ART. LXI.—*The Upper Devonian Rocks of Southwest Pennsylvania;* by JOHN J. STEVENSON, Professor of Geology in the University of New York.

THE Vespertine or Pocono sandstone of the Pennsylvania Survey is a massive sandstone from 350 to 450 feet thick in southwestern Pennsylvania, and is the lower division of the Lower Carboniferous rocks. In Fayette and Westmoreland Counties, under Laurel and Chestnut Ridges, the last of the Alleghany Ridges toward the west, the Vespertine sandstone rests immediately upon a mass of gray to reddish-gray sandstones, interstratified with red to gray and olive shales.

These, representing the upper portion of the Devonian, are well exposed in the gaps of the Conemaugh River through the two ridges, as well as in the similar gaps made by the Youghiogheny River. In Laurel Ridge there are a few imperfect exposures in the deeper gorges made by the larger streams within Westmoreland and northern Fayette. In Chestnut Ridge there are no exposures of the Devonian in Westmoreland County, but in Fayette, south from the Youghiogheny River, these rocks are shown in the gap made by Dunbar Creek, as well as on the National Road, and in the deep gorges made by Shute's Run, Redstone Creek and the principal tributaries to Sandy Creek.

Lithologically, the transition from the Vespertine or Pocono sandstone to the Devonian rocks is sufficiently distinct. The great sandstone breaks down into a sandy shale, interstratified with some argillaceous shale, which in turn becomes merged into the well-defined red-gray to olive shales and sandstones representing the Upper Devonian. During the hasty examination of 1876, I was unable to make any close study of the section, and so provisionally regarded the lower rocks as belonging to the same series with the upper. This conclusion was given in my report to Professor Lesley for 1876. But the examinations made in the several gaps during 1877 showed the previous conclusion to be erroneous, and that the lower portion of the section from the very base of the Pocono sandstone is Devonian and not Lower Carboniferous.

A general section of the Devonian rocks, as observed in the gaps mentioned above, is as follows:—

1.	Shales and thin gray sandstones	80 feet.
2.	White to reddish-gray sandstones with some shale	70 "
3.	Reddish-gray micaceous sandstones with red to gray and olive shales	150 "
4.	Red to gray shaly sandstones with variegated clays and shales	200 "
	Total	500 "

Lithologically, the top portion, No. 1 of the section, is a transition mass, more closely related to the overlying than to the underlying rocks. But its relations are clearly shown by the fossils which occur in it. This part of the section is well exposed in the several gaps referred to, as well as on the National Road as it winds up the western side of Chestnut Ridge in Fayette County. At all localities examined it shows the same character, the sandstones are light-gray to brown and in thin beds, while the shales vary from brown to dull blue.

By far the greater part of the rest of the section consists of shale and shaly sandstone, in almost equal proportions and in alternating layers, from two to four feet thick. The sandstones are exceedingly micaceous, and, on the Conemaugh River, are for the most part little more than a compact micaceous mud; but in both gaps of the Youghiogheny there are compact gray sandstones, good enough to be used for building purposes. On the National Road, ten or twelve miles south from the Youghiogheny River, the shale and micaceous sandstones re-appear as on the Conemaugh. These micaceous sandstones are reddish-brown, have a concretionary structure and for the most part break down readily on exposure to the weather. Characteristic fossils are found throughout the section and many of the harder layers have their upper surfaces covered by a close mat of fucoids.

A curious conglomerate, from ten to twenty feet thick, occurs near the middle of the section and seems to be persistent, having been seen under Chestnut Ridge on the Conemaugh and Youghiogheny rivers as well as on the National Road. It is very much like that at the base of the Vespertine or Pocono sandstone, but the pebbles are not flattened and they are much larger than those seen in any other conglomerate exposed within southwest Pennsylvania. They are oval, thoroughly rounded and polished as by long rolling in water. Most of the larger pebbles are quartz, but with them are others of felsite-porphyry, quite soft, which had been blackened exteriorly before they were embedded in the material cementing the mass.

Relations of these Rocks.

