

THE OHIO JOURNAL OF SCIENCE

PUBLISHED BY THE
OHIO STATE UNIVERSITY SCIENTIFIC SOCIETY

VOLUME XVI

JUNE, 1916

No. 8

TABLE OF CONTENTS

SHIDELER—The Ordovician-Silurian Boundary.....	329
REED—The Epibranchial Placodes of <i>Squalus Acanthias</i>	336
HORSFALL—Additions to the Jassoidea of Missouri.....	354
PRICE—Starch in Apple Trees.....	356
SCHAFFNER—A General System of Floral Diagrams.....	360

THE ORDOVICIAN-SILURIAN BOUNDARY.

W. H. SHIDELER.

Of late there has been an increasing disagreement as to just where the Ordovician-Silurian division should be drawn, and there has developed a strong movement toward shifting the division plane from its old and commonly accepted position at the Richmond-Albion (Upper Medina-Brassfield or "Ohio Clinton") break, down to the Maysville-Richmond break, thus incorporating the whole of the Richmond into the Silurian.

The shift in boundary is proposed* primarily for the following reasons, to express them briefly:

1. Only about 5% of the Maysville species are common to the Richmond, and these are nearly all generalized and long-lived types, while the Richmond introduces twenty new generic and four new family types; while all of the Bryozoa, Echinodermata, and most of the corals, trilobites and brachiopods are strikingly different.

2. The Ordovician relationships of the Richmond are neutralized by an equally strong Silurian tendency when compared with the Silurian.

*E. O. Ulrich. The Ordovician-Silurian Boundary. Etude faite a la XII. Session du Congres geologique international, reproduite du Compte-Rendu.

3. The Richmond-Albion break is regarded as impracticable for the separation of major time units, because there is no break there in the Anticosti series, and the break between the Lower Medina (Queenstown-Juniata—Richmond) and the Upper Medina (Albion—Brassfield or “Ohio Clinton”) is frequently obscure.

4. The later Maysville seas were notably restricted, and at the close of the Maysville were drained away. The Arnheim shale (earliest Richmond†) was deposited over the gently warped surface of the interior, and the break is shown in overlap irregularities in sequence and thickness of deposits.

This break is correlated with larger and more distinct breaks in the Appalachian and other regions.

These points will be briefly discussed in order. However, it may be said here that the writer holds that in so far as crustal warpings and their consequent changes in land and sea relations are concerned, they are best reflected in the faunal changes which take place. The less local and more wide-spread the movement the greater the effect upon the life of the time. It is held that as a general proposition slight oscillations have but little repressive effect upon the forms of a given area, and but few new forms are introduced, while broad movements are likely to result in decided repressions on the one hand, and radical innovations on the other, and actual physical records of diastrophism might well be lost, obscured or inaccessible, and yet be reflected in a very positive and far-reaching way upon the life of the times.

1. In comparing the life of the Maysville with that of the Richmond, faunal lists have been based upon the recently published Bibliographic Index of American Ordovician and Silurian Fossils.* This has been modified by data collected by the writer and by Prof. S. R. Williams during seven seasons' systematic field work in the disputed strata. The lists include fossils from the Maysville of the Cincinnati dome, of New York and of Canada, and Richmond fossils from the Cincinnati region, the upper Mississippi Valley, and from the Fernvale

† In ascending order the subdivisions of the Richmond are commonly given as Arnheim, Waynesville, Liberty, Whitewater, Elkhorn, and Belfast. The Saluda is the western shallow-water equivalent of the upper half of the Whitewater and all of the Elkhorn.

* R. S. Bassler, Bull. 92, U. S. Nat. Mus., 1915.

of Illinois, Tennessee, Missouri, Arkansas and Oklahoma. The reasons for excluding the Anticosti series will be given later.

In these lists all forms of problematic origin, doubtful range and uncertain relationships have been excluded.

Of the 413 Maysville species, 58, or about 14%, lived on into the Richmond. Nor are all species of generalized types and long range, but we have among them such highly specialized cystoids as *Streptaster vorticellata*, *Agelacrinus cincinnatiensis* and *Cyclocystoides magnus*, while Bassler lists the starfish *Hudsonaster incomptus* and *Mesopalaeaster shafferi*. *Heterocrinus juvenis* and *Iocrinus subcrassus* represent the crinoids. Eleven species of Bryozoa are common, ten of Brachiopoda, six Pelecypods, ten Gastropods, four Ostracods, etc., etc.

Of the 217 Richmond genera, 116 are common to the Maysville. Of the 101 which are not, 68 occur below the Maysville, leaving 33 genera which are really new. And these introduce five new families, the Fenestellidæ, Rhopalonariidæ, Batorcriniidæ, Halysitidæ and Loxonematidæ.

2. But contrast with this the fact that the Upper Medina (Albion) and Clinton give 255 genera, only 82 of which have been found in the Richmond, and of these 68 are long-ranging groups, which came up from Pre-Richmond times, usually Black River or Trenton.

Of the 173 genera not common to the Richmond, 40 also lived below the Richmond, leaving 133 as really new. And these 133 new genera introduce 35 new families, the suborders Larviformia and Sagenocrinoidea, the orders Madreporaria, Diploporita and Streptophiuriæ, and the subclass Hexacoralla. Should we consider the Upper Medina alone the proportion of new major groups would be still greater.

Compared with the above record the innovations of the Richmond seem almost lonesome, and the faunal break looms up still greater when we consider that of all the Richmond species, but one lone species, *Halysites catenularia*, occurs in the upper strata. But more of *Halysites* presently.

In comparing two faunas there is a difference of quality as well as of quantity, and both are of conspicuous value in comparing the Richmond and the Upper Medina-Clinton faunas.

To make a direct comparison between these two groups of faunas and see just how much the Ordovician relations of the Richmond are neutralized by the Silurian tendencies, 14% of the Maysville species are common to the Richmond, and but one Richmond species goes on up into the Upper Medina or Clinton.

While 68% of the Maysville genera pass the break into the Richmond, less than 4% of the Richmond genera pass on into the Upper Medina or Clinton. Or, if we add 16 Richmond genera that do not reappear until the Niagara, we still get less than 5% to compare with the 68% of Maysville genera passing into the Richmond.

The differences between faunas are shown not only in the introduction of new types, but also in the disappearance of old ones. Making new comparisons on that basis, 54 Maysville genera are absent from the Richmond, though 15 of these reappear later, leaving 39 which, so far as the strata have afforded us any knowledge, became extinct at the close of the Maysville. This would be very nearly 23%, and it includes three major groups, the families Pattersoniidae, Anomalo-crinidae and Trinucleidae.

In the case of the Richmond, we find 136 genera are absent from the Upper Medina-Clinton. But 16 of these reappear later, leaving 119, or over 54%, of the Richmond genera which became extinct, as compared with the 23% in the previous case. And here we have represented the extinction of 14 families, to compare with the 3 closing with the Maysville.

It is because the Anticosti strata are regarded as filling in the stratigraphic break between the Richmond and the Upper Medina, while their fossils fill in the faunal break and give us a faunal transition, that they were not considered in making up the faunal lists here considered.

Somewhere during Pre-Albion times there must have been evolving all of the species, genera, families, etc., which appear so suddenly and are so radically different from the Richmond forms. These groups, judged by the standards of present day evolutionists, must have required a very long time for their differentiation. It is not to be expected, then, that during all of this time at least a few of the hardier, wide-ranging forms should have migrated around their barriers into the Richmond sea? Broad diastrophic oscillations began in the

Maysville and culminated at the close of the Richmond, and the temporary lowering of barriers would be expected to let in a few forms. But it is significant that only a few new genera and only one species are common to the Richmond and the Upper Medina-Clinton, and the great invasion does not come in until after the Richmond-Upper Medina break. That break must have ended in the broader letting down of faunal barriers.

It may be said that *H. catenularia* is absent from the Richmond of the Cincinnati area, but it should occasion no surprise should it be found here.

3. When two series of strata are separated over broad areas by both a distinct physical break and a radical faunal difference, it should detract little if any from the value of that break as a division plane, should there somewhere be discovered a series of strata filling in the break.

