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UPPER ORDOVICIAN FORMATIONS IN ONTARIO AND QUEBEC

BY

A. F. FOERSTE

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PREFACE.

The provinces of Ontario and Quebec offer a fertile field for geological investigation. The problems involved often are of more than local interest. Their solution would be welcomed not only by the geologists of Canada, but also by those of the neighbouring states on the south.

One of these problems is the geological history of the later Ordovician strata in Ontario and Quebec. This problem involves not only the unravelling of the order of succession of these strata, and their correlation with formations elsewhere, but also the determination of the conditions under which these strata were deposited, the source of the faunas which inhabited the seas at the time of their deposition, and the direction of migration of these faunas.

All of these lines of investigation have received attention, and to give due credit to the numerous investigators would require a voluminous bibliography. Billings, Whiteaves, Nicholson, and Ami have made many contributions to our knowledge of the fossils. Logan, Bell, Ells, and Low made valuable contributions to our knowledge of the stratigraphy. Grabau has given special attention to the conditions under which the sediments were deposited, while Ulrich and Schuchert have followed the lines of migration of the faunas. The investigations recorded on the following pages, therefore, are merely an attempt to seek additional information which might serve in the future solution of the problems involved.

While engaged on the study of the Cincinnatian faunas of Ohio, Indiana, and Kentucky, the writer found the "Geology of Cincinnati," by John M. Nickles, a most valuable handbook. This pamphlet, published in 1902 as part of the Journal of the Cincinnati Society of Natural History, contains numerous lists of fossils, and embodies all that was known at that time regarding their vertical distribution within the area indicated. It was based upon the investigations of numerous collectors, whose conclusions had been subjected to critical analysis by Ulrich as well as by Nickles. At the time this pamphlet was published, the Cincinnatian rocks were divided into three major divisions. In descending order, these were:

Richmond group.
Lorraine group.
Utica group.

The first name, Richmond, did not involve any comparison with New York formations. The second and third names, Lorraine and Utica, were expressions of an opinion that the middle and lower parts of the Cincinnatian measures, as here defined, could be correlated with certain well-known New York strata, whose faunas were described in the "Palæontology of New York."

To the writer, this correlation never appeared very obvious. The very abundant fauna of the lower and middle parts of the Cincinnatian section of the Ohio valley is but scantily represented in New York state, while the characteristic Utica and Lorraine faunas of New York find representatives in the Cincinnatian areas at only a few narrow horizons. The two faunas appear to have been deposited in two basins, which most of the time must have been quite distinct. For this reason it was deemed inadvisable to retain the New York names for the Cincinnatian groups. Therefore Orton's name, Eden, was revived for the lower group, and the name Maysville[1] was proposed for the middle group, as typically exposed in Ohio, Indiana, and Kentucky.

However, if the New York and Ohio later Ordovician formations be regarded as having been deposited in distinct basins, it becomes a matter of interest to determine to which of these two basins the later Ordovician deposits along the northwestern shores of Lake Ontario belong. These deposits evidently occupy an intermediate position, geographically, between the Lorraine and Utica areas, east of Lake Ontario, in New York, and the Richmond, Maysville, and Eden areas in Ohio, Indiana, and Kentucky.

Moreover, the labours of Ulrich demonstrate that the Richmond of the Mississippi valley and thence westward contain faunal elements quite distinct from the typical Richmond of the Ohio River valley. It becomes a matter of interest, therefore, to trace the boundaries between the Ohio and the Mississippi

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[1] Science, Vol. XXII, p. 149, 1905.

basins during Richmond time. This interest is increased by the fact that the western Richmond is known to extend as far east as Lake Michigan, on the eastern border of Wisconsin, the northeastern part of Illinois, and also as far as the southwestern corner of the same state, along the Mississippi, while the Ohio Richmond extends westward across half the width of the state of Indiana, along its southern boundary. Is it the Ohio or the Mississippi type of Richmond which occurs on Manitoulin and Drummond islands, and on the southern shores of Georgian bay? To which type of Richmond do the deposits along the southern shores of Georgian bay, and west of Toronto belong?

Again, ever since the investigations on the Anticosti fauna by Billings it was known that Richmond strata occurred on Anticosti, and it was regarded as practically certain that Richmond faunas existed also on Snake island in Lake St. John. Can any considerable portion of the Anticosti type of Richmond be traced to Snake island, or even farther westward?

The St. Lawrence valley has long been known to contain numerous exposures of strata apparently referable to the Utica and Lorraine of New York. At the western extremity of these later Ordovician areas, a short distance east of Ottawa, the exposures are only about 115 miles distant from the Lorraine gorge in New York. To what extent do the Lorraine and Utica elements of the New York faunas dominate in the apparently corresponding strata along the St. Lawrence valley?

These are some of the problems awaiting solution. It will be more conducive to a proper understanding of the following pages, however, to state that the writer, in his field work, attempted as much as possible to confine himself to a study of the distribution of the Richmond strata, and the order of succession of their faunas. All observations on the underlying Lorraine faunas were made merely while seeking outcrops of Richmond strata. The territory covered was so large that concentration on the Richmond part of the problem was considered desirable.

The field work was in the nature of a reconnaissance. It was desired to locate those territories which would promise the best results when the later detailed investigations were under-taken. It must be evident, therefore, that the following pages are to be regarded as merely preliminary to further study.

It should be emphasized that in these pages it is attempted merely to indicate to what extent it is possible to discover the elements of the Lorraine faunas of New York and of the Cincinnatian faunas of Ohio, Indiana, and Kentucky in the upper Ordovician sections of Ontario and Quebec. It is not attempted in the present state of our knowledge to impose either the New York or the Cincinnatian names of divisions and subdivisions of upper Ordovician strata on Canadian geology, but merely to state to what extent progress in correlation of the various strata in these different states and provinces has been made and where the uncertainties still lie.

The writer is under great obligations to Mr. R. W. Brock for enabling him to carry on these investigations under the auspices of the Canadian Geological Survey. It was with his encouragement that these investigations were begun, and it is hoped that they may prove of some service even in the preliminary stages of the work. The writer is also under great obligations to Dr. Ulrich and Dr. Bassler who have always placed their extensive knowledge of American Palæozoic rocks at the writer's disposal. He is also under obligations to Miss A. E. Wilson for the laborious work in preparing the fossil lists at the end of this report.

Upper Ordovician Formations of Ontario and Quebec.

CHAPTER I.

UPPER ORDOVICIAN OF NEW YORK STATE.

NOMENCLATURE.

The state of New York was a pioneer in the classification of Palæozoic strata into divisions and subdivisions, in the development of a nomenclature adequate to indicate the various degrees of division, and in the publication of a sufficient number of illustrations of fossils to make possible the ready identification of each of these divisions. The result is that the classification of Palæozoic strata proposed for the state of New York became a standard for all other states, and was adopted also in Canada.

It cannot be said, however, that in the naming of the various subdivisions the claims of priority were adhered to slavishly. This was shown, for instance, in the discarding of the term *Salmon River*, proposed by Conrad in 1839. This term included about the same series of strata as that for which the name *Hudson River* was long used in New York geology. In the Annual Report of the Geological Survey of New York for 1838, Conrad recognized the following divisions:

> Saliferous rock of Eaton (including the Medina red sandstone).
> Olive sandstone and slate cut through by Salmon river in Oswego county.
> Black limestone and shale of Trenton falls, embracing the Birdseye and Calciferous sandrock of Eaton.

In the Annual Report for 1839, Conrad used for these divisions the following terms:

> Niagara sandstone, red (including the Medina).
> Salmon River sandstone, olive.
> Trenton group, including Trenton limestone and slate; Mohawk limestone; Grey limestone and sparry veins; Grey calcareous sandstone.

The following fossils were listed from the Salmon River sandstone:

Pterinea carinata (= *Byssonychia radiata*)
Pterinea planulata (= *Clidophorus planulatus*)
Pterinea modiolaris (= *Modiolopsis modiolaris*)
Cyrtolites ornatus

The same classification of the strata was used by Conrad in the Annual Report for 1840.

Anyone familiar with New York stratigraphy will recognize the fact that Conrad applied the term Salmon River to the strata later included by Hall in the Hudson River group. In describing *Cyclonema bilix*, from Richmond, Indiana, he gives its horizon as limestone of the age of the rocks of the Salmon River series, New York.

None of the other geologists followed Conrad in his use of the term Salmon River. Vanuxem, in the Annual Report for 1840, employed the term in a very different sense, or at least with a very restricted application. This is shown by the following classification:

Medina sandstone (called red sandstone of Oswego in the Annual Report for 1839).
Salmon River sandstone (including only the practically unfossiliferous sandstone forming the falls of the Salmon river, and corresponding strata elsewhere).
Pulaski shales (shales of Salmon river of former reports).
Frankfort slate.
Black slate or shale (later called Utica by Emmons).
Trenton limestone.
Birdseye limestone.
Mohawk limestone.

In this classification the name Salmon River was retained for that part of Conrad's section in which, as a palæontologist, he was least interested, and all the fossiliferous part of the Salmon River section was used to form the new division, the *Pulaski* shales. This was done notwithstanding the fact that Conrad based the adoption of the name Salmon River upon the presence of a distinct fauna which he himself began to describe, and which Vanuxem was obliged to name in order to designate what was meant by the term *Pulaski*. Pulaski was the largest village on the Salmon river.

The term *Frankfort* was applied to strata exposed in the Trenton Falls basin, so far to the east of the sections along the Salmon river, that it is not known yet whether any representative of the true Frankfort shale occurs as far west as Oswego and Jefferson counties. That Vanuxem had no clear knowledge as to where to draw the line between the Frankfort and the Pulaski shales is shown by his reference of Whitall's quarry, near Rome, to the Frankfort.

In the final report, published in 1842, Vanuxem adopted the following terminology:

Medina.
Grey sandstone of Oswego.
Hudson River group.
  Pulaski.
  Frankfort.
Utica.
Trenton.

In this list it will be noticed that he used the term *Grey sandstone of Oswego*, in place of Salmon River sandstone of his 1840 report, ignoring his own use of the term *Red sandstone of Oswego* for an entirely different formation in 1839. The term *Hudson River group* was made to include both the Pulaski and the Frankfort shales, but omitting the Grey sandstone of Oswego, which was placed above the Hudson River. This application of the term Hudson River to strata in western New York has proved most unfortunate since the type localities of the true Hudson River group, along the Hudson river, in eastern New York, belong not only to an entirely different basin of deposition, but to a much lower horizon, the typical Hudson River group consisting almost entirely of Trenton shales, and, therefore, lying below, rather than above the Utica shale. Whatever may be considered the value of the term Hudson River, when applied to Trenton strata in the type areas, along the Hudson river, there can be no hesitancy in declaring the term improper for the upper Ordovician strata in the more western area, east of Lake Ontario, which belong to a much higher horizon. The name *Utica*, for the black shale overlying the Trenton, was adopted in 1842 both by Vanuxem and Emmons.

In that part of the final report, published in 1842 by Emmons, the following classification was adopted:

Grey sandstone.
Lorraine shales.
Utica slate.
Trenton limestone.

In this list the term *Lorraine* was adopted in place of Pulaski shales because at Lorraine, in addition to the Pulaski shales, are seen those lower strata which are not exposed at Pulaski. He evidently included under this term all of the strata ranging from the base of the unfossiliferous grey sandstone section, at Salmon River falls, and at corresponding horizons elsewhere, down to the top of the Utica slate, as exposed in the Lorraine gorge. In this sense, the term Lorraine has the same significance as the term Hudson River, as incorrectly applied by Vanuxem to upper Ordovician strata in the areas adjacent to Lake Ontario. Hence the term Lorraine should replace the term Hudson River as formerly applied incorrectly to strata above the Utica, in western New York.

The true significance of the term *Hudson River* was not fully appreciated until Dr. Rudolf Ruedemann published his studies on the "Lower Siluric Shales of the Mohawk Valley," in 1912. Then it became evident that three basins of deposition may be recognized in that part of New York crossed by this valley. In the eastern basin along the Hudson river no strata above the lower Trenton have been recognized. In the middle basin, extending westward from the vicinity of the Hudson river, the great mass of shales all belongs to the Trenton, with the exception of the comparatively insignificant mass called by Ruedemann, the *Indian Ladder shale.* The latter possibly might be correlated with the strata exposed in the lower part of the gorge at Lorraine, but these beds certainly never were intended to serve as typical representatives of the Hudson River group by those who brought this name into prominence. In fact, the term Hudson River can have no significance except for strata comparable with those found in the vicinity of the Hudson river, and these are of Trenton, or even earlier age. As a term for upper Ordovician strata overlying the Utica, the name Hudson River is entirely inappropriate, and no excuse exists for its further retention with that significance.

FAUNA.

UTICA.

The Utica of New York is more restricted in its distribution than formerly supposed. According to Dr. Ruedemann it does not enter the Schenectady and Levis basins in the eastern parts of that state. Nevertheless the Utica fauna may be regarded as an Atlantic invasion, the location of the channel admitting this invasion being still unknown.

The typical Utica of New York includes the following characteristic species:

Climacograptus typicalis.
Dicranograptus nicholsoni.
Glossograptus quadrimucronatus short, long-spined variety.
Leptograptus annectans.
Mastigograptus simplex.
Mastigograptus tenuiramosus.
Pleurograptus linearis.
Cyathophycus reticulatum.

The following species are rare in the underlying Canajoharie (Trenton) shale, but become dominant forms in the Utica:

Climacograptus putillus.
Lasiograptus eucharis.
Triarthrus becki.

The following species are equally common in both shales:

Leptobolus insignis.
Lingula curta.

Fissile black shales, lithologically identical with the typical Utica of New York, are widely distributed in Canada. They occur along the channel north of Manitoulin island, in Lake Huron, and thence southeastward to the southern shores of Georgian bay. East of Toronto, at Whitby, they are exposed along the northern shores of Lake Ontario. Numerous exposures occur in the vicinity of Ottawa and thence eastward. Along the St. Lawrence valley they occur northeastward as far as Beauport, east of Quebec. Northward, this fauna occurs as far as Lake St. John. On the island of Anticosti it is represented in the Macastey black shales.

In the lower part of these shales *Ogygites canadensis* is present. At higher elevations *Triarthrus spinosus* and *Triarthrus glaber* occur. The first two of these species are widely distributed in Canada. Their entire absence in the typical Utica of New York suggests deposition of the Canadian deposits in a different basin. Possibly, there is also a difference in age, the lower Canadian black shales being older than the typical Utica of New York. For the lower Canadian black shales, as exposed along Georgian bay, Prof. Raymond proposed the name Collingwood shales.

LORRAINE.

It is unfortunate that Conrad's term, Salmon River, was ignored and that the name Hudson River gained such wide currency in the geology not only of New York but also of many other states, and of Canada. It is unfortunate, also, that the term Lorraine has come into general use, since the palæontological labours of Conrad in reality established the first sound basis for the classification of New York rocks, and there was no doubt as to what strata he intended to have included under the term Salmon River. As a matter of fact, however, the term Lorraine has grown into general use and will be found not only in the geology of various parts of the United States but also in that of Canada. It, therefore, becomes important to determine just what the name Lorraine implies.

At the village of Lorraine, in Jefferson county, New York, the following fossils occur in the creek in the northeastern corner of the village:

Heterocrinus columnals.
Glyptocrinus columnals.
Cornulites of straight free type.
Pholidops subtruncata.
Dalmanella of testudinaria group.
Glyptorthis crispata.
Rafinesquina alternata, flat form.
Plectambonites sericeus.
Catazyga erratica.
Byssonychia radiata.
Clidophorus planulatus.
Colpomya faba-pusilla.
Cuneamya scapha-brevior.
Ctenodonta lorrainensis.

Modiolopsis of *concentrica* group.
Lyrodesma poststriatum.
Archinacella pulaskiensis.
Cyrtolites ornatus.
Hormotoma gracilis-sublaxa.
Trinucleus concentricus.
Calymene sp.

At a moderately higher horizon, 2 miles eastward, on the road to Worthville, the same species as in the preceding list are found, with the addition of

Ischyrodonta curta
Sinuites cancellata.

At a slightly higher horizon, at Worthville, the following are added to the list, still associated with *Trinucleus concentricus:*

Rafinesquina nasuta.
Modiolopsis modiolaris.
Orthodesma nasutum.

At still higher horizons, east of Worthville, *Ischyrodonta curta*, associated with *Modiolopsis modiolaris*, and *Orthodesma nasutum*, becomes more common, and *Rafinesquina mucronata* is added to the list.

Still higher horizons are exposed at the Bennett bridge, about a mile down stream from the Salmon River falls. Here the following species occur:

Rafinesquina alternata.
Rafinesquina mucronata.
(No *Plectambonites* or *Dalmanella* was noted.)
Byssonychia radiata.
Pholadomorpha pholadiformis.
Orthodesma nasutum.
Lyrodesma poststriatum.
Archinacella pulaskiensis.

The highest fossiliferous strata occur within a short distance of the base of the Salmon River falls. Here the following species occur:

Glyptocrinus columnals.
Pholidops subtruncata.
(*Dalmanella* and *Plectambonites* absent.)
Rafinesquina mucronata.
Rafinesquina alternata.
Catazyga erratica.
Byssonychia radiata.
Modiolopsis modiolaris.
Pholadomorpha pholadiformis.
Ischyrodonta curta.
Clidophorus planulatus.
Lyrodesma poststriatum.
Cyrtolites ornatus.
Isotelus sp.
(No *Trinucleus.*)

To the preceding lists of fossils from the immediate vicinity of Lorraine and thence eastward as far as Worthville, where *Trinucleus concentricus* still is present, the following may be added from the "Paleontology of New York," Volume I:

Buthotrephis subnodosa, central parts of group.
Diplograptus peosta, olive or green slates of group.
Lingula rectilateralis, soft argillaceous shales in lower part of group.
Dalmanella centrilineata (young of common form belonging to *testudinaria* group in the higher parts of group, associated with "*Orthis testudinaria*, *Trinucleus*, and crinoid columns").
Zygospira sp. (*Atrypa increbescens* = incorrect determination) shales of group.
Modiolopsis anodontoides, upper arenaceous part of the group.
Cymatonota parallela, soft shaly parts of group.
Orthoceras lamellosum.

In this list, *Diplograptus peosta* (*pristis*, *pars*), *Lingula rectilateralis*, and *Zygospira* sp., probably came from the lower shaly parts of the group, in the gulf northwest of the village. *Dalmanella centrilineata* probably came from the *Trinucleus* horizon within the northeastern edge of the village. *Modiolopsis anodontoides* may have come from the higher lands in the immediate vicinity of the village. *Buthotrephis subnodosa*, and *Cymatonota parallela* may have come from horizons a short distance below the level of the exposures within the limits of the village, since it is evident that *Trinucleus* was regarded by Hall as ranging into the higher parts of the group. As a matter of fact, *Trinucleus*, *Dalmanella*, and *Plectambonites* are unknown at present from the horizons in the upper part of the group as exposed from the vicinity of Bennett Bridge and thence eastward up the Salmon river to the great falls, nor are they known from equivalent exposures elsewhere in New York. It is evident that Hall used the expression, "higher parts of the group," so as to include also distinctly lower horizons than those exposed at the Bennett bridge.

During this ascent in the geological scale, from the creek within the limits of Lorraine village to the highest fossiliferous strata at the base of the Salmon River falls, no striking lithological changes are noted. The quantity of arenaceous material increases rather gradually, and this continues into the practically unfossiliferous sandstone section forming the Salmon River falls, so that there appears no lithological reason for regarding the Salmon River Falls sandstone as a distinct formation. It is merely the upper less fossiliferous part of the underlying Lorraine section. Moreover, no abrupt faunal change is noted anywhere. The disappearance of certain species and the introduction of others occur usually singly, so that no faunal break can be utilized in the discrimination of subdivisions of the Lorraine.

The Pulaski section, as exposed east of Pulaski, as far as the railway bridge, a mile east of town, corresponds to that part of the Lorraine section seen in the vicinity of Worthville and thence eastward for about a mile. The following species were found east of Pulaski:

Cornulites sp.
Lingula sp.
Schizocrania filosa.
Dalmanella of *testudinaria* group.
Plectambonites sericeus.
Rafinesquina alternata.
Rafinesquina nasuta.
Rafinesquina mucronata.
Cornulites sp.
Byssonychia radiata.
Colpomya faba-pusilla.
Modiolopsis modiolaris.
Orthodesma pulaskiense.
Cymatonota pholadis.
Ischyrodonta curta.
Clidophorus planulatus.
Lyrodesma poststriatum.
Cuneamya cf. *elliptica.*
Archinacella pulaskiensis.
Cyrtolites ornatus.
Trinucleus concentricus.
Calymene sp.

To this list of fossils from Pulaski, the following may be added from the "Paleontology of New York," Volume I:

Buthotrephis subnodosa, central parts of group.
Pterinea demissa, higher parts of group.
Cymatonota parallela, soft shaly parts of group.
Hormotoma gracilis-sublaxa, throughout the group.
Clathrospira subconica, central parts of group.
Archinacella pulaskiensis, argillaceous and calcareous parts of group.
Sinuites cancellata, rare in lower shaly parts, common in central parts.
Trocholites planorbiformis, central parts.
Orthoceras coralliferum, shales and sandstones of group.
Orthoceras lamellosum.
Ormoceras crebriseptum, shaly calcareous strata of group.

In this list the various references of the fossils to lower, middle, and higher parts of the group may be of little value, since in the immediate vicinity of Pulaski, from the railway bridge one mile east of town to the exposures a mile down stream west of town, the rocks dip westward at a rate only moderately less than the rate of fall of the stream, so that the total thickness of the section exposed is only moderate.

It is quite evident that the preceding lists of fossils from the vicinity of Lorraine, Worthville, Pulaski, Bennett Bridge, and the Salmon River falls, do not suggest the presence of a Richmond fauna within the Lorraine formation of New York, unless the occurrence of *Pholadomorpha pholadiformis* at the Bennett Bridge locality be regarded as sufficient to identify the upper part of the Lorraine as Richmond, even when unsupported by the presence of other fossils elsewhere regarded as typical of the Richmond. As will be noted later, strata closely resembling the Lorraine and containing *Pholadomorpha pholadiformis* immediately underlie the Waynesville division of the Richmond in both the provinces of Quebec and Ontario, and appear to correspond to strata in the Maysville formation.

The term Lorraine was proposed by Emmons because at Lorraine are exposed the lower strata not seen at Pulaski. These lower strata include those shales in the gulf northwest of the village which overlie the *Triarthrus becki* horizons at the base of the gulf, near its mouth. As far up as *Triarthrus becki* could be found, the shales at the bottom were identified by Emmons as Utica.

No detailed investigations of this lower part of the Lorraine section, within the gulf, were made by the writer. Some years ago, Doctors Ulrich and Ruedemann went the entire length of the gulf, quite an arduous undertaking, and came to the conclusion that the entire section, up to within a short distance of the level of Lorraine village, corresponded approximately to the *Eden* division of the Cincinnatian series of rocks. The overlying strata, however, including those from the level at Pulaski to the top of the fossiliferous zones at the Salmon River falls, appear to be later than any part of the Eden at Cincinnati and apparently correspond to Maysville strata. The uppermost horizons, containing *Pholadomorpha pholadiformis*, belong much higher than the Eden, but perhaps not sufficiently high to be included in the Richmond. This suggests the division of the Lorraine into at least two divisions, an upper and a lower one, the *lower* including the *Eden* part.

For the *upper* division the name *Pulaski* can be retained, but the lower, Eden, division cannot be identified with the Frankfort, now that the fossil content of the Frankfort has been worked out by Dr. Ruedemann.[1] The Frankfort shale, at its type locality, holds an impoverished Utica fauna with some Trenton elements retained which are not known in the Utica. Dr. Ruedemann lists from the typical Frankfort the following species:

Climacograptus typicalis.
Prasopora sp.
Lingula sp.
Leptobolus insignis.
Orbiculoidea tenuistriata.
Dalmanella testudinaria mut.
Dinorthis pectinella.
Rhynchotrema inaequivalve.
Camarotoechia sp.
Modiolopsis sp.
Cf.Serpulites longissimus, Murchison.
Orthoceras sp.
Triarthrus becki.
Trinucleus concentricus.

No strata containing *Dinorthis pectinella, Rhynchotrema inaequivalve*, or *Camarotoechia* have been found in the lower part of the Lorraine gulf. A form of *Climacograptus* having the thecae and growth of *C. typicalis*, but the dimensions of *C. putillus*, occurs in the black shales south of Allandale, a short distance west of the mouth of the Lorraine gulf, but these strata are referred to the Utica. The following fauna was collected here:

Climacograptus typicalis var.
Glossograptus quadrimucronatus-postremus.
Mastigograptus cf. *tenuiramosus.*
Cornulites sp., attached laterally.
Schizocrania filosa.
Leptobolus insignis.
Zygospira sp.
Orthoceras sp.
Triarthrus becki.
Trinucleus concentricus.

