THE ORDOVICIAN SECTION IN THE MANITOULIN AREA OF LAKE HURON.

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1. INTRODUCTION.

During the summer of 1911 and 1912, the writer was given the opportunity, by Dr. R. W. Brock, of visiting the Ordovician sections in the Lake Huron area under the auspices of the Canadian Geological Survey. During the first summer he was accompanied by Prof. Arthur M. Miller, who made a special study of the Mohawkian strata on Cloche and Goat islands, and in the vicinity of Little Current, and who gave him the benefit of his extended acquaintance with Mohawkian strata, especially in relation to the correlation of these strata as exposed in the Lake Huron area with those of Kentucky. During the summer of 1911, and during a part of 1912, he had also the assistance of Mr. E. J. Whittaker, of the Canadian Geological Survey, especially in his investigations of the Cincinnatian strata. Mr. Whittaker has since given special attention to the Cincinnatian strata in the vicinity of Meaford, and some of his observations are here incorporated. The notes here presented are merely preliminary to a more extended study of the field.

As will be noted on the following pages, the writer has had the frequent assistance of Dr. E. O. Ulrich, Mr. R. S. Bassler, Prof. Percy E. Raymond, Dr. Ruedemann, and others, in the interpretation of the fossil faunas. It will be readily recognized, however, that these investigators were at a disadvantage in not being able to examine the faunas themselves in the field, since the writer may have failed to collect some of the most valuable diagnostic fossils.

2. Basal Bed; Red Clay Shales; Lowville.

The oldest Ordovician rocks, in that part of Lake Huron which lies north of the eastern end of Manitoulin island, are exposed for a distance of several miles along the western shore of Cloche peninsula, facing Cloche channel. At the northern end of the line of exposure these oldest Ordovician rocks rest upon and against an east and west ridge of quartzite mapped by the Canadian Geological Survey as Huronian. They consist of reddish clay shales whose thickness is not known even approximately. At one locality, along a small gully, a vertical section, 60 feet thick, is exposed above lake level, whitish limestones making their appearance 70 feet above the lake, but the entire thickness of the red clay section probably is much greater. Fossils were found at only one horizon, at a locality about a mile south of the northwestern angle of the peninsula, where a few feet of more or less indurated, brownish, sandy layers are imbedded in the reddish clay section, a short distance above the level of the new line of railway now in the process of construction. Here a species of *Pterotheca*, closely allied to *Pt. attenuata* but only about 20 mm. in width, and a species of *Cyrtodonta*, 25 mm. long and closely related to *C. janesvillensis*, suggest the Platteville or Lowville age of the strata involved. Well preserved specimens of *Archinacella* and *Lingula* also occur.

3. Swift Current Beds; Chiefly Whitish and Reddish Limestones; Leray.

Along the southern half of Cloche peninsula, whitish limestones overlie the red clays. Owing to the southward dip of the strata, the base of this limestone series descends to water level more than a mile before reaching Swift Current, the locality at which the railroad passes from the peninsula over to Cloche island. The general color of these limestones is whitish, but where they rest upon the Huronian quartzites, and in the immediate vicinity of the quartzite hills, they frequently are reddish. This reddish color evidently is due to the material derived from the quartzites and other Huronian strata which had been greatly disintegrated by weathering before the deposition of both the basal red clays and of the Swift Current limestones began. A quarry recently opened at Swift Current, for the purpose of providing the ballast needed for the new line of railway, exposes beautifully the top of a quartzite knoll covered by some of the upper layers of this limestone section. Where these limestones are in contact with the quartzite they not only are reddish in color but they also include pebbles and smaller fragmental material, evidently derived directly from the quartzite knoll. Among this fragmental material occur most of the fossils so far collected, including a pygidium of *Bathyurus*, the sipho of *Actinoceras bigsbyi*, a *Rhyn-*

