

THE STRATIGRAPHY OF THE DEVONIAN-MISSISSIPPIAN
BOUNDARY IN SOUTHWESTERN VIRGINIA

by

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INTRODUCTION

This study was undertaken in order to obtain a better understanding of the stratigraphic succession involving the Devonian-Mississippian boundary in southwestern Virginia. Conflicting opinions exist on the position of this systemic boundary, and especially on the contacts between formations. Four phases of the problem are treated in this paper: (1) the position of the Devonian-Mississippian boundary, (2) the presence or absence of Kinderhookian beds, (3) the facies changes within the succession studied, and (4) the study of evidence supplied by fossils.

Because of the characteristically imperceptible gradation of one lithology into another, and the lenticular nature of individual beds, lithologic correlations hold little time significance. Faunal studies seem to provide a satisfactory solution. Unfortunately the fossils that are associated with the Devonian-Mississippian succession have received little detailed study. With the exception of a few relatively incomplete discussions of pertinent faunas, it was necessary to use fossils described and figured from other areas.

The area studied extends from the crest of Brush Mountain five miles west of Blacksburg, Montgomery County, Virginia, to the gorge of Laurel Creek through Pine Mountain near Broadford, Smyth County, Virginia, a distance of about 100 miles. Seven excellent sections showing the relationships of the strata in question occur in this area (plate 1.).

Section NumberLocality

- | | |
|---|--|
| 1 | U.S. Route 460, at the crest of Brush Mountain, five miles west of Blacksburg, Virginia. |
|---|--|

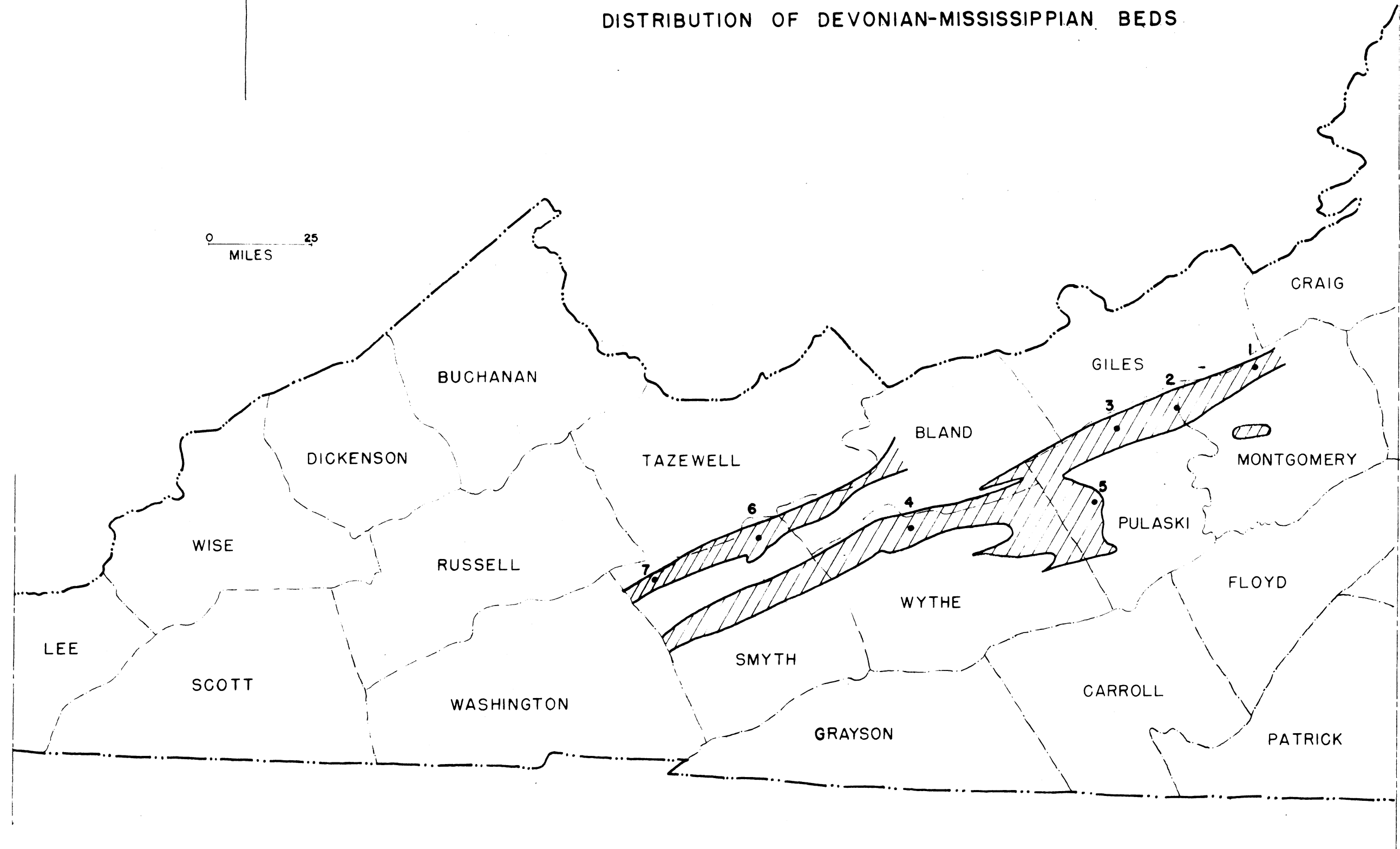
Section NumberLocality

- | | |
|---|--|
| 2 | Norfolk and Western Railway cut, along New River, one-half mile northwest of Parrott, Pulaski County, Virginia. |
| 3 | State Route 100, at the crest of Cloyd Mountain, five miles west of Dublin, Pulaski County, Virginia. |
| 4 | U.S. Route 52, just north of bridge over Reed Creek, six miles west of Wytheville, Wythe County, Virginia. |
| 5 | U.S. Route 11, beginning with concrete culvert on west side of Draper Mountain, one mile south of Pulaski, Pulaski County, Virginia. |
| 6 | State Route 16, at the crest of Little Brushy Mountain, a few miles west of Chatham Hill, Smyth County, Virginia. |
| 7 | State Route 91, along the gorge of Laurel Creek just north of Broadford, Smyth County, Virginia. |

Section 5 represents the most easterly development of the succession studied. Sections 1 to 4 are in the same belt of outcrop and constitute a median phase. Sections 6 and 7 are in another belt of outcrop and represent the most westerly phase of development described in this paper.

Field work was begun in the fall of 1951 and continued intermittently until June, 1952, at which date two months of full-time investigation was begun.

INDEX MAP
SHOWING
LOCATION OF GEOLOGIC SECTIONS
AND
DISTRIBUTION OF DEVONIAN-MISSISSIPPIAN BEDS



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The preparation of this manuscript was made possible through the cooperation of a number of people. W. E. Moore acted as chairman of the thesis committee. B. N. Cooper contributed suggestions concerning the field work and read the manuscript. J. E. Sanders spent two days in the field with the writer reviewing the regional aspects of the stratigraphy. G. A. Cooper and J. S. Williams gave freely of their time in checking identifications of fossils. W. D. Lowry and R. V. Dietrich contributed valuable suggestions and aid concerning special problems. The writer wishes to express grateful appreciation to all of these people who gave of their time and energy without stint.

