shale into the Bois d'Arc limestone, it is not surprising that the lower part of this limestone, in such places, has a New Scotland aspect. Since, however, there are a number of fossils that are characteristic of this limestone it is best treated as a separate formation. It is more nearly the Becraft than the New Scotland of the New York section. The names of the fossils which are peculiar to this formation are as follows:—

Characteristic Species of the Bois d'Arc Limestone (Devonian).

Dendropora n. sp., *Favosites shriveri*, *Trachypora* n. sp., *Pisocrinus* sp., *Codaster* n. sp., *Cyrtina rostrata*, *Eatonia singularis*, *Leptostrophia magnifica*, *Leptostrophia oriskania*, *Meristella lævis*, *Meristella lentiformis*, *Rensselæria marylandica*, *Spirifer concinna*, *Spirifer cyclopterus*, cf. *hartleii*,

Stropheodonta becki, Strophonella cavumbona, Trematospira n. sp., *Uncinulus* 2 n. sp., *Mytilarca* cf. *acutirostra, Orthonychia* cf. *plicatum, Platyceras* n. sp., cf. *tenuiliratum.*

Widely-ranging species. — After having listed separately most of the species which occur in each of the four formations under appropriate headings, it is well in order to make the faunal list complete to give now the names and range of the species which are not characteristic of any one formation and which have a stratigraphic range greater than that of a single formation. In a sense they are forms which bind together the faunas of the four formations. They have been arranged in tabular form under class headings, Table II. The list shows that some species which have heretofore been considered characteristic of certain horizons are no longer so. This is well exemplified by *Leptænisca concava*, which is restricted to a 4-foot horizon in the New Scotland of New York. In Oklahoma it ranges through more than 300 feet, starting in the Henryhouse (Silurian) and terminating in the Bois d'Arc (Devonian). Another diagnostic fossil of the New Scotland and Linden is *Camarocrinus ulrichi.* In the Arbuckle Mountains it has the same range as *Leptænisca concava.* The fauna of the Upper Henryhouse is prophetic of the Helderbergian, but it is still Silurian since it contains a larger number of associated Niagaran species. This is very interesting when it is remembered that none of the Cayugan series is represented. These and other points of interest will be treated in a more comprehensive manner in the complete stratigraphic and paleontologic report which will appear later as a U. S. Geological Survey publication.

Table of Silurian and Helderbergian formations.—When the Chimneyhill, Henryhouse, Haragan, and Bois d'Arc formations are arranged in tabular form opposite synchronous formations of the completed geologic column, it is at once apparent that they represent but a small part of the time from the beginning of the Silurian period to the close of the Helderbergian epoch of the Devonian. That the reader may have before him a graphic idea of this relation, a table of Silurian and Helderbergian formations is given in Table III. Except for the new terms here proposed, it has been compiled from the tables given by Schuchert in his Paleogeography of North America. In the various districts considered, the times of no deposition as well as eroded sediments have been indicated by the word "Break."