chotrema probably *Rh. ainsliei*, and a *Dalmanella* (*Pionodema*) belonging to the *subaequata* group. Among the bryozoans, Dr. E. O. Ulrich identified *Escharopora ramosa*, *Phyllodictya labyrinthica*, *Rhinidictya fidelis*, *Rh. nicholsoni*, *Rh. trentonensis*, and forms of *Rh. mutabilis* and of *Homotrypella instabilis*, suggesting relationship to the upper Platteville fauna of Minnesota and the Leray fauna of New York. This fauna is exposed also at a slightly higher geological horizon, immediately below the very fine grained "Birdseye" limestone, along the railroad about three quarters of a mile south of Swift Current. At a small quarried exposure along the same line of railway, but about a mile north of Swift Current, strands of some form of *Tetradium* occur, in the white limestones, which can not be identified with *T. cellulosum*.

The very fine grained, white, "Birdseye" limestone, at the top of the Swift Current limestone series, forms a convenient lithological means of separating this series from the overlying part of the Black river beds. It is well exposed at several localities within a mile going southward from Swift Current. Its thickness is about 11 feet. It is interbedded with a small amount of whitish clay, and contains but very few traces of fossils.

Lithologically, the "Birdseye" limestone at the top of the Swift Current limestone section resembles the Tyrone limestone as exposed in Central Kentucky. This resemblance was noticed by Prof. Arthur M. Miller, who was a member of the party in 1911, and who made a thorough study of the entire Mohawkian group, giving the writer the benefit of his extended experience. It is probable that the entire Swift Current limestone section is to be correlated with the Tyrone, but this can not be determined from the meager fauna at hand. The total thickness of this section is unknown. Fifty feet probably is a moderate estimate.

4. Cloche Island Beds; "Black River" Limestones.

With the exception of the northern line of out crops on Cloche island, and those in the vicinity of Swift Current already described, almost the entire surface of Cloche island is formed by those darker limestones between the Leray member of the Lowville at the base and the Trenton limestones at the top to which it frequently has been customary to confine the term Black river. In the lower part of this Cloche island phase of the Black river section, fine grained limestones alternate with coarser grained layers for a vertical distance of about 30 feet. These strata are overlaid by coarser grained limestones in which finer grained layers are not conspicuous, and which attain a thickness of about 50 feet. These strata are well exposed along the railroad within two miles going south from Swift Current. The total thickness of the Cloche island beds may equal 150 feet, but no locality was found where this could be determined.

The two most characteristic fossils of the lower part of the Cloche island beds are *Columnaria halli* and *Stromatocerium rugosum*. *Columnaria halli* ranges from the base of these beds to about 45 feet above the base. *Stromatocerium rugosum* was found about 20 feet above the base and may occur also at other levels in the lower part of these beds. It is evident that both *Columnaria halli* and *Stromatocerium rugosum* may be looked for in the underlying Swift Current limestones, since *Columnaria halli* occurs in the upper or Leray member of the Tyrone formation in Central Kentucky, and has been found also in the Lowville at Watertown, New York; while *Stromatocerium rugosum* is found in the Lowville northeast of Watertown, New York.

Receptaculites occidentalis begins its range about 20 feet above the base of the Cloche island beds; it becomes common at 55 feet above the base, where the first specimens of *Maclurea logani* are seen. No specimens of *Gonioceras anceps* were discovered within 80 feet of the base of these limestones, but they begin their range a short distance above this level, and all three species, *Receptaculites occidentalis, Maclurea logani*, and *Gonioceras anceps* extend to the extreme top of the section as exposed on Cloche island, but have not been found in the lowest Trenton layers found on Goat island, immediately southward. The presence of these fossils is therefore used here to discriminate the Black river from the overlying Trenton limestones. It should be remembered, however, that *Receptaculites occidentalis* has been identified by Ulrich from the Curdsville bed, in the lower Trenton of Kentucky, and species of *Maclurina*, which can not readily be distinguished from *Maclurea* in the field, occur in the Trenton of the northwestern states. Moreover, considering the very close similarity of the Curdsville fauna on Goat island to that found in the underlying Cloche island limestones, it would be rash to state that no *Gonioceras* ever will be found in the Curdsville. The chief point is that the great abundance of *Receptaculites*, *Gonioceras*, and *Maclurea* distinguishes the top of the Cloche island Black river limestones readily from the base of the lowest Trenton limestones found on Goat island.

