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Middle Cambrian rocks crop out the full length of the Appalachian Valley. Throughout Maryland and Virginia as far south as the New River there is only the one outcrop belt next to the Blue Ridge. In it lithologic distinctions are hard to recognize, since all the beds are mainly limestone, and fossils are few and far between. Although it is believed that the full Middle Cambrian sequence is present, all the strata are grouped in the Elbrook formation. From the New River southwestward to central Alabama somewhat similar conditions obtain in the Blue Ridge belt, but faults bring up Cambrian beds to the west, forming numerous other outcrop belts. In some of them lithologic distinctions render it easy to recognize three formations.

As I pointed out in 1938 (p. 12), even though the type locality for the Maryville is in another belt to the southwest, it is customary to use the outcrop belt at Rogersville, Tenn., as the standard of comparison. There, not only the Rutledge and Rogersville formations, but also the Maryville, possess clear-cut lithologic characteristics, and their boundaries are so well defined that no doubt remains as to their identity and limits. Furthermore, both the Rutledge and Rogersville formations are fossiliferous, which eliminates confusion on that score.

Northwestward from the Rogersville region, with its ideal conditions, the shale constituents of the Rutledge practically vanish and the Rogersville becomes a limestone with very minor shale intercalations. Therefore, in the most western Cambrian outcrop belt of southwestern Virginia, the three Middle Cambrian formations lose their identity in the Honaker limestone, which is evidently equivalent to the Elbrook formation cropping out farther north and east. Southwestward from central Tennessee increase of shale content in the Middle Cambrian rocks of all the outcrop belts, except that of the Blue Ridge, causes the entire series to resemble, and become difficult to separate on lithologic grounds from, the Upper Cambrian Nolichucky

shale. Consequently, Middle and early Upper Cambrian beds are mapped as the Conasauga shale. In my opinion, however, after adequate base maps are supplied and the faunas are thoroughly studied, advantage can be taken of slight lithologic variations to distinguish the several formations now grouped in the Conasauga.

From this brief summary of distribution it is apparent that the Maryville formation is readily recognizable in typical limestone development between more shaly formations, only in certain outcrop belts from the New River in southwestern Virginia to central Tennessee. It should be added that, where the lithologic alterations take place and separate formations cannot be recognized, the total thickness remains about the same, indicating thereby that all formations are still represented. From the studies on which this paper is based, it is now possible to recognize the fact that the Maryville formation is represented in the Conasauga, and it is possible to refer rocks to it on the basis of faunal content.

At its type locality (Keith, 1895) the Maryville formation is described as consisting of 150 to 550 feet of massive blue limestone, with little change in appearance except for frequent earthy, siliceous bands and occasional grayish-blue mottled beds. In the Estillville quadrangle, where the name was first introduced, Campbell (1894) describes the formation as consisting of 550 to 650 feet of comparatively pure, heavy-bedded blue limestone, carrying large masses of chert in the southeastern part of the quadrangle. Little more has been written about the formation, chiefly because it has not been recognized except when found as a typical limestone development in the area previously outlined.

No organic remains, except calcareous algae, have been found in the Maryville formation where it is typically developed as a rather massive limestone. Algal deposits in any formation possess more or less pronounced characteristics, which permit their use in the same manner as any other fossils, but insufficient study has been given in most cases to render them useful for precise correlation. Thus far the algal deposits of the Maryville limestone have been used only in field work for tracing beds in limited regions. Size, shape, and characteristics of silicification are the criteria usually relied upon for this work. Since trilobites or other animal remains were not found in the heavy Maryville limestone beds, the impression went out that the formation is unfossiliferous, and for many years this idea prevented recognition of the fossils that were in hand from the formation. About 1934 faunas were reported from sections where all agreed that the containing beds represent the Maryville formation. From

then on thought was given to the possibility that correlation of fossils from beds with nontypical lithologic development would permit their reference to the Maryville. I hinted at this possibility in 1938 (p. 13) when I found that if the strike was crossed in a northwesterly direction at several places in the Coosa Valley, Ala., Rutledge and Rogersville fossils turned up in normal succession, and beyond them other faunas of presumably younger age, but still beneath the Nolichucky equivalents. At that time certain studies of western North American collections had not yet been made, and I could not be sure of my conclusions. In 1940 it was possible to prove the late Middle Cambrian age of these western faunas, thus providing a basis for further studies in the Appalachians.