For it is inconceivable that there should be erosion over the whole earth at once. Somewhere there must have been bodies of water, and in these must have accumulated the record of strata and of fossils which is represented elsewhere by the physical break. So, unless removed by subsequent denudation, there must exist somewhere a complete physical and faunal record of each break.

Therefore the filling in of such lost intervals is but to be expected, and it is not the presence of such transition strata which determines the value of the break, but it is the amount of sedimentation and the horizontal distribution of the transition strata, the amount of erosion and the degree of faunal break over broad areas, which determine the value.

4. If the Richmond-Upper Medina boundary, so distinct in Ohio, Indiana and Kentucky, be impracticable because the Richmond-Albion boundary is occasionally obscure, and if thereby be degraded to a minor position, then the same thing certainly should apply to the Maysville-Richmond break, which may show a decided physical break in the Appalachians or elsewhere, but shows either the most obscure kind of a break in Ohio, Indiana and Kentucky, or else none at all.

It is to be expected in the shallows about the ocean margins that every little movement of the shore line will be strongly marked in the accumulating sediments. Here every little oscillation will produce a physical break, and the results of

a fair sized movement would be quite conspicuous. Yet even a fair-sized movement probably would show little or no effect upon the main sedimentation or upon the life of the sea as a whole.

Such appears to be the case with the Maysville-Richmond break. We should naturally expect to find breaks about the shores of the interior sea of this time, and we do get them in New York, Pennsylvania, Tennessee, etc., but over the broad interior, there is but scanty and obscure evidence of such a break.

It is not intended to deny the presence of such a break, but this break is held to have been the result of a broad though feebly developed and fleeting upwarping, not to be compared either physically or faunally in its results with later movements.

If the Arnheim be taken as the basal member of the Richmond, then it cannot be said that there is any definite physical break between the Maysville and the Richmond, at least in Ohio, Indiana and Kentucky.

The evidence as shown in overlap irregularities in sequence and thickness of deposits is inconsistent and obscure at the best. And the evidence is much less distinct than it is in the case of the breaks at the top of the Arnheim, at the base of the Whitewater (*Gyroceras baeri* zone, where in Adams County and elsewhere there is a veritable basal conglomerate), at the base of the Saluda, within the Saluda and at the top of the Saluda-Elkhorn.

To summarize the evidence here presented, the Maysville-Richmond break is found to be inconvenient and inadequate physically. Regardless of the evidence of physical breaks, the close relationships of the two faunas speak for itself.

And the radical difference between the faunas of the Richmond and the Upper Medina-Clinton indicates a greater period of disturbance and a greater letting down of barriers than in the case of the close of the Maysville.

To make a few more comparisons, 58 times as many Maysville as Richmond species pass on up; 4 times as many new genera and 7 times as many new families are introduced during the Upper Medina-Clinton as are introduced during the Richmond; nearly 5 times as many families close with the Richmond as close with Maysville; 3 times as many genera failed to pass

the Richmond-Upper Medina break as failed to pass the Maysville-Richmond break.

Retaining, then, the Ordovician-Silurian boundary at its old and generally accepted position between the Richmond and the Upper Medina, a slight refinement may be made in the drawing of the boundary in Ohio.

The Richmond has been considered as ending with the Belfast* beds, a series of strata developed in Ohio along the east side of the Cincinnati dome. They are generally barren of fossils, and chiefly on the basis of rather common annelid remains have been classed as Ordovician, despite the finding of *Halysites catenularia* and *Orthis flabellites* in them. But during the past season there have been added to these *Dalmanella elegantula* and var. *parva*, *Rhynochonella janea* and *Hormotoma sublata*, all found near Lawshe and near West Union, Adams County, Ohio.

Disregarding the annelid remains, which cannot be used in correlating anything, the total fauna of the Belfast is Brassfield (Upper Medina) in its affinities.

The Ordovician-Silurian boundary of Ohio, Indiana, and Kentucky should be drawn, then, at the top of the next underlying beds, the Elkhorn and its equivalents.

* Foerste, Jour. Cin. Soc. Nat. Hist., Vol. XVIII, Feb., 1896, pp. 161-199.