Triarthrus becki, Trinucleus concentricus, and *Glossograptus quadrimucronatus-postremus*, range up the stream to the mouth of the gulf. The graptolites were determined by Dr. Ruedemann. No evidence of the presence of typical Frankfort shales has been secured so far, and, therefore, the correlation of any part of the shales in the Lorraine gulf section with the Frankfort is regarded as inadvisable. This leaves the Eden part of the Lor-

[1] The Lower Siluric Shales of the Mohawk valley, N.Y. State Bull. 162, pages 34-37.

raine section without a name. Even if the Frankfort beds be of later age than the Utica, this does not establish the age of the lower Lorraine shales as Frankfort. Moreover, until better evidence than any adduced so far is secured, the Frankfort may be regarded as above the Utica but below the typical Eden. Since Dr. Ruedemann intends to make a special study of the Lorraine of New York, the writer will leave the lower Lorraine division unnamed. At present, the typical Frankfort is unknown west of Rome, which is 45 miles distant from the nearest exposures of the strata immediately overlying the Utica in the area east of Lake Ontario.

A PROVISIONAL TERMINOLOGY FOR THE NEW YORK UPPER ORDOVICIAN STRATA.

According to the preceding observations it is not unlikely that the term Lorraine does not properly include the Frankfort, since typical Frankfort shales may not occur in the vicinity of the village of Lorraine. It certainly was not intended to include under this term the grey sandstone exposed at the Salmon River falls and at Oswego. It will be noted that Vanuxem in his final report, also excluded the "Grey sandstone of Oswego" from the Hudson River group, although recognizing its position below the Medina. However, the lithological change from the top of the fossiliferous part of the Lorraine into the overlying unfossiliferous sandstone is so gradual that there seems no good reason, at present known, for placing the sandstone in a different formation, although this sandstone might be regarded as an upper division of a single formation, also including the typical Lorraine. If the term Lorraine is to be retained, as a substitute for Salmon River, when the latter term is used in its original sense, it seems necessary to extend the significance of the term Lorraine upward at least sufficiently to include the "Grey sandstone of Oswego."

If the term Salmon River is not to be used in its original extended sense, then there is no reason why it should not be utilized in its restricted sense, as employed by Vanuxem in 1840. If the "Red sandstone of Oswego" represents a higher horizon than the "Grey sandstone of Oswego," then the latter term certainly does not have priority, and the term Oswego cannot supersede Salmon River as a designation for the unfossiliferous sandstones at the top of the Lorraine formation, as here extended. This gives the following classification for the New York rocks here under consideration:

Medina.	
Lorraine............	Salmon River sandstone. Pulaski shales and sandstones. Lower Lorraine shales, unnamed (Near Eden of Cincinnatian).
Unnamed group......	Frankfort. Utica.
Trenton.	

In western New York, the Queenston red clay shales intervene between the Medina and the Lorraine; at various localities in Ontario and Quebec, the lower or Waynesville division of the Richmond intervenes between the Queenston and the Lorraine; and the Salmon River sandstone is absent, so that in Canada the succession becomes:

Medina.	
Queenston...........	Whitewater and Saluda divisions of the Richmond.
Waynesville division of Richmond.	
Lorraine.............	Pulaski. Unnamed division (Near Eden of Cincinnatian).
Utica shale of New York.	
Collingwood.	
Trenton.	

This classification retains objectionable features; but it represents an effort to preserve as much as possible the terms proposed by the early investigators of New York geology, without discarding the term Lorraine which has grown into such general use.

CHAPTER II.

THE LORRAINE AND UNDERLYING FORMATIONS IN ONTARIO AND QUEBEC.

QUEBEC AND EASTERN ONTARIO.

In attempting to trace Lorraine strata northward, into Canada, the supposed equivalents of the Pulaski division appear to have a wide distribution, far greater than in New York.

Scattered exposures, of small area, occur at various localities east of Ottawa, as far east as Vars, in the province of Ontario. Exposures occur also at various localities east of Montreal, including Chambly Canton, and St. Hilaire. About halfway between Montreal and Quebec, Lorraine strata occur on the lower parts of the Nicolet and Bécancour rivers. Dr. Ami has identified Lorraine strata along the southern side of the St. Lawrence river, almost as far east as the city of Quebec, but these exposures have not been seen by the writer. Sufficient, however, is known to indicate a wide areal distribution of the Lorraine east of Ottawa and in the province of Quebec.

NICOLET RIVER SECTION.

The relations of these Lorraine strata to the overlying formations are shown best along the Nicolet river, about halfway between Montreal and Quebec, at a point about 2½ miles south of Ste. Monique station (Figures 1 and 2). Here the base of the Queenston red clay shales is underlaid by richly fossiliferous strata referred to the Waynesville division of the Richmond, and the latter are underlaid in turn by strata referred to the Lorraine. In the upper part of the Lorraine *Pholadomorpha pholadiformis* and forms similar to *Modiolopsis concentrica* are present, associated with *Pterinea demissa*. At this upper or *Pholadomorpha* horizon no *Plectambonites sericeus* was noticed, although it is found in the lower part of the overlying Richmond and also at lower levels in the Lorraine. *Dalmanella* also is not recorded as present from the upper part of the Lorraine section, unless it occurs at the extreme top; it is very abundant, however, from those parts of the Lorraine which *underlie* the *Pholadomorpha* zone.

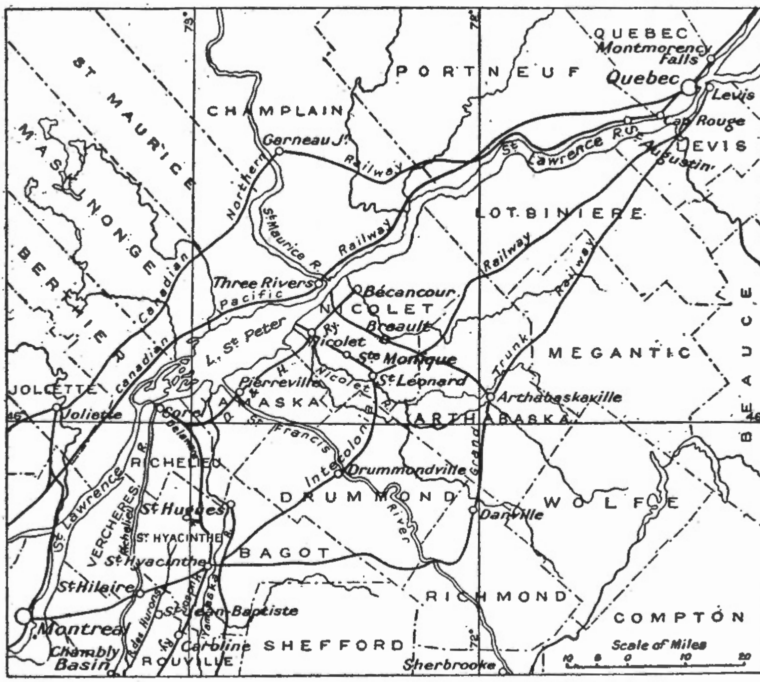

Figure 1. Portion of Quebec, showing fossil localities.

The following species have a considerable range throughout the Lorraine along the Nicolet river:

Heterocrinus columnals.
Glyptocrinus columnals.
Cornulites, straight free form.
Rafinesquina mucronata.
Rafinesquina alternata, flat form.
Zygospira cf. *modesta*.
Pholidops subtruncata.
Byssonychia radiata.
Cymatonota sp.
Clidophorus praevolutus.
Ctenodonta lorrainensis.
Archinacella pulaskiensis.
Sinuites cancellata.
Lophospira cf. *bowdeni*.

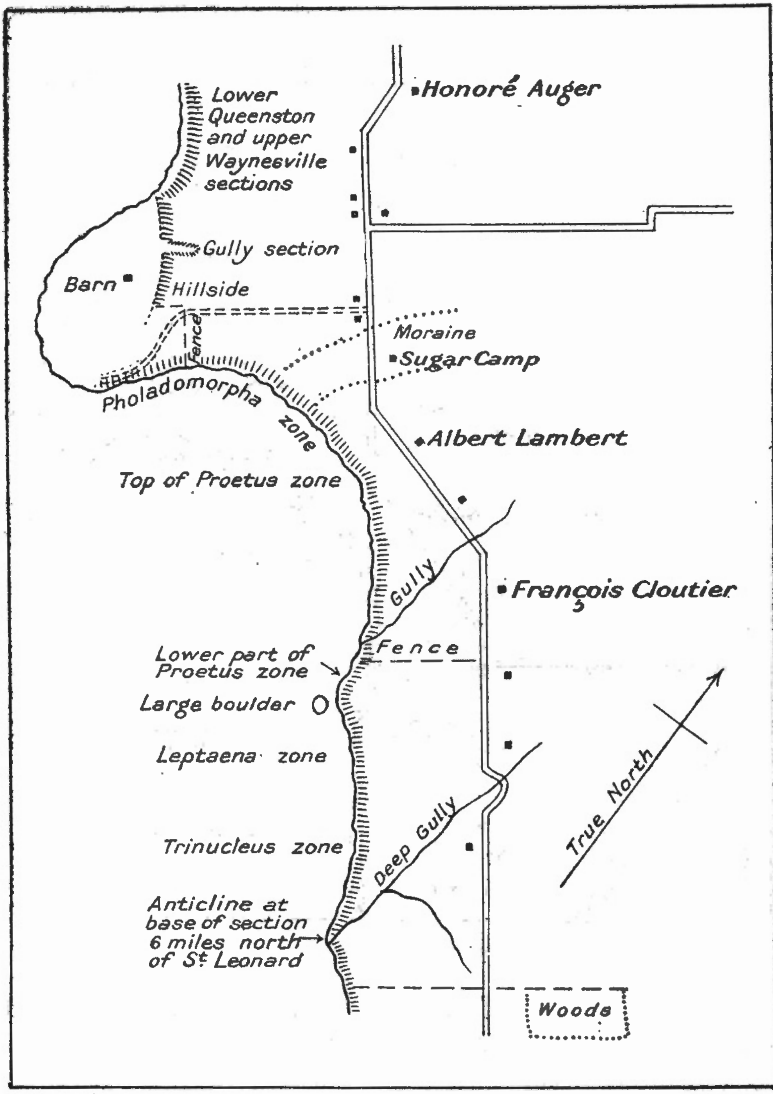

Figure 2. Sketch map of the east bank of the Nicolet river between 2 and 4 miles southwest of Ste. Monique, showing rock exposures.

The more exact distribution of the various species, as far as known, is given in the following detailed account of the Nicolet River section. Of course, the citations of *Heterocrinus* and *Glyptocrinus* columnals can have no value excepting as they indicate an impression produced by their frequent occurrence. In the absence of the heads of the crinoids, the finding of the columnals does not warrant the use of these fragments of the stems in correlation.

The Nicolet river enters the St. Lawrence from the south at a place about 9 miles southwest of Three Rivers, Quebec. The section about to be described may be reached from Ste. Monique station on the Nicolet branch of the Intercolonial railway. From this station a road leads southwest and in a distance of 1½ miles joins a road roughly parallel to the Nicolet river. The river road follows a southeast course and 1½ miles from the point where the road from the railway station joins, it reaches a strong easterly bend of the Nicolet river near the home of Honore Auger. Directly opposite the Honore Auger home, the Queenston red shales are exposed and a short distance southeastward, at a bluff along the bend of the river, the contact between the Queenston and the underlying, richly fossiliferous Richmond strata, is exposed. Detailed sections were measured from the base of the Queenston, through the fossiliferous Richmond and down into the underlying Lorraine. The Queenston is regarded as also of Richmond age. In the following accounts of the Nicolet River sections the detailed description of the immediately underlying richly fossiliferous strata definitely known to be of Richmond age is reserved for a later section of this report (pages 141-150).

The following sections are a study only of the vertical distribution of the fossil life. No attempt was made in the field to secure an accurate record of the lithological character of the strata. Such statements as here are recorded are based chiefly on memory and indicate only the chief characteristics of the strata involved. In the case of the Nicolet River section, first described, it may be added that the argillaceous shale in that part of the section which extends from layer Y to layer W, is more or less calcareous, and at certain levels tends to merge into an impure limestone. By far the greater part of the underlying strata consists of soft clay shale, with only occasional hard, impure limestone layers interbedded. Toward the lower part of the section, beginning near layer I, these shales become more sandy and all of the basal part of the section consists of comparatively thin-bedded sandy shales or shaly sandstones.

Section No. 1, at Bluff Southwest of Home of Honore Auger.

		Thickness feet.	Total thickness.[1]
	Red shales underlain by blue shales, forming the basal part of the *Queenston* (*Upper Richmond*)	....	...
	Mainly argillaceous shale with some interbedded limestone forming the *Upper part of the Waynesville* (*Lower Rich-mond*) *Section*................	57½	57½
(W)	Zone W, top of *Strophomena hecuba* zone	2	59½
	Limestone....................................	½	60
	Base of exposure at southern end of cliff.		

Proceeding from this cliff due southward along the base of the hill at the eastern edge of the field, the mouth of a narrow, steep gully is reached, giving an excellent exposure of part of the preceding section, and also exposing some of the underlying strata. The description of this gully section, section No. 2, follows.

Section No. 2, Along Gully, South of Section No. 1.

		Thickness feet.	Total thickness.
	Mainly argillaceous shale with some interbedded limestone corresponding, stratigraphically, to the lower part of section No. 1. All of the strata in this section No. 2 belong to the Waynesville member of the Richmond	22	
(W)	Zone W, top of *Strophomena hecuba* zone..........	2½	59½
	Mainly argillaceous shale......................	36½	96
(T)	Zone T, highest horizon for *Catazyga headi*..........	1½	97½
	Mainly argillaceous shale......................	8½	106
	Base of measured part of gully section.		

[1]In the following measured sections, some of the fossiliferous horizons were too thin to be measured separately, but their relative position is indicated by inserting the list of fossils present at the proper points between the measured parts of the sections. In addition, some of the more important fossil horizons are indicated by letters.

That part of the general section extending from zone (T) downwards is exposed also along the steep hill-side about 100 yards south of the mouth of the gully. Here the following section is shown:

Section No. 3, Hillside Section, South of Gully.

		Thickness feet.	Total thickness.
	Cross-bedded limestone layer		
(T)	Zone T, highest horizon for *Catazyga headi*..........	2	97½
	Mainly argillaceous shale, also belonging to the Waynesville member of the Richmond, and described elsewhere in this report. Only the upper part of this interval is exposed in section No. 2..............	54½	152
	Argillaceous shale..............................	2	154
	Thin layer with *Catazyga headi* abundant, *Strophomena planumbona* rare..............................	...	...
(S)	Argillaceous shale with *Catazyga headi* abundant. Two specimens of *Rhynchotrema perlamellosum* occurred in a loose slab at this horizon, associated with *Strophomena planumbona* and *Catazyga headi*. It is probable that this slab was practically at its original level. This zone S forms the base of that part of the section which may be referred definitely to the *Waynesville division of the Richmond*. The immediately underlying strata are not yet definitely referred either to the overlying Richmond or to the underlying Lorraine strata......................	2	156
	Shaly strata..................................	4	160
	Thin layer with *Catazyga headi* abundant..........	...	...
	Argillaceous shale..............................	9	169
	Harder limestone with *Plectambonites sericeus* common	½	169½
	Shaly strata..................................	13	182½
	Not exposed..................................	16½	199
	Shaly strata with *Cymatonota* intermediate between *recta* and *pholadis*, near the middle...............	14	213
	Bed poorly exposed.............................	20	233
(R)	Shales with *Catazyga headi* very abundant, *Byssonychia radiata* and with occasional specimens of *Cyrtolites ornatus*, *Clathrospira subconica*, and *Byssonychia*..................................	5½	238½

The *Catazyga headi* horizon (R) may be found as follows: From the home of Honore Auger follow the road on the east side of the river southward to two barns on the west side of the road, a short distance before reaching a low, wooded moraine. Take the lane passing between the barns and follow it westward until it passes down the hill at the margin of the river. The top of the hill here is fully 130 feet above the river. The horizon (R) occurs where the rapidly descending road approaches the northern end of the long, continuous, and very steep bluff exposures which line the river bank for more than a mile southward. Its vertical distance above the river here is 60 feet. This *Catazyga headi* horizon occurs 139½ feet below the top of the highest horizon at which this species is seen and the species is found at numerous other levels at different distances below level (R).

Zone (S), containing *Strophomena planumbona* and *Rhynchotrema perlamellosum* is the lowest horizon at which forms definitely suggesting the Waynesville phase of the Richmond are known to occur. Below zone (R) the rock assumes a very Lorraine-like appearance and holds Lorraine forms. The affiliations of the strata between zones (S) and (R) have not yet been determined. The *Catazyga* occurring at horizon (R) is the typical *Catazyga headi*, such as occurs in the lower part of the Waynesville section in western Ontario and in the middle part of the Waynesville in Ohio, Indiana, and Kentucky. It is not the *Catazyga erratica* of the Lorraine of New York, However, no other species definitely suggesting Waynesville affinities is known to occur in these beds.

Along the wagon road mentioned at the end of the description of the preceding section (section 3) the following strata are exposed, duplicating the lower part of that section.

	Section 4.	Thickness feet.	Total thickness.
	Argillaceous shale with *Pterinea demissa* and *Byssonychia*	7	212½
	Thin layer with *Hebertella* common, *Byssonychia* few		
	Argillaceous shale poorly exposed	23	235½
	Argillaceous shale with *Pholidops subtruncata, Rafinesquina alternata, Byssonychia radiata*	3	238½
(R)	Top of argillaceous shale exposed at margin of bluff, south of wagon road, with *Catazyga headi* very common. Also a few *Rafinesquina alternata, Pholidops subtruncata*		238½

The presence of *Hebertella occidentalis* in considerable numbers, associated with *Catazyga headi*, was noted also in the area 18 miles east of Ottawa, at an exposure occurring about a mile west of Vars and a quarter of a mile north of the railway. Here also the *Hebertella occidentalis* horizon is regarded as underlying the more typical Waynesville zone, the latter being suggested by the presence of *Strophomena fluctuosa* along the creek about a quarter of a mile south of the railway where it crosses the same country road as that on which the *Hebertella* locality is situated.

The layer (R) of section 4 corresponds to the layer (R) in the hill-side exposure, section No. 3, previously described. At and above this horizon, occasional specimens of *Clathrospira subconica* are seen. Below the layer (R) at various levels, the following species occur: *Cornulites flexuosus* of the Lorraine as figured by Hall, *Psiloconcha sinuata* or a distorted species, *Eotomaria*, *Bythocypris cylindrica*, and *Ctenobolbina ciliata*.

From the western end of the wagon road mentioned in connexion with the description of sections 3 and 4, a high, abrupt bluff extends more than a mile southward, up the river, forming its eastern bank. This exposure is so long and includes such a great thickness of strata, that the description will be divided more or less arbitrarily into parts, each part consisting of strata presenting some characteristic in common.

In descending order the following zones are discussed in the Nicolet River section:

Pholadomorpha zone.
Proetus zone.
Leptaena zone.
Trinucleus zone.

In the province of Quebec *Pholadomorpha pholadiformis* occurs both above and below the *Pholadomorpha* zone: above, it occurs at numerous localities in strata definitely referred to the Waynesville member of the Richmond; below, it occurs in the *Proetus* zone at the mouth of the Rivière des Hurons, east of Chambly basin. The *Pholadomorpha* zone is merely that part of the section which lies below the lowest strata definitely referred to the Waynesville and above the highest strata containing *Proetus chambliensis*. Eventually it may be included definitely in the lower part of the Richmond section.

The *Proetus* zone extends from the highest strata containing *Proetus chambliensis* to the highest zone containing *Leptaena invenusta*. Occasional specimens of *Proetus* occur in the upper part of the underlying zone. At the mouth of the Rivière des Hurons, *Strophomena planumbona* occurs in this zone.

The *Leptaena* zone extends from the highest strata containing *Leptaena invenusta* to the highest strata containing *Trinucleus concentricus*. *Leptaena* also ranges through a considerable part of the underlying *Trinucleus* zone.

The *Trinucleus* zone includes all of the Nicolet section known at present beneath the highest layers containing *Trinucleus concentricus*. Judging from the St. Hyacinthe section, *Triarthrus becki* ranges through the greater part of this zone, although known only at its top in the Nicolet River section.

It is not known at present what stratigraphic value these faunal zones have, since not enough exposures at different localities have been examined to determine their vertical and geographic range of variation. However, they express our present state of knowledge of faunal zones in the so-called Lorraine of eastern Canada.

No unconformity or distinct lithological break has been noticed in any part of the Nicolet River section, not even at the base of the Queenston red shale, nor are the palæontological breaks as sharply demarcated as the names of these zones might suggest. In describing a part of the section as Richmond and a part as Lorraine no definite line of demarcation must be assumed. Only those strata definitely referred for some reason to the Richmond are described as Richmond and the remainder are allowed to remain under the term Lorraine. Eventually the upper part of these so-called Lorraine strata, especially the *Pholadomorpha* zone, may be added definitely to the Richmond, but the meagre bryozoan evidence at present appears, according to Ulrich, to be against such a procedure.

The first part of the long bluff section on the Nicolet river consists of those strata which contain *Pholadomorpha pholadiformis*, and a species resembling *Modiolopsis concentrica*. These strata overlie the *Proetus chambliensis* horizons described under section 6. They are correlated provisionally with the upper part of the Lorraine of New York, as seen at Bennett Bridge and below the Salmon River falls.

Section 5.

		Thickness feet.	Total thickness.
(S)	Lowest strata containing *Strophomena planumbona* and *Rhynchotrema perlamellosum* (Base of strata referred definitely to the *Waynesville member of the Richmond*)...		156
	Argillaceous shale exposed on the hill-side, in section 3, previously described...........................	82½	238½
(R)	Argillaceous shale exposed at margin of bluff, south of wagon road, *Catazyga headi* very common........	½	239
	Shaly strata with *Zygospira modesta, Pholidops subtruncata* very common, and *Clidophorus praevolutus* few; forming the *top of the Pholadomorpha pholadiformis zone of the Lorraine*, as identified in Ontario and Quebec.......................................	5½	244½
(Q)	Shaly strata with heavy sandstone layer, fine-grained, at the base. *Pholidops* common, *Dalmanella, Rafinesquina mucronata*..........................	3	247½
	Shaly strata with *Pholidops subtruncata*, and a form of *Cymatonota* between *recta* and *pholadis*............	18½	266
	Argillaceous shale, not accessible here, measured by dropping a weight at the end of a string, at the northern edge of the long bluff. Sandstone layers, of the Lorraine type, occur in several conspicuous layers interbedded with the upper part of the shale and form a total thickness of about 2 feet in this part of the section. Total thickness of this interval.....	22	288
(P)	Conspicuous sandstone layer at the base of the preceding strata. A hard sandstone layer which has fallen from the cliff, apparently from some point between layers (Q) and (P), contains the following fossils: *Zygospira modesta, Catazyga headi, Pterinea demissa, Whitella* resembling *obliquata*, and a *Modiolopsis* resembling *concentrica*...................		