REVIEW OF PREVIOUS WORK

The first description of Upper Devonian and Lower Mississippian beds in the southern Appalachian region was given by W. B. Rogers and H. D. Rogers (1836). While W. B. Rogers worked in Virginia, his brother, H. D. Rogers, the first state geologist of Pennsylvania, was describing the Paleozoic strata of that State. Working independently they came to similar conclusions, the first publication of their work appearing in 1836. This report of progress (1836, pp. 12-16) presented a series of Arabic numbers used to designate the Paleozoic "formations". The next report (1838, p. 18) set forth a series of Roman numerals to replace the previous system, and added one more numeral to include the lower Cambrian clastics not recognized before. Twenty years later (1858, pp. 104-109) they substituted a curious system of anglicized Latin divisions of the

day and night for the Roman numerals. These names made little impression

Rogers Brothers 1858

Rogers Brothers 1836

Primal Series	I
Aroral "	II
Matinal "	III
Levant "	IV
Surgent "	V
Scalent "	VI
Pre-Meridian	VII
Meridian "	VIII
Post-Meridian	VIII (Schoharie? to Chemung)
Cadent "	IX (Catskill)
Vergent "	X (Pocono)
Ponent "	XI
Vespertine	XII and XIII
Umbra "	
Seral "	

and soon lapsed into disuse. M. R. Campbell (1894, p. 177) introduced the name "Price sandstone" for Vespertine. The name was taken from Price Mountain, Montgomery County, Virginia, where the sandstone is conspicuously exposed. No measured type section was given. Campbell discarded the lithologic designation later (1925, pp. 23-28), and named it the Price formation as it is known today. References to the Price formation are made by G. W. Stose (1923, pp. 53-56) and H. P. Woodward (1932, pp. 66-68). B. N. Cooper (1937, pp. 414-431) wrote a comprehensive paper on the Price formation in Virginia, publishing the first faunal list of any significance. Other literature dealing with the Price formation includes, B. N. Cooper (1939, pp. 47-54; 1944, pp. 145-151), and Charles Butts (1940, pp. 336-350). D. B. Reger (1926, p. 205) attempted to subdivide the Price formation in southwestern Virginia and West Virginia. J. H. Swartz's papers on the age of the black shales in southwestern Virginia and Tennessee (1924; 1926; 1929) seem to be of doubtful value in clarify-

ing the stratigraphic relationships of these shales. Confusion exists on the number of shales present, on the correctness of identification when black shale names are used away from type localities, and on age relationships of the black shales.

The type section for the Chemung formation occurs at Chemung (upper) Narrows, eleven miles below Elmira, New York. This series of Upper Devonian sandstones and shales was named and described by James Hall (1839, pp. 322-326). Beds of Upper Devonian age in Virginia having similar lithology have been referred to as "Chemung" by Charles Butts (1933, p. 34) and others. G. H. Chadwick (1935, pp. 857-862) demonstrated the type Chemung to be a facies of the "Upper Portage" division of the Senecan Series. It is now believed that the "Chemung formation" in Virginia represents, at least in part, beds younger than those of the New York succession (G. A. Cooper and others, 1942, p. 1734, and chart). B. N. Cooper (1939, pp. 46-47; 1944, pp. 139-143) describes the "Chemung formation", but recognizes the impropriety of that name. Charles Butts (1940, pp. 322-333) also gives a description of the "Chemung formation" and includes several measured sections.

STRATIGRAPHY

Since M. R. Campbell (1894, p. 177) first described the "Price sandstone", its lower limit, and the Devonian-Mississippian boundary, has generally been regarded to be marked by the Cloyd member lying at its base. In areas where the Cloyd member (usually conglomeratic) is absent or was not recognized, the base of the Price formation and therefore the systemic boundary, was placed considerably lower. The writer's study

proves that the Cloyd member is younger than the oldest Mississippian beds found in the area covered by this report. Underlying the Cloyd member is a thick sequence of rusty weathering, marine, alternating sandstone flags and silty shales. This sequence is referred to here as the Parrott formation because of its prominent exposure at Parrott, Pulaski County, Virginia. The Parrott formation has been included in the Price formation in the past whenever the Cloyd member was not recognized, and when the base of the Price formation was determined on fossil evidence. Where the Cloyd member is well developed it was recognized as the base of the Price formation, and the underlying Parrott formation included in the "Chemung formation". The Parrott formation is characterized by a Camarotoechia-Chonetes fauna, the upper part of which carries Allorhynchus and Pseudosyrinx, two genera indicative of the Mississippian.

Underlying the Parrott formation is the great thickness of Upper Devonian clastics known as the "Chemung formation". This formation, as defined by Butts (1940, pp. 322-333), had its upper limit at the base of, but possibly including, the Broadford formation at Broadford, Virginia. Of the section in Montgomery County, Virginia, Butts (1940, p. 343) said:

".... coal beds are about 1000 feet above the base of the formation (Price formation) marked by the contact of the conglomerate member and the underlying Devonian sandstone ("Chemung formation")....."

The conglomerate indicated by Butts in the above quotation overlies 492 feet of the Mississippian Parrott formation. It is evident that in Montgomery County at least, Butts included a considerable thickness of Mississippian beds in the "Chemung formation".

The Broadford sandstone was considered by Reger to be of Mississip-

pian age. This writer has traced the Broadford sandstone from its type locality at Broadford, Virginia, to Blacksburg, Virginia, and determined its age to be Devonian. At the type locality the sandstone is barren of fossils, however, at a distance of ten miles to the northeast the Broadford sandstone contains a fauna of unmistakable Devonian types, the most abundant representative of which is Cyrtospirifer disjunctus. In other areas Reger confused the "Broadford sandstone" with much younger beds than those of the type section.

DEVONIAN SYSTEM

Senecan and Chautauquan Series

The youngest Devonian beds in southwest Virginia between Blacksburg and Broadford consist of a thick body of sandstones and shales with a maximum thickness of about 2000 feet. These beds were identified by Butts (1933, p. 34) as the "Chemung formation" because of their similarity to the New York Chemung.

The sandstones of the "Chemung formation" range from coarse to medium grained. Some are carbonate-cemented, feldspathic, or hematitic. Generally the calcareous beds are sideritic, and weather to the characteristic rusty coloring that is associated with the Upper Devonian beds in Virginia. The feldspathic beds become more frequent near the top of the Devonian sequence, and some of these beds may properly be considered arkoses. Both orthoclase and plagioclase feldspar are present. The extremely hard, red sandstones in the upper part of this sequence are generally medium to fine grained, and derive their coloring from a hematitic cement. Shales are silty and poorly fissile.