Near the top of the Black river exposures on Cloche island, within a mile of the southwestern termination of that part of the railroad which crosses Cloche island, *Protarea vetusta, Calapoecia canadensis*, *Petraia aperta*, a large celled form of *Columnaria alveolata*, with more or less discrete and rounded corallites, 7 mm. in diameter, and a specimen doubtfully identified as *Eurystomites undatus* occur. Of these, *Protarea vetusta* has been recorded hitherto only from the lower Trenton, but the other four forms mentioned have so far not been recorded from the Trenton, and are regarded as characteristic Black river species or varieties.

Among other forms occurring in the Cloche island limestones may be mentioned *Rafinesquina inquassa, Dalmanella gibbosa,* and *Conradella obliqua,* all of which suggest Black river age. *Streptelasma profundum, Rhynchotrema (?) ottawaensis, Orthis tricenaria, Dinorthis pectinella,* a small *Dalmanella* belonging to the *testudinaria* group, *Strophomena filitexta, Plectambonites curdsvillensis, Leperditia fabulites, Bumastus milleri,* and numerous other species range from the Cloche island Black river limestones into the Curdsville strata, exposed at the base of the Trenton on Goat island. *Solenopora compacta, Herbetella bellarugosa,* and *Actinoceras bigsbyi,* hitherto not found above the Cloche island limestones, may eventually be found also in the Curdsville beds on Goat island, since they occur in the Trenton elsewhere. Not being familiar with Black river faunas, the writer submitted the fossils collected to Prof. Percy E. Raymond, and was pleased to receive his confirmation as to the Black river age of the Cloche island limestones.

The bryozoans were submitted to Dr. E. O. Ulrich, with the following results: *Batostoma humile, B. varium, B. winchelli, Eridotrypa mutabillis, Homotrypa minnesotensis, Nicholsonella ponderosa, Phyllodictya frondosa, Phylloporina sublaxa, Prasopora insularis* are represented by varieties also occurring in the Decorah shales of the Mississippi basin, and thus tend to corroborate the reference of the Cloche island beds to the Black river. As a matter of fact, *Batostoma winchelli* and *Homotrypa minnesotensis* were identified also from the Curdsville bed in the lower part of the Trenton on Goat island, and some of the other species, such as *Batostoma humile, Eridotrypa mutabilis,* and *Prasopora insularis,* are known to range upward into the lower Trenton, but, to Dr. Ulrich, this bryozoan fauna presented a distinct Decorah shale facies. Most of these bryozoans were collected in the upper part of the Cloche island beds, above the 80 foot level mentioned in the preceding lines. Further collecting may indicate the presence also of other faunas within these beds.

5. Curdsville and other Trenton Exposures on Goat Island.

The lowest exposures of the Trenton on Goat island present a fauna very similar to that of the underlying part of the Black river, excepting for the apparent absence of *Receptaculites, Maclurea, Gonioceras,* and a few other fossils, and the presence of the interesting crinoid and cystid fauna known from Curdsville, Kentucky, and from Kirkfield and other Trenton localities in Ontario. While a form of *Dalmanella* belonging to the *testudinaria* group, and *Plectambonites curdsvillensis* are present in these lower Trenton strata on Goat island, they occur also at various horizons in the underlying Cloche island limestones.