		Thickness feet.	Total thickness.
	Argillaceous shale	9½	297½
	At this level, various loose slabs of rock have fallen from the cliff, whose origin apparently is somewhere below layer (P), but they may have come from a higher source. In these slabs the following association of fossils occurs: *Cornulites flexuosus*, *Catazyga*, and *Pholidops;* *Catazyga* and *Hebertella* ; *Catazyga*, *Rafinesquina mucronata*, *Zygospira modesta* and *Cymatonota* of rather large size for this genus; *Catazyga*, and *Ctenobolbina ciliata;* *Zygospira modesta*, *Pholadomorpha pholadiformis*, *Pterinea demissa*, a *Modiolopsis* resembling *concentrica*, and *Calymene.*		
	Argillaceous shale, with the following species: *Bryozoans*, *Glyptocrinus* columnals, *Rafinesquina alternata*, *Clidophorus*, *Ctenodonta lorrainensis*, *Byssonychia radiata*, and *Isotelus*	5½	303
	At this level, loose slabs of rock occur, containing *Hebertella*, *Rafinesquina mucronata*, *Catazyga headi*, *Ctenodonta lorrainensis*, *Byssonychia radiata*, and *Modiolopsis concentrica.*		
	Argillaceous shale	2½	305½
	(Lowest heavy sandstone layer, opposite a large glacial boulder, forms the base of this interval).		
	Argillaceous shale. (Base of another hard layer occurs at bottom of this interval.)	6½	312
	Argillaceous shale. (Base of a hard layer occurs at bottom of this interval)	5	317
	Argillaceous shale	18	335
(O)	Argillaceous shale	46½	381½
	Fossils in loose rock fragments at the base of the immediately overlying interval: Crinoid columnals with radiating striæ, *Glyptocrinus* columnals, *Rafinesquina alternata*, *R. mucronata*, *Zygospira modesta*, *Pholadomorpha pholadiformis.* This horizon is 225·5 feet below the lowest horizon containing *Strophomena planumbona*, and *Rhynchotrema perlamellosum*, and while it is not certain that *Pholadomorpha pholadiformis* occurs at as low a horizon as this, it is at least possible.		
	Very fresh talus along this interval, probably nearly at its original level, and containing *Glyptocrinus* columnals, *Zygospira modesta*, *Rafinesquina alternata*, large *Cymatonota*, and *Clidophorus*	27	408½

	Thickness feet.	Total thickness.
Argillaceous shale with the following fossils in loose fragments of rock, probably nearly in situ: *Cornulites flexuosus* Lorraine form, *Rafinesquina mucronata* very common, *Zygospira modesta*, *Catazyga headi* very rare, *Lophospira beatrice*, and *Ctenodonta lorrainensis*..................................	51½	460
Argillaceous shale with fossils of any kind very scarce, among these are: *Glyptocrinus* columnals, crinoid columnal with radiating striæ, *Cornulites flexuosus*, *Catazyga* scarce, *Byssonychia*, *Clidophorus* and *Calymene*..................................	48	508
Argillaceous shale nearly unfossiliferous............	63	571
From the talus lying along the overlying interval, all evidently loose blocks fallen from some horizon far above this level, the following fossils were collected: *Rafinesquina alternata* and *Cyclonema bilix: Pholadomorpha pholadiformis*, *Modiolopsis concentrica*, and *Calymene; Rafinesquina alternata*, *Strophomena planumbona*, *Str. hecuba*, and *Catazyga*.		
Argillaceous shale with few fossils, including *Ctenodonta*, *Clidophorus*, *Orthoceras*, and *Calymene*......	60	631
Fossils very rare here. A moderate twist in the rocks, not a fault..........................	18	649
Fossils rare; *Glyptocrinus* columnals and *Pholidops* in situ....................................	29	678
Fossils rare, including crinoid columnals with radiating striæ: *Heterocrinus* columnals, *Pholidops subtruncata*, *Dalmanella*, *Plectambonites sericeus* large, *Zygospira modesta*, *Catazyga headi*, tall *Ctenodonta*, *Byssonychia radiata* in situ here, *Protowarthia*......	16½	694½
(*Base of strata provisionally left in upper Lorraine.*)		
(N) Highest strata containing *Proetus chambliensis*, 538·5 feet below lowest *Strophomena planumbona* and *Rhynchotrema perlamellosum* horizon..........	..	694½

The chief feature of that part of the section which lies between horizon (R) and the top of the zone in which *Proetus chambliensis* occurs is the presence of *Pholadomorpha pholadiformis* and of a *Modiolopsis* resembling *concentrica*, in the upper third of this interval. Since *Pholadomorpha pholadiformis* occurs in the Waynesville member of the Richmond in the Nicolet River section, ranging from 40 to 60 feet beneath the top of the strata referred to this member, it is possible that this species eventually may be found also in the interval between horizons (S) and (R), where strata occur whose affinities to the rocks above and below must be regarded as doubtful for the present. Since typical *Modiolopsis concentrica* associated with *Pholadomorpha pholadiformis*, ranges from the base to the top of the Waynesville in Ohio and Indiana, and even occurs in the Liberty member of the Richmond in those states, it is possible that the similar form found in the Nicolet River section also eventually will be found in the intermediate strata, between horizons (S) and (R). In that case the strata between (S) and (R) could readily be included in the same subdivision as those intervening between (R) and the top of the *Proetus chambliensis* zone, since they resemble the latter lithologically, consisting chiefly of argillaceous shale, while the Waynesville part of the section tends to be more calcareous, especially toward the top. It must be admitted, however, that there is no distinct lithological break at the base of the strata here assigned to the Waynesville. On the contrary, the transition from the more argillaceous and shaly strata below to more calcareous layers above is quite gradual and the strongly calcareous elements do not appear until quite a distance above the horizons at which undoubted Waynesville fossils make their first appearance. Hence, the lithology cannot be utilized in suggesting where the limits between Richmond and Lorraine are to be drawn, in this Nicolet River section.

Those strata below layer (R), in which *Pholadomorpha pholadiformis* and the *Modiolopsis* resembling *concentrica* occur, are correlated provisionally with the upper parts of the Lorraine section of New York, as exposed between Bennett Bridge and the base of the Salmon River falls. It must be admitted, however, that this correlation is based upon very insufficient grounds, since such characteristic upper Lorraine species as *Modiolopsis modiolaris*, *Orthodesma nasutum*, and *Ischyrodonta curta* have not been found so far at this supposed Lorraine *Pholadomorpha* horizon, beneath the undoubted Waynesville strata, in the

Nicolet River section, although *Ischyrodonta curta* is known in association with *Catazyga erratica* and *Pholadomorpha pholadiformis*, below a horizon containing *Catazyga erratica* and *Orthodesma nasutum* at Weston, northwest of Toronto.

Until recently, the presence of *Pholadomorpha pholadiformis* and of a *Modiolopsis* resembling *concentrica* would have been regarded as sufficient to identify the containing strata as Richmond. In Ohio, Indiana, and Kentucky these species are not known in the Arnheim, but range from the lower part of the Waynesville member of the Richmond to the top of this member and into the lower parts of the overlying Liberty member. It is true that *Modiolopsis corrugata* and *Modiolopsis sulcata*, which evidently are merely distorted specimens of *Pholadomorpha pholadiformis*, were described by Miller and Faber, in 1892, as coming from near the top of the hills or on the hills at Cincinnati, Ohio, but the museum labels, accompanying the types, at Chicago university, give their origin as in Warren county, Ohio, and there is no reason for believing that these Warren County specimens have come from any horizon lower than the Waynesville member of the Richmond.

The reference of these strata in the Nicolet River section, below horizon (R), in which *Pholadomorpha pholadiformis* occurs, to the upper Lorraine, is based chiefly upon the occurrence of a few species of bryozoans in association with *Pholadomorpha pholadiformis* and *Modiolopsis concentrica* at several localities in the more western parts of the province of Ontario, quite remote both from the areas in the province of Quebec, here under discussion, and also from the typical Lorraine of New York. For instance, at various localities on Manitoulin island, including the exposures 2 miles northeast of the village of Gore Bay, various localities between 2 and 3 miles south and southwest of Little Current, and also the exposures along the shore between 2 and 3 miles north of Wekwemikongsing, strata, lithologically resembling the Lorraine of New York, occur below more calcareous strata in which an undoubted Waynesville fauna is present. In the upper part of these Lorraine-like strata, *Pholadomorpha pholadiformis* and a *Modiolopsis* resembling *concentrica* occur, as in the corresponding zone in the Nicolet

River section. A similar succession of faunas and of lithological conditions is noted also in the vicinity of Meaford, on the southern shore of Georgian bay. From this lower or Lorraine *Pholadomorpha* zone, on Manitoulin island and near Meaford, a few bryozoans were collected and submitted to Dr. E. O. Ulrich. All of these suggested to him affinities with species occurring near the Bellevue horizon, near the middle of the Maysville, in Ohio, rather than with any known Richmond species.

For the present, therefore, it seems necessary to identify the Lorraine-like strata, containing *Pholadomorpha pholadiformis*, on Manitoulin island, and along the southern shores of Georgian bay, as equivalent to Maysville, rather than to Richmond strata. Since similar conclusions were drawn by Dr. Ulrich regarding the stratigraphical position of the *Pholadomorpha pholadiformis* zone at the Bennett Bridge locality, in the Lorraine of New York, it seems possible to correlate the Lorraine-like strata of Manitoulin island and of the southern part of Georgian bay with the upper part of the typical Lorraine of New York. It should be noted, however, that at these localities in western Ontario, as well as in the Nicolet River section, the typical Lorraine species, *Modiolopsis modiolaris*, *Orthodesma nasutum*, and *Ischyrodonta curta*, are absent. The first species is absent also in the Lorraine-like strata of the intermediate areas; for instance, at Streetsville, and along the Humber river, west of Toronto, but *Orthodesma nasutum* and *Ischyrodonta curta* are present in the *Pholadomorpha* zone at Weston, northwest of Toronto.

If the correlation of the Lorraine-like strata, on Manitoulin island, near Meaford, and at Streetsville, with the typical upper Lorraine of New York, be accepted provisionally, then the identification of the lithologically similar *Pholadomorpha pholadiformis* containing strata in the Nicolet River section as upper Lorraine may be accepted more readily, since these strata in the Nicolet River section not only occur in a similar position, beneath an undoubted Waynesville fauna, but also contain a fauna sufficiently similar to that of the so-called Lorraine of western Ontario to permit correlation with the latter.

It is quite evident that there is not sufficient known regarding the fauna of the *Pholadomorpha pholadiformis* zone in the Lorraine-like strata of either the province of Quebec or that of Ontario to place the identification of this horizon with the upper Lorraine of New York and the middle Maysville of Ohio and Indiana beyond all question. However, since this fact has become apparent, no opportunity for sufficient further research to lead to conclusive results has been found, and the correlations here suggested are presented with all the elements of uncertainty which must remain until more data have been accumulated. It should be observed, however, that such few data as have been collected recently, in the vicinity of St. Hilaire and along the Rivière des Hurons, favour the Richmond, rather than the Lorraine age of some of the *Pholadomorpha* containing strata formerly regarded as Lorraine. At the former locality, *Streptelasma rusticum*, *Strophomena planumbona*, and *Str. hecuba* were found in this association, and the two species of *Strophomena* here cited occurred at the latter locality; so that it is becoming increasingly probable that eventually a considerable part of those *Pholadomorpha* containing strata will be referred definitely to the Richmond.

Returning to a consideration of the Lorraine-like *Pholadomorpha pholadiformis* zone, below horizon (R), in the Nicolet River section, the following facts may be noted. *Pholidops subtruncata*, *Rafinesquina mucronata*, *Clidophorus praevolutus*, and *Ctenodonta lorrainensis* are abundant and range also to far lower levels. At certain horizons a form intermediate between *Cymatonota recta* and *C. pholadis* occurs. *Catazyga headi* also appears to have a great vertical range. It is abundant 77 feet below the *Strophomena planumbona* horizon. The specimens in the loose slabs between 130 and 140 feet below the *Strophomena planumbona* horizon indicate the presence of *Catazyga headi* also at some interval below the 238½-foot level. Occasional specimens probably occur between 250 and 350 feet below the *Strophomena planumbona* horizon. The specimens near the 571-foot level may have dropped from a much higher level, but those at the 694½-foot level undoubtedly are in place.

In the description of the still lower parts of the section it will be found that *Catazyga headi* has a very great vertical range, passing at still lower levels into *Catazyga erratica*.

Owing to the steepness of the bluff along most of this line of outcrop, the fossils are found chiefly in the talus and their stratigraphical value must be determined by the lithological character of the talus and the nature of that part of the bluff at which the specimens were collected, but, as a rule, the conditions here are very favourable for determining the general characteristics of the section. The dip of the strata along the bluff is so great that the various layers usually disappear within a distance of several hundred yards, and often within a much smaller distance, depending not only upon the dip of the strata but also upon the height of the bluff. Specimens collected from loose material always are described as such.

In the following continuation of the description of the Nicolet River section, the interval between the last mentioned layer (N) in the previously described part of the section and the lowest *Strophomena planumbona* zone, at the base of the undoubted member of the Richmond, is indicated. The layer (N) forms the top of the *Proetus chambliensis* division of the Lorraine. Since a part of this division is well exposed along the Richelieu river, at Chambly Canton, 15 miles east of Montreal, and no other much better section is known, it may also be called provisionally the Chambly member of the Lorraine, as exposed in the province of Quebec.

Section No. 6.

		Thickness feet.	Total thickness.
(S)	Lowest strata containing *Strophomena planumbona* and *Rhynchotrema perlamellosum*................	..	156
	Interval..	538½	694½
	Top of Proetus Chambliensis Zone of the Lorraine.....	..	694½
(N)	Argillaceous shale with *Glyptocrinus* columnals, *Heterocrinus* columnals, *Pholidops subtruncata*, *Dalmanella*, *Rafinesquina alternata*, *Plectambonites sericeus*, *Catazyga headi*, *Ctenodonta* cf. *filistriata*, *Byssony-*		

		Thickness feet.	Total thickness.
	chia, Ctenodonta lorrainensis, Cymatonota near *recta, Pterinea demissa, Proetus chambliensis* fragments. This part of the section is due southwest of the home of Alfred Lambert, about a mile south of the home of Honore Auger.	33	727½
	Argillaceous shale with *Glyptocrinus* and *Heterocrinus* columnals, *Pholidops, Dalmanella, Plectambonites* large, *Zygospira modesta, Catazyga, Byssonychia radiata* large, *Clidophorus planulatus, Ctenodonta lorrainensis, Pterinea demissa* small, *Archinacella pulaskiensis, Sinuites cancellata, Calymene,* and *Proetus chambliensis* rather common.	14	741½
	Thin layer full of *Catazyga headi,* 580 feet below lowest *Rhynchotrema perlamellosum* and *Strophomena planumbona.*		
	Argillaceous shale with *Catazyga headi* in place in the middle. Also *Pholidops, Dalmanella, Plectambonites* large, *Zygospira modesta; Proetus chambliensis* common.	22	763½
	Argillaceous shale with *Heterocrinus* columnals, *Pholidops, Catazyga,* and with *Proetus* not rare.	27	790½
(M)	Argillaceous shale with *Catazyga headi* abundant near the middle, associated with *Glyptocrinus* columnals, *Aspidopora* (*A. spinulosa,* Ulrich, unpublished species from the Eden group in Ohio), *Calymene,* and large *Isotelus.* Near the base of this interval *Catazyga* is associated with the same *Aspidopora,* and *Heterocrinus* columnals, also columnals with radiating striæ, *Cornulites flexuosus* of the Lorraine type of Hall, and *Dalmanella.*	42	832½
(L)	Argillaceous shale with *Aspidopora* (*spinulosa*) not rare, *Rafinesquina mucronata* rare, *Cornulites flexuosus,* and *Dalmanella* very common. At the base of this interval there is a limestone layer with *Catazyga* abundant, *Plectambonites* large and common, *Byssonychia,* and crinoid columnals with radiating striæ.	22	854½
	Argillaceous shale with thin limestone layers containing large specimens of *Plectambonites,* and numerous specimens of *Catazyga headi* in the middle and upper layers. In the lower part the following species occur: *Glyptocrinus* columnals, columnals		

	Thickness feet.	Total thickness.
with radiating striæ, and *Catazyga.* At the base of the interval *Whitella* resembling *obliquata* and *Proetus chambliensis* occur......................	34	888½
Argillaceous shale with *Glyptocrinus columnals, Dalmanella, Plectambonites, Rafinesquina mucronata, Catazyga.* Very large gneiss boulder here.........	24	912½
Argillaceous shale with *Glyptocrinus* and *Heterocrinus* columnals, *Cornulites flexuosus, Dalmanella* and *Rafinesquina mucronata* very common, *Plectambonites, Zygospira modesta, Catazyga, Pholidops, Calymene,* and *Proetus chambliensis*..............	29	941½
Argillaceous shale................................	40	981½
(K) *Leptaena* common in thin limestone layer, about an inch in thickness................................	..	...
Highest horizon at which *Leptaena* has been found 825·5 feet below the lowest *Strophomena planumbona* and *Rhynchotrema perlamellosum* layer............	..	981½

The chief feature of that part of the Nicolet River section which lies between layers (N) and (K), and which here is described as section No. 6, is the great vertical range of *Proetus chambliensis.* Between layers (N) and (K) this vertical range amounts to 287 feet, and here the species is most common, but occasional specimens have been found as low as 182 feet below the top of layer (K), giving a total vertical range of 467 feet for this trilobite. Section No. 6, therefore, includes that part of the *Proetus chambliensis* zone which lies above the highest known *Leptaena* zone.

Rafinesquina mucronata has not been found lower than 50 feet below the uppermost *Leptaena* layer (K). *Ctenodonta lorrainensis* was not recorded below the 741½-foot level. A brachial valve of some species of *Strophomena,* 27 mm. wide, presenting an excellent cast of the interior, was found in situ near the 706-foot level. A lamellibranch suggesting *Cuneamya* and resembling *Cuneamya scapha* at least in outline, occurs near the *Aspidopora* horizons near the 800-foot level.

Catazyga apparently ranges throughout section 6, but is especially abundant at the 741½, 810, 830, 854½, and 875-foot levels. Below the uppermost *Leptaena* layer (K), there is a long interval, of nearly 400 feet, in which *Catazyga* is unknown at present, but it is found again at still lower levels. *Pholidops* ranges to considerably lower levels than the base of section 6.

Whether the crinoid columnals and the various species of *Dalmanella, Plectambonites, Zygospira, Sinuites, Clidophorus, Byssonychia, Cymatonota, Whitella,* and *Cornulites,* found in the Nicolet River section, have any diagnostic value in separating these strata into minor divisions has not been determined as yet.

The *Aspidopora spinulosa* mentioned at several horizons, in the description of section 6, is a form regarded by Ulrich as having affinities with an unpublished species found in the Eden of Ohio. This conviction is confirmed by the presence of *Dekayella ulrichi* which was identified by Ulrich from among material collected at the same horizon. *Dekayella ulrichi* is one of the most typical fossils of the Eden of Ohio, Indiana, and Kentucky, ranging throughout this group of strata, and usually occurring in great abundance. Hence the *Proetus chambliensis* zone of the Nicolet River section is provisionally correlated with the Eden. The same *Aspidopora spinulosa* occurs also in the exposures along the Richelieu river at Chambly Canton. Here it is associated with a form identified by Ulrich as *Bythopora arctipora,* another characteristic Eden form. These identifications by Ulrich also suggest the Eden affinities of that part of the Nicolet River section in which *Proetus chambliensis* is present.

The abundant presence of *Proetus chambliensis* in these supposed Eden beds is of interest since a closely related, if not identical species, *Proetus spurlocki,* Meek, occurs in the Southgate member of the typical Eden in Ohio. This Southgate member forms the middle part of the Eden and lies above that part of the Eden in which *Trinucleus concentricus* is abundant. Moreover, *Rafinesquina mucronata* is closely related to, if not identical with that form in the middle Eden which was identified by Nickles, in his "Geology of Cincinnati," with *Rafinesquina squamula* James, although the types of the latter species were described as occurring at an elevation of 350 feet above the Ohio river, at Cincinnati, and, therefore, were found in the Fairmount division of the Maysville. *Pholidops subtruncata* is much more closely related to *Pholidops cincinnatiensis* than its descriptive name would suggest, since the subtruncate outline is not as constant a character as the specific name would suggest, even within the type area of that species. In the vicinity of Cincinnati, *Pholidops cincinnatiensis* ranges through the lower and middle Eden.

The presence of *Leptaena* in the lower parts of the extended *Proetus chambliensis* horizon, along the Nicolet river, finds its counterpart in the presence of *Leptaena gibbosa* James, in the Economy or lower Eden member in Ohio and Kentucky which, however, is very different from the species found in the Nicolet River section.

The brachiopoda appear to corroborate the evidence presented by the few bryozoans so far identified, so that the Eden age of the *Proetus chambliensis* beds may be accepted tentatively. It should be noted, however, that the *Catazyga* ranging throughout the *Proetus chambliensis* zone on the Nicolet river apparently is the *Catazyga headi* and not the *Catazyga erratica*, although a special study of these Catazygas should be made. Moreover, the collections belonging to the Canadian Geological Survey contain a specimen of *Pholadomorpha* and several specimens of a species of *Strophomena* resembling *planumbona*, which are labelled as coming from Chambly; and both species are known to occur at the southern end of the body of water known as the Chambly basin, at the mouth of the Rivière des Hurons. Here only the *Proetus chambliensis* beds are exposed, while the fossils mentioned have hitherto been regarded as characteristic Richmond forms.

No very exact correlation of the *Proetus chambliensis* beds with any part of the typical Lorraine of New York is possible at present. None of the more characteristic forms belonging to the Pulaski division of the Lorraine, such as *Modiolopsis modiolaris*, *Ischyrodonta curta*, or *Glyptorthis crispata* Emmons, have been found in the province of Quebec. If the *Proetus chambliensis* beds have any equivalents within the Lorraine of New York, they probably will be found below the typical Pulaski beds, in the lower half of the Lorraine. Such beds are exposed within the gorge, northwest of the village of Lorraine, but the fauna of this lower part of the Lorraine section requires further study.

In the following continuation of the description of the Nicolet River section, the interval from the lowest *Strophomena planumbona* layer (S) to the highest level for *Leptaena* (K) is indicated.

Section 7.

		Thickness feet.	Total thickness.
(S)	Lowest strata containing *Strophomena planumbona* and *Rhynchotrema perlamellosum*	..	156
	Interval	825·5	
	Top of the Leptaena Zone of the Lorraine.		
	Although the overlying zone is here called the *Proetus* zone, the range of *Proetus chambliensis* extends fully 182 feet below the top of the *Leptaena* zone.		
(K)	Highest level containing *Leptaena* of *rhomboidalis* group, in a layer, unmeasured, only a few inches thick. At this *Leptaena* horizon a large specimen of *Pterotheca pentagona* was found		981½
	Argillaceous shales containing *Glyptocrinus* columnals, columnals with radially arranged striæ, *Pholidops*, large specimens of *Plectambonites sericeus*, *Byssonychia radiata*, and *Sinuites*. At the base, *Dalmanella* and *Rafinesquina mucronata* occur associated with long crinoid stems	50	1,031½
	Exposures in the bed of the river, containing *Pholidops*, *Dalmanella*, *Plectambonites*, numerous fragments of *Proetus chambliensis*, all near base	75	1,106½
	The following strata occur south of mouth of gully opposite home of Francois Cloutier:		
	Argillaceous shale, with exposures chiefly in river bed. *Heterocrinus* columnals, *Cornulites flexuosus*, *Plectambonites* large, *Dalmanella*, *Byssonychia radiata*, and *Sinuites cancellata*	26	1,132½
	Fossils few. *Glyptocrinus* and *Heterocrinus* columnals, *Cornulites flexuosus*, *Pholidops*, *Dalmanella*, *Plectambonites*, *Sinuites*, and numerous fragments of *Proetus*	31	1,163½
(J)	(Lowest recorded horizon for *Proetus chambliensis* in the Nicolet River section, 1,007·5 feet below the lowest *Strophomena planumbona* and *Rhynchotrema perlamellosum* horizon).		
	Fossils few. *Dalmanella*, and *Byssonychia*. *Whitella* was found in place 5 feet below top of this interval	32	1,195½

		Thickness feet.	Total thickness.
(I)	Fossils few. *Heterocrinus columnals, Pholidops, Dalmanella, Byssonychia radiata.* Near the base of this section *Coeloclema*, suggesting Eden affinities, occurs	33	1,228½
	Argillaceous shale with *Dalmanella, Eotomaria, Sinuites*, and *Calymene*	24	1,252½
	Argillaceous shale with *Heterocrinus* columnals, *Dalmanella* common, *Plectambonites, Byssonychia* with numerous plications, and *Calymene*	28	1,280½
	Argillaceous shale with *Phylloporina* common in a thin layer at the top, and *Coeloclema* in another thin layer at the middle of the section. Also *Heterocrinus* columnals, *Dalmanella* common, *Byssonychia radiata* common, and *Calymene*	43	1,323½
	Argillaceous shale with few fossils. *Heterocrinus* columnals with radiating striæ occur in overlying interval. Chiefly fine-grained sandstone. Even the shale here is sandy; this is true also of the overlying shales as far as layer (I) and, to a certain extent, even as far as layer (K)	31	1,354½
	Argillaceous shale with graptolites rare, *Dalmanella, Whitella, Sinuites*, also a large form of *Cymatonota*	32	1,386½
	Sandy shales with graptolites common, also with *Dalmanella*, and *Byssonychia radiata*	27	1,413½
	Argillaceous shale with *Heterocrinus, Dalmanella, Byssonychia, Whitella, Sinuites, Hormotoma sublaxa*	32	1,445½
(H)	*Second Leptaena horizon*, thin layer, unmeasured, 1,289·5 feet below lowest *Strophomena planumbona* and *Rhynchotrema perlamellosum*	..	1,445½
	Argillaceous shale with *Dalmanella* common, a very oblique form of *Hormotoma suggesting sublaxa*, and apparently with *Catazyga* very rare	22	1,467½
	Argillaceous shale with *Cornulites flexuosus, Dalmanella*, and *Byssonychia*	32	1,499½
(G)	*Third horizon*, unmeasured, with *Leptaena* common, associated with *Dalmanella* common, and *Plectambonites, Byssonychia* few; 1,343·5 feet below lowest *Strophomena planumbona* and *Rhynchotrema perlamellosum* layer	..	1,499½
	Sandy shales, with *Dalmanella, Plectambonites*	51	1,550½
(F)	*Catazyga erratica* horizon, thin layer, not measured, 1,394·5 feet below lowest *Strophomena planumbona* and *Rhynchotrema perlamellosum* layer	..	1,550½

The chief feature of this part of the Nicolet River section is the great vertical range of *Leptaena*, although at considerable intervals. Between layers (K) and (G) the interval is about 520 feet, but *Leptaena* occurs also 125 feet, and 310 feet lower, giving a total of 830 feet for the known vertical range of this fossil in the Nicolet River section. Only two bryozoans were identified from this horizon. The *Coeloclema* suggests Eden affinities. The *Phylloporina* is a new species, with numerous pits and is most closely related, among described species, to *Ph. trentonensis* Ulrich. The graptolites, in the lower part of the section, belong to the group of *Glossograptus* (*Orthograptus*) *quadrimucronatus*, and have no diagnostic value since this group has a very long vertical range.