Butts considered the lower boundary of the "Chemung formation" to be in the zone of first appearance of large Chemung-type fossils, above the fissile shale of the underlying Brallier formation. The lithological change from the Brallier to the "Chemung" is gradational. "Chemung" lithology is marked by a decrease in fissility of the shales, and the appearance of sandstone flags alternating with the shales. These beds persist upwards to within 200 feet of the top of the Devonian in southwestern Virginia, and are lithologically very similar to the marine beds of the Parrott formation. The upper 200 feet of the Devonian succession is composed of medium to thick bedded, reddish-gray sandstone.

The fossils of the "Chemung formation" are dispersed throughout the succession; however, coquina-like zones of fossils are present and are especially numerous near the top of the succession. Preservation of the inner silky layer indicates the presence of original shell material. When exposed the calcite weathers easily, and the resulting casts emphasize fossil zones. Butts (1940, pp. 329-332) has listed a large fauna for these beds representing several years of collecting. His collections were taken largely from float, however, and no attempt was made to assign fossils to particular zones. Fossils identified by the writer were taken from the upper 200 feet of the Devonian sequence, and will be discussed in conjunction with the Broadford formation.

Use of the name "Chemung" in Virginia has implied a more precise correlation with the New York succession than the evidence warranted. Geologists working in the New York and Pennsylvania Devonian have recognized the influence of facies changes along time lines, and this is reflected in the fact that few formation names are used at considerable

distances from their type localities. The Chemung of New York has now been elevated to stage rank (Cooper, G. A., et. al., 1942), keeping the same time limits that Chadwick gave the group, i.e., Upper Senecan. The "Chemung" of southwestern Virginia is thought to rise as high as the upper Cassadaga (G. A. Cooper, and others, 1942, Devonian Correlation Chart). The absence of a Catskill red-bed facies, the Hampshire formation of northern Virginia, in the southwestern counties of Virginia is generally considered to indicate an unconformity at the top of the Devonian. It is significant that no positive physical evidence has yet been presented to support this opinion.

Broadford Sandstone

Within the area covered by this report the upper 200 feet of the Devonian beds previously included in the "Chemung formation" are marked by an increase in thickness and frequency of sandy layers. These sandstones are generally coarser than the beds immediately above or below them, and individual layers range in composition from carbonate-cemented quartz sands to true arkoses. At Broadford, Smyth County, Virginia, the type locality, this sandstone is conspicuously exposed. The section crops out along State Route 91, where the gorge of Laurel Creek passes through Pine Mountain. At this locality the Broadford sandstone is very coarse grained, and because of its greater resistance is the ridge-maker of Pine Mountain. Ten miles to the north on State Route 16, at the crest of Little Brushy Mountain, the Broadford sandstone loses its identity as a ridge-maker, being secondary to the younger Price formation and Cloyd member. The relationship described on State Route 16 holds true in the

Little Walker-Cloyd-Brushy Mountain belt of outcrop to the northeast.

Fossils were collected from all sections of the Broadford sandstone except the type section, where only a single alate Chonetes was found. Specimens identified include Chonetes, Camarotoechia contracta?, Productella, Thiemella, Schuchertella, Cyrtospirifer disjunctus, Cyrtospirifer disjunctus sulcifer, Mytilarca, Leptodesma, a branching bryozoan (Rhombo-pora?), and abundant crinoid columnals. This is a typical Upper Devonian fauna. The brachiopod Cyrtospirifer disjunctus var. sulcifer is a very distinctive variety of the species that seems to be restricted to the Conewango Stage of the Upper Devonian. K. E. Caster (1930, p. 28), reports it as common in the Broadfordian of New York and Pennsylvania. Most of the associates of this fossil are found in the New York and Pennsylvania beds. The evidence strongly suggests a Conewango age for the Broadford sandstone, making it the youngest marine Devonian formation in southwestern Virginia with the possible exception of the black shales south of Smyth County, Virginia.

The term "Broadford" was first used by Reger (1926, p. 520), the section along State Route 91 being the type locality. In extending the name to other localities in Virginia and West Virginia, he consistently correlated with the Broadford sandstone, sandstones in the younger Parrott and Price formations which contain Syringothyris and other Mississippian forms. An intensive examination of the type section by the writer yielded only a single Chonetes; certainly no Price fossils occur there. Although the Broadford sandstone at its type locality is apparently devoid of diagnostic fossils, it is within a succession of fossiliferous beds and distinctive lithologies that make it possible to fix its position in other

sections. The following section was measured at Broadford, Virginia.

Geologic Section 7. - Price, Parrott, and Broadford formations; State Highway 91, along the gorge of Laurel Creek just north of Broadford, Smyth County, Virginia.

Thickness
Feet

Price formation

7. Shale, fine grained, bluish-black. 5+

Cloyd member (48 feet)

6. Sandstone, medium grained, feldspathic, thick bedded;
2 feet of conglomerate in middle of interval. 48

Parrott formation (207 feet)

5. Concealed interval. 15
4. Sandstone flags and shale. 25
3. Sandstone, reddish-gray on weathered surface, beds
1 foot thick: abundance of Fenestrellina. 7
2. Sandstone flags and shale partings, individual sandstone
beds becoming thicker; contains Chonetes, Syringothris
Pseudosyrinx, Leptaena, and Fenestrellina. 150

Broadford sandstone (190+ feet)

1. Sandstone, coarse-grained, reddish-gray, feldspathic;
lenses of conglomerate in upper part. 190+

At the crest of Little Brushy Mountain, a few miles west of Chatham Hill, Virginia, the same beds are represented, but in a much thinned sequence.

Geologic Section 6. - Price, Parrott, and Broadford formations; State Route 16, at the crest of Little Brushy Mountain a few miles west of Chatham Hill, Smyth County, Virginia.

	Thickness Feet
Price formation	
4. Shale, fine grained, bluish-black.	18
Cloyd member (27 feet)	
3. Sandstone, massive, medium grained; contains <u>Chonetes</u> , <u>Camarotoechia</u> , <u>Spirifer</u> , <u>Syringothyris</u> , <u>Aviculopectin</u> , small high spired gastropods (<u>Loxonema?</u>), and several poorly preserved corals.	27
Parrott formation (105 feet)	
2. Sandstone flags and shale, abundant <u>Chonetes</u>	105
Broadford sandstone (25+ feet)	
1. Sandstone, medium to thick bedded; contains <u>Chonetes</u> , <u>Cyrtospirifer disjunctus</u> , and <u>Mytilarca</u>	25+

The Broadford sandstone here, as in the type locality, is the first massive sandstone above a locally developed secondary sandstone ridge maker in the upper Brallier formation (Devonian). The entire sandstone succession on Little Brushy Mountain exhibits a marked decrease in size of grains, and a general thinning of individual beds relative to beds in the section at Broadford. The fine-grained bluish-black shale at the top of the Cloyd member serves as an excellent key bed in correlating the two sections. The two sections compare well in both lithology and fossils.

The fauna of the Broadford sandstone on Little Brushy Mountain indicates unmistakably its Devonian age.

MISSISSIPPIAN SYSTEM

Kinderhookian and Osagean Series

Parrott Formation

The type section for the Parrott formation is located in the Norfolk and Western Railway cut, near a signal light and switch box, about half a mile north of Parrott, Pulaski County, Virginia. Here it is limited above by thick beds of conglomerate in the Cloyd member, and limited below by the massive sandstone beds of the Broadford sandstone which contain large Devonian Cyrtospirifers.