Lithologic changes from the clearly defined formations of the Rogersville region to the Honaker limestone on the one hand, and to the Conasauga shale on the other, are not abrupt. In the one direction the limestone content increases at the expense of the shale constituents, while in the opposite direction conditions are reversed. To a worker in the Cambrian it is not strange, therefore, that animal remains were discovered in the Maryville formation where shaly elements are first introduced. Incidentally, it may be mentioned in passing that those of us who are accustomed to collecting from Cambrian rocks seldom search long for fossils in massive limestones or dolomites. Experience has taught us that fossils are to be had only in certain types of crystalline limestone, and almost universally in limestone nodules or thin irregular limestone layers in shale, or in thin shale layers between massive limestones. Massive shales also generally lack fossils, but if they do occur, they are abundant and usually include many examples of entire trilobites.

Furthermore, it is well not to forget that for many years numerous Nolichucky species were referred to the Maryville, and until they could be reassigned to their true stratigraphic position, they served merely to obscure the picture. A few linguloid brachiopods were reported from thin shale seams in the upper part of the Maryville limestone northwest of Morristown, and at a few other localities. These fossils are of so little value for correlation purposes that little attention was paid to them. In 1934 Hall and Amick found a small lot of fossils in thin shale bands in the Maryville along Forked Deer Creek, where it cuts through Copper Ridge west of Clinch Mountain (U. S. 25). These fossils were described by me in 1938. As they were recognized as being altogether new, they could not be used for correlation purposes, particularly since they were known from only one spot.

Step by step our understanding of the true stratigraphic position of the Rutledge, Rogersville, and Nolichucky species became clear, and fossils were being found in unquestioned Maryville, with the result that a direct approach to the problem was possible. After acquiring some knowledge of the late Middle Cambrian faunas in the Cordilleran region, and comparing them with those found definitely in the Maryville formation on Clinch Mountain, the idea that the *Olenoides* and possibly other faunas of the Conasauga shale were of the same age gained in appearance of validity. The fauna obtained from the railroad track east of Heiskell, Tenn., was relocated and the section reexamined. It seemed that these fossils came from the Maryville formation without reasonable doubt. At this point further field investigation was called for, and arrangements were accordingly made to examine the outcrops in the Cambrian belt at the western base of Clinch Mountain, beginning in the north with the Forked Deer Creek section and making traverses along all roads crossing the strike, until it could be proved what really happened to the beds clearly recognizable in the northern part of the belt. This work was carried out in May 1941.

Beginning with the Forked Deer Creek section, the roads across Copper Ridge were traversed one after another. It was rather easy to recognize the Rutledge, Rogersville, and Maryville formations, overlain by typical Nolichucky strata, in every section for at least 20 miles. Unfortunately, no fossils were found in the Maryville in these sections. Of course, not much success was expected in this direction, because only where rather deep new road cuts are made is it possible to pick up the softer fossiliferous beds in such deeply weathered rocks as are the rule in the region. For many more miles the outcrops are less satisfactory owing to the fact that the area is farther from the Clinch River, but it is possible to trace the existence of the several formations by topographic expression and from restricted, deeply weathered rock outcrops. No time was given to the search along this portion of Copper Ridge.

Investigations were then centered about the outcrops west of Knoxville. As previously stated, study of the collection obtained in 1885 from along the railway tracks east of Heiskell, 11 miles northwest of Knoxville, and for many years referred, along with other fossils in similar limestone, to the Nolichucky formation, had raised the question of its age. Reexamination of that section proved conclusively that this fauna occurs in the lower half of the Maryville formation, which here includes considerable shale. Next, the new face of the road cut on the Clinton Highway (U. S. 25W) near Bull Run, 13

miles west of Knoxville, was examined. There two faunas were found, adding the data necessary for the conclusive assignment of faunas from the Conasauga in northwestern Georgia and Alabama to the Maryville. Since the section along the highway west of Knoxville lies in the area in which the formations were mapped as Conasauga, it is only a small step to the reassignment of the faunas from Georgia and Alabama.

In Hall and Amicks' section on Forked Deer Creek the 455 feet of Maryville is composed almost entirely of limestone. Of this total thickness about 36 feet is described as shaly, about 12 feet is called impure, owing to argillaceous bands or mottling, and only about 30 feet is recorded as shale; even in the thin bands of shale, limestone lenses and layers are present. At several horizons mention is made of wavy lines. Downstream to the west of highway U. S. 25 the Rutledge is very well exposed, because the Clinch River cuts down the dip of the Rome shales against the Rutledge. Steep slopes above the limestone cliffs cause the soft Rogersville to crop out nearly everywhere, and above it the rather massive Maryville limestone. In Owl Hollow, about 1 mile west of the bridge over which route 25 crosses the Clinch River, the Rutledge is well exposed. Here it is a very dark blue massive limestone, irreglularly mottled with argillaceous shale, but has a conspicuous limestone layer about 40 feet thick. This limestone has the same wavy, banded and mottled appearance as the Rutledge limestone. In this section the lower 250 feet of the Maryville consists of heavy blue limestone, most of which is "wormy," or ribboned like the Rutledge. Above this about 50 feet of rock is more shaly, with bands up to 10 inches thick of almost pure argillaceous shale. Such shale bands appear again in augmented quantity in the upper part of the formation. Much of the limestone in the upper third of the formation is ribboned. The same conditions characterize the Notchy Creek and Puncheon Camp Creek sections farther west.

No other sections are available, owing to the deep weathering and lower relief between Puncheon Camp Creek and the railroad cut south of Heiskell, more than 30 miles to the southwest. The Heiskell section extends along the railway, beginning at the eastern edge of the flood plain of Bull Run, which is cut into the Rutledge and Rogersville. It was observed that shale content increases in the sections west of Clinch Mountain and Copper Ridge as one goes southwestward, which in part explains the wider stream valleys and the lowered ridges. At Heiskell the shale content has increased until the Maryville resembles the Rogersville and Nolichucky so much that it may be mistaken for either of them. Layers of limestone pebble conglomerate,

with the pebbles separated by matrix, and a few thin zones of edgewise conglomerate, were observed. Layers of oolitic limestone are rather common, one of them yielding the *Eteraspis* fauna.

Near Bull Run, 13 miles west of Knoxville on the Clinton road (U. S. 25W), recent widening of the highway has exposed a large face of the Maryville formation. About 370 feet of beds were measured. Unfortunately, the base is not exposed and one cannot be sure of the logical point at which to draw the Maryville-Nolichucky boundary. Although the rock in this cut is fresher than the outcrops usually to be seen, yet the limestone content is far less than the shale. Edgewise and pebble beds are common, and many of the limestone layers are clearly lenses. Oolitic beds are common. Nearly all the shale, whether in beds or as partings between limestone layers and lenses—without regard to the type of limestone—is micaceous and fucoidal, a condition which generally precludes the existence of fossils. About 40 feet above the base, as exposed, several small nodules yielded *Lingulella* species and *Alokistocare* cf. *projectum* Resser. A little more than 30 feet higher in the section the *Eteraspis* fauna occurs in the thin-bedded limestones with shale partings, associated with more massive, oolitic crystalline limestone, containing patches of *Girvanella*. The fossiliferous nodules and layers contain vaughnite in the form of pebbles and irregular masses, often sharply brecciated. Thus it will be observed that these faunas are found in the lower fourth of the formation as here exposed.