When Prof. Arthur M. Miller visited the exposures at the extreme northeastern end of the railway line crossing Goat island, he was impressed with the Curdsville facies of the fauna included. He found *Carabocrinus vancortlandi*, *Cleiocrinus regius*, and *Glyptocrinus ramulosus*, to which have been added more recently *Reteocrinus alveolatus* and *Cyclocystoides halli*, a typical Kirkfield fauna. Among the bryozoans collected at this horizon Dr. E. O. Ulrich identified provisionally *Batostoma winchelli*, *Bythopora* cf. *alcicornis*, *Callopora multitabulata*, *Eurydictya multipora*, *Homotrypa minnesotensis*, *Monticulipora (?) cannonensis*, *Rhinidictya minima*, and *Rh. mutabilis*. Apparently there is an admixture of Black river with Trenton species, but possibly the real explanation is merely the greater vertical range of various species hitherto not found above the Black river.

The total thickness of the strata to be assigned to the Curdsville bed is unknown. From the lowest strata seen on Goat island to the highest strata containing an abundance of the columns of *Glyptocrinus ramulosus*, the interval is nearly 30 feet. The *Carabocrinus vancortlandi* layer is about 7 feet above the base of this section, and most of the other crinoids and cystids occur about 11 feet above this level. *Stromatocerium* is rare in the layer immediately overlying the upper *Glyptocrinus* horizon, but becomes common at a higher horizon which is exposed along the southern margin of Goat island. Possibly 20 feet would be sufficient to cover this interval, and an equal interval might account for the strata intervening between this abundant *Stromatocerium* horizon along the southern edge of Goat island and the lowest strata exposed along the shore in the eastern margin of Little Current.

6. Trenton Exposures at Little Current, on Manitoulin Island, including Collingwood Formation.

Immediately at water's edge, east of Little Current, the following bryozoans were collected and submitted to Dr. E. O. Ulrich: *Arthoclema billingsi*, *Callopora multitabulata*, *Dekayella trentonensis*, *Eridotrypa mutabilis*, *Mesotrypa infida*, *M. cf. whiteavesi*, *Monticulipora arborea*, *Prasopora simulatrix*, and *Rhinidictya fidelis*. The fauna as a whole impressed Dr. Ulrich as resembling that in the *Nematopora* horizon in the upper Prosser. While some of the species are found also in the Wilmore, these are forms which occur also in the upper Prosser, while conversely no forms are seen here which occur only in the Wilmore. A small specimen of *Strophomena* and numerous specimens of *Rhynchotrema inaequivalve* occur at the same horizon.

If the abundant Trenton fauna found in the white limestones northwest of Collingwood, on the lake front, find any equivalent in the Mantoulin area, this must lie somewhere between 20 and 30 feet above the lake in the section exposed east of Little Current,

but no good exposures have been found. *Tetradium* bundles occur at 45 feet above the lake, and massive specimens are found 4 feet farther up.

The strata immediately above the *Tetradium* horizon consist of fissile black shales interbedded with limestone near the base. These strata were formerly regarded as Utica, but they probably represent an older formation than the Utica of New York, and recently Prof. Percy E. Raymond has proposed for them the name Collingwood. Their most characteristic fossil is the trilobite long known as *Asaphus canadensis. Triarthrus spinosus*, and a graptolite, identified by Dr. Ruedemann as *Diplograptus quadrimucronatus*, also occur. At Little Current, 11 feet of this Collingwood shale are exposed, but the total thickness may equal 20 feet.

7. Cincinnatian Beds on Manitoulin.

A. Sheguindah Beds; Eden.

Along the road from Little Current to Sheguindah, the strata immediately overlying the Collingwood formation are exposed at several localities. One of these extends from three miles southeast of Little Current southwards up the hill. Here the top of the Collingwood is overlaid by shales which near the base are blackish but much softer. Within 9 feet of the base, these clay shales contain a species of *Triarthrus*. A small *Primitia* and a *Leptobolus* extend from the base upward for about 37 feet. The only species of graptolite noted is fairly common, and was determined by Dr. Ruedemann as nearest to *Diplograptus peosta*, but with closer arranged thecæ; it ranges from the base for 43 feet upward. *Dalmanella* appears at 25, between 37 and 43 feet, and at higher levels. The first trace of limestone was found 43 feet above the base, but limestone layers do not become common until an elevation 100 feet above the base has been reached.