The occurrence of *Pterotheca pentagona*, associated with *Proetus chambliensis*, at the top of the section, is of interest since the same species occurs in the *Proetus chambliensis* zone, also, along the Richelieu river, at Chambly Canton. Both *Proetus chambliensis* and *Rafinesquina mucronata* seem to be absent at all horizons below the upper part of the *Leptaena* zone. *Catazyga erratica* is known at present only from layer (F) at the base of section 7. It may occur slightly higher, but apparently is replaced by *Catazyga headi* in all the higher parts of the Nicolet River section. This distribution is quite disconcerting in all attempts at correlating the so-called Lorraine of the Nicolet River section with any part of the typical Lorraine of New York, since in New York *Catazyga erratica* has a considerable distribution in the typical Pulaski member of the Lorraine. However, if the *Proetus chambliensis* zone be regarded as below the Pulaski member of the New York Lorraine, then the *Leptaena* zones of the Nicolet River section must belong to still lower horizons.

The *Leptaena* zones of the Nicolet River section appear to be represented also in southern Ontario, for instance at the Don Valley brick-yards, in the eastern part of Toronto. Here *Leptaena* is associated with bryozoans regarded by both Ulrich and Bassler as of Eden age. It has already been stated that in Ohio and Kentucky the only form of *Leptaena* known from Cincinnatian strata below the level of the Richmond occurs in the lower or Economy member of the Eden.

In the following part of the description of the Nicolet River section the interval between the lowest *Strophomena planumbona* layers and the top of this part of the section is indicated.

Section 8.

		Thickness feet.	Total thickness.
(S)	Lowest layers containing *Strophomena planumbona* and *Rhynchotrema perlamellosum*	..	156
	Interval	1,394½	
	Trinucleus Concentrica Zone of the Lorraine.		
(F)	*Catazyga erratica* horizon	..	1,550½
	Sandy strata with very few fossils, chiefly *Dalmanella*	75½	1,626
(E)	Top of Fourth horizon with *Leptaena* common	..	1,626
	Interval with sandy shales as above, with *Leptaena* common, at various intervals, both in the sandstone and in limestone. *Byssonychia radiata* common. There are a few limestone layers in this part of the section. The sandstone layers are thin-sheeted	50	1,676
	Same sandy shale as above. Talus from a gully	37	1,713
(D)	Thin layer, unmeasured, with *Trinucleus* in place; associated with *Glyptocrinus*, *Heterocrinus* columnals, *Cornulites flexuosus*, *Dalmanella*, and *Plectambonites*. This is the highest level at which *Trinucleus* is known at present in this section, 1,557 feet below lowest *Strophomena planumbona* and *Rhynchotrema perlamellosum* layer	..	1,713
	Sandy shales as above, fossils few. *Dalmanella*, *Clidophorus*, *Hormotoma sublaxa*	50	1,763
	Sandy shale with a few crinoid stems, and *Dalmanella*	51	1,814
(C)	Thin layer, unmeasured, with *Triarthrus becki* rare, associated with *Calymene*, 1,658 feet below lowest *Strophomena planumbona* and *Rhynchotrema perlamellosum* layer	..	1,814
	Sandy shales with *Dalmanella* and *Trinucleus*	46	1,860
(B)	Thin layer, not measured, with several good specimens of *Leptaena* associated with *Cymatonota pholadis*, *Trinucleus*, and *Calymene*, 1,704 feet below lowest *Strophomena planumbona* and *Rhynchotrema perlamellosum* horizon	..	1,860

	Thickness feet.	Total thickness.
Sandy shale with *Trinucleus* and *Dalmanella*	60	1,920
Sandy shales	75	1,995
(A) Sandy shales with *Trinucleus* associated with very poor specimens of *Catazyga* and *Leptaena;* also with *Dalmanella* and *Aspidopora*	44	2,039
Thin layer, unmeasured, with *Trinucleus* common, some having long genal spines	..	2,039
Sandy shales and sandstones not well exposed for collecting: too steep. *Dalmanella*	50	2,089
Sandy strata as above. *Dalmanella, Trinucleus* with long genal spine	41	2,130
Somewhat more argillaceous strata. *Dalmanella, Plectambonites, Clidophorus, Trinucleus*	32	2,162
Sandy shales with *Dalmanella, Clidophorus, Ctenodonta* common	42	2,204
Sandy shales, fossils few. *Dalmanella, Trinucleus* common	68	2,272
Sandy shales, fossils few, including *Trinucleus*	52	2,324
Sandy shales, fossils few	80	2,404
Sandy shales, fossils few, *Dalmanella* common, one specimen 20 mm. wide	75	2,479
Sandy shales, fossils few, including *Trinucleus*	34	2,513
(A strong fold or anticline occurs at this point in the section, 2,357 feet below the lowest *Strophomena planumbona* and *Rhynchotrema perlamellosum* layers, or 2,513 feet below the base of the Queenston shales.)		

The chief feature in that part of the section which underlies the *Catazyga erratica* horizon is the presence of *Trinucleus.* As a matter of fact, the highest level for *Trinucleus* known at present is 140 feet below this *Catazyga erratica* horizon, but it very likely will be discovered eventually at still higher horizons. The present known range of *Trinucleus,* to the base of the actually measured part of the Nicolet River section, is 800 feet, but it undoubtedly has a very considerable range below the limits of this part of the section. *Triarthrus becki* is known in the Nicolet River section only at an horizon about 188 feet below the *Catazyga erratica* horizon. In other words it is known only from the upper part of the *Trinucleus* zone. South of the dam at St.

Hyacinthe, however, it has a range of at least 700 feet in the *Trinucleus* zone, associated with *Leptaena*. For the present, however, it is assumed that the *Triarthrus becki* horizon in the Nicolet River section corresponds also to the horizon exposed on the Yamaska river, 2 miles northwest of St. Hugues, since at the latter locality *Triarthrus becki* is associated with both *Trinucleus concentricus* and *Leptaena*. *Triarthrus* and *Trinucleus* have also been found in the exposures east of Breault, on the western side of the Bécancour river, 14 miles southeast of Three Rivers.

The exposures immediately southwest of Petite Caroline station, 25 miles east of Montreal, contain *Leptaena*. *Trinucleus* was not found by the writer although he made long and diligent search for this fossil at this locality, but its presence here is reported by J. J. O'Neill.[1]

The *Catazyga* at the Petite Caroline locality may prove to be *Catazyga erratica*, but the specimens seen, although common at certain horizons, were too distorted for exact determination. For the present, the Petite Caroline locality is referred to the upper part of the *Trinucleus* zone.

At the river exposures below the dam at St. Hyacinthe, *Trinucleus concentricus* associated with *Triarthrus becki* and *Leptaena* is rather common. Hence the Nicolet River section also is referred to the upper part of the *Trinucleus* zone.

Later in this report it is stated that it is believed the bryozoans will be of immense service in the task of making correlations. The great section along the Nicolet river does not offer, however, much information at present, since the bryozoans have not been collected as yet. Among the few specimens submitted from the *Proetus chambliensis* zone between 538½ and 825½ feet below the base of the Waynesville member of the Richmond, Dr. E. O. Ulrich identified:

Aspidopora spinulosa (Not described).
Dekayella ulrichi. . . . . All Eden, at Cincinnati.

From the corresponding *Proetus* zone at Chambly Canton, he identified:

Aspidopora spinulosa (Not described).
Bythopora arctipora. . . . . All Eden, at Cincinnati.

[1] St. Hilaire (Beloeil) and Rougemont Mountains, Quebec. Memoir 43, Geol. Surv., Canada, p. 14, 1914.

The *Aspidopora* was most common along the Nicolet river between the 790½ and 832½-foot levels, and the *Dekayella ulrichi* came from about the same level. The highest level at which the variety of *Leptaena rhomboidalis* occurs in this section is 825 feet below the Waynesville. The lowest level for *Proetus* is at 1,007 feet below the Waynesville and near the 1,072-foot level below the same horizon, *Coeloclema* occurred. While the exact species was not determined, the presence of the genus *Coeloclema* suggested Eden affinities. At the 1,280½-foot level, (1,125 feet beneath the Waynesville) a species of *Phylloporina*, nearest *trentonensis*, was found, and near the 1,300-foot level, the *Coeloclema* occurred again. Graptolites are common between the 1,386½-foot and 1,413½-foot levels. They belong to the *Orthograptus quadrimucronatus* group. Another horizon for *Leptaena* occurs at the 1,445½-foot level and still another at the 1,499½-foot level. *Catazyga erratica* occurs at the 1,626-foot level, another *Leptaena* horizon at the 1,676-foot level, and *Trinucleus* at the 1,713-foot level. *Triarthrus becki* is rare at the 1,814-foot level (1,653 feet below the Waynesville). *Trinucleus* is common down to the 2,515-foot horizon at base of the measured section; how far below this level, has not been determined.

At the *Trinucleus* horizon along the Bécancour river, three-fourths of a mile east of Breault station, *Coeloclema commune* was found, suggesting Eden affinities, but *Coeloclema* is known now also from the Cynthiana formation in central Kentucky, below the level of the Eden.

Judging from the preceding data, Maysville strata can form only a comparatively small part of the Nicolet River section, although possibly forming a thicker zone than in the New York section. The greater part of the section evidently corresponds to the Eden of the Ohio section.

CHAMBLY CANTON.

Chambly Canton (Figure 1) is located on the Central Vermont railway, 15 miles east of Montreal. A road leads northeastward from the railway station to the bank of the Richelieu river, a short distance below the dam. The exposures extended from here northwestward, along the western shore of the river, to the point where the river enlarges for 1½ miles, forming Chambly basin. The strata show very little dip. Towards the dam, for a distance of several hundred yards, the strata consist chiefly of shale, penetrated almost horizontally by a dyke. Farther west, toward the entrance of the river into the basin, considerable more fine-grained sandstone is interbedded, but fossils are not so abundant here. Most of the fossils were collected along the eastern half of the shale exposure. These shales have a dark grey or greyish black colour, and at certain horizons are richly fossiliferous. The fauna undoubtedly is much greater than that here listed, since the list here given is the result of only two hours of collecting.

Glyptocrinus columnals.
Heterocrinus columnals.
Glossograptus (*Orthograptus*) *quadrimucronatus-approximatus*.
Aspidopora spinulosa (not described).
Bythopora (*arctipora* according to Ulrich).
Columnals with numerous radiating striæ.
Pholidops subtruncata, common.
Dalmanella sp., seen only in the sandstones, westward.
Plectambonites sericeus large, very common.
Rafinesquina mucronata, common.
Rafinesquina alternata, 32 mm long, and very flat.
Catazyga headi, very common.
Zygospira modesta, few.
Byssonychia radiata, in the sandstones, westward.
Byssonychia with fine radiating plications, in the shales.
Clidophorus praevolutus, common.
Ctenodonta lorrainensis, several.
Ctenodonta sp., nearest *simulatrix* in outline.
Ctenodonta sp., nearest *albertina* in outline.
Colpomya (*Modiolopsis*) *faba-pusilla*.
Cymatonota recta, several.
Lyrodesma poststriatum, common.
Lamellibranch resembling *Modiolopsis concentrica*.
Pterinea demissa, 35 mm. in height.
Rhytimya small, resembling *compressa* in outline, but with sharply defined postumbonal radiating striæ.
Rhytimya oehana.
Ctenodonta cf. *filistriata*.
Archinacella pulaskiensis.

Eotomaria sp. nearest *canalifera.*
Hormotoma with no trace of surface markings, small form.
Sinuites cancellata.
Spyroceras resembling *bilineatum* but much larger, and more rapidly tapering.
Proetus chambliensis.
Bythocypris cylindrica.

The types of *Pholadomorpha chambliensis*, *Orthodesma approximatum*, *Clidophorus praevolutus*, *Pterotheca pentagona*, and *Technophorus punctostriatus-quincuncialis* are based upon specimens in the collections of the Geological Survey, and are there labelled as coming from Chambly.

The chief features to be noted in this fauna are the presence of an abundance of *Proetus chambliensis*, *Catazyga headi*, and *Rafinesquina mucronata* and the absence of *Leptaena rhomboidalis*. This suggests an equivalence to that part of the Lorraine section on the Nicolet river which has been called the *Proetus chambliensis* zone. This zone extends from 538 to 825 feet below the lowest *Strophomena planumbona* and *Rhynchotrema perlamellosum* horizon. The associated fauna includes *Pholidops subtruncata*, *Ctenodonta lorrainensis*, *Archinacella pulaskiensis*, and an undescribed *Aspidopora* belonging to same species as one found at the same horizon in the Nicolet River section. No specimens of *Trinucleus* or of *Triarthrus* were found in the Chambly Canton section.

MOUTH OF THE RIVIÈRE DES HURONS.

(Figure 1.)

Exposures occur also north of Chambly Canton, at the mouth of the Rivière des Hurons. Here the strata are well exposed on the southern side of the river, where it turns strongly westward immediately before flowing into Chambly basin. The dip of the strata is southeastward, and some of the strata continue to be exposed along the line of strike up the river as far as the first bridge. Beyond this point other exposures occur as far as the first road on the east which joins the road following the Rivière des Hurons. About halfway between the bridge and the strong bend of the river, at its mouth, *Strophomena planumbona* is very common in several thin layers which occupy a zone about 3½ feet thick. This *Strophomena* zone contains also *Catazyga headi*, and *Proetus chambliensis*.

The *Strophomena planumbona* zone may be recognized also at the bend of the river. Here *Pholadomorpha pholadiformis* was found associated in the same slab with *Pholidops subtruncatus*, *Clidophorus praevolutus*, *Ctenodonta lorrainensis*, and *Technophorus quincuncialis*. *Pholadomorpha pholadiformis* occurred also in the exposures north of the bridge. Among the other fossils found at the strong bend in the river, near its mouth, are *Dalmanella "testudinaria,"* *Rafinesquina alternata*, *Plectambonites sericeus*, *Byssonychia radiata*, and *Pterinea demissa*.

It is probable that *Pholadomorpha chambliensis* (No. 2069 in Collection of Geol. Surv., Can.) described by the writer from the Chambly area, is to be regarded merely as another of the various synonyms of *Pholadomorpha pholadiformis*. It is certain that the latter species has a great vertical range in the so-called Lorraine of Quebec. The specimens of *Strophomena planumbona* found at the mouth of the Rivière des Hurons cannot be distinguished from typical specimens found in the Richmond in the Cincinnatian areas of Ohio and Indiana. In this respect the specimens differ from those figured by the writer in the Bulletin of Denison University (No. 8404 in Coll. of Geol. Surv., Can.) the latter being more convex and somewhat triangular anteriorly. The *Pterotheca pentagona* described by the writer from the Chambly area unquestionably came from the *Technophorus quincuncialis* zone. The types of all of these forms probably were obtained not on the western side of the Richelieu river, at Chambly Canton, but on the eastern side, at the mouth of the Rivière des Hurons.

It is evident that the presence of *Pholadomorpha pholadiformis* and *Strophomena planumbona* in horizons as low as the *Proetus* zone will make the recognition of the latter almost impossible where only small exposures with meagre faunas are at hand. Since also a form resembling *Modiolopsis concentrica* was found in the *Proetus* zone in the Chambly area, it is evident that a meagre representation of the *Proetus chambliensis* fauna may have a decided Richmond aspect to one familiar with the Ordovician faunas in the Cincinnatian areas of Ohio and Indiana. As far as *Strophomena planumbona* is concerned, however, it should be remembered that this species is represented already in the Trenton of Kentucky by the closely similar form described by the writer as *Strophomena ulrichi*, hence similar forms are to be expected somewhere within the great mass of strata intervening between the Trenton and the Richmond, at least in other areas, although unknown from these intermediate strata in the region surrounding Cincinnati.

ST. HILAIRE.

St. Hilaire station (Figure 1) is on the Grand Trunk railway, about 18 miles northeast of Montreal. It is on the eastern side of the Richelieu river, 8 miles northeast of Chambly Canton station. From the station a road leads off southeastward up the hill, for a distance of three-quarters of a mile, and then turns southwards rather abruptly. About half a mile southeast of the station, along the northeastern side of the road, the shallow drainage ditch exposes dark grey or blackish argillaceous shales, containing the following fossils:

Heterocrinus columnals.
Cornulites sp. (=Lorraine form of *Tentaculites flexuosus*, Hall).
Pholidops subtruncata.
Dalmanella.
Zygospira modesta.
Byssonychia radiata.
Clidophorus planulatus or *praevolutus*.
Ctenodonta lorrainensis.
Cymatonota recta.
Psiloconcha inornata.
Pterinea demissa, 15 mm. high.
Rhytimya cf. *radiata* or *compressa*.
Rhytimya with outline suggesting *Cuneamya scapha*, but with no distinctly defined lunule; median sulcus less oblique, shell higher, and more abruptly truncated than in *Rh. producta;* no radiate granulose lines.
Pholadomorpha pholadiformis.
Cyrtolites ornatus.
Ctenobolbina ciliata.
Ceratopsis oculifera.

It may be said that this fauna definitely belongs below the *Strophomena planumbona* horizon, as exposed in the Nicolet River section, and is regarded, provisionally, as below the Waynesville member of the Richmond. It is regarded also as definitely above the horizons at which *Proetus* is so abundant. This would place the road side exposure southeast of St. Hilaire station somewhere between the *Strophomena planumbona* horizon at the base of the Waynesville member in the Nicolet River section and the top of the *Proetus* horizon, 500 feet beneath.

After the most careful search, no specimens of *Trinucleus* were found in the Nicolet River section above an horizon located 1,500 feet below the *Strophomena planumbona* level. In these circumstances it is difficult to believe in those identifications of *Trinucleus* in which apparently it is found associated with fossils indicating a much higher horizon. Unless enough of the specimen is at hand to certify undoubtedly to its trilobitic character, it is necessary to remember that everything which *suggests* the pitted border of a *Trinucleus* is not to be accepted at once as a genuine trilobitic fragment. This statement would be unnecessary if it were not for the fact that an unusually large-celled disk-shaped bryozoan occurs at and above the Chambly horizon, whose weathered surface occasionally resembles at first sight the pitted surface of *Trinucleus*, and the imprint of which is even more deceptive. Hence the occurrence of *Trinucleus* in any strata belonging to the Chambly or *Proetus chambliensis* zone is to be received with considerable scepticism in the absence of specimens whose origin is undoubted.

In the "Geology of St. Bruno Mountain," by John A. Dresser, published in 1910 as Memoir No. 7 by the Geological Survey, the following fossils, collected at St. Hilaire by R. Harvie, are identified by Dr. E. O. Ulrich:

Paleschara beani (James).
Pholidops cincinnatiensis Hall.
Rafinesquina (?) sp. nov.
Byssonychia, cfr. *B. suberecta* Ulrich.
Ctenodonta, sp. nov. Near *C. pectunculoides*, and *C. cingulata*.
Ctenodonta, sp. indet. Small, of the *C. levata* group.
Clidophorus, sp. nov. Near *C. planulatus* (Conrad).

Psiloconcha sinuata Ulrich.
Psiloconcha, sp. nov., var 1.
Psiloconcha, sp. nov., var. 2.
Pholadomorpha pholadiformis ? (Hall). A fragment.
Whitella, sp. nov.. (Near *W. quadrangularis*.)
Whitella, sp. nov. (Near *W. sterlingensis* and *W. obliquata*.)
Isotelus, cfr. *I. gigas* (pygidium).
Ctenobolbina ciliata (Emmons) var.

In the Nicolet River section, species of *Whitella*, near *Wh. quadrangularis* and *Wh. obliquata* occur not only above the *Strophomena planumbona* horizon, but also between 85 and 130 feet below the *Strophomena planumbona* horizon, associated with *Pholadomorpha pholadiformis*. Similar *Whitellas*, however, occur also at much lower horizons; for instance, at 730, 1,000, 1,200, and 1,300 feet below the *Strophomena planumbona* horizon, and *Whitellas* are very abundant in the *Trinucleus* zone below the dam at St. Hyacinthe. Hence the presence of Whitellas having a Richmond facies in the St. Hilaire area does not necessarily establish the horizon as definitely of Richmond age.

In the report on "St. Hilaire (Beloeil) and Rougemont Mountains, Quebec," by J. J. O'Neill, published in 1914 as Memoir 43 by the Geological Survey, Canada, the following fossils from St. Hilaire station determined under the supervision of Professor Charles Schuchert are recorded:

Stomatopora. Sp. undet.
Paleschara beani James.
Tubiculous annelids.
Cornulites richmondensis Miller ?
Pholidops subtruncata Hall, or *Ph. cincinnatiensis* Hall.
Rafinesquina alternata Emmons.
Zygospira modesta Hall.
Pterinea demissa Conrad.
Byssonychia suberecta Ulrich.
Psiloconcha sinuata Ulrich.
Psiloconcha subovalis Ulrich.
Psiloconcha inornata Ulrich.
Modiolopsis concentrica Hall and Whitfield.
Pholadomorpha pholadiformis Hall.
Whitella, three species, undet.
Rhytimya radiata Ulrich.

Cymatonota semistriata Ulrich.
Cymatonota recta Ulrich.
Ctenodonta pectunculoides Hall.
Ctenodonta, sp. undet., of the *C. levata* group.
Clidophorus n.sp., near *C. planulatus*.
Cyrtolites ornatus Conrad.
Isotelus gigas DeKay ?
Ctenobolbina ciliata Emmons ?

In these lists, it is probable that the new species of *Rafinesquina* is the form described recently by the present writer as *Rafinesquina mucronata*. The *Psiloconcha sinuata* may be the form recently described as the variety *borealis* of that species. The *Clidophorus* near *planulatus* may be the form recently described as *Clidophorus praevolutus*. The *Ctenodonta* near *C. pectunculoides* and *C. cingulata* probably is the form recently described as *Ct. lorrainensis*.

With such long lists of fossils it might appear that the identification of the horizon at St. Hilaire should be an easy matter. Unfortunately most of the fossils listed appear to have very long vertical ranges and so their value for more exact identification of horizons is lessened. As far as may be judged from these additional lists, the St. Hilaire strata correspond to those *Pholadomorpha pholadiformis* horizons in the Nicolet River section which are beneath the lowest *Strophomena planumbona* and *Rhynchotrema perlamellosum* horizon at that locality. Apparently similar strata are well exposed along the Rivière des Hurons, several miles southwest of St. Jean Baptiste, and in the St. Bruno Mountain area, judging from the collections in the possession of the Geological Survey.

PETITE CAROLINE.

Rougemont station is located on the St. Cesaire branch of the Central Vermont railway, about 24 miles east of Montreal, and 11 miles east of Chambly Canton station. From here a road proceeds 2½ miles northeastward to Petite Caroline station (Figure 1). Near a farmhouse about a quarter of a mile before reaching this station, there is a considerable exposure of hornstone on the western side of the road, the volcanic area lying farther westward. This hornstone has been quarried sufficiently to reveal a number of fairly fossiliferous horizons, and no doubt if the collector were present while quarrying is going on a considerable fauna could be collected. The following specimens were secured from the solid rock, to avoid the possibility of picking up fragments carried here by glacial action.

Glyptocrinus columnals.
Heterocrinus columnals.
Columnals with radiating striæ.
Cornulites flexuosus, Lorraine form of Hall.
Dalmanella, common.
Plectambonites sericeus, very common.
Rafinesquina alternata, one specimen.
Leptaena sp. of the *rhomboidalis* group.
Catazyga headi, very common.
Eotomaria.
Calymene, common.

In the Nicolet River section, *Leptaena* occurs 825, 1,290-1,345, 1,480, and 1,700 feet below the *Strophomena planumbona* horizon. The highest horizon for *Trinucleus* so far discovered occurs 1,560 feet below this *Strophomena planumbona* horizon. The fauna so far collected does not warrant the definite assignment of the Petite Caroline locality to any of these *Lepatena* horizons, but provisionally it is placed near the top of the *Trinucleus* horizon since *Leptaena* is fairly common at the 1,676-foot level in the Nicolet River section and ranges through several hundred feet of the *Trinucleus* zone as exposed at St. Hyacinthe.