A similar section occurs on Spring Branch near Bakers Mill, about halfway between U. S. 25W and the Heiskell section.

We have now outlined the regional distribution of the Maryville formation where it can be recognized by lithologic characteristics, and have shown the faunal content where it undergoes lithologic change in one outcrop belt. This tracing along Copper Ridge has carried the formation into the typical Conasauga development. Future field work should enable us to trace the formation farther in the Copper Ridge, and into other belts as well, but sufficient data are now in hand to suggest the major Maryville faunas at least.

The faunal alignment seems to be somewhat as follows. Relying on the position of the *Alokistocare* and *Eteraspis* faunas in the Heiskell and Clinton road sections, it seems that they are in the lower third of the formation. On the other hand the *Perioura* fauna seems to occur in the lower part of the upper third. In the assignment of species to the Maryville from among those in the Conasauga of Georgia and Alabama, the only possibility is to take collections as a whole, when they contain forms known to represent the Maryville. On this basis the following lists are constructed.

TENNESSEE

Forked Deer Creek (lower part of upper third of formation):
- *Deltophthalmus halli* Resser
- *Lingulella* sp.
- *Perioura masoni* Resser
- *Proagnostus maryvillensis* Resser

Heiskell section (presumably lower third of formation):
- *Acrotreta* sp.
- *Eteraspis crassa* (Resser)
- *Eteraspis glabra* (Walcott)
- *Hyolithes* sp.
- "*Olenoides*" sp. and a new trilobite genus

Bull Run, 13 miles northwest of Knoxville:

40 feet above base (as exposed)—
- *Alokistocare* cf. *projectum* Resser
- *Lingulella* sp.

About 30 feet higher—
- *Alokistocare* cf. *americanum* (Walcott), and two other species
- *Eteraspis glabra* (Walcott)
- "*Olenoides*" sp.

GEORGIA

Livingston (loc. 89x); chert nodules and shale:
- *Alokistocare americanum* (Walcott)
- *Alokistocare georgense* Resser
- *Alokistocare projectum* Resser
- *Amecephalina coosensis* Resser
- *Chancelloria drusilla* Walcott

ALABAMA

South of Yanceys Bend of Coosa River, near Blaine, 3 miles east of Center, Ala. (loc. 90x); cobbles in shale:
- *Acrocephalops granulosa* Resser
- *Acrothele bellula* Walcott
- *Acrotreta kutorgai* Walcott
- *Alokistocare americanum* Walcott
- *Alokistocare angustatum* Resser
- *Alokistocare blainense* Resser
- *Alokistocare centerense* Resser
- *Alokistocare lingulum* Resser
- *Amecephalina bella* Resser
- *Amecephalina convexa* Walcott
- *Armonia elongata* Walcott
- *Blainia centerensis* Resser
- *Brooksella alternata* Walcott
- *Ehmania smithi* (Walcott)
- *Ehmaniella antiquata* (Salter)

Eteraspis gregaria (Walcott)
Eteraspis paula (Walcott)
Hyolithes partitus Resser
Kochaspis coosensis (Walcott)
Laotira cambria Walcott
Lingulella hayesi (Walcott)
Micromitra alabamaensis (Walcott)
Olenoides curticei Walcott
Pelagiella blainensis Resser

1 mile northeast of Moshat, about 5 miles southeast of Center, Cherokee County, Ala. (loc. 112); shale containing nodules:

Acrocephalops insignis (Walcott)
Acrocephalops nitida Resser
Elrathia alabamensis Resser
Eteraspis paula (Walcott)
Euryrhachis ? centerensis Resser
Perioura typicalis Resser

It is possible that other faunas in hand may belong in the Maryville besides these here given the new assignment.

If the foregoing faunal assignments are sound, the Maryville formation is to be regarded as more or less exactly equivalent to the Bloomington formation of the Wasatch region, the Marjum of the House Range, and the Eldon of the Canadian Rockies.

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