It is in these upper limestones and in the interbedded clays that the typical Eden fauna listed below occurs. The fossils were examined by Ulrich, Bassler, and Nickles conjointly, the determinations being only provisional, until microscopic slides can be prepared. Along the Sheguindah road, *Amplexopora persimilis*, *Callopora sigillarioides*, *Coeloclema communis*, *Hemiphragma whitfieldi*, *Perenopora vera*, and a *Stigmatella* near *clavis* or *nana* occur. From the corresponding strata at Tamarac Point, 10 miles southwest of Little Current, *Aspidopora* cf. *areolata*, *Arthropora clevelandi*, *Bythopora arctipora*, and *Primitia centralis* occur in addition to those already named. At the corresponding horizon at Gorrel Point, two miles northeast of Gore Bay, *Aspidopora eccentrica*, *Bollia persulcata*, *Bythocypris cylindrica*, *Jonesella crepidiformis*, *Primitia cincinnatiensis*, and *Acidaspis crossotus* are added to the list. At the exposures immediately south of the high Richmond Clay Cliffs, on the eastern side of Cape Smyth,

Dekayella ulrichi and some species of *Eridotrypa* is present. These fossils indicate the Eden age of the upper limestones in this Sheguindah section. The strata belong somewhere near the upper part of the Economy or the lower part of the Southgate section apparently. The thickness of this richly fossiliferous limestone and clay section may equal 20 feet, but only the lower 5 feet are well exposed along the Sheguindah road.

One hundred and twenty-seven miles southeast of Little Current, along Workman's brook, two miles east of Meaford, *Trinucleus bellulus* and *Callopora sigillarioides* are exposed about 4 feet above lake level, and this is the reason for including the lower clay shales in the same section as the upper undoubted Eden limestones. In the Workman brook section, the Eden limestones become common about 75 feet above lake level, and that part of the Eden section which lies above this level may equal 50 feet.

B. Wekwemikongsing Beds; Lorraine.

Overlying the undoubted Eden beds, there is a series of strata containing *Whiteavesia pholadiformis, Modiolopsis concentrica, Byssonychia radiata, Lyrodesma poststriatum, Clidophorus planulatus*, a large *Ctenodonta* belonging to the *pectunculoides* group, and a species of graptolite identified by Dr. Ruedemann as nearest to *Diplograptus angustifolius* mut. *vespertinus* from the Middle Lorraine of New York. In fact, the general aspect of these strata is Lorraine, since the lamellibranchs occur in siliceous limestones which weather into fine grained sandstones, as is the case in the typical Lorraine.

In the lower strata belonging to the Wekwemikongsing section, as exposed south of Little Current, Dr. Ulrich identified *Bythopora dendrina* and *Bythopora gracilis*. From a corresponding horizon at the base of the Wekwemikongsing section, immediately south of the Richmond Clay Cliffs, on the eastern side of Cape Smyth, he identified *Dekayia pelliculata* in addition to the species named. The most interesting list, however, was obtained along Workman's brook, east of Meaford, where, in the 25 feet of strata underlying the *Catazyga erratica* horizon, Dr. Ulrich identified *Callopora* near *dalei, Coeloclema* sp., *Dekayia appressa, Heterotrypa* cf. *inflecta, Leptotrypa ornata*, and *Perenopora compressa*. These bryozoans suggest the middle Maysville age of these strata below the *Catazyga erratica* horizon. Dr. Ulrich placed them at approximately the Bellevue horizon. The base of the Wekwemikongsing beds on Workman creek appears to be about 50 feet below the *Catazyga erratica* horizon.