Within the area covered by this report the Parrott formation is composed of rusty weathering, marine, alternating sandstone flags and shales, with a few lenses of more massively bedded sandstone 1 to 3 feet thick. It is bounded above by the Cloyd member, and limited below by the Broadford sandstone. The maximum thickness measured for the Parrott formation was 601 feet in the Draper Mountain area (Geologic Section 5), and the minimum thickness was 105 feet on Little Brushy Mountain (Geologic Section 6). The flagstones are composed of fine to medium grained quartz sand. In general the sand grains are angular and well sorted. Orthoclase and plagioclase feldspar are present, and the cementing material may be either carbonate or hematite. The shales are mostly silty and poorly fissile.

The fauna of the Parrott formation is primarily a Camarotoechia-Chonetes fauna, these genera being by far the most abundant. Other

fossils identified include; a small Syringothyris, Pseudosyrinx, Allorhynchus, Productella cf. P. concentrica, Spirifer, Platyceras, Aviculopectin, Loxonema?, Leptodesma, Fenestrellina, and fragments of corals.

All of the marine fossils listed for the Price formation have undoubtedly been taken from the Parrott formation. Butts supported an Osagean age for this fauna, and undoubtedly the upper part of the Parrott formation is of that age. However, the list above (and Butts') contains a number of genera belonging to the Hamburg fauna found in the Bedford shale, the Glen Park limestone, the Hamburg colite, the top of the New Albany shale, and the Louisiana limestone, which are generally regarded as Mississippian Kinderhook in age. G. A. Cooper (1942, p. 1762) discusses the equivocal nature of this fauna, and names the Devonian elements; Atrypa, Nucleospira, Productella, "Delthyris", Cypricardella, Sphenotus, and Pholadella. The Mississippian elements, according to Cooper are: Spirifer (S. marionensis type), "Goniatites", and Syringothyris. He points out that the latter is a well established Devonian fossil in New York and Pennsylvania. K. E. Caster (1934, p. 163) considers the Bedford Syringothyris as definitely a Mississippian form. He believes that the Devonian elements are a modified "recurrent" Hamilton fauna, that are only a minor part of the Bedford fauna when compared with the Mississippian elements. When Caster compared the Bedford fauna with the fauna of the Knapp formation of Pennsylvania (a more easterly equivalent), he found that the Devonian elements were absent while all of the Mississippian elements were present. Caster believed that both the Bedford shale and the Knapp "formational suite" were Lower Kinderhookian, and not Devonian.

None of the Devonian elements found in the fauna of the Parrott for-

mation are known to be restricted to the Devonian, however, two genera, Pseudosyrinx and Allorhynchus, are restricted to the Mississippian. These are the only two fossils found in the Parrott formation that seem to be excluded in the lists for the Hamburg fauna. B. N. Cooper (1939, p. 52) reported the presence of Munsteroceras in the lower Price (Parrott) formation, and A. K. Miller (1936) described a specimen of Protocanites lyoni from the same beds. Both of these goniatite genera occur in the type Kinderhookian. J. M. Weller and others (1948, p. 116) say:

"...to the east, Protocanites occurs in association with Imitoceras in the Cuyahoga Group of Ohio and in association with Munsteroceras in the lower part of the Price formation of southwestern Virginia; at both these localities the containing beds are almost certainly Kinderhookian in age, ..."

In a negative manner it is significant that no clear evidence has ever been presented for a physical break of such major proportions as the absence of the entire Kinderhookian at the systemic boundary. Physically and faunally the entire succession from the Broadford sandstone to the lower Price formation is essentially transitional.

Price Formation

H. R. Campbell (1894, p. 177) named the Price "sandstone" from Price Mountain, Montgomery County, Virginia. The name is practically synonymous with the Pocono formation of northern Virginia.

The Price formation is a coarse grained, generally light-colored, cross bedded, arkosic sandstone. It is nonmarine, contains abundant plant fossils and, in southwestern Virginia, contains three coal beds. The James River is generally considered the dividing line for Price and Pocono usage as formational names. North of Bath County, Virginia, the Pocono

formation rests directly on the Hampshire red beds of Devonian age. Southwest of Bath County the Price-Pocono lithology is gradually supplanted by the marine Parrott formation, of Mississippian age.

No measured sections were made, for the purposes of this report, in the Price formation. However, it is important to note that the Price or Pocono is undoubtedly the oldest Mississippian formation present in northeastern areas of the State. The Price formation thins in a southwesterly direction from possibly 1500 feet in Montgomery County, to about 100 feet in Smyth County, Virginia. A succession of marine sandstone flags and shales, named the Parrott formation in this report, supplants all but the upper part of the Price formation in southwestern Virginia. Where the Price formation is present it is always younger than the Parrott formation. The Price formation is not the oldest Mississippian formation in southwestern Virginia, and its base can not be considered the systemic boundary.

Cloyd Member

The Cloyd member of the Price formation was named by Charles Butts (1933, p. 36) for its conspicuous exposure on Cloyd Mountain, Pulaski County, Virginia. Previously the name "Ingles conglomerate" had been applied to the same beds by M. R. Campbell (1894, p. 177), because of the presence of a similar conglomerate on Ingles Mountain, Montgomery County, Virginia. Butts noted the presence of Orthorhynchula linneyi (= O. stervensoni), the chief guide fossil of the top of the Martinsburg formation, in the beds immediately below the "Ingles conglomerate", and concluded that the "Ingles" was the Clinch sandstone of Silurian age. Butts (1940,

p. 343) defined the Cloyd conglomerate member as follows:

"The conglomerate member of the Price, lying at its base, is a coarse-grained, white quartz sandstone having lenses and layers of conglomerate with white quartz pebbles as much as $1\frac{1}{2}$ inches in diameter."

No measured sections or statement of thickness were given. In the writer's experience the Cloyd member is usually a massive sandstone, similar to the overlying Price beds, of which it is a part, containing lenses of white quartz pebble conglomerate. Most of the pebbles are quartzite, but some are vein quartz, granite, and even greenstone. The number of conglomerate lenses ranges from none in the Little Brushy Mountain Section (Geologic Section 6), to at least three in the Dublin, Parrott, and Blacksburg sections. The thickest lense of conglomerate, 17 feet thick, was measured at the Parrott Section. At this locality white quartz pebbles quarter of an inch to 2 inches in greatest diameter were noted. Ripple marks were well developed on the top of the bed, and the base showed evidence of considerable scour and fill in the underlying sandstone and shale. The Cloyd member reaches its maximum development as a conglomeratic zone in the Dublin, Parrott, and Blacksburg sections, thinning in all directions away from this restricted belt of outcrop.

The Cloyd member is an integral part of the Price formation. It lies at the base of the Price formation, it is nonmarine, and it is genetically related to the overlying beds of the Price.

The Cloyd member of the Price formation does not mark the base of the Mississippian succession. Although Butts states that it does, he has drawn the lower limit of the Price formation 435 feet below the Cloyd mem-

ber in the Broadford section (Butts, 1940, p. 340). The true stratigraphic position of the Cloyd member is at the base of the Price formation, and above the Mississippian Parrott formation.

Correlations With the Grainger Shale of Tennessee

M. R. Campbell (1894, Estillville Folio No. 12) used the name "Grainger shale" for the rusty weathering, marine, sandstone flags and shales that were bounded above by the Newman limestone, and limited below by a black shale. Campbell recognized the youngest black shale in the area as belonging to the Chattanooga shale, but Keith (1896, Morristown Folio, No. 27) did not. Wherever Keith saw the younger and thinner of the two black shales in northeastern Tennessee he inferred a thrust fault resulting in a repetition of older beds. The obvious result of this was that Keith had included older beds in the Grainger shale than Campbell had. Campbell understood the true succession, and since his usage has priority it should be followed.

The name "Grainger" has not been used in Virginia since M. R. Campbell proposed the name "Price". Undoubtedly the Grainger shale contains beds in common with the Price formation, the Parrott formation, and the Broadford sandstone. The Grainger is generally conceded to span the systemic boundary. Descriptions of the lithology and fauna of the Grainger shale compare well with the Virginia succession. The lower "Newman limestone" is actually the Maccrady shale that overlies the Price formation in Virginia. All of the black shale succession underlying the Grainger shale in Tennessee is not present in the area covered by this report, and

exact correlations between Virginia and Tennessee must await more detailed examination of the area between Broadford, Virginia and the State line.

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APPENDIX I

Measured Geologic Sections

Geologic Section 1. - Price, Parrott, and Broadford formations; U.S. Route 460, at the crest of Brush Mountain, 5 miles west of Blacksburg, Montgomery County, Virginia.

	Thickness Feet
Price formation	
Cloyd member (62 feet)	
5. Conglomerate, angular to subrounded quartzite pebbles quarter of an inch in diameter.	3
4. Covered interval, conglomerate float 1 foot thick in lower third.	53
3. Conglomerate, pebbles well rounded, flattened, sandy matrix.	6
Parrott formation (492 feet)	
2. Section mostly covered. Sandy flags and silty shale, with some chocolate and buff colored sandstone intervals 1 to 3 feet thick. Contains <u>Camarotoechia</u> , <u>Chonetes</u> , and scattered pelecypods and plant fragments.	492
Broadford formation (150+ feet)	
1. Sandstone; medium to thick bedded, mostly coarse grained, very resistant; upper part somewhat feldspathic, some beds limy; buff, chocolate and gray on outcrop. Con- tains <u>Cyrtospirifer disjunctus sulcifer</u> , <u>Schucertella</u> ,	

Thickness
Feet

Goniatites, Thienella, Leptodasma, and crinoid

columnals. 150

Geologic Section 2. - Price, Parrott, and Broadford formations; Norfolk
and Western Railway cut, along New River, half a
mile west of Parrott, Pulaski County, Virginia.

Price formation

Cloyd member (77 feet)

- | | |
|---|----|
| 17. Conglomerate, subrounded quartzite pebbles in fine matrix. | 6 |
| 16. Sandstone, massive, crossbedded and micaceous. | 40 |
| 15. Shale, silty with rude laminations. | 9 |
| 14. Conglomerate. | 1 |
| 13. Shale, silty. | 4 |
| 12. Conglomerate, white quartz pebbles quarter of an inch to 2 inches on greatest diameter, flattened. Ripple marks on top of bed; scour and fill at base. | 17 |

Parrott formation (468 feet)

- | | |
|--|----|
| 11. Sandstone flags and shales interbedded. | 8 |
| 10. Sandstone, cross bedded. | 3 |
| 9. Sandstone and shales interbedded; <u>Camarotoechia</u> and <u>Goniatites</u> in abundance, some pelecypods, and plant fragments. A few 1 inch conglomerate lenses. | 71 |
| 8. Sandstone, concretionary and purplish. | 4 |

Thickness
Feet

7. Section mostly covered. Scattered sandstone beds
1½ feet thick. 70
6. Sandstone, micaceous and chocolate colored. 8 distinct
Camarotoechia and Chonetes zones. 47
5. Section mostly covered; scattered massive sandstone
beds 1 foot thick. Fucoid markings on surface of beds. 50
4. Scattered sandstone beds 1 foot thick, interval
mostly covered. 130
3. Sandstone, resistant; weathers buff, gray, and brown.
Contains Productella cf. P. concentrica, Chonetes,
Camarotoechia, and Leptodesma. 70
2. Covered interval. 15

Broadford formation (200+ feet)

1. Sandstone, very resistant; contains Cyrtospirifer
disjunctus. 200

Geologic Section 3. - Price, Parrott, and Broadford formations; Along
State Highway 100, at the crest of Cloyd Mountain,
five miles west of Dublin, Pulaski County, Virginia.

Price formation

Cloyd member (63 feet)

20. Conglomerate, quartz pebbles quarter of an inch to
2 inches thick; grades into iron stained sandstone. .. 3½
19. Covered interval. 1

	Thickness Feet
18. Sandstone, very hard.	1
17. Shale, thin bedded, blue.	12 $\frac{1}{2}$
16. Conglomerate, iron stained.	$\frac{1}{2}$
15. Shale.	1
14. Conglomerate, graded bedding; pebbles 2 inches greatest diameter.	12
13. Covered interval.	15 $\frac{1}{2}$
12. Sandstone, hard, white, sugary.	5
11. Shale, thin bedded, silty, weathers light blue; some sandstone interbeds.	6
10. Sandstone, dense, black, with 1 $\frac{1}{2}$ feet conglomerate at base.	5

Parrott formation (518 feet)

9. Shale, thin bedded, silty, drab green and buff.	25
8. Sandstone, medium grained, feldspathic, chocolate colored.	5
7. Sandstone with shale interbeds; carries <u>Camarotoechia</u> , <u>Chonetes</u> , an orbiculoid brachiopod, and <u>Leptodesma</u> . ..	57
6. Sandstone with shale interbeds, sandy beds becoming thicker bedded; upper 20 feet concretionary.	144
5. Covered interval.	111
4. Sandstone and shales interbedded; <u>Camarotoechia</u> and <u>Chonetes</u> , some pelecypods.	131

Thickness
Feet

3. Sandstone, massive; Camarotoechia, Chonetes,
Productella cf. P. concentrica, Aviculopectin, and
Leptodesma. 18
2. Sandstone and shale interbedded. 28

Broadford formation (200+ feet)

1. Sandstone, massive, coarse grained, and feldspathic;
carries Cyrtospirifer disjunctus. 200

Geologic Section 4. - Price, Parrott, and Broadford formations; U.S. Route
52, just north of bridge over Reed Creek, six miles
west of Wytheville, Wythe County, Virginia.