In the final report of the First Geological Survey of Pennsylvania, Formation IX, the red Catskill of New York, is mentioned as occurring in the district under consideration. Following that report, I intimated in my second annual report to Professor Lesley that the rocks described in this article might be referred to that formation; on the maps accompanying my third annual report, now passing through the press, the areas are colored as Catskill. This, which was done to pre-

serve unity in the maps of the survey, is not in full accord with the facts.

To determine the relations of rocks one may be guided by lithological characters and relative position, or if possible he may trace the rocks to some typical locality, or should fossils be present he may make his determinations by means of those. For the most part, geologists are satisfied to abide by the last test, as it is of universal application and saves a great expenditure of time and labor. But some geologists are disposed to think the simpler method inaccurate, and seem inclined to rebel against an imagined assumption on the part of paleontologists. It is desirable then to ascertain whether or not the relations of these rocks can be determined by tracing or by lithological characters.

The bold anticlinal axes of southwest Pennsylvania are the Alleghany Mountains, Negro Mountain, the Viaduct axis, Laurel Ridge and Chestnut Ridge, all mountainous for the greater portion of their extent within the State of Pennsylvania. Under these axes alone may one look for exposures of the lower strata, for away from them the surface rocks belong to the Coal Measures.

An exposure under the Alleghanies in Maryland reaches below the Pocono or Vespertine sandstone, but northward there is no described exposure anywhere on the west side of those mountains in Somerset County of Pennsylvania; and, as far as can be ascertained from the report of Mr. Platt's close survey, the deepest gorge on that side is cut down only to the rocks of Formation XI, the Umbral. But in Cambria County, which is immediately north from Somerset, the exposures extend below Formation X, the Vespertine.

Negro Mountain separates itself from the Alleghany Mountains in northern Maryland and passes through Somerset County of Pennsylvania, dying out in southern Cambria, as may be learned from the reports of the Messrs. Platt upon those counties. No exposure in this ridge extends below Formation X.

The Viaduct axis separates itself from the Negro Mountain in northern Maryland and continues as a strong axis through Somerset, Cambria and Clearfield Counties of Pennsylvania. But it nowhere shows anything below the upper portion of Formation X, as appears from the reports made by Messrs. F. and W. G. Platt.

Laurel Ridge, at the line between Pennsylvania and West Virginia, exposes only the upper portion of the Umbral, XI, but at the Youghiogheny River, the upper part of the Devonian is reached, its section being exposed by the railroad cuts. Here and there, northward from the Youghiogheny, a deep

gorge is cut down to the Devonian, but owing to the thick coat of debris, no exposures occur and no section can be obtained south from the Conemaugh River. The fold declines north from that river, so that the gaps made within Cambria County by Chest and Black Lick Creeks reach barely to Formation X, and no gap in Clearfield County, south from that of the west branch of the Susquehanna, seems to expose any lower rock. These facts are gathered from the reports of Messrs. F. and W. G. Platt on Cambria, Somerset and Clearfield Counties, and from my own careful observations in Fayette and Westmoreland.

Chestnut Ridge first shows the Devonian rocks near the National Road in Fayette County, but thence northward the axis diminishes in strength, a given stratum being fully 1,000 feet lower at the Conemaugh than at the National Road. Between that road and the Youghiogheny River, several gorges are cut down to the Devonian, but no section can be obtained until the Youghiogheny River is reached. North from the river, owing to the decline of the axis in that direction, the deepest gorges soon fail to reach the Devonian and no exposure exists between the Youghiogheny and the Conemaugh. North from the Conemaugh the fold still decreases in strength, as is well shown by the fact that the Lower Coals creep constantly higher up its sides, so that the gaps made by Black Lick and other streams cannot do more than barely to reach Formation X, especially since the great Conglomerate of XII thickens very materially in that direction, as abundantly appears from the report on Clearfield County by Mr. Franklin Platt.

There is no exposure whatever for more than fifty miles along the west slope of the Alleghany Mountain; no exposure occurs in Negro Mountain or the Viaduct axis, so that no exhibition of Devonian Rocks appears between the Alleghanies and Laurel Ridge, a distance of twenty-five miles in an east and west direction; there are three exposures within seventy-five miles along Laurel Ridge, the intervals being forty and thirty-five miles; while in Chestnut Ridge there are three exposures within sixty miles, the intervals being ten and thirty-five miles. Surely under such circumstances one may hesitate before accepting any conclusion based on mere stratigraphy.