The only bryozoans identified between the *Catazyga erratica* horizon and the base of the undoubted Richmond, with *Catazyga headi, Cyclonema bilix*, and *Strophomena planumbona*, 160 feet farther up, are *Stigmatella* cf. *nicklesi, Discotrypa* cf. *elegans*, and *Spatiopora aspera*, also suggesting Maysville age.

In Ohio, *Whiteavesia pholadiformis* and *Modiolopsis concentrica* come in at the base of the Fort Ancient division of the Waynesville bed, and continue to the top of the Waynesville, but they are represented by at least very similar forms even in the Liberty. Under these circumstances it was natural at first to regard these strata, on Manitoulin, which carry the *Whiteavesia pholadiformis* and *Modiolopsis concentrica* fauna as Richmond. However, the bryozoans submitted to Dr. Ulrich tell a very different story, and, until further evidence has been accumulated, it is regarded wiser to remove them from the Richmond column. For collecting purposes these beds are well exposed for a distance of about two miles along the shore between Wekwemikongsing and the Richmond Clay Cliffs on the eastern side of Cape Smyth. The total thickness of the Wekwemikongsing section on Manitoulin island may equal 100 feet in the Cape Smyth area.

8. Richmond Strata on Manitoulin Island.

C. Waynesville Beds, or Lower Richmond.

Overlying the Wekwemikongsing beds, with their Lorraine fauna, is a series of interbedded limestones and clay shales of undoubted Richmond age. At the base of these undoubted Richmond beds, *Hebertella insculpta*, frequently associated with *Catazyga headi*, is almost invariably present, and since *Hebertella insculpta* and *Catazyga headi*, on Manitoulin, are limited to the basal part of these beds, both fossils here serve as valuable diagnostic fossils. Associated with these fossils in the same layers occur: *Streptelasma rusticum*, *Columnaria alveolata*, *Protarea papillata*, *Rhombotrypa quadrata*, *Hebertella occidentalis*, *Platystrophia clarksvillensis*, *Strophomena huronensis*, *Rafinesquina alternata* very flat form, *Plectambonites sericea*, *Rhynchotrema perlamellosa*, *Zygospira modesta*, *Cyclonema bilix*, and *Pterinea demissa*. These associated fossils, however, are not confined to the *Hebertella insculpta* and *Catazyga headi* horizon but range upward for variable distances into the overlying Richmond.

The lower part of the Richmond, on Manitoulin, is by far the richest in fossil remains, and many species, especially among the brachiopoda, appear to be confined to this lower part. Between Gore Bay, Kagawong, and Little Current, a conspicuous coral reef, from one to three feet thick, containing *Columnaria alveolata* and *Calapoecia huronensis*, frequently is found between 35 and 45 feet above the base of the *Hebertella insculpta* horizon. It has been found that while most of the fossils which begin their range at or near the *Hebertella insculpta* horizon reach the *Columnaria* reef horizon, many of these species do not extend their range beyond this reef. Among the latter may be mentioned: *Protarea papillata*, *Constellaria polystomella*, *Rhombotrypa quadrata*, *Crania scabiosa*, *Rafinesquina* very flat form, *Plectambonites sericea*,

Strophomena huronensis, Str. nutans, Str. neglecta, Str. planumbona, Str. sulcata, Platystrophia clarksvillensis, Zygospira kentuckiensis, Helicotoma brocki, Spyroceras hammelli, and various gasteropods and lamellibranchs not as yet identified. A form closely allied to *Zygospira kentuckiensis* occurs in the fossiliferous horizons of the Queenstown shales in the area south of Georgian Bay.

Among the various species beginning their range in that part of the Richmond section which underlies the Columnaria reef, but extending also above the latter, may be mentioned: *Stromatocerium huronensis, Strephochetus richmondensis, Tetradium huronensis, Streptelasma rusticum, Columnaria alveolata, Calapoecia huronensis, Hebertella occidentalis, Rhynchotrema perlamellosa, Zygospira modesta,* and various gasteropoda and pelecypoda not identified.