Price formation

14. Shale, sandy, thin bedded, and micaceous; lower 15
feet finer grained, blue-gray, dirty weathering shale. 35

Cloyd member (87 feet)

13. Sandstone, massive, and resistant. 16
12. Sandstone, calcareous, weathers easily. 1
11. Sandstone, includes lense of conglomerate with
quartzite and sandstone pebbles and cobbles, 1 foot
thick. 25
10. Sandstone, with several 1 to 4 foot intervals of
bluish-black silty shale, and 8 inch conglomerate. ... 45

Parrott formation (325 feet)

9. Sandstone flags and shale. 16

	Thickness Feet
8. Sandstone.	8
7. Sandstone flags and shale; carries <u>Chonetes</u> , <u>Camarotoechia</u> , <u>Syringothyris</u> , <u>Allorhyncus</u> , and a small spirally coiled gastropod.	65
6. Sandstone, blue.	1
5. Sandstone, cobbly, and shale; <u>abundant Chonetes</u>	56
4. Covered.	67
3. Sandstone flags and shale; 1 foot bed of dark colored shale.	72
2. Sandstone flags and shale, some red sandstone layers; <u>Chonetes</u> abundant.	40

Broadford formation (40 feet)

1. Section noticeably more resistant, individual sand-
stone layers are thicker and more numerous; some shale
interbeds; carries Cyrtospirifer disjunctus. 40

Geologic Section 5. - Price, Parrott, and Broadford formations; U.S. Route
11, beginning with culvert on west side of Draper
Mountain, one mile south of Pulaski, Pulaski County,
Virginia.

Price formation

Cloyd member (20+ feet)

9. Sandstone, hard, bluish and buff colored, medium to

Thickness
Feet

thick bedded; conglomerate float one foot thick
in culvert. 20

Parrott formation (601 feet)

8. Sandstone, thin bedded, separated by intervals of
silty shale. 83
7. Sandstone, medium to thick bedded; gray, brown, and
bluish on weathered outcrop. 97
6. Sandstone, thin bedded, limy; dark purplish cast. 18
5. Sandstone flags and silty shale, rusty weathering. ... 50
4. Sandstone, medium bedded; carries Chonetes,
Camarotoechia, Syringothyris, Leptodesma, and small,
high spired gastropods. 38
3. Sandstone flags and shale. 211
2. Sandstone, thin to medium bedded, very limy; carries
Chonetes, small, high spired gastropods, (Loxonema?)
and a large planospirally coiled cephalopod. 104

Broadford formation (250+ feet)

1. Sandstone, massive, limy to arkosic, bluish cast on
fresh surface; carries Cyrotospirifer disjunctus var
sulcifer, Thiemella, Schucertella, several productel-
lid-type brachiopods, and Leptodesma?. 250+

This section is particularly interesting in that it is one of the
more easterly developments of the Price formation in southwestern Virgi-

nia, and is very well exposed. The Cloyd horizon here has thinned considerably, and the conglomerate itself is seen only as float. The Parrott formation is very thick and marine fossils occur in fully 50% of the beds throughout the whole succession. Some plant fragments were found in the succession, and the lower third is distinctly limy. The Broadford probably reaches its maximum thickness in the Draper Mountain area, and here the fauna includes a large number of species.

Geologic Section 6. - Price, Parrott, and Broadford formations; State Route 16, at the crest of Little Brushy Mountain a few miles west of Chatham Hill, Smyth County, Virginia.

Thickness
Feet

Price formation

4. Shale, fine grained, bluish-black. 18

Cloyd member (27 feet)

3. Sandstone, massive, medium grained; carries Chonetes, Camarotoechia, Spirifer, Syringothyris, Aviculopectin, small high spired gastropods (Loxonema ?), and several poorly preserved corals. 27

Parrott formation

2. Sandstone flags and sandy shale, abundant Chonetes. .. 105

Broadford formation (45+ feet)

1. Sandstone, medium to thick bedded; contains Chonetes, Cyrtospirifer disjunctus, and Mutillarca. 45+

Geologic Section 7. - Price, Parrott, and Broadford formations; State Highway 91, along the gorge of Laurel Creek just north of Broadford, Smyth County, Virginia.

Thickness
Feet

Price formation

7. Shale, fine grained, bluish-black. 5+

Cloyd member (48 feet)

6. Sandstone, medium grained, feldspathic, thick bedded;
2 feet of conglomerate in middle of interval. 48

Parrott formation (207 feet)

5. Concealed interval. 15
4. Sandstone flags and shale. 25
3. Sandstone, reddish and gray on weathered surface, beds
one foot thick; abundance of Fenestrellina. 7
2. Sandstone flags and shale partings, individual sandstone
beds becoming thicker; carries Chonetes, Camarotoechia,
Syringothyris, Pseudosyrinx, Leptaena, and Fenestrel-
lina. 150

Broadford formation (190+ feet)

1. Coarse grained, reddish gray, feldspathic sandstone;
conglomeratic. 190+

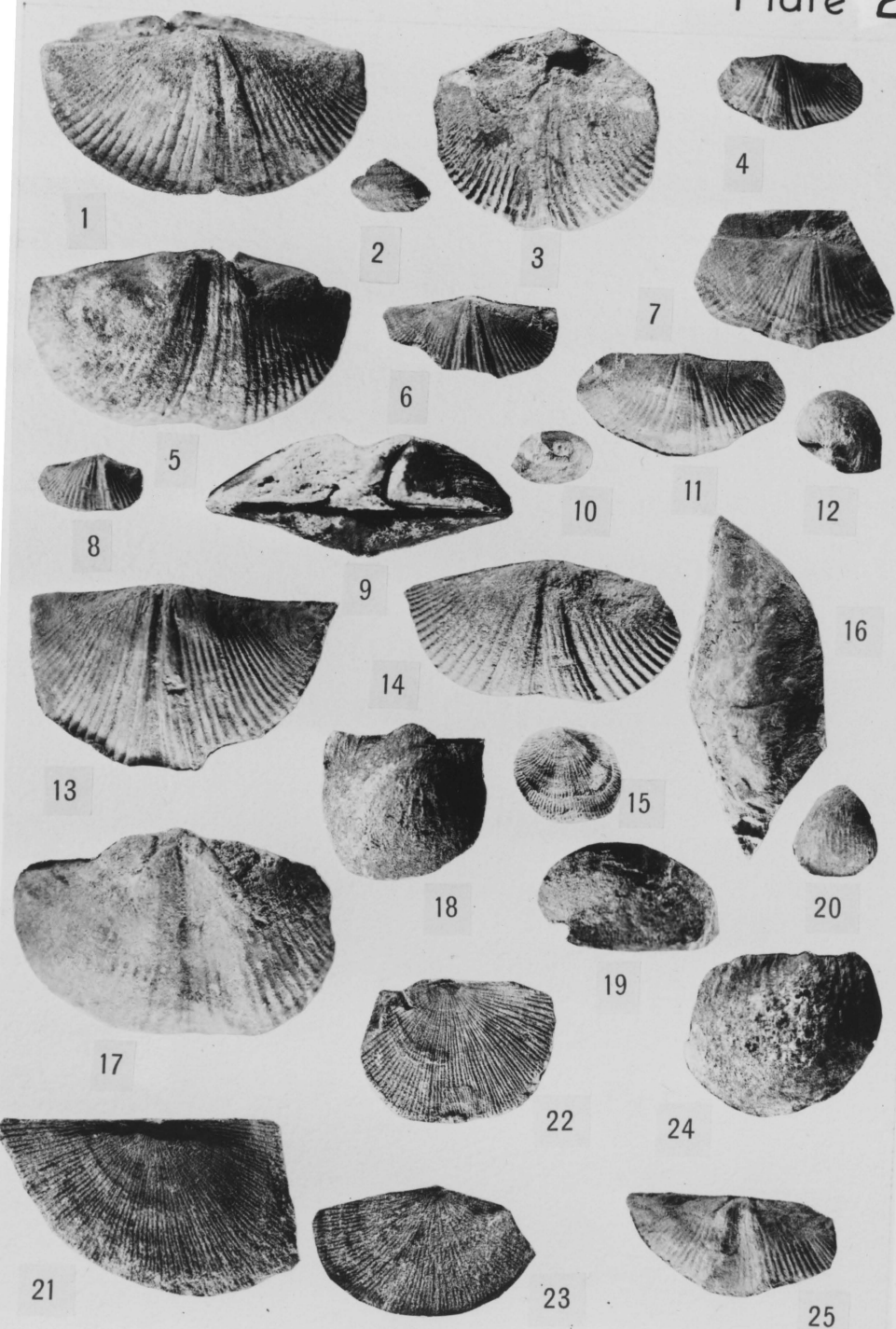
Explanation of Plate 2.