But is lithology any better? At all exposures to which reference has been made, except those in Clearfield County, respecting which I have no knowledge, rocks more or less similar in appearance are found immediately below Formation X, which is believed to represent the gray Catskill of New York. As they are at the top of the Devonian, they are likely to be

Catskill or Chemung, or to represent both groups, unless indeed those have thinned out. Professor H. D. Rogers thus describes the Chemung and Catskill of Pennsylvania:—

"VERGENT SERIES.

"VERGENT FLAGS (*Portage flags of New York*).—A rather fine-grained gray sandstone in thin layers, parted by thin alternating bands of shale. It abounds in marine *vegetation*. Thickness in Huntingdon 1,700 feet.

"VERGENT SHALES (*Chemung group of New York*).—A thick mass of gray, blue and olive-colored shales, and gray and brown sandstones. The sandstones predominate in the upper part, where the shales contain many fossils. Thickness in Huntingdon 3,200 feet.

"PONENT SERIES.

"PONENT RED SANDSTONE (*Catskill group of New York*).—In its fullest development this is a mass of very thick alternating red shales with red and gray argillaceous sandstones. It has very few organic remains. Among them is *Holoptychius*, and one or two other remarkable fossil fishes, of genera distinctive of Old Red Sandstone. This formation has its maximum thickness in its southeastern outcrops, where it measures more than 5,000 feet."—*Final Rep. First Geol. Surv. Penn.*, vol. 1, p. 108.

On pages 140, 141 and 142 of the same volume, Professor Rogers gives some further details respecting the lithological characters of the rocks. In the northwest belt, the Vergent or Portage flags consist of dark gray flaggy sandstones parted by thin layers of blue shale, with large marine plants and a *Nucula* as the chief fossils, while in the next belt toward the west they are made up of thin-bedded, fine-grained, siliceous gray sandstones, intimately alternating with blue and greenish shales.

In the middle belt, the Vergent Shales or the Chemung consists of gray, red to olive sandy shales, with gray and red argillaceous sandstones, but no details are given respecting this group in the belts west or northwest from the Alleghany Mountains.

In the northwest belt, the Ponent or Catskill consists of fine and argillaceous sandstones, with an increase of red and green shale and with some calcareous layers.

On page 793 of vol. ii of the same report, Professor Rogers points out the similarity between the deposits of the Ponent and Vergent, and states that the sediments of the former are quite as impalpable as are those of the latter.

If all these descriptions be compared with those already given of the rocks occurring in the gaps of the Youghiogheny

and Conemaugh through Laurel and Chestnut Ridges, it will be seen that, as far as lithological characters are concerned, those rocks may be either Catskill or Chemung, though indeed the evidence seems to be rather in favor of their being Chemung, for if one wished to describe them briefly and comprehensively, he could do no better than to combine Professor Rogers' descriptions of the Portage and Chemung, thus:—

"A rather fine-grained gray and brown sandstone in thin layers parted by alternating bands of gray, blue, olive and red shales. It abounds in marine vegetation, and in the upper part the shales contain many fossils."

Since it would be excessively difficult to determine the relations of these rocks by mere stratigraphy, and since the lithological characters fail to throw any distinct light upon the matter, the third test must be employed.

What are the fossils?

In the Summer of 1877, while making examinations in the Conemaugh Gap through Chestnut Ridge, I found, almost midway in the section given on another page, numerous specimens of *Spirifer Verneuilii*, *Rhynchonella Stephani* and *Streptorhynchus Chemungensis*, associated with many lamellibranchs and poorly preserved brachiopods, which could not be determined at the time. Further examination showed that these species occur up to within eighteen inches of the undoubted Pocono sandstone, or Formation X. The same species were found in abundance on the National Road as well as in the Youghiogheny Gaps; and, at all localities, the harder layers at from 100 to 150 feet below that sandstone are covered by a thick mat of fucoids, many of which have very thick stems and are several feet long.

In order that no doubt might remain respecting these species, I sent some specimens to Professor Hall, who has made out the following list;—

1. *Lingula*, sp.; 2. *Discina grandis* or *D. Alleghaniensis;* 3. *Streptorhynchus Chemungensis;* 4. *Rhynchonella Stephani;* 5. *Spirifera Verneuilii;* 6. *Palæoneilo maxima;* 7. *Sanguinolites rigida;* 8. *S. clavulus;* 9. *S. ventricosa?* 10. *Mytilarca Chemungensis;* 11. *Pteronites*, sp.; 12. *Pteronites*, sp.; 13. *Actinodesma recta;* 14. New form, undt.; 15. *Orthoceras crotalum?*.

These were collected at one locality and in haste, the only object being to obtain a few specimens of the more common forms. Of the list, Nos. 6 and 13 are found in New York only in the Hamilton rocks, while No. 15 is very closely allied to a Hamilton species and may be identical with it; but respecting the other forms there is no doubt—they are Chemung. All of these forms occur also in the layers interstratified with those containing the fucoids. They are not stray specimens, such as might have been washed from the older into the newer rocks,

for they are found in great abundance throughout the section and they are as well preserved as Chemung fossils usually are in New York. With these are immense quantities of fucoids, such as are characteristic of the Portage or lower Chemung in New York. But in the whole section there is not an *Anodonta*, not a fish-plate, not any fossil of any sort which can in any way be identified as belonging to the red Catskill of New York.

It is more than probable that the section represents only the lower portion of the Chemung and that not only the red Catskill, but also the upper portion of the Chemung is wanting in this part of Pennsylvania.*

What then has become of the great Catskill group? The upper or gray Catskill is represented, no doubt, by the Pocono or Vespertine sandstone, but the lower or red Catskill has disappeared. Nor is this disappearance at all strange. It is simply what might have been expected.

Professor H. D. Rogers, on pp. 141 and 142 of vol. i, of his Final Report, shows with what rapidity the Ponent or red Catskill thins out toward the northwest: that it is 5,000 to 6,000 feet thick in the southeast belt; 2,500 to 1,000 feet in the northwest belt; and 400 to 0 feet in the fifth belt; the diminution in each belt being distinct as one goes northwest or even west. No details are given respecting the variations of the group in a due west direction or towards the southwest, most probably because no possibility of tracing the group existed then any more than now. The presence of Ponent rocks is incidentally mentioned in notes upon the southern Alleghanies and the gaps through Chestnut and Laurel Ridges, but these observations were evidently regarded as too detached and too unimportant to be of value, since no reference is made to them in the general summary of the group given in vol. i of the Final Report.

All the evidence points in one direction. It is impossible by any stratigraphical work to make direct connection between the localities under consideration and those where the age of the rocks is settled beyond dispute; the lithological characters of

* In the Proceedings of American Philosophical Society, vol. xvii, p. 270, it is stated that at 300 feet below the *Pittsburgh Coal bed*, or midway in the Lower Barren Series, certain Chemung fossils have been found. I have been advised that, while pleading the cause of the Chemung group in the gaps through Laurel and Chestnut Ridges, I would do well to explain how Chemung fossils happen to be present midway in the Coal measures.

No explanation is necessary further than to say that the species were wrongly identified. I have examined the specimens and have recognized the following species:—

Lophophyllum proliferum M'C., *Athyris subtilita* H., *Spirifer planoconvexus* Shum., *Orthis carbonaria* Swal., *Chonetes granulifera* Owen, *Productus pertenuis* Meek?, *Hemipronites crassus* M. and H., *Lima retifera* Shum., *Astartella vera* H.

These are usually thought to be quite characteristic of the Coal measures.

the rocks in question are much like those of the Chemung, while the fossils, both animal and vegetable, are unquestionably of Chemung age. But one conclusion remains—the rocks are Chemung and, as already stated, probably represent only the lower Chemung; the great Catskill group has so far thinned out, that it is represented only by its upper or gray member, the Vespertine of Pennsylvania.