In the report on "St. Hilaire (Beloeil) and Rougemont Mountains, Quebec," Memoir 43 of the Geological Survey, published in 1914, the following fauna, as identified by Professor Charles Schuchert, and found in the locality one-fourth of a mile south of the Petite Caroline station, are recorded:

Crinoidal columnals very abundant.
Dalmanella testudinaria Dalman.
Plectambonites sericeus Sowerby.
Catazyga anticostiensis Billings ? (probably *erratica* Hall.)
Clidophorus, sp. undet.
Calymene callicephala Green.
Trinucleus concentricus Eaton.

ST. HUGUES OR YAMASKA RIVER.

St. Hugues (Figure 1) is 39 miles northeast of Montreal, on the St. Hyacinthe and St. Guillaume branch of the Canadian Pacific railway, and 12 miles north of St. Hyacinthe. A short distance northwest of the station, a road passes southwest towards the Yamaska river, and half a mile from the railway it reaches the river road turning off northwestward. The river road is in a bad condition but serves to lead the visitor to the river banks about a mile down stream, where the best exposures in this vicinity are found. The locality is a little more than a mile below the mouth of the Chibouet river, on the northeastern side of the river, directly opposite a point where a road comes down the hill from the western side of the river.

The rock is chiefly shale and argillaceous limestone. Here the following fossils were found; occasionally all of those here listed occur in the same slab.

Crinoid columnals.
Dalmanella "testudinaria," very common.
Plectambonites sericeus, large.
Leptaena invenusta Foerste.
Catazyga erratica.
Clidophorus, sp. nov. resembling *neglectus* in outline.
Lyrodesma poststriatum.
Cyrtolites ornatus.
Calymene sp.
Triarthrus becki, common in certain layers.
Trinucleus concentricus, common in certain layers.

Recently, Mr. R. Harvie, of the Geological Survey, has made a special study of the exposures on the western side of the Yamaska river, from the ferry landing west of St. Hugues for a distance of about 2 miles northward. Fossils were collected at three localities. Locality *A* is located at the bend of the river about a mile north of the ferry landing, and is about opposite the locality from which the fossils listed above were collected. Locality *B* lies about a quarter of a mile farther upstream, and nearer the crest of an anticline whose axis crosses the river about a third of a mile below the ferry landing, as indicated upon the accompanying sketch map (Figure 3). Hence locality *B* represents fossils from some horizon lower than that at *A*. Locality *C*, about 2 miles below the ferry landing, lies south of a syncline intervening between localities *A* and *C*, and its relative position with reference to locality *A* is unknown.

The following fossils were collected by Mr. Harvie at the localities mentioned.

Localities.	A.	B.	C.
Coeloclema commune	......	x	......
Dalmanella "testudinaria"	......	......	x
Glyptorthis sp	......	x	......
Plectambonites sericeus	x	......	......
Leptaena invenusta	x	......	......
Catazyga erratica	x	......	......
Byssonychia radiata	......	x	......
Colpomya faba	......	x	......
Cymatonota pholadis	......	x	......
Whitella rotund form	......	x	......
Whitella complanata	......	x	......
Clidophorus planulatus	......	......	x
Archinacella pulaskiensis	......	x	......
Sinuites cancellata	......	x	......
Pterotheca sp	......	x	......
Isotelus with genal spine 20 mm. long	......	x	......
Triarthrus becki	x	x	x
Trinucleus concentricus	......	x	......

From these lists it is evident that the localities at St. Hugues correspond to the *Trinucleus* zone, as exposed in the Nicolet River section. The *Coeloclema* is found also in the *Leptaena* zone in the Nicolet River section and its presence suggests Eden affinities. The presence of *Pterotheca* in the St. Hugues area is noteworthy, since in the Nicolet River section this genus was represented by a specimen occurring at the top of the *Leptaena* zone. Only fragments of the *Glyptorthis* are known and these represent a more coarsely plicated species than *Glyptorthis crispata*, Emmons.

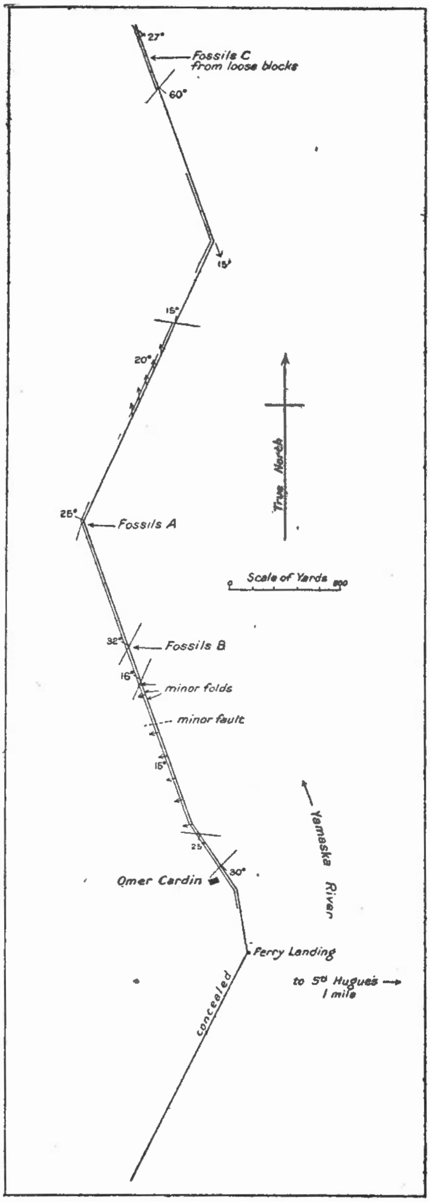

Figure 3. Yamaska river, southwest shore near St. Hugues.

ST. HYACINTHE.

St. Hyacinthe (Figure 1) is 30 miles northeast of Montreal. The main part of the town is on the western side of the Yamaska river, and south of the Grand Trunk railway, but a bridge crosses the river east of the town and connects with the station on the St. Hyacinthe and St. Guillaume branch of the Canadian Pacific railway. Exposures begin southwest of this bridge, a short distance beyond the mouth of two streams entering the river from the southeast, and extend as far as a dam crossing the river south of the town.

Fossils were collected in the river bed itself, in a single limestone layer located near the northern limit of this line of exposures, and about 15 feet from the eastern margin of the river at low water. Here the following fossils were found.

Heterocrinus columnals.
Dalmanella "testudinaria" very common.
Byssonychia radiata, very common.
Cymatonota pholadis.
Clionychia curta (sp. nov.)
Lyrodesma poststriatum.
Modiolopsis, small species.
Cyrtolites subplanus.
Lophospira sp. nov., with tall spire
Trinucleus concentricus, very common.

Recently Mr. R. Harvie, of the Geological Survey, has made a study of that part of the exposures in the bed of the river which begins at the western angle of the dam and continues down the river a short distance beyond the highway bridge, where the measured part of the section terminates at a major fault, indicated upon the accompanying sketch map (Figure 4). The rocks dip down stream, away from the dam, so that the bottom of the section is at the dam, and the highest part of the measured section is at the major fault. Several minor faults and dykes of igneous rocks are present. The total thickness of the section is 720 feet. Fossils were collected at the localities 1–7, within 10 feet (above and below) of the points indicated by the numbers at the head of the accompanying list of fossils. The direction and amount of dip of the strata investigated by Mr. Harvie also are indicated on the map.

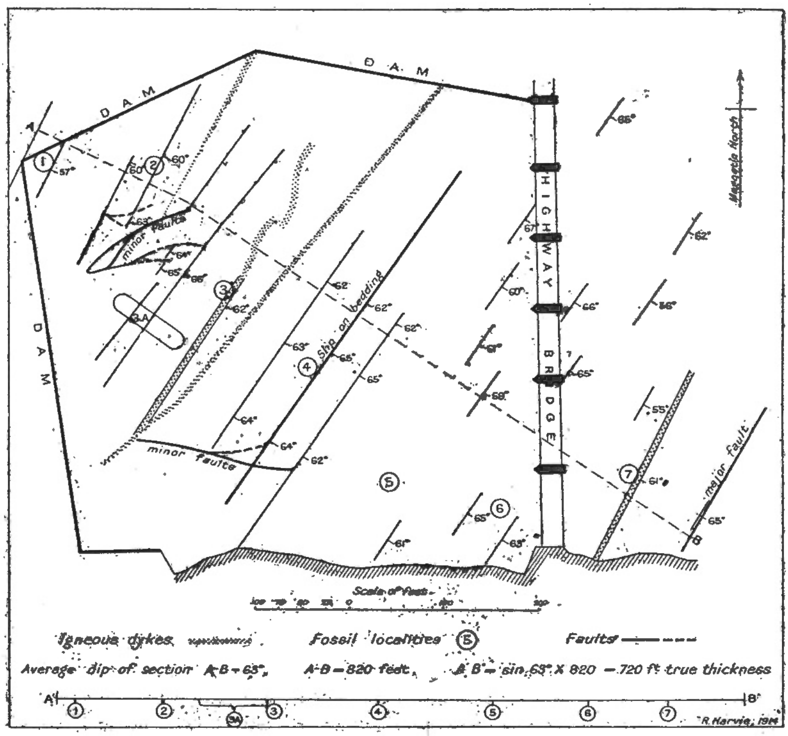

Figure 4. Plan of river bed below the dam at St. Hyacinthe, Quebec.

List of Fossils Found in the Section Immediately Below the Dam at St. Hyacinthe.

Locality number / Distance above base of section	1	2	3A	3	4	5	6	7
Locality number	1	2	3A	3	4	5	6	7
Distance above base of section	20	110	150–220	230	340	460	560	640
Ohiocrinus cf. *geniculatus* Ulrich	....	....	....	....	....	x	....	....
Lingula	....	....	....	x	....	....	....	....
Dalmanella "testudinaria" Dalman	....	....	....	x	x	x	x	....
Leptaena invenusta Foerste	x	....	x	x	x	....	....	....
Catazyga erratica Hall	x	....	x	....	....	....	....	....
Zygospira modesta Hall	x	....	....	....	....	....	....	....
Byssonychia radiata Hall	....	x	....	....	x	....	....	....
Clionychia curta Foerste (sp. nov.)	....	....	....	x	....	....	....	....
Colpomya faba Conrad	....	....	....	....	x	....	x	x
Cymatonota pholadis Conrad	x	x	x	x	x	....	....	....
Clidophorus planulatus Conrad	x	....	....	....	x	....	....	x
Clidophorus brevis Foerste (sp. nov.)	x	x	x	....	x	....	....	x
Lyrodesma poststriatum Emmons	x	....	....	....	....	....	....	....
Cuneamya scapha-brevior Foerste	....	....	....	....	....	....	x	....
Archinacella pulaskiensis Foerste	....	x	....	x	....	....	....	....
Sinuites cancellata Hall	....	....	x	x	....	x	....	....
Cyrtolites cf. *parvus* Ulrich	....	....	....	x	....	x	....	....
Trinucleus concentricus Eaton	....	....	x	x	x	x	....	....
Triarthrus becki Green	....	x	x	x	x	....	x	....
Calymene callicephala Green	....	....	x	x	....	....	....	....

From this list it is evident that the fauna collected by Harvie belongs to the *Trinucleus* zone of the Nicolet River section. Moreover, the major fault at the top of the measured part of the section cannot have been attended with a very great throw, since the fossils collected by the writer farther north, and listed as coming from the northern limit of exposures in the river bed, evidently belong to the same fauna.

The most striking feature of this section at St. Hyacinthe, compared with the corresponding section on the Nicolet river, is the great range of *Triarthrus becki*. As a matter of fact, however, *Triarthrus becki* and *Trinucleus concentricus* range in New York state downward into the Trenton, so that the extended range of *Triarthrus becki* at St. Hyacinthe would not be noteworthy, were it not for the limited range of this species in the Nicolet River section.

The presence of an *Ohiocrinus* of the *geniculatus* type also is of interest, since the specimen found can not be distinguished from the species of *Ohiocrinus* found in the Eden strata at Tamarack point, west of Little Current, on Manitoulin island, in Lake Huron, and the latter differs from *Ohiocrinus geniculatus*, Ulrich, from the lower Eden, at Cincinnati, Ohio, only in its larger size. The *Catazyga* is of the *erratica* type, and the general fauna resembles the Lorraine of New York sufficiently to indicate that the Trenton must lie at still lower horizons than anything exposed at St. Hyacinthe. *Cyrtolites parvus* Ulrich, occurs in the upper part of the Cynthiana formation at Covington, Kentucky, opposite Cincinnati, Ohio.

BREAULT, ON BÉCANCOUR RIVER.

Breault station (Figure 1) is located 75 miles northeast of Montreal, and 14 miles southeast of Three Rivers, on the Three Rivers and Arthabaska branch of the Grand Trunk railway. The village consists only of a few houses, and a road leads northeastward to a gully entering the Bécancour river less than a mile from the station. Exposures occur at various points in the bottom of this gully, and the following fossils were found toward the upper part of this set of exposures.

Glyptocrinus columnals.
Heterocrinus columnals.
Coeloclema commune (determined by Ulrich).
Dalmanella "testudinaria."
Glyptorthis sp.
Byssonychia radiata.
Clidophorus.
Modiolopsis.
Triarthrus becki.
Trinucleus concentricus, common.

Much better exposures occur one-eighth of a mile down the river from the mouth of the gully, and elsewhere along the stream, but have not been studied as yet.

The Breault locality probably corresponds to the *Trinucleus* zone as exposed in the Nicolet River section, and as exposed also along the Yamaska river, northwest of St. Hugues and at St. Hyacinthe.

ST. AUGUSTIN, SOUTHWEST OF QUEBEC.

(Figure 1.)

Fifty-six miles northeast of the Breault locality on the Bécancour river, is St. Augustin, a railway station on the north shore of the St. Lawrence, about 12 miles southwest of Quebec. East of the railway station, argillaceous shales with graptolites are exposed. West of the mouth of the creek which serves as an outlet for Lac Calvaire, the graptolites are accompanied by *Dalmanella*. Directly south of the west end of Lac Calvaire, along the railway, the following fossils are found:

Graptolites common.
Crinoid columnals.
Hallopora sigillarioides.
Hemiphragma sp. (determined by Ulrich).
Dalmanella, very common.
Plectambonites sericeus, large, rare.
Plectambonites plicatellus, common in certain layers.
Zygospira.
Rhynchotrema, large form like *increbescens*.
Trinucleus sp. with long genal spines.
Triarthrus becki, not rare.

About an eighth of a mile farther eastward, one-third of a mile before reaching the contact with the Sillery, a conglomerate is exposed, containing the following species:

Streptelasma.
Dalmanella.
Hebertella.
Plectambonites sericeus, large, common.
Rhynchotrema.

This conglomerate is believed to belong to the Trenton, and the overlying argillaceous shales to horizons corresponding to the lower part of the Cincinnatian section in Ohio. It is recognized, of course, that a much more extended examination of these beds must be made before definite correlation of these shales east of St. Augustin with Cincinnatian strata be accepted. There is a possibility of these shales turning out to be Trenton, but their Trenton age could not be recognized from the few fossils secured. The total thickness of these shales must be at least several hundred feet, and they certainly belong below the lowest strata so far studied along the Nicolet river, thus greatly augmenting the total thickness of strata supposed to have equivalents in the Cincinnatian section.

It is becoming evident that *Trinucleus concentricus* and *Triarthrus becki* either range through considerable parts of both the lower "Hudson river" and Trenton rocks, or that they are represented in both series of strata at least by closely similar forms, so far not differentiated in the field. Under these conditions it will probably require a very careful collecting of the graptolite and bryozoan elements in the fauna to determine the age of the argillaceous shales east of St. Augustin.

MONTMORENCY FALLS.

(Figure 1.)

The same statement may be made regarding the exposures 6 miles northeast of Quebec, at the Montmorency falls. Here several hundred feet of fissile black shales, such as usually are regarded as representing the typical Utica, rest against the more or less faulted Trenton, and are overlaid, southeastward, along the railway, by softer clay shales containing graptolites and *Triarthrus becki*. Until recently, no one would have doubted the Utica age of the fissile black shales or the Eden age of the overlying strata, but now, apparently, owing to the study by Dr. Ruedemann of lithologically similar strata in the Mohawk valley of New York, the age of these Canadian strata is once more sufficiently in doubt to make further investigation desirable, although the Utica age of Montmorency Falls shales is provisionally taken for granted.

In view of the considerable exposures of shales along the St. Lawrence near Quebec, overlying undoubted Trenton limestones, it seems possible that the total thickness of strata in the province of Quebec, corresponding to the Cincinnatian section in Ohio, Indiana, and Kentucky, not including the Queenston shales, may equal 4,000 feet, and including the Queenston may equal 5,000 feet.

RELATIVE STRATIGRAPHIC POSITION OF SOME OF THE QUEBEC PROVINCE HORIZONS.

The following is a crude attempt to indicate the relative position of the various faunas discussed in this report, using the Nicolet River section as a standard of comparison. Being only a first attempt, based upon data so far secured, it is, of course, subject to considerable error, but nevertheless may serve as a guide to future research.

No attempt has been made to indicate the relative positions of the St. Augustin, and Montmorency Falls faunas, but both are regarded as belonging far below the base of the Nicolet River section.

0 feet—*Base of Queenston.*

0 feet—*Top of Zygospira kentuckiensis zone, at top of Nicolet River section;* exposed also 1½ miles southwest of Vars and 2 miles southwest of Hawthorne.

55— 100 feet—Erratic blocks northwest of St. Hugues, at St. Hilaire, 1¼ miles southeast of the village and at Rivière des Hurons, at *Strophomena hecuba* zone.

100— 156 feet—Blocks on hill-side east of St. Hilaire, at *Strophomena planumbona* zone. Probable horizon also of the *Strophomena fluctuosa* zone west of Vars.

245— 400 feet—At St. Hilaire southeast of station, in *Pholadomorpha* zone.

700—1,000 feet—At Chambly Canton, and mouth of Rivière des Huron in *Proetus zone.* Here belong also the exposures 2 miles northwest of Vars, and west of Hawthorne.

1,700—2,050 feet—At St. Hyacinthe, St. Hugues, and Breault, in *Trinucleus* zone, including also *Triarthrus* and *Leptaena.* The *Petite Caroline* locality probably also belongs here.

Referring now to the published geological maps of the territory here discussed, the Montreal, Quebec, and Three

Rivers sheets, it will be noticed that these determinations fall in very well also with the structure as already unravelled by earlier investigators.

The Ordovician area south of the St. Lawrence river is folded in a direction approximately but not strictly parallel to the Appalachian folding farther southeastward. At present, however, the evidences of this folding are chiefly local, and few of the axes of either the synclines or of the anticlines have been traced for long distances.

Only in case of those synclines which are occupied by remnants of the formerly widespread red Queenston shales, do the published geological maps of this area give any suggestion as to the width and length of any of these synclines.

The most western of the Queenston red clay shale areas mapped in the province of Quebec enters the area of the Montreal sheet (No. 571) from the north. The centre of this area crosses the St. Francis area about 4 miles southeast of Pierreville. The syncline evidently has a southwesterly direction, and in the map the Queenston beds terminate at the David river, about 8 miles north of St. Hugues. Recently, however, the red Queenston shales were struck in the borings for gas in the vicinity of St. Amable, between 4 and 6 miles north of St. Hyacinthe, on the western side of the railway. Here fully 1,000 feet of Queenston beds have been penetrated, and since only glacial deposits cover these beds their original thickness probably was greater.

Connecting the St. Amable localities with the Queenston red shale area, as mapped on the St. Francis river, the syncline should cross the Yamaska river in range III, about 2½ miles northwest of St. Hugues. As far as known, no exposures occur here. The most western exposures mapped by Harvie are about 2 miles west of the mouth of the Chibouet river and belong to the *Trinucleus* zone of the Lorraine. Moreover, the dips in this area indicate a syncline about 1½ miles west of the Chibouet river, and a small anticline about half a mile from the mouth of this river.

However, at St. Hyacinthe the rocks dip distinctly southeast, while the axis of the Pierreville syncline is known to be northwest of St. Hyacinthe, suggesting a narrow synclinal structure here, possibly not exceeding 7 or 8 miles in width. The eastern boundary of the Pierreville syncline is indicated by the presence of the *Trinucleus* division of the Lorraine at St. Hugues, St. Hyacinthe, and east of Rougemont mountain.

The axis of a second syncline occupied by Queenston strata crosses the Nicolet river in the vicinity of Ste. Monique, and according to the map the Queenston shales continue for a distance of 11 miles southwest. About 2 miles southeast of Ste. Monique these Queenston shales are underlaid by fossiliferous strata dipping northwest and the syncline terminates at an anticline whose axis lies about 3 miles southeast of Ste. Monique. Between the southern end of the Nicolet syncline and the northern end of the Pierreville syncline there probably is an anticline, the evidence for which is buried by glacial deposits. The width of the Nicolet syncline may not exceed 7 miles.

Northeastward the Queenston shales occupying the Nicolet syncline are not indicated beyond the Gentilly river, but a third syncline is indicated on the Quebec sheet, No. 375, by a Queenston area beginning about 2 miles west of Forestdale on the Gentilly river and extending northeastward for a distance of 21 miles crossing the Petite Rivière du Chene.

The indentations of Ordovician strata in the Archæan outline north of the St. Lawrence river north of Grondines and Les Ecureuils may indicate prolongations of the Nicolet and Du Chene synclines.

It will be noticed that the Pierreville, Nicolet, and Du Chene synclines have a more northerly direction than the St. Lawrence and Champlain fault. Apparently the resistance offered by the Archæan mass north of the St. Lawrence river to the thrust of the rocks from the southeast produced first folding and then faulting.

Farther southward in the province of Quebec, the Nicolet and Pierreville synclines may terminate in shallow troughs not including the Queenston. So far the evidence for this is not very clear, but the presence of Richmond strata east and southeast of St. Hilaire Station, and on the Rivière des Hurons, 4 miles northeast of Chambly basin, accompanied by the presence of the *Trinucleus* zone of the Lorraine at St. Hugues, St. Hyacinthe, and east of Rougemont mountain at least lends colour to such a suggestion.

The trough of the Pierreville syncline apparently rises toward St. Hilaire and Chambly.

Synclinal structure, judging from the Montreal sheet, dominates the structure of the Ordovician area as far as the Napierville area, 25 miles southwest of Chambly Canton.

NAVAN.

Navan station (Figure 5) is nearly 11 miles east of Ottawa, on the Canadian Pacific line to Montreal (Figure 5); the village is at the crossroads less than a mile northeastward. Continuing along the same road northeast of the village, exposures of the Collingwood black shale with *Triarthrus spinosus* are met. This shale, formerly identified with the Utica of New York, overlies the Trenton limestone, but the contacts are not seen here. Nearly 2 miles northeast of Navan station, a crossroad turns off southeastward, between concessions VII and VIII, and exposes more of the Collingwood black shale, both north and south of the railway. Half a mile south of the railway, between lots 13 and 14, at a road corner, the basal beds of the strata regarded as equivalent to one of the lower horizons in the Cincinnati group, consisting of brownish argillaceous strata containing *Plectambonites sericeus*, are found. *Dalmanella* and *Triarthrus becki* occur 1½ miles southeast of this road corner, at the bridge across Bear creek, along the road leading southeast to Vars. These lower strata correspond to the lower Eden of the Cincinnatian sections in Ohio and neighbouring states.

VARS.