Broadford Fossils

All figures on this plate are natural size.

FIGURE

1. Cyrtospirifer disjunctus var sulcifer (Hall). Dorsal valve showing sinus in the fold. Broadford sandstone on Brush Mountain along State Route 460, 5 miles west of Blacksburg, Virginia.
2. Gastropod. Unidentifiable. Broadford sandstone on Draper Mountain along U.S. Route 11, 1 mile south of Pulaski, Virginia.
3. Cyrtospirifer disjunctus var. sulcifer (Hall). Dorsal valve.
Locality same as fig. 1.
4. Cyrtospirifer disjunctus (Sowerby). Dorsal valve. Broadford sandstone on Little Brushy Mountain along State Route 16, west of Chatham Hill, Virginia.
5. Cyrtospirifer disjunctus var. sulcifer (Hall). Ventral valve.
Locality same as fig. 1.
6. Cyrtospirifer disjunctus var. sulcifer (Hall). Dorsal valve.
Locality same as fig. 2.
7. Cyrtospirifer disjunctus (Sowerby). Dorsal view showing part of cardinal area. Locality same as fig. 4.
8. Cyrtospirifer sp. Ventral valve. Broadford sandstone on Draper Mountain along U.S. Route 11, 1 mile south of Pulaski, Virginia.
9. Cyrtospirifer disjunctus var. sulcifer (Hall). Posterior view.
Broadford sandstone on Brush Mountain along State Route 460, 5 miles west of Blacksburg, Virginia.



Explanation of Plate 2, continued.

Broadford Fossils

All figures on this plate are natural size.

FIGURE

10. Gastropod. Unidentifiable. Broadford sandstone. Locality same as fig. 8.
11. Cyrtospirifer disjunctus (Sowerby). Dorsal valve. Broadford sandstone on Little Brushy Mountain along State Route 16, west of Chatham Hill, Virginia.
12. Productella lachrymosa? (Conrad). Broadford sandstone. Locality same as fig. 8.
13. Cyrtospirifer disjunctus var. sulcifer (Hall). Dorsal valve. Locality same as fig. 8.
14. Cyrtospirifer disjunctus var. sulcifer (Hall). Dorsal valve. Locality same as fig. 9.
15. Thiemella sp. Impression of dorsal valve. Locality same as fig. 9.
16. Mytilarca sp. Left valve. Broadford sandstone. Locality same as fig. 11.
17. Cyrtospirifer disjunctus var. sulcifer (Hall). Ventral valve. Broadford sandstone on Brush Mountain along State Route 460, 5 miles west of Blacksburg, Virginia.
18. Productella sp. Dorsal view. Broadford sandstone on Draper Mountain along U.S. Route 11, 1 mile south of Pulaski, Virginia.

Explanation of Plate 2, continued.

Broadford Fossils

All figures on this plate are natural size.

FIGURE

19. Productella sp. Side view. Broadford sandstone. Locality same as fig. 18.
20. Productella lachrymosa ? (Conrad). Anterior view. Broadford sandstone. Locality same as fig. 18.
21. Schuchertella sp. Dorsal view. Broadford sandstone. Locality same as fig. 17.
22. Schuchertella sp. Dorsal view. Broadford sandstone. Locality same as fig. 18.
23. Schuchertella sp. Dorsal view. Broadford sandstone. Locality same as fig. 17.
24. Productella sp. Ventral view. Broadford sandstone. Locality same as fig. 18.
25. Cyrtospirifer disjunctus (Sowerby). Ventral view. Broadford sandstone on Little Brushy Mountain along State Route 16, west of Chatham Hill, Virginia.

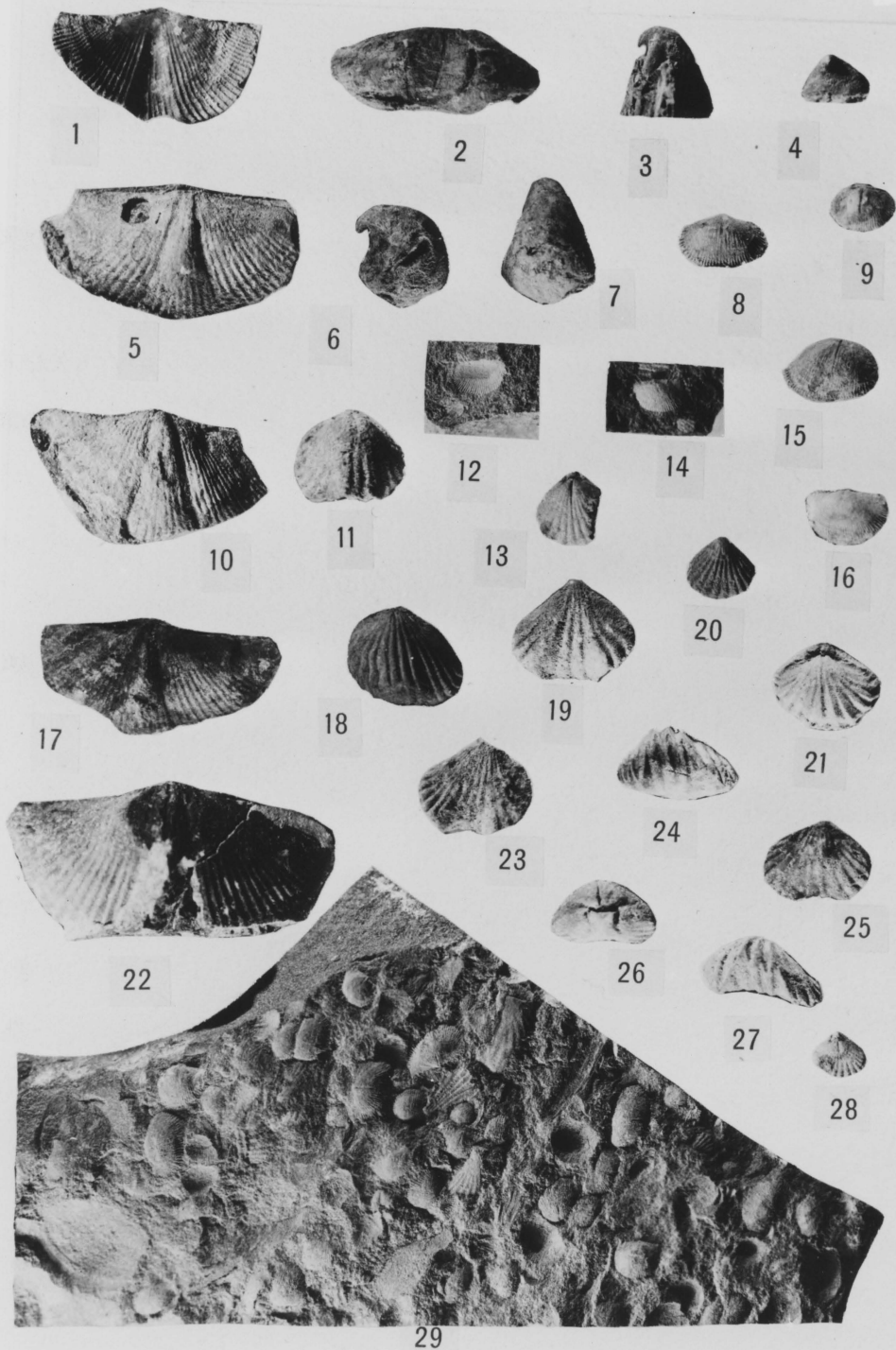
Explanation of Plate 3.

Parrott and Cloyd Fossils

All figures on this plate are natural size.

FIGURE

1. Spirifer sp. Impression of exterior of dorsal valve. Cloyd member on Little Brushy Mountain along State Route 16, west of Chatham Hill, Virginia.
2. Syringothyris? Ventral view showing muscle scar. Cloyd member. Locality same as fig. 1.
3. Platyceras sp. Dorsal view. Cloyd member. Locality same as fig. 1.
4. Platyceras sp. Posterior view. Cloyd member. Locality same as fig. 1.
5. Spirifer sp. Dorsal valve. Cloyd member. Locality same as fig. 1.
6. Platyceras sp. Dorsal view. Cloyd member. Locality same as fig. 1.
7. Platyceras sp. Anterior view. Cloyd member. Locality same as fig. 1.
8. Chonetes sp. Dorsal valve. Cloyd member. Locality same as fig. 1.
9. Chonetes sp. Dorsal valve. Cloyd member. Locality same as fig. 1.
10. Spirifer sp. Dorsal valve. Cloyd member. Locality same as fig. 1.
11. Camarotoechia sp. Dorsal valve. Parrott formation. Cloyd Mountain along State Route 100, 5 miles west of Dublin, Virginia.
12. Chonetes sp. Impression of dorsal exterior showing spines on cardinal margin. Parrott formation near Parrott, Virginia.
13. Camarotoechia sp. Cloyd member on Little Brushy Mountain along State Route 16, west of Chatham Hill, Virginia.



Explanation of Plate 3, continued.

Parrott and Cloyd Fossils

All figures on this plate are natural size.

FIGURE

14. Chonetes sp. Dorsal valve. Parrott formation near Parrott, Virginia.
15. Chonetes sp. Dorsal valve. Parrott formation. Locality same as fig. 13.
16. Chonetes sp. Dorsal valve. Cloyd member. Locality same as fig. 13.
17. Spirifer sp. Dorsal valve. Cloyd member. Locality same as fig. 13.
18. Camarotoechia sp. Dorsal valve. Parrott formation on Cloyd Mountain along State Route 100, 5 miles west of Dublin, Virginia.
19. Camarotoechia sp. Ventral valve. Parrott formation. Locality same as fig. 18.
20. Camarotoechia sp. Ventral valve. Cloyd member. Locality same as fig. 13.
21. Camarotoechia sp. Dorsal view. Cloyd member. Locality same as fig. 13.
22. Spirifer sp. Dorsal view. Cloyd member. Locality same as fig. 13.
23. Camarotoechia sp. Ventral valve. Parrott formation. Locality same as fig. 18.
24. Camarotoechia sp. Anterior view. Cloyd member. Locality same as fig. 13.

Explanation of Plate 3, continued.

Parrott and Cloyd Fossils

All figures on this plate are natural size.

FIGURE

25. Camarotoechia sp. Ventral view. Cloyd member. Locality same as fig. 13.
26. Camarotoechia sp. Posterior view. Cloyd member. On Little Brushy Mountain along State Route 16, west of Chatham Hill, Virginia.
27. Camarotoechia sp. Anterior view. Locality same as fig. 26.
28. Camarotoechia sp. Dorsal view. Locality same as fig. 26.
29. Chonetes sp. and Camarotoechia sp. Parrott formation. Slab showing typical occurrence in Montgomery and Pulaski Counties, Virginia. Near Parrott, Virginia.

Explanation of Plate 4.

Parrott and Cloyd Fossils

All figures on this plate are natural size.

FIGURE

1. Camarotoechia sp. and Chonetes sp. Parrott formation. Slab showing typical occurrence near Parrott, Virginia.
2. Loxonema sp. Cloyd member on Little Brushy Mountain along State Route 16, west of Chatham Hill, Virginia.
3. Orbiculoid brachiopod? Parrott formation. Locality same as fig. 1.
4. Coral. Cloyd member. Locality same as fig. 2.
5. Aviculopectin sp. Cloyd member. Locality same as fig. 2.
6. Camarotoechia sp., Chonetes sp., and Aviculopectin sp. Cloyd member. Locality same as fig. 2.



1



2



3



4



6



5

SYSTEM	SERIES	Stage or Group	COMPARISON OF CLASSIFICATIONS OF DEVONIAN-MISSISSIPPIAN BEDS								
			M.R. Campbell 1925		D.R. Reger 1926		Charles Butts 1940		Interpretations from Devonian and Mississippian Correlation Charts		L. Glover 1952
MISSISSIPPIAN	OSAGEAN		Price formation		Price formation		Price formation		(Weller, and others 1948)	Price formation	
	KINDERHOOKIAN	Easley Group		Ingles cgl.		Broadford ss.		Cloyd cgl.		Price formation	
		Fabius Group								Cloyd cgl.	Cloyd member
											Parrott formation
UPPER DEVONIAN	BRADFORDIAN (part)	Conewango									Broadford sandstone
	CHAUTAUQUAN	Cassadaga	"Devonian shale and sandstone"						(G.A. Cooper and others 1942)	"Chemung"	Devonian shales and thin bedded sandstones
	SENECAN (Upper)	Chemung		Chemung formation		Chemung formation					

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