That part of the Richmond section on Manitoulin which lies between the base of the *Hebertella insculpta* zone and the base of the rich *Columnaria* reef corresponds approximately to the upper part of the Waynesville bed, especially to that part to which the term Blanchester has been applied.

D. Kagawong Beds, or Upper Richmond.

Columnaria alveolata and *Calapoecia huronensis* have a considerable vertical range, but the horizon at which they occur in sufficient abundance to form a conspicuous reef evidently is an important paleontological horizon, since it marks the disappearance of a considerable part of the underlying Richmond fauna. Moreover, it appears also to be at or above this horizon that *Beatricea undulata, Columnaria calycina,* and various thick-walled gasteropoda, such as *Liospira helena,* a large *Bellerophon,* and a large *Bucania* or *Salpingostoma* come in. These species are apparently such forms as could stand rough waters.

In general, the fauna in the strata immediately above the *Columnaria* reef appears to be a meager one. At least very few species have been listed from this zone excepting such forms as *Hebertella occidentalis, Rhynchotrema perlamellosa,* and *Zygospira modesta,* which appear to be able to survive under very adverse conditions.

At one locality, on an east and west road three miles south of Little Current, *Strophomena vetusta* and *Ceraurus (Eccoptochile) meekanus* occur just above this *Columnaria* reef. These fossils suggest the upper Liberty or the Whitewater age of the strata involved, while the great abundance of the *Columnaria alveolata,* and of *Calapoecia huronensis,* accompanied by *Beatricea undulata,* suggest the Saluda age of the same strata. In either case, the horizon is distinctly above that of the Waynesville of Ohio.

Another conspicuous zone, between Gore Bay, Kagawong, Honora, and Little Current, is a *Stromatocerium* reef which usually is found between 25 and 30 feet above the *Columnaria* reef, but

which occurs eastward at greater intervals. It is the interval between these two reefs which usually presents such a meager fauna. Locally, however, for instance between Manitouaning and Cape Smyth, the lower parts of this section appear richly fossiliferous.