Two miles and one-half southeast of the road corner at which the lowest exposures regarded as having equivalents in the Cincinnatian section of Ohio, Indiana, and Kentucky occur, at a road crossing between concessions VII and VIII, and 1½ miles south of the bridge mentioned in the preceding lines, there are several good exposures of clay shales interbedded with fine-

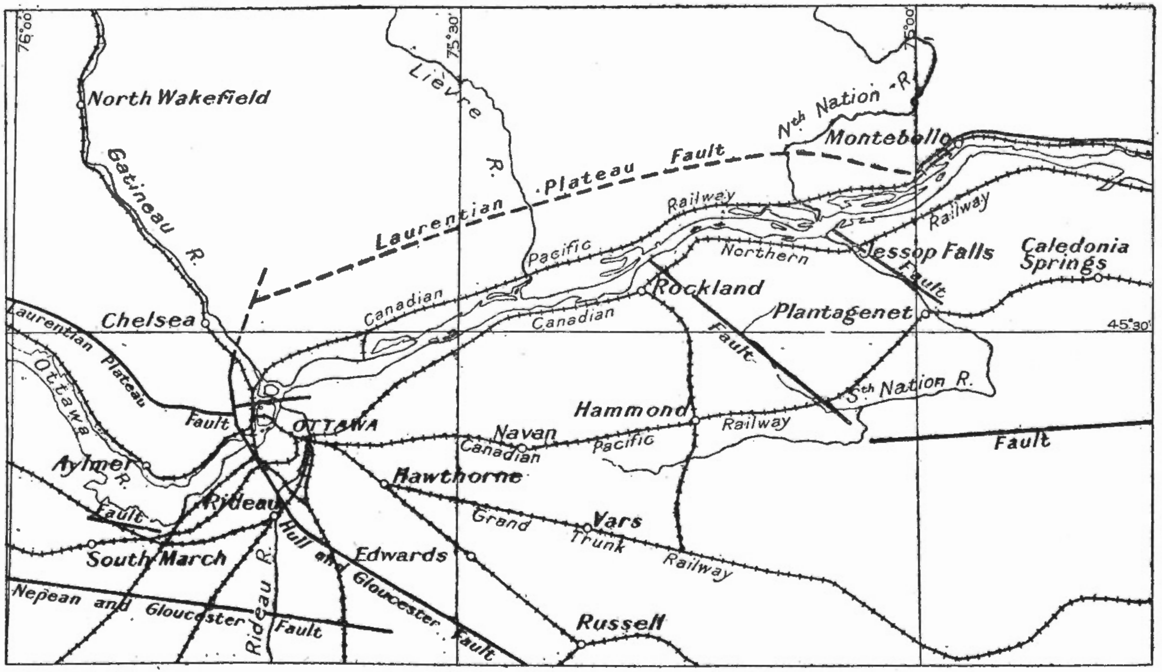

Figure 5. Portion of eastern Ontario showing fossil localities.

grained, harder, siliceous, shaly layers. The locality may be reached also by going from Vars station (Figure 5), 15 miles east of Ottawa, on the Grand Trunk railway, first three-fourths of a mile westward along the railway track and then a mile northwestward, to the road crossing mentioned above. The strata are richly fossiliferous here. Some fossils were collected at a bridge, west of the road crossing; others were found south of the crossing. The following is a list of the species seen:

Glyptocrinus columnals.
Bryozoan impressions.
Dalmanella sp.
Rafinesquina mucronata
Plectambonites sericeus.
Zygospira modesta.
Pholidops subtruncata.
Byssonychia radiata.
Clidophorus praevolutus.
Cymatonota pholadis, near *recta*, Ulrich.
Cuneamya cf. *neglecta* Hall, non Meek.
Lyrodesma poststriatum.
Psilonychia sinuata.
Rhytimya granulosa.
Eotomaria nearest *canalifera.*
Acidaspis free cheek.
Calymene sp.
Proetus chambliensis.
Bythocypris cylindrica.
Ctenobolbina cf. *ciliata.*

The horizon at which these fossils were obtained is regarded as considerably below the lowest strata containing *Pholadomorpha pholadiformis* and *Modiolopsis concentrica.* On the other hand, it is regarded also as distinctly above those horizons in the Cincinnatian sections in which *Leptaena* occurs associated with *Trinucleus* and *Triarthrus*. For the present, it is correlated with the upper part of the *Proetus* horizon, as exposed at Chambly. Along the Nicolet river, this horizon belongs about 600 feet below the lowest *Strophomena planumbona* zone, which occurs at the base of the strata there correlated with the Waynesville of Ohio.

Three-fourths of a mile southeast of the road corner last discussed, south of a stream crossing, there is another fossil locality. It may be reached by going from Vars three-fourths of a mile westward, along the railway track, and then nearly half a mile northwest along the road.

At this locality, sandy, shaly, fine-grained strata occur interbedded with clay, on both sides of the road. The following species were found:

Glyptocrinus columnals.
Rafinesquina mucronata,
Plectambonites sericeus.
Pholidops subtruncata.
Clidophorus praevolutus.
Pterinea demissa.
Proetus chambliensis.

No difference could be noted between this fauna and that at the crossroad, nearly a mile northwestward. However, at this more southern locality there are also numerous loose blocks in the field east of the road, and some along the road itself, which are regarded as residual blocks from some higher horizon, brought in contact with rocks belonging to the *Proetus* zone by faulting. These blocks contain the following species:

Plectambonites sericeus.
Hebertella occidentalis.
Strophomena sulcata.
Rafinesquina mucronata.
Zygospira modesta.
Catazyga headi.
Pholidops subtruncata.
Clidophorus praevolutus.
Clathrospira subconica.

It is probable that these blocks are from a horizon corresponding approximately to the *Strophomena sulcata* horizon in the lower part of the richly fossiliferous Richmond zone in the Nicolet River section, between 60 and 70 feet above the lowest strata containing *Strophomena planumbona* and *Rhynchotrema perlamellosum*, but the presence of *Catazyga* suggests a somewhat lower horizon.

HAWTHORNE.

A similar fauna lacking *Strophomena sulcata*, however, is found also elsewhere in those strata east of Ottawa which have equivalent horizons in the Cincinnatian strata of Ohio and Indiana. For instance, along the railway a mile northwest of Hawthorne station (Figure 5), about 3 miles east of the Rideau river at Ottawa, the following species occur in the thin limestones interbedded in the clay shales:

Glyptocrinus columnals.
Bryozoan casts.
Cornulites.
Pholidops subtruncata.
Dalmanella
Plectambonites sericeus.
Rafinesquina mucronata.
Hebertella occidentalis.
Zygospira modesta.
Ctenodonta lorrainensis.
Lyrodesma poststriatum.
Pterinea demissa, small.
Calymene.
Proetus chambliensis.
Bythocypris cylindrica.

This fauna is correlated with the *Proetus* zone of the Nicolet River section.

In the neighbouring fence corner, sandstone boulders are so numerous that it may be assumed that they were picked up in making the road bed for the railway. These sandstones are very fine-grained, of a brownish colour, and fairly soft; they evidently represent the weathered remains of the very fine-grained siliceous limestone so characteristic of the so-called Lorraine of this part of the country. Most of the sandstone slabs vary between 1½ inches and 2 inches in thickness. They contain the following fauna, in addition to some of those in the preceding list, especially *Plectambonites sericeus* and *Rafinesquina mucronata:*

Hebertella occidentalis.
Catazyga headi.
Byssonychia radiata.
Isotelus.

Among the sandstone slabs there are some limestone blocks, containing:

Plectambonites sericeus, very common.
Rafinesquina mucronata.
Hebertella occidentalis, common.

RAMSAY STATION.

Along the same line of railway, the New York and Ottawa, 5 miles southeast of Ottawa, is Ramsay station (Figure 5). About a mile west of the station the Ottawa pike crosses a branch of Greens creek. Following the creek westward as far as the church, the following fossils are found in the clay shales and the interbedded sandy layers or fine-grained limestones.

Glyptocrinus columnals.
Heterocrinus columnals.
Cornulites.
Pholidops subtruncata, common.
Dalmanella, common.
Hebertella.
Plectambonites sericeus, common.
Zygospira modesta.
Byssonychia radiata.
Pterinea demissa.
Acidaspis, free cheek.

Mr. W. R. Billings has in his possession specimens of *Catazyga headi* obtained from this locality. Lithologically the rock resembles that found in the *Proetus chambliensis* zone.

CONCLUDING REMARKS.

In examining the fauna of the various Lorraine exposures east of Ottawa, and thence northeastward as far as Quebec, the absence of the most characteristic Lorraine fossil, *Modiolopsis modiolaris*, is striking. Not less noteworthy is the absence of such forms as *Ischyrodonta curta*, *Orthodesma nasutum*, *Glyptorthis crispata*, and *Rafinesquina nasuta*. Moreover, the *Trinucleus*, so common east of Pulaski and for several miles east of Lorraine, in New York, occurs in the Lorraine of the province of Quebec only at much lower horizons. On the contrary, the *Proetus chambliensis* which is so common at certain horizons in the Lorraine of the province of Quebec, is unknown in the Lorraine of New York, and must be at least very rare, there.

The conclusion seems inevitable that the Lorraine of New York and the Lorraine of Quebec and of the extreme eastern portion of Ontario represent sedimentations in different basins, sufficiently distinct to make possible the differences in fossil content here noted. The Frontenac axis which is indicated by outcrops of the Pre-Cambrian, extending in a general north and south direction through the Thousand Island region, appears to have been sufficiently developed in later Ordovician time to have separated the Quebec basin from that part of New York which borders the eastern part of Lake Ontario, and also from that part of Ontario which lies between the northern shore of Lake Ontario and Georgian bay.

WESTERN ONTARIO.

The typical Maysville fauna, with its numerous forms of *Platystrophia*, its various species of *Plectorthis*, and its *Strophomenas* of the *planoconvexa* group, is not present in Canada. The various representatives of the Maysville fauna identified so far consist chiefly of bryozoans, suggesting the presence of strata belonging somewhere between the top of the Fairmount and the typical Bellevue members, as exposed in the vicinity of Cincinnati. The number of these bryozoan species is not great. They represent a meagre incursion from the south into the region between Manitoulin island and the areas surrounding Toronto. Eastward, this Maysville bryozoan element is even more sparingly represented in the Pulaski of New York.

The lamellibranch fauna of the Pulaski of New York apparently finds close relatives in the strata which intervene between the top of the Fairmount and the base of the typical Bellevue, at Hamilton, Ohio. This appears, however, to have been a southward migration of a northern fauna rather than a northward migration of a southern one.

In general, the faunas of those Canadian strata which most nearly approach the Maysville in time, appear to have been northern faunas, possibly also in large part of northeastern origin. There is no evidence of the presence, in Ontario or Quebec, of the typical Mount Hope, Fairmount, Corryville, or Mount Auburn members of the Maysville, as represented in the Cincinnatian areas.

It is doubtful whether the typical Lorraine of New York has any wide extension in the area west of the Frontenac axis in the province of Ontario. Such typical upper Lorraine forms as *Orthodesma nasutum*, and *Ischyrodonta curta* are known within this area, only from Weston, 3 miles northwest of Toronto, although Hall figured a specimen of *Ischyrodonta curta* from Grimsby, along the southern shore of Lake Ontario; but this must have been an erratic specimen. *Modiolopsis modiolaris*, another characteristic upper Lorraine form, is not known from any part of Ontario. The only characteristic New York upper Lorraine fossil found also in the supposed Lorraine of Ontario is *Pholadomorpha pholadiformis*, but the value of this fossil in identifying the Lorraine in Ontario is destroyed by the fact that it occurs in the provinces of Ontario and Quebec, as well as in Ohio, Indiana, and Kentucky, also throughout the Waynesville member of the Richmond. In these circumstances, the only reason for identifying any of the strata, in Ontario, which contain *Pholadomorpha* and which occur beneath undoubted Richmond strata, with the Lorraine of New York instead of the Richmond of Ohio, is the fact that Dr. E. O. Ulrich determined the bryozoans in the *Pholadomorpha* zone of the so-called Lorraine, which occur beneath undoubted Richmond strata, on

Manitoulin island, and at corresponding horizons near Meaford, on the south shore of Georgian bay, as of middle Maysville rather than of Richmond age. It is, therefore, chiefly these bryozoa which suggest the Maysville age of those *Pholadomorpha*-containing beds in the province of Ontario which have the lithological aspect of Lorraine strata. In making these statements, however, I wish to emphasize the fact that only a few species of bryozoans were found in these supposed Lorraine strata in Ontario, and that further collections might modify considerably conclusions based on the few species of bryozoans hitherto collected. These further collections of bryozoan material I have not had the opportunity, so far, to make.

The element of doubt as to the correctness of the correlation of the upper part of the Lorraine-appearing strata in Ontario with the top of the Lorraine in New York is increased also by the presence of some of the other fossils associated with *Pholadomorpha* in these strata. For instance, north of the railway bridge at the southeastern end of Streetsville, 18 miles west of Toronto, *Opisthoptera fissicosta*, a typical Richmond form, is seen in the upper part of the Lorraine-like strata, and *Strophomena sulcata* another typical Richmond form, occurs at least 50 feet lower in the section. In fact, the Lorraine-like *Pholadomorpha* zone at Streetsville may be referred definitely to the Richmond.

This upper Lorraine-like zone appears to contain a considerable fauna and it is exposed at a sufficient number of localities in southern Ontario to invite further study. In the valley of the Humber river, on the western side of Toronto, there must be some good upper Lorraine exposures since a considerable number of species from this locality are represented in the collections of the Royal Ontario National Museum at Toronto. Exposures occur also at other localities northwest of Toronto, along the southern shore of Georgian bay, and on Manitoulin island. However, I have had no opportunity to give these more than a very superficial examination. In general, it may be stated that while it is not regarded as impossible that *Pholadomorpha* may occur in strata of Maysville as well as in those of Richmond age, it is probable that further research will place at least the upper part of these so-called Lorraine *Pholadomorpha*-containing strata more or less definitely in the Richmond.

The lower parts of the supposed Lorraine of Ontario are well exposed at numerous localities near Toronto, on the south shore of Georgian bay, and on Manitoulin island. These require, however, much further study. Indeed, their study can scarcely be said to have begun. Enough has been seen to indicate that they contain a considerable fauna, including bryozoans. The present state of knowledge scarcely warrants any attempt to correlate these lower strata with definite parts of the New York Lorraine section. The possibility of correlation of some parts of the southern Ontario Lorraine with a part of the Lorraine as exposed in the province of Quebec is suggested by the exposure in the Don Valley brick-yards, in the eastern part of Toronto. Here there is a zone at which a *Leptaena* of the *rhomboidalis* group is associated with *Catazyga erratica* and *Trinucleus concentricus*. This association of fossils is strongly suggestive of that between 1,395 and 1,550 feet below the lowest horizon containing *Strophomena planumbona* and *Rhynchotrema perlamellosum*, in the Nicolet River section. The associated bryozoan fauna suggests Eden and lower Maysville affinities. It is possible that when these faunas are carefully collected they may be found distinctly separable into an upper, Maysville, and a lower, Eden, zone, but so far the bryozoans have been collected indiscriminately, and it is fortunate that they have attracted sufficient attention on the part of local collectors to have been preserved at all. Evidently much remains to be learned regarding the supposed Lorraine strata of the province of Ontario. At present, the chief point of interest so far suggested by previous studies appears to be the fact that the Lorraine of Ontario presents much more in common with the Eden and Maysville of Ohio, Indiana, and Kentucky, than with the Lorraine of the province of Quebec, while it presents scarcely anything which might be called characteristic in common with the typical Lorraine of New York, unless the exposures at Weston, northwest of Toronto, are regarded as an exception.

Catazyga erratica has a very restricted vertical distribution in the Lorraine of Ontario. *Glyptorthis crispata* is unknown there. Even such common New York forms as *Pholidops subtruncata*, *Archinacella pulaskiensis*, *Clidophorus planulatus*, *Colpomya faba-pusilla*, and *Ctenodonta lorrainensis*, either are absent or are sufficiently rare not to have been found as yet.

Calcareous strata are more common in the Lorraine of Ontario than in the typical Lorraine of New York, and it is in association with these calcareous strata that the bryozoans become more numerous. It is chiefly the bryozoans which suggest the affinity of the Canadian representatives of the Lorraine with the Maysville and Eden of Cincinnatian areas.

BETWEEN GEORGIAN BAY AND LAKE ONTARIO.

TORONTO.

So numerous are the outcrops of the upper and lower Lorraine-like strata in the vicinity of Toronto, within a radius of 20 miles (Figure 6), that eventually a very interesting fauna will be collected. It is quite evident that no serious study of these faunas has been attempted as yet, since only a few of those species actually collected have been carefully identified.

Considering the close vicinity of the Don Valley brick-yards to Toronto, it is remarkable how little definite information is at hand regarding the vertical range of any of the species found at that locality. To unravel this will require the close attention of some one located sufficiently near the quarry to examine the material from each level in succession, while different parts of the quarry face are cut away.

At one horizon in the Don Valley brick-yard, *Leptaena rhomboidalis* cf. variety *invenusta*, occurs associated with *Catazyga erratica* and *Trinucleus concentricus*. Associated in the same layer are various bryozoa among which Dr. E. O. Ulrich identified a species of *Aspidopora* and one of *Bythopora*, both suggesting Eden affinities, and also *Hallopora communis* and *Spatiopora maculosa*, both suggesting lower Maysville relationship.

In the same manner, a miscellaneous collection of bryozoa submitted to Dr. Ray S. Bassler, from the Don Valley brick-yard quarry, by Prof. W. A. Parks, included a mixture of Eden and

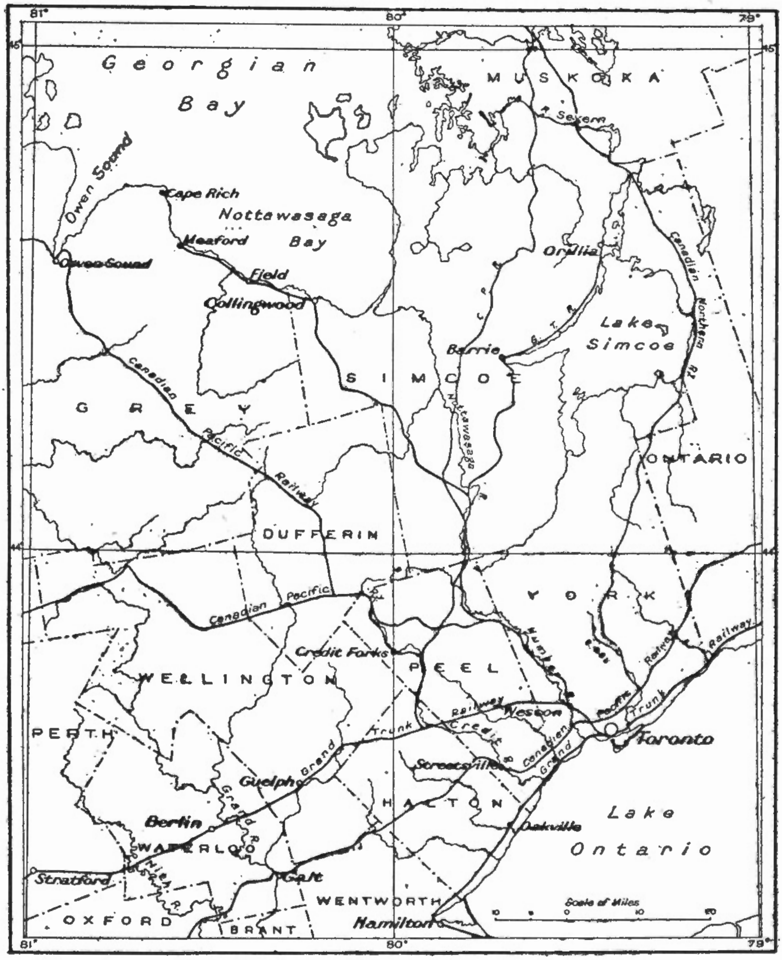

Figure 6. Portion of western Ontario showing fossil localities.

Maysville forms. The various members of the Maysville formation, in Ohio, in the order of their succession, from top to bottom, are:

Mount Auburn.
Corryville.
Bellevue.
Fairmount.
Mount Hope.

The following species were identified by Bassler from the Don Valley brick-yard quarry:

Atactopora maculata.......Fairmount member of Maysville horizon at Cincinnati.
Hallopora dalei............Mount Hope and Fairmount members.
Hallopora subplana........Mount Hope member of Maysville.
Arthropora shafferi........Upper Eden to Corryville member of Maysville.
Perenopora vera...........All Eden and Mount Hope member of Maysville.
Bythopora arctipora........All Eden.
Dekayella ulrichi..........All Eden.
Aspidopora sp.............Eden form.
Chiloporella sp............Eden form.
Stigmatella sp.............Eden form.

Notwithstanding these careful determinations by Dr. Bassler, it is impossible at present to make even a suggestion as to where the line is to be drawn, within the Don Valley brick-yard, between the Eden and Maysville. There is no lithological change to be noted in the quarry face, suggesting an important time break, and none of the horizons for any of the species have been determined.

Dr. Bassler determined also the following species from some unknown locality near Toronto:

Spatiopora cf. *maculosa*....Fairmount member of Maysville.
Paleschara cf. *beani*........Eden formation.

From Weston, 3 miles northwest of the northwestern boundary of Toronto, he identified

Bythopora gracilis.........Fairmount to Arnheim, the latter being the lowest member of the Richmond in Ohio.
Hallopora sp.............Maysville formation.

The upper zones of the supposed Lorraine strata in the vicinity of Toronto, are exposed on the Humber river, west of Toronto, as already indicated. The fossils found here belong to the *Pholadomorpha pholadiformis* and *Modiolopsis* cf. *concentrica* zone, but they have not been studied as yet.

Whitella hindi, from the vicinity of Toronto, which was described by Billings, probably came from the upper Lorraine as exposed along the Humber river.

Diplograptus hudsonicus from the Hudson river, on the lake shore at Toronto, and from Weston, was described by Nicholson. The best specimens are said to have come from flags brought to Toronto, probably from some quarry on the Humber. Along the Humber the *Pholadomorpha* zone in the upper part of the Lorraine is exposed, and at this horizon on Manitoulin island *Diplograptus vespertinus* Ruedemann, is widely distributed. At the *Leptaena* horizon in the lower Lorraine, at the Don Valley brick-yards, *Climacograptus* (*Mesograptus*) *putillus* was identified by Ruedemann. Without having access to the types of *Diplograptus hudsonicus* it is impossible to identify this species, but it seems possible that it may have been *Diplograptus vespertinus* or some other variety of *Diplograptus quadrimucronatus*.

WESTON.

The village of Weston (Figure 6) is located about 3 miles northwest of the present northwestern boundary of Toronto. West of the middle of the village a bridge crosses the Humber river, and exposures extend from this bridge for about a mile southward. One of the bluffs on the west side of the river has a vertical exposure of about 20 feet and another bluff on the east side exposes about 40 feet of rock and shale. The clay shale largely predominates, but the fossils can be detected most readily in the interbedded rock layers.

The following species were identified from the strata exposed along the river bank in a total section probably not exceeding 40 feet.

Plectambonites sericeus.
Rafinesquina alternata, flat form.
Rafinesquina mucronata.
Catazyga erratica.
Pterinea demissa.
Byssonychia radiata-borealis.

Modiolopsis concentrica.
Pholadomorpha pholadiformis.
Colpomya faba.
Cymatonota lenior.
Ischyrodonta curta
Lyrodesm posstriatum.
Cyrtolites ornatus.
Clathrospira subconica.
Cyclonema bilix.
Loxoceras with vertical colour marking on inner layers of shell.
Endoceras sp.
Calymene sp.
Arthraria, 5 inches in length.

About half a mile southwest of the bridge at Weston, along the pike following the western side of the Humber valley, and 60 feet above the level of the exposures in the river bed at the bridge, a small tile ditch at the margin of the field exposed rock containing numerous specimens of *Catazyga erratica* associated with a typical specimen of *Orthodesma nasutum* Conrad.

The presence of *Ischyrodonta curta* and *Orthodesma nasutum* in association with *Catazyga erratica* and *Pholadomorpha pholadiformis* appears to establish the presence of the upper Lorraine of New York in these exposures along the Humber river, at Weston. The *Ischyrodonta curta* was found on the western side of the river where a vertical exposure of about 8 feet of rock occurs a short distance down stream from the 40-foot bluff exposure on the eastern side of the river. Several specimens occurred in the same layer with *Catazyga erratica, Pholadomorpha pholadiformis, Byssonychia radiata, Colpomya faba, Clidophorus planulatus*, and *Lyrodesma poststriatum.* The *Cymatonota lenior* occurred just beneath. The species of bryozoa identified by Dr. R. S. Bassler from the vicinity of Weston, namely *Bythopora gracilis* and *Hallopora* sp., and regarded by him as suggestive of Maysville age, probably came from the *Pholadomorpha* zone in the so-called Lorraine at Weston. Several species of bryozoans, recently collected by the writer from this zone at Weston, failed to show any definite Richmond affinities. Hence the possibility remains that the lower part of the Lorraine-like strata forming the *Pholadomorpha* zone in Ontario may be of Maysville age, an age also favoured by Dr. Ulrich for the *Pholadomorpha* zone at the top of the typical Lorraine in New York.

RELATIVE STRATIGRAPHIC POSITION OF CERTAIN LORRAINE EXPOSURES IN SOUTHERN ONTARIO.

Eventually it probably will be possible to determine more exactly the relative stratigraphic position of the various Lorraine exposures in southern Ontario. For the present the following data must suffice.

At Streetsville the fossiliferous Richmond strata immediately beneath the red Queenston shales attain an elevation of about 525 feet above sea-level. At Oakville, about 9 miles almost directly southward, the highest fossiliferous layers beneath the Queenston shales are about 330 feet above sea-level. If the same rate of dip occurs between Weston and Mimico, a distance of about 6 miles, then the strata in the river bed at the Weston bridge should occur at the lake level at Mimico, while the *Orthodesma nasutum* horizon, 60 feet above the river bed exposures at the Weston bridge, should occur near the railway level at Mimico.

According to well borings, the Trenton at Mimico is reached at 376 feet below sea-level, and the Trenton at Clarkson, 9·5 miles southwest, is reached at 538 feet below sea-level. At the same rate of dip any rock at the level of the railway at Mimico should occur about 250 feet below the highest exposures of the fossiliferous Richmond rock beneath the Queenston at Oakville.