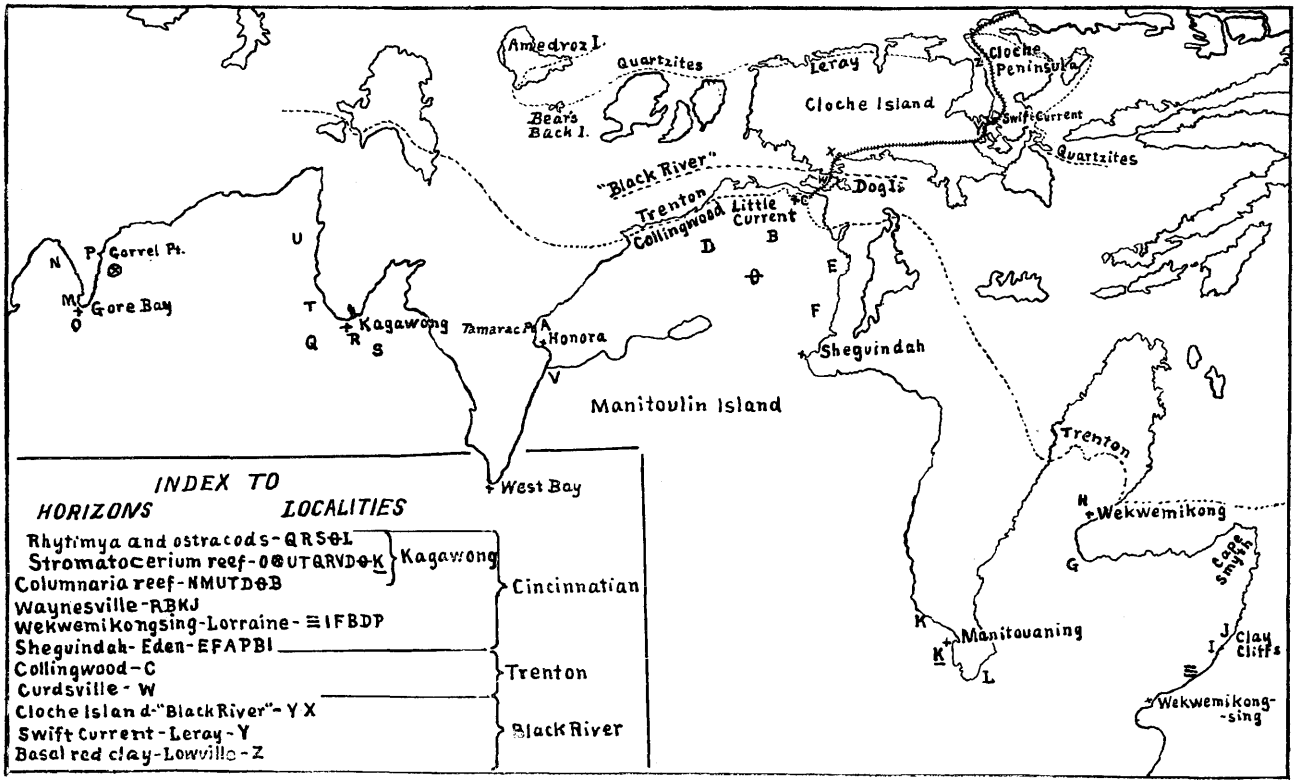
Immediately above the *Stromatocerium* reef, at Kagawong and Gore Bay, a rich pelecypod, gasteropod, and ostracod fauna, but not consisting of many species, comes in. Among these, *Ortonella hainesi* suggests the Whitewater age of the strata involved, while *Leperditia cæcigena* and *Primitia lativia* are common at certain horizons in the Saluda of Indiana but range to the top of the Elkhorn in Ohio. *Cyrtodonta ponderosa, Ctenodonta iphigenia*, a large *Archinacella*, and various species of *Lophospira* occur. Among the species which continue their range upward from below are *Strephochetus richmondensis, Tetradium huronensis, Hebertella occidentalis, Zygospira modesta, Byssonychia radiata*, and *Pterinea demissa*. They are all forms capable of continuing existence in muddy waters, judging from the frequency with which they are found in argillaceous limestones, fine grained sandstones, and clays. The total thickness of this upper part of the Richmond, from the *Stromatocerium* reef to the base of the Clinton, varies apparently from 45 to 60 feet, on Manitoulin.

E. Queenstown Shales.

The northwestern extension of the red clay shales, to which the term Queenstown has been applied in the Niagara Falls area, is well exposed on the Saugeen peninsula which separates Georgian Bay from the main body of Lake Huron. In the vicinity of Collingwood, Meaford, Owen Sound, and westward, these red shales evidently represent the strata above the Columnaria reef horizon as exposed on Manitoulin. The only fossiliferous strata found in these Queenstown shales, however, belong to those horizons above the *Stromatocerium* reef in which ostracods are abundant. In addition to *Leperditia cæcigena* and *Primitia lativia, Eurychilina striatomarginata* and *Drepanella canadensis* are present, accompanied by the Richmond form of *Bythocypris cylindrica, Byssonychia radiata, Pterinea demissa*, a *Zygospira* resembling *Z. kentuckiensis, Bythopora delicatula*, and other characteristic Ordovician fossils.

At the Forks of the Credit, 65 miles southeast of Meaford, no trace of this Richmond fauna was found anywhere in the Queenstown red clay shale section.

In the vicinity of Meaford, the highest layers of the Richmond fauna occur fully 100 feet above the top of the richly fossiliferous Waynesville fauna at the base. The total thickness of the Queenstown shales, in the vicinity of the Niagara Falls, however, is estimated at 1000 feet, so that it may be only the basal part of the Queenstown shale which is of Richmond age, although there appears no lithological reason for imagining a different age for the upper part of the Queenstown section.



FOERSTE "On the Ordovician Section in the Manitoulin Area of Lake Huron."