If the same dips prevail in the Toronto area, then the top of the exposures at the Don Valley brick-yard, about 5 miles northeast of Mimico, should belong stratigraphically about 170 feet beneath any rocks which occur at railway level at Mimico.

If the preceding calculations have any value at all, the following conclusions may be drawn:

At Streetsville, *Strophomena sulcata* is rather common in some of the layers exposed at the foot of the bluff west of the Credit river, northeast of the home of William Crozier, about 1½ miles south of the Coral zone exposure, opposite the middle of the village. According to crude Locke level measurements, this *Strophomena sulcata* horizon occurs about 72 feet below the Coral zone exposure. Correcting for the dip, an interval of 50 feet appears ample.

The *Orthodesma nasutum* zone of Weston should occur about 200 feet below the *Strophomena sulcata* zone at Streetsville, and the *Ischyrodonta curta* zone at Weston may occur 80 feet below the *Orthodesma nasutum* zone at the same locality, making allowance for the dip.

The top of the exposure at the Don Valley brick-yard should be 170 feet beneath the *Orthodesma nasutum* zone at Weston, stratigraphically, or 90 feet below the *Ischyrodonta curta* zone at the same locality. The exact horizon for the *Leptaena invenusta* horizon at the brick-yard is unknown at present, but it certainly occurs some distance below the top.

The interval from the top of the exposure at the Don Valley brick-yard to the top of the Trenton is estimated at 470 feet, giving a total of 790 feet from the base of the Coral zone to the top of the Trenton, and a total of 835 feet from the base of the Queenston to the top of the Trenton.

In the Beachville well this interval between the Queenston base and Trenton top is given as 695 feet. At Clarkson, a well passed through 800 feet of these strata before reaching the Trenton, but did not begin as high as the base of the Queenston. At St. Catharines, about 35 miles south of Toronto, a well passed through 868 feet between the Queenston base and the top of the Trenton.

Probably the estimate of 835 feet given above for the total thickness of the strata between the base of the Queenston and the top of the Trenton in the Toronto area is at least approximate. The thickness of the Utica part of this section is not definitely known. Estimating it at 150 feet, the interval between the Queenston base and the top of the Utica becomes 685 feet. Moreover, the top of the Don Valley brick-yard exposures in that case should be about 320 feet above the Utica.

According to these measurements, *Pholadomorpha pholadiformis* has a known vertical range of 330 feet in the Toronto area. How much farther down it may occur is unknown, but if the top of the Don Valley brick-yard exposure occurs only 170 feet lower than the *Ischyrodonta curta* horizon at Weston then it is worth while remembering that *Pholadomorpha* is unknown at the brick-yard, and the *Trinucleus* fauna, which is a distinctly lower fauna, occurs here.

In the upper part of its range *Pholadomorpha* occurs in strata unquestionably Richmond. In the light of recent discoveries the strata at Streetsville as far down as the *Strophomena sulcata* horizon are also regarded as Richmond (see page 133). At Weston the Richmond base is not definitely located as yet. The underlying horizons, in which *Catazyga erratica*, *Orthodesma nasutum*, and *Ischyrodonta curta* occur associated with *Pholadomorpha pholadiformis* are regarded still as debatable ground, left for the present in the Lorraine, since in New York they unquestionably belong in the Lorraine.

Possibly the uppermost parts of the Lorraine section of New York, as represented at the Salmon River falls, include strata belonging stratigraphically above the *Ischyrodonta curta* and *Orthodesma nasutum* horizons, and correspond to those strata at and above the *Strophomena sulcata* horizon at Streetsville which are referred here to the lower Richmond.

In a similar manner future investigations may be expected also elsewhere to add to the Richmond division a part of the strata at present left in the upper part of the Lorraine on account of lack of evidence demanding their reference to a higher horizon.

The considerable vertical range of *Catazyga erratica* in the Toronto area also deserves some attention. At the Don Valley brick-yards it occurs at least as low as the middle of the exposures. Estimating the interval between the top of the brick-yard exposure and the *Orthodesma nasutum* horizon at Weston at 250 feet, the vertical range of *Catazyga erratica* in the Toronto area certainly exceeds 280 feet and may equal 500 feet.

In the Meaford area, specimens of *Catazyga*, identified as *erratica*, occur as high as the lowest beds containing *Strophomena planumbona*, and it is only in the overlying beds that *Catazyga headi* has been identified with confidence.

WORKMAN BROOK, SOUTHEAST OF MEAFORD.

Along Workman brook, about 3 miles southeast of Meaford, (Figure 6), there are almost continuous exposures of strata resembling the Lorraine, but there is no great variety of fossils present, and the bryozoans appear to be confined to few species.

The base of the strata definitely referred to the Richmond is placed provisionally at the 325-foot level above the lake, where *Catazyga* occurs associated with *Strophomena planumbona* (see page 127). The upper part of the underlying strata also eventually may be referred to the Richmond, but at present the bryozoan contents suggest an earlier age. At 288 feet above the lake, according to Locke level measurements, *Orthoceras* is common, associated with numerous specimens of a species of *Stigmatella*. The same species of *Stigmatella* occurs in the overlying strata as far up as the *Strophomena planumbona* layer. Farther down stream a fence crosses the brook, and between this fence and a small wooden bridge across the brook, between 260 and 265 feet above the lake, the following species were found:

	Vertical range at Cincinnati.
Spatiopora aspera........................	Basal Bellevue.
Discotrypa cf. *elegans*....................	Basal Bellevue.
Stigmatella, tubercular form, cf. *nicklesi*....	Basal Bellevue.

Down stream from the small wooden bridge, between the 220 and 215-foot levels, *Stigmatella* and *Discotrypa* cf. *elegans* were found. *Taeniaster meafordensis* was very abundant in a thin layer a short distance farther down the brook. At 208 feet above the lake *Stigmatella* was present. At 203, a large *Rafinesquina* and a single well preserved *Catazyga erratica* were seen. Loose specimens of the *Stigmatella* occur as low as the 200-foot level. The bryozoans so far mentioned suggest the presence of lower Bellevue beds between the 200 and 325-foot levels along Workman brook.

At 191 feet above the lake, gasteropods are fairly abundant in a thin layer. At the 167-foot level, *Catazyga erratica* occurs associated with a large form of *Plectambonites sericeus;* and *Rafinesquina mucronata*, and a variety of *Orthodesma canaliculatum* occur at the 154-foot level. The only bryozoan found between the 167 and 189-foot levels was a species of *Eridotrypa*. The level of the driveway at the bridge crossing the brook at the pike is 142 feet above the lake, according to the Locke level. Between this 142-foot level and the lower *Catazyga erratica* horizon, at 167 feet, the following species were found:

	Vertical range at Cincinnati.
Coeloclema sp.	Base of Bellevue.
Dekayia appressa	Basal Bellevue.
Heterotrypa cf. *inflecta*	Basal Bellevue.
Leptotrypa ornata	Base of Bellevue.
Perenopora compressa	Above the Fairmount.

The following specimens were found loose at the bridge levels along Workman brook.

Stigmatella sp.	
Hallopora cf. *dalei* or *nodulosa*	Below the Bellevue at Cinncinnati.

The bryozoans collected between the bridge level and the lower *Catazyga erratica* horizon, according to Dr. E. O. Ulrich, suggest lower Bellevue affinities. They belong above the Fairmount and below the ordinary Bellevue as seen at Cincinnati. but are found intercalated in the lower part of the Bellevue as exposed at Hamilton, Ohio, where the Bellevue is much thicker than at Cincinnati. This intercalated basal Bellevue in the Hamilton area appears to represent an invasion from the north.

Lying loose in the bed of Workman brook, at various levels above the bridge horizon, are slabs of arenaceous limestone, quite angular and evidently not transported far, in which *Pholadomorpha pholadiformis* and a form of *Modiolopsis* belonging to the *concentrica* group occur. In Ohio, these forms have long been regarded as characteristic of the lower Richmond, being especially common in the lower or Fort Ancient division of the Waynesville member. Along Workman brook, and at various other localities in Canada, however, these or closely related forms are fairly common in strata whose bryozoan elements according to Dr. Ulrich, suggest a lower Bellevue age. To one familiar with the stratigraphic succession in Ohio this proves very disconcerting. I must frankly acknowledge that I should like to see the bryozoan evidence very much increased before accepting the conclusions to be derived from the few species known so far without a certain hesitancy, and so, I have no doubt, would Dr. Ulrich. The correlations here suggested are merely tentative, and are based upon such meagre evidence as is at hand.

Most of my notes on the Workman Brook section have been lost. The preceding account contains most of the information which is still at hand. To these notes it is possible to add only a few general impressions which remain in memory.

In the vicinity of the bridge across Workman brook, the strata have a Lorraine-like aspect. This aspect continues for a short distance below the level of the abutments of the bridge, the latter being estimated as standing about 132 feet above lake level. Here the comparatively unfossiliferous, Lorraine-like, arenaceous, fine-grained, thin-bedded limestones, interbedded with clay, rest upon a section in which clay shale predominates very largely. Intercalated with these clay shales are occasional, even more thinly bedded, but coarser grained limestones, which contain an Eden fauna, similar to that found at various localities beneath the *Pholadomorpha* zone on Manitoulin island. Descending the creek, the lower two-thirds of the Eden section consists almost entirely of clay shale, in which fossils are very rare. *Trinucleus* occurs in a layer about 25 feet above the lake level. No trace of the Collingwood black shale is exposed, although this shale may occur only a short distance below the lake level.

Workman brook enters the lake at the western end of the great clay cliffs west of Boucher point. In attempting to estimate the height of these cliffs by means of a Locke level, an estimate of 148 feet was made. The slopes of these clay cliffs are covered with talus from the upper layers here exposed. Numerous bryozoan fragments belonging, however, to few species, were collected. Some of these were submitted to Dr. E. O. Ulrich at the same time that the specimens from the Eden formation, 2½ miles north of Wekwemikongsing, on the eastern shore of Manitoulin island, were being examined and both were pronounced as of essentially the same age.

Another section is exposed in a gully perhaps half a mile southeast of Boucher point at locality 10. The base of the gully is located south of the pike. The rocks exposed in the gully belong to the *Pholadomorpha* zone or the upper part of the supposed Lorraine section. The base of the more richly fossiliferous part of the Richmond occurs 150 feet above the railway, and the latter is about 165 feet above the lake, according to the Locke level. The richly fossiliferous part of the Richmond evidently corresponds most nearly to the Waynesville member, as exposed in Ohio and Indiana, and the underlying strata have a Lorraine-like aspect and belong to the series which on Manitoulin island contain *Pholadomorpha pholadiformis*.

In the Workman Brook section at locality 7 the occurrence of *Catazyga* at the 349, 325, 203, and 167-foot levels is noteworthy. Of the *Catazygas*, those occurring at the 167, 203, and 325-foot levels resemble *erratica* in having a broad shallow depression along the median parts of the brachial valve, but the pedicel valve is not distinctly flattened along the median parts. The *Catazyga* at the 349-foot level, is the species *headi*. If the *Catazyga* at the 325-foot level, where it is associated with *Strophomena planumbona*, were a typical form of *Catazyga headi*, then *Catazyga* here might prove a diagnostic fossil in the Meaford area, the typical *Catazyga headi* suggesting Richmond affinities and the forms resembling *Catazyga erratica* suggesting Lorraine affinities. However, I was unable to recognize the form at the 325-foot level, which I regard as a Waynesville horizon, as distinct from the *Catazygas* at the 203 and 167-foot levels, for which the associated bryozoans appear to suggest Lorraine affinities.

MANITOULIN ISLAND.

SOUTH OF CLAY CLIFF.

Along the eastern margin of Manitoulin island (Figure 7, locality 8), at Clay cliff, 3 miles north of Wekwemikongsing, the richly fossiliferous Waynesville beds are well exposed far above the level of the lake and the Waynesville rubble covers the entire underlying slope as far as the margin of the lake (see pages 124-126). About a quarter of a mile south of the high Waynesville cliffs there is a much lower abrupt exposure, 30 feet

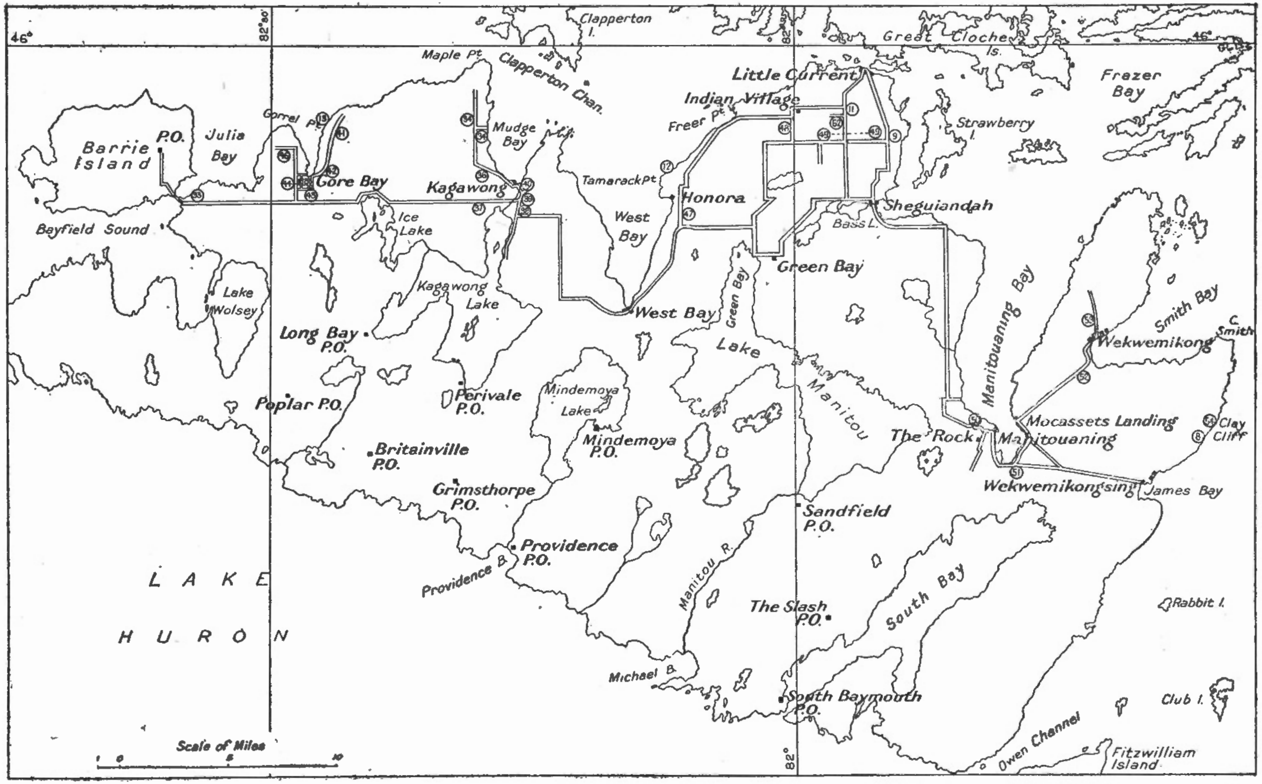

Figure 7. Portion of Manitoulin island showing fossil localities.

in height, in which the prevailing clays are interbedded with siliceous limestone layers, some of which weather into strata resembling the so-called Lorraine sandstones. Here *Plectambonites sericeus*, a small *Rafinesquina*, *Hebertella occidentalis*, *Dalmanella*, *Zygospira modesta*, *Cyrtolites carinatus*, *Ctenodonta* cf. *filistriata*, *Lophospira tropidophora*, *Cornulites*, *Pterinea demissa*, and *Calymene* are found.

From this locality, Dr. Ulrich identified the following species of bryozoans:

	Vertical range at Cincinnati.
Arthropora sp.	
Bythopora dendrina	Upper Fairmount.
Dekayia pelliculata	Upper Fairmount.

On the basis of the bryozoans here collected, Dr. E. O. Ulrich refers these strata to the Maysville, somewhere near the Bellevue bed. Apparently two horizons are present, since among another series of bryozoans collected at the same locality he identified:

	Vertical range at Cincinnati.
Amplexopora persimilis	Lower Eden.
Arthropora sp.	
Hallopora communis	All Eden.
Hallopora sigillarioides	All Eden.
Coeloclema commune	All Eden.
Dekayella ulrichi	All Eden.
Eridotrypa sp.	
Stigmatella sp. cf. *clavis*	Eden.

This confusion of evidence apparently suggests the presence of two formations within the short vertical range of 30 feet, but no lithological changes indicating a break were noted. Of course, this part of the section requires detailed study.

Going half a mile southward along the shore toward Wekwemikongsing, the horizons intervening between this bryozoan zone and the base of the Waynesville are exposed, since the dip of the rock is southward. The upper part of this intervening zone includes fine-grained, arenaceous limestones which have a strong resemblance lithologically to the Lorraine of New York. In these limestones *Pholadomorpha pholadiformis* and a form of *Modiolopsis* resembling *concentrica* occur associated with *Byssonychia radiata*, *Pterinea demissa*, *Lyrodesma poststriatum*, *Clidophorus planulatus*, a large *Ctenodonta* belonging to the *pectunculoides* group, *Cyrtolites ornatus*, and a graptolite identified by Dr. Ruedemann as *Diplograptus foliaceus-vespertinus*. The peculiar dumb-bell impression, described by Billings as *Arthraria*, is represented by specimens about 4 inches in length.

This is one of the best collecting grounds for the *Pholadomorpha* zone fauna on Manitoulin island, although excellent specimens occur also in the talus dropping from the cliffs at Gorrel point, 2 miles northeast of Gore bay.

SHEGUIANDAH ROAD, 3 MILES SOUTH OF LITTLE CURRENT.

The Collingwood black shales merge so gradually into the overlying softer, more argillaceous, and lighter coloured shales, on Manitoulin island, that it is difficult to determine exactly where the line at the base of the Eden is to be drawn. This difficulty is increased by the great scarcity of fossils, at least of diagnostic fossils, near the supposed base of the Eden, on Manitoulin island and along the southern side of Georgian bay.

The richly fossiliferous zones of the Eden south of Little Current occur fully 100 feet above the typical Collingwood shales. To Dr. Ulrich, Dr. Bassler, and Prof. Nickles the bryozoans collected in these Eden zones on Manitoulin suggested the presence of the upper part of the Economy or the lower part of the middle or Southgate divisions on the Eden. The Eden fauna is not known west of Lake Huron, but it is present around Toronto, and appears to be present also in the lower half of the Lorraine, below the Pulaski zone, east of Lake Ontario, in New York, and in the lower parts of the so-called Lorraine in the eastern part of Canada, east of the Frontenac axis. It is so sparingly represented in Canadian areas that it must have been a southern invasion there from the areas surrounding Cincinnati.

Within the eastern limits of Little Current, on Manitoulin island, the base of the Collingwood shale is exposed near the upper margin of the hill and black shale exposures occur also on the hill tops in the western part of the town. Various exposures of black shale are seen along the lake road from Little Current to Sheguiandah. About $2\frac{1}{2}$ miles from Little Current, the road turns directly southward, and at this point the shale becomes less black in colour, does not split so readily into large thin sheets, but is more likely to break into small angular fragments, apparently much more argillaceous than the underlying Collingwood shale. The top of the Collingwood shale is placed about 200 yards south of the bend in the road, and here occur the last specimens of *Triarthrus becki*. Above this horizon (locality No. 9, Figure 7) *Leptobolus insignis*, *Orthoceras*, and a small *Primitia* are more or less common for a vertical distance of 33 feet. *Dalmanella* comes in at 26 feet from the base, and becomes common at 37 feet, and, associated with a *Diplograptus* near *peosta*, probably a new species, continues to 33 feet above the *Triarthrus* horizon. Here the first trace of crinoidal limestone is found. Up to the 70-foot level, limestone layers are scarce, and they do not become common until the 102-foot level is reached. Between 102 and 107 feet above the *Triarthrus* horizon, thin limestone layers are abundant and are very fossiliferous. Bryozoan fragments are common. The following species were identified by Dr. Ulrich, Dr. Bassler, and Prof. Nickles, having been submitted to them conjointly:

Amplexopora persimilis.
Hallopora sigillarioides.
Coeloclema commune.
Perenopora vera.
Stigmatella clavis.
Hemiphragma whitfieldi.
Arthropora cleavelandi.

This evidently is the same fauna as that found immediately north of Clay cliff, nearly 3 miles north of Wekwemikongsing, along the eastern shore of Manitoulin island. It apparently is a middle Eden fauna. *Dalmanella* is abundant and rather large. *Byssonychia vera* is not rare. A small *Calymene* is present. The exposure is at the top of Burnett hill, 3 miles south of Little Current.

A short distance southward, there is a road crossing, and the remainder of the section here described lies along the crossroad, westward between localities 9, 45, and 49 in Figure 7. Owing to the low gradient, the Locke level measurements are of little value. Rocks lithologically resembling the Lorraine make their appearance at the 158-foot level; here *Rafinesquina alternata* and *Byssonychia radiata* are found. From the 180-foot level, the following bryozoans were identified by Dr. Ulrich:

Arthropora sp.	
Bythopora dendrina..........	Upper Fairmount and Corryville at Cincinnati.
Bythopora gracilis...........	Upper Fairmount and higher in the Maysville at Cincinnati.

Immediately above, at the 183-foot level, a specimen of *Pholadomorpha pholadiformis* was found in rock evidently belonging to the same stratigraphic unit as the bryozoans cited above. No other exposures are seen until the lower part of the richly fossiliferous Waynesville member of the Richmond is reached near the road from Little Current to Bass lake, at 278 feet above the *Triarthrus becki* horizon.

The association of *Pholadomorpha pholadiformis* with bryozoans suggesting a much older age than the Richmond is noteworthy. Since both of the associated forms of *Bythopora* range upward from the upper Fairmount in the Maysville at Cincinnati, their testimony does not differ greatly from that given by the bryozoans along Workman brook, which suggest a horizon for the *Pholadomorpha* zone corresponding to the lowest part of the Bellevue.

The following are the details of the section referred to above, given in descending order:

	Thickness feet.	Total thickness.
Top of argillaceous limestone with *Streptelasma* and *Strophomena sulcata*. This part of the section belongs to the *Waynesville division of the Richmond*, an unknown distance above its base. (For overlying strata see page 117 of this report). The exposures are immediately east of the road from Little Current to the middle of Bass lake, in lot 5 in concession IV...............		278½
Interval. This interval was measured along too low and long a gradient to have value......................	95	278½
Thin horizon with *Pholadomorpha pholadiformis*..........	..	..
Interval..	2	183½

	Thickness feet.	Total thickness.
Thin horizon with *Bythopora gracilis* and *dendrina*........	..	...
Interval..	23	181½
Thin horizon in Lorraine-like strata with *Rafinesquina alternata* and *Byssonychia radiata*.......................	..	...
Interval..	25	158½
Clay shale and sandstone...............................	5½	133½
Sandstone layers with large *Dalmanella* in the more calcareous layers..	5	128
Exposures poor...	10	123
The base of these exposures occurs at the intersection of the Sheguiandah road with the road between lots 10 and 11.		
Not exposed..	6	113
Eden limestone layers including the following bryozoans, determined by Ulrich: *Amplexopora persimilis, Hallopora sigillarioides, Coeloclema commune, Hemiphragma whitfieldi, Perenopora vera,* and *Stigmatella clavis* or *nana,* and a rather large *Dalmanella, Byssonychia vera, Cyrtolites carinatus, Sinuites cancellata, Calymene granulosa*	5	107
Clay shale with very little interbedded limestone..........	59	102
First trace of limestone, crinoidal, only a lens an inch thick and a few feet long, occurs at base of this interval......	..	...
Dalmanella, Diplograptus peosta........................	5½	43
An unknown small rhynchonelloid, same species as at Tamarack point, occurs at the base of this interval....	..	...
Diplograptus peosta, Dalmanella, Leptobolus, and *Bythocypris*	5½	37
Dalmanella, Leptobolus, Orthoceras, Bythocypris in dark and fairly fissile shale................................	5½	32
Leptobolus...	5½	26½
Leptobolus, Orthoceras, and *Bythocypris*	4	21
Less fissile dark shale..................................	7	17
Diplograptus peosta, Leptobolus, Orthoceras, Triarthrus becki, 200 yards south of bend in road....................	1	10
Black shale, greyer and less fissile than the underlying Collingwood shale................................	9	9
Collingwood shale......................................	..	0

In this section, only a 5-foot zone in which Eden clay is interbedded with richly fossiliferous limestones, is present. The underlying clays, greenish and softer above, and darker and more fissile below, have a total thickness of about 100 feet. These lower clays are also referred to the Eden section, but upon very little evidence. Only the lower half of these clays is fossiliferous, these fossils are confined to few species, and these species are not necessarily of Eden age. The interval between the exposed 5-foot section of Eden limestones at the top of the so-called Eden, and the lowest recognized Richmond strata is 170 feet; but this interval probably includes additional Eden strata at the base and undoubtedly includes additional Richmond strata at the top. How much of this part of the intervening section may be included in the Maysville is unknown at present.

BASS LAKE ROAD, SOUTH OF LITTLE CURRENT.

The direct road to the middle part of Bass lake goes from Little Current at first southwestward and then southward, reaching McLean hill about 1½ miles from the town. The road to Honora and West Bay turns off at the foot of the hill, and from this road corner southward (locality No. 11, Figure 7) there is a continuous exposure of clay shale for a vertical distance of 82 feet. From this point to the 100-foot level, thin layers of limestone are interbedded in the clay, and in these limestones occur the same Eden bryozoans as those listed from along the Sheguiandah road. Above this level, for some distance, the hill-side is covered by a talus of sliding material.

At the 156-foot level there is a limestone layer about one foot thick, forming a rather conspicuous outcrop along the winding road. From the exposures between the 156 and 145-foot layers, Dr. Ulrich identified:

Arthropora sp.
Bythopora dendrina.
Bythopora gracilis.

The last two species were identified also between the 145 and 136-foot levels. This evidently is the same fauna as that collected west of the Sheguiandah road, about 70 feet above the Eden bryozoan zone in the section described in the preceding pages. To Dr. Ulrich these forms resembled most those found at the top of the Fairmount member of the Maysville.

The form of *Modiolopsis* resembling *concentrica* occurs at the 157-foot level. A shallow road side spring occurs at the 168-foot level. Between this level and the 173-foot level, this *Modiolopsis* is rather common in loose slabs that have come a short distance down the hill-side. The slabs have an appearance like that of the Lorraine, and continue rather plentifully up to the 182-foot level. These Lorraine slabs are common in the talus covering the lower parts of the hill, and contain *Rafinesquina alternata*, *Pholadomorpha pholadiformis*, *Modiolopsis* of *concentrica* group, *Pterinea demissa*, and *Cyrtolites ornatus*. The base of the Waynesville is not well exposed, but belongs at about the 215-foot level.

The following are the details of this section along the road from Little Current to the middle of Bass lake, at McLean hill, measured in ascending order.

	Thickness feet.	Total thickness.
Strata regarded as the base of the known *Waynesville division of the Richmond*, and as probably the horizon for *Hebertella insculpta*, which is found only in loose blocks below this level. (For description of overlying strata see page 118 of this report).		
Interval	27½	215
Thin horizon with *Trematis* loose	..	...
Interval	5½	187½
Lorraine-like sandy limestone. At the bottom of this interval occurs a shallow spring along the road where it ascends the hill in a southwesterly direction. *Modiolopsis concentrica* occurs within 5 feet both above and below this spring	14	182
Lorraine-like sandy limestones	11	168
Thin horizon with *Modiolopsis* resembling *concentrica*	..	...
Highest limestone with *Dalmanella*	1	157
Interval with *Bythopora dendrina* and *Bythopora gracilis*	11	156
Interval	11	145
Interval with loose slabs of Lorraine-like looking siliceous limestones containing *Rafinesquina alternata* 1½ inches long, *Modiolopsis concentrica*, *Pterinea demissa*, *Cyrtolites ornatus*	22	134
Interval	11	112
Clay with thin limestone layers containing *Hallopora onealli*, *Dalmanella* and regarded as equivalent to the Eden limestones in the Sheguiandah road section	18½	101
The thickness of the overlying Eden limestone section has not been accurately determined.		
Clay shale	82½	0
Where Honora road turns off westward from road to middle of Bass lake.		

In this section there is apparently an interval of 114 feet which might be referred to the Maysville. Although very uncertain, this estimate, made along a steeper gradient, probably is very much nearer the truth than the estimate of something less than 170 feet, as made from the previously described section along the Sheguiandah road between lots 10 and 11 in concession XI, and between concessions IV and V farther westward.

An estimate of 110 feet for the Eden, and 110 feet for the Maysville, probably would not be far from the facts.

The Eden limestones are well exposed also 1½ miles north of Sheguiandah, where the road to Little Current runs in an east and west direction. A mile north of Sheguiandah, the unfossiliferous clay shales beneath the Eden limestones are well exposed.

INDIAN VILLAGE, SOUTHWEST OF LITTLE CURRENT.

Slabs of rock belonging to the Maysville formation, including *Modiolopsis concentrica*, are found also where the road to Honora turns westward from the north and south road passing between lots 15 and 16, west of the Indian village, 3½ miles southwest of Little Current (locality No. 48, Figure 7). Near the foot of the hill, immediately south of this road corner, clay and sandy limestone, with bryozoans, occur. The road corner is 137 feet below the top of the solid limestone which contains *Calapoecia* and *Columnaria* along its upper surface, and which is regarded as belonging just beneath the Gore Bay *Columnaria* horizon (page 99). The exposures are too poor to be of value for getting a good section here.

TAMARACK POINT.

The fossiliferous Eden limestones are well exposed just above lake level along the eastern shore of Tamarack point (locality No. 12, Figure 7). At this locality various bryozoans were collected which Ulrich identified as the following Eden species:

Amplexopora persimilis.
Arthropora cleavelandi.
Aspidopora cf. *areolata.*
Bythopora arctipora.
Hallopora sigillarioides.
Dekayella ulrichi.
Perenopora vera.
Stigmatella nana.
Hormotoma gracilis-angustata.
Sinuites cancellata.
Lepidocoleus jamesi.
Primitia centralis.

GORREL POINT, NORTHEAST OF GORE BAY.

From the village of Gore Bay, Manitoulin island, the road along the top of the cliff leads northeast to the line between concessions XIV and XV, and then turns abruptly eastward. A short distance south of this turn, a path descends the bluff, very steep for about 10 feet, and then at an easy grade for the remainder of the way to the lake. It ends at the northern end of a long stretch of high clay banks. The clay banks here consist of clay shales containing numerous graptolites identified by Dr. Ruedemann as *Diplograptus foliaceus-vespertinus*, and some of the fine-grained siliceous limestone slabs which have slipped down the steep hills contain *Pholadomorpha pholadiformis* and a *Modiolopsis* resembling *concentrica*. It might be possible to get some estimate of the thickness of the Maysville formation here.

The graptolite-bearing clay shales are overlaid by a section in which thin limestone layers full of bryozoans, and other fossils, are interbedded with the shales.

At one point, southward, these limestones form a small promontory, marked on the Geological Map No. 605, as Gorrel point (locality No. 13, Figure 7). From these limestones, Dr. Ulrich, Dr. Bassler, and Prof. Nickles identified the following bryozoans and ostracods:

Arthropora cleavelandi.
Bythopora arctipora.
Bythocypris cylindrica.
Jonesella crepidiformis.
Primitia centralis.

This is evidently an Eden fauna, and stratigraphically it occupies the same position as the bryozoan horizons at Tamarack point, south of Little Current, along the Sheguiandah road, and one-fourth of a mile south of Clay cliff in the Cape Smith area. From some higher level, at Gorrel point, slabs containing *Pholadomorpha pholadiformis* have fallen down the cliff.

The occurrence of *Diplograptus foliaceus-vespertinus* in the underlying clay shales is of interest since it indicates the presence of this species in the Eden as well as in the *Pholadodomorpha* zone of the Maysville. It will be remembered that this mutation was listed from the *Pholadomorpha* zone along the shore between Clay cliff and Wekwemikongsing.

The *Diplograptus* resembling *peosta*, listed from the lower part of the clay shales along the Sheguiandah road, was identified by Dr. Ruedemann also from the *Trinucleus horizon* on the southern shore of Georgian bay, one mile east of Fields, a station west of Collingwood. Along Workman brook, east of Meaford, this *Trinucleus* horizon occurs 25 feet above the lake and here is regarded as lower Eden.

GENERAL OBSERVATIONS ON THE LORRAINE OF ONTARIO AND QUEBEC.

From the preceding observations it becomes evident that the richly fossiliferous Waynesville horizons of both Quebec and Ontario are underlaid by horizons, lithologically resembling the Pulaski part of the Lorraine, and containing in the upper parts, at least, the lamellibranch *Pholadomorpha pholadiformis*. In addition to this a *Modiolopsis* resembling *concentrica* frequently is present. *Catazyga* is abundant at various horizons in this Lorraine-like zone in the province of Quebec and in the eastern part of Ontario. It has a considerable vertical distribution also in the vicinity of Toronto, but near Meaford it is confined to four thin layers, and in one of these it is very rare. On Manitoulin it is unknown in the Lorraine-like strata, occurring only at the base of those richly fossiliferous limestones which here are referred definitely to the Waynesville member of the Richmond. *Pterinea demissa*, *Byssonychia radiata*, *Lyrodesma poststriatum*, and *Cyrtolites ornatus* are comparatively common, but occur both in Richmond and Lorraine rocks on Manitoulin island. Associated with this *Pholadomorpha pholadiformis* and also in the immediately underlying horizons there are bryozoans ranging between the top of the Fairmount and the base of the ordinary Bellevue in typical Cincinnatian areas. In Ontario the *Pholadomorpha* zone shows some affinity, therefore, with the middle part of the Maysville formation, as exposed in Cincinnatian areas. For local purposes, the term *Wekwemikongsing* beds has been proposed for this part of the Ordovician rocks of western Ontario.

Below this *Pholadomorpha* zone comes a section of thin limestones interbedded with clay, both containing a fauna which may be correlated with the Eden of Cincinnatian areas. Along Workman brook, east of Meaford, and also at various localities near Toronto, there is a considerable thickness of similar strata beneath the *Pholadomorpha* zone which can be assigned to the Eden formation.

It is not so certain whether the clay shales underlying the richly fossiliferous Eden bryozoan horizons on Manitoulin island are to be correlated with the Eden. These lower clay shales contain a very noncommittal fauna apparently, but judging from the exposures at Meaford they may be included in the Eden at least tentatively. For these strata, extending from the top of the thin limestone section, containing an abundance of Eden bryozoans, down to the top of the black Collingwood shales, containing *Triarthrus*, the local name *Sheguiandah* beds, has been proposed.

Any further subdivision must be based upon a much fuller knowledge of the contained fauna than we now possess.

When these upper Ordovician exposures in southern and western Ontario are compared with the Eden and Maysville of Cincinnatian areas, great gaps will be noticed. Most of the Eden forms so far identified from Ontario, have a considerable vertical range in Cincinnatian localities, but such evidence as they offer is in favour of a middle Eden age. There is no evidence so far at least of the presence of the lower strata included in the Eden at Cincinnati. While strata from the lower or Fairview division of the Maysville may be present in Ontario, the evidence so far favours the view that the Fairview here is absent and that the upper Lorraine horizons of Ontario wedge in between the Fairmount and Bellevue divisions of the typical Maysville in Cincinnatian areas. No one acquainted with the faunas of the Cincinnatian rocks can fail to be impressed with the general absence of many of the most familiar upper and lower Maysville brachiopoda, bryozoans, and other forms of Cincinnatian areas in the approximately corresponding strata of Ontario. Note for instance the general absence of such familiar forms as *Platystrophia laticosta*, *Pl. ponderosa*, *Plectorthis plicatella*, *Pl. fissicosta*, and of species of *Strophomena* of the *planoconvexa* group.

The epicontinental seas within which the Ordovician strata were deposited, evidently were much more basin-like in character than formerly supposed. The record preserved is much more fragmentary than formerly suspected, and is broken often at much more frequent intervals than formerly would have been admitted. Under these conditions exact correlation usually is possible only within very narrow limits. The readiness with which the minor formation names were formerly carried over wide expanses of territory is fast disappearing. While this may prove an inconvenience to the elementary student, it is in the interest of the advance of exact science.

It is doubtful whether the use of the term Lorraine in connexion with these upper Ordovician Ontario strata can be of great value. There are too many differences and too few resemblances between the Lorraine faunas of Ontario and the typical Lorraine fauna of New York.

The use of the terms Maysville and Eden for the strata exposed in Ontario eventually may prove much more appropriate, since there appears to be a fair prospect of securing sufficient bryozoans from the supposed Lorraine strata of Ontario to permit their correlation with the Maysville and Eden formations of Ohio, Indiana, and Kentucky, at least in a general way. How sharply it will be possible to discriminate between the Maysville and Eden in the various Ontario sections can be determined only by further study. However, numerous exposures occur within easy reach of Toronto, and eventually no doubt a much greater mass of evidence will become available.

CHAPTER III.

RICHMOND FORMATION IN ONTARIO AND QUEBEC.

Waynesville and Whitewater.

If the *Pholadomorpha pholadiformis* horizons are to be regarded as of lower Bellevue or middle Maysville age, then the immediately overlying richly fossiliferous strata, which are of upper Waynesville age, must be regarded as the lowest of the Ohio Richmond beds found in the provinces of Ontario and Quebec.

The Arnheim and lower part of the Waynesville member of the Ohio Richmond are absent. The upper part of the Waynesville, however, is widely distributed between Manitoulin island in the northern part of Lake Huron and the vicinity of Toronto, north of Lake Ontario. This Waynesville fauna is not found west of Lake Huron, and the Waynesville content becomes less in the approximately equivalent strata in the eastern part of Ontario, east of the Frontenac axis. The lower Richmond fauna of Ontario appears to be a southern invasion from the areas around Cincinnati. Mingled with the Waynesville forms, however, are other species which probably are of northern origin.

The typical Whitewater and Saluda fauna of Ohio, Indiana, and Kentucky is so sparingly represented in Canadian areas, even in the region extending from Manitoulin island to the vicinity of Toronto, at least as far as the number of characteristic species is concerned, that it seems much more probable that certain species in the Saluda fauna entered the Richmond areas around Cincinnati from the north than that they entered Canadian areas from the south. These forms include such species as *Beatricea*, *Tetradium*, *Columnaria*, and *Calapoecia*. In general, corals and other massive lime-secreting organisms are to be regarded as characteristic of southern faunas, and suggest Gulf of Mexico rather than Boreal invasions; however, the wide dispersion of the fossils here mentioned and their large and vigorous growth northward, during Richmond times, suggests the possibility of a different centre of distribution during the deposition of the Richmond.

That the general Richmond fauna of Ontario and Quebec did not enter by the St. Lawrence channel is suggested by the very different combination of faunas found in the Richmond of Anticosti island.

WESTERN ONTARIO.

MANITOULIN ISLAND.

Everywhere on Manitoulin island (Figure 7) the richly fossiliferous Waynesville zone begins with a horizon in which the typical Richmond fossil, *Hebertella insculpta*, is more or less common. It frequently is associated with *Catazyga headi*, a form ranging far below the typical Richmond in the province of Quebec, but whose value as a diagnostic fossil depends on the fact that on Manitoulin island no form of *Catazyga* has been found in strata underlying the *Hebertella insculpta* horizon. *Hebertella insculpta* occurs at the base of the richly fossiliferous Waynesville horizon, also 6 miles northwest of Meaford, along the road following the western side of Nottawasaga bay. This locality lies 85 miles southeast of Manitoulin island. No specimens of *Catazyga headi* were noticed here; however, 3 miles southeast of Meaford, on Workman brook, *Catazyga headi*, associated with *Strophomena planumbona*, occurs at the base of the richly fossiliferous Waynesville, but without the presence of *Hebertella insculpta*, and several horizons containing *Catazyga* occur at still lower levels at this locality.

Neither *Hebertella insculpta* nor *Catazyga headi* have been discovered so far at the base of the richly fossiliferous Richmond at the various localities west of Toronto, along the northern shores of Lake Ontario, although a form of *Catazyga* occurs a considerable distance below the top of the Lorraine-like arenaceous limestones, containing *Pholadomorpha pholadiformis*, a mile down stream from the railway bridge southeast of Streetsville. *Catazyga headi* was listed by Spencer, in the Canadian Naturalist, in 1882, from the material found in the old lake beaches at the west end of Lake Ontario, near Hamilton, but the exact horizon from which these drift specimens of *Catazyga* came is unknown.

Catazyga headi is abundantly represented at the base of the richly fossiliferous Waynesville in the extreme eastern part of Ontario, east of Ottawa, and also at various localities in the province of Quebec. In the latter province, it is abundant at this horizon along the Nicolet river, 18 miles south of Three Rivers. It occurs also among the Waynesville material on Snake island, in Lake St. John, about 125 miles north of Quebec. However, at these eastern localities, at Ottawa and in the province of Quebec, *Catazyga headi* ranges far below the typical Richmond, into strata regarded as Lorraine, as may be seen in the Nicolet River section. *Hebertella insculpta*, a characteristic Richmond fossil, however, is unknown between Ottawa, Three Rivers, and Lake St. John although the fossil which is commonly associated with it in the Lake Huron areas, *Catazyga headi*, occurs throughout this area and as far east as Anticosti island, about 370 miles farther eastward than Lake St. John.

Associated with the *Hebertella insculpta* and *Catazyga headi* at the base of the richly fossilferous Waynesville, on Manitoulin island, are the following species:

Streptelasma rusticum.
Columnaria alveolata.
Protarea papillata.
Calapoecia huronensis.
Rhombotrypa quadrata.
Hebertella occidentalis.
Platystrophia clarksvillensis.
Strophomena huronensis.
Rafinesquina alternata, very flat.
Plectambonites sericeus.
Rhynchotrema perlamellosum.
Zygospira modesta.
Pterinea demissa.
Cyclonema bilix.

These associated fossils, however, are not confined to the *Hebertella insculpta* and *Catazyga headi* horizon, but range upward for variable distances into the overlying part of the Waynesville, some extending their range even for considerable distances into those Richmond beds which overlie the Waynesville member.

The lower or Waynesville part of the Richmond, on Manitoulin island, is by far the richest of the Richmond deposits 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 1 to 3 feet thick, containing *Columnaria alveolata* and *Calapoecia huronensis*, frequently is found between 35 and 45 feet above the base of the *Hebertella insculpta* horizon. For this coral reef the name Gore Bay reef has been proposed. This reef serves locally as a convenient horizon marker.

It has been found that, while most of the fossils which begin their range at or near the *Hebertella insculpta* horizon reach the Gore Bay *Columnaria* reef, many of these species do not extend their range beyond this horizon. Among the latter may be mentioned: *Protarea papillata, Constellaria polystomella, Rhombotrypa quadrata, Crania scabiosa, Rafinesquina alternata* with very flat form, *Plectambonites sericeus, Strophomena huronensis, Str. nutans, Str. neglecta, Str. planumbona, Str. sulcata, Platystrophia clarksvillensis, Zygospira kentuckiensis, Helicotoma brocki, Spyroceras hammelli,* and various gasteropods and pelecypods not identified. A scrutiny of this list suggests the presence here of an upper Waynesville fauna. Such forms as *Hebertella insculpta*, and *Catazyga headi* make their first appearance in Ohio, Indiana, and Kentucky, at the base of the upper or Blanchester division of the Waynesville. *Strophomena nutans, Strophomena neglecta,* and *Zygospira kentuckiensis* are first seen a short distance above the base of Blanchester division.

Among the various species, on Manitoulin island, which begin their range in that part of the Richmond section which underlies the Gore Bay *Columnaria* reef, but continue also above the latter, may be mentioned: *Stromatocerium huronense, Girvanella richmondensis, Tetradium huronense, Streptelasma rusticum, Columnaria alveolata, Calapoecia huronensis, Hebertella occidentalis, Rhynchotrema perlamellosum, Zygospira modesta,* and various gasteropoda and pelecypoda not identified. Apparently these are all forms which managed to continue existence in muddy waters. They are such forms as frequently are found in argillaceous and arenaceous deposits. In Ohio, Indiana, and

Kentucky, they frequently are found in muddy and sandy strata in which all other species have become rare.

Columnaria alveolata and *Calapoecia huronensis* have a considerable vertical range, but the horizon at which they occur in sufficient abundance to form the conspicuous Gore Bay reef evidently is an important palæontological horizon, since it marks the disappearance of a considerable part of the underlying Richmond fauna. Moreover, it appears to be 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. All of these species from above the coral reef apparently are such forms as could live in rough, muddy waters.

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

At one locality, on an east and west road 3 miles south of Little Current, *Strophomena vetusta* and *Ceraurinus marginatus* occur just above this Gore Bay reef. In Ohio, *Strophomena vetusta* is represented in the Blanchester division of the Waynesville by an early form, but the range of the more typical specimens begins in the Liberty and extends into the Whitewater. *Ceraurinus marginatus* is unknown outside of Manitoulin, but the closely related species *Ceraurinus meekanus*, occurs in the Whitewater of Indiana and Ohio. At Manitowaning, at the Clay cliff north of Wekwemikongsing, and on Rabbit and Club islands, east of Manitoulin island, a species of *Beatricea*, usually referable to *undulata*, occurs in strata which appear to belong above the Gore Bay reef horizon. In Indiana and Kentucky *Beatricea* is especially common in the Saluda division of the Richmond, and in the immediately underlying beds which carry a Whitewater fauna. In Indiana, *Columnaria alveolata* and *Calapoecia huronensis* also are more abundant at the base of the Saluda than at any other horizon.

While the exact correlation of these strata on Manitoulin island, above the Gore Bay reef, with any of the divisions of the Richmond in Ohio, Indiana, and Kentucky, must remain more or less in doubt for the present, until more information can be secured, it seems quite evident that their horizon is distinctly above that of the Waynesville of Ohio. Provisionally they may be referred to the Whitewater, possibly to that part of the Whitewater which in southern Indiana is quite arenaceous, and, excepting at a few horizons, is quite unfossiliferous. For this part of the Whitewater, the term *Saluda* was proposed some years ago, and while the reference of the strata immediately above the Gore Bay reef, on Manitoulin island, to the Saluda may be rather lithological than palæontological, this reference accords most nearly with our present state of knowledge on the subject.

It may be stated that a day's examination of the coral zone and overlying strata west of the bridge north of Streetsville junction convinced Dr. Ulrich that the general facies of the fauna suggested Whitewater affinities. The coral reef at Streetsville appears to correspond stratigraphically to the Gore Bay coral reef on Manitoulin island.

Another conspicuous zone, between Gore Bay, Kagawong, Honora, and Little Current, on Manitoulin island, is a *Stromatocerium huronense* reef which usually is found between 25 and 30 feet above the *Columnaria* reef, but which occurs farther eastward at greater intervals. It probably would be more accurate to say that this *Stromatocerium* forms reefs at various horizons, but that these various horizons occur sufficiently near each other within the same vertical zone to make their reference to the same general reef possible. Since this *Stromatocerium* reef is well exposed at various localities in the vicinity of Mudge bay, at the head of which the village Kagawong is situated, the name *Mudge Bay* reef will be suitable for it. At this Mudge Bay reef horizon, *Tetradium* often is common, sometimes in fact more common than the *Stromatocerium*. It is the interval between the Gore Bay and Mudge Bay reefs which usually presents such a meagre fauna, as already stated, although locally, especially near the eastern end of the island, the lower parts of this interval appear to be richly fossiliferous.

Immediately above the Mudge Bay *Stromatocerium* reef, at Kagawong and Gore Bay, a rich pelecypod, gasteropod, and ostracod fauna, but not consisting of many species, comes in. Among the pelecypods, *Ortonella hainesi* suggests the Whitewater age of the strata involved. Near Weisburg, in Indiana, *Ortonella hainesi* occurs in the Whitewater strata immediately underlying the Saluda, the latter being probably only a local arenaceous phase of the Whitewater. Among the ostracods, *Leperditia caecigena* and *Primitia lativia* also suggest the Saluda age of the Manitoulin strata here considered, but in Ohio and Indiana they appear to range from the Saluda to the top of the Richmond. If the Saluda in southern Indiana be regarded as merely a local arenaceous phase of the Whitewater as typically exposed in the more northern parts of that state, the reference of certain fossils in the Manitoulin Island section to the Saluda, and of other fossils in the same strata to the Whitewater will be seen to be in substantial agreement.

Among other fossils occurring above the Mudge Bay *Stromatocerium* reef are *Cyrtodonta ponderosa*, *Ctenodonta iphigenia*, a large *Archinacella*, and various species of *Lophospira*. Among those species which continue their range upward, from below the Mudge Bay reef, are *Girvanella richmondensis*, *Tetradium huronense*, *Hebertella occidentalis*, *Zygospira modesta*, *Byssonychia radiata*, and *Pterinea demissa*. All of these are forms which are capable of continuing their existence in muddy waters, judging from the frequency with which they are found in dolomite, fine-grained sandstones, and indurated clays.

The total thickness of this upper part of the Richmond, from the Mudge Bay *Stromatocerium* reef to the base of the Manitoulin dolomite, varies apparently from 45 to 60 feet, at most localities on Manitoulin island.

Although the Gore Bay and Mudge Bay reefs can be traced from west of Gore Bay to the vicinity of Little Current, their exact equivalents farther westward at Manitowaning, and thence eastward to Wekwemikong and Clay cliff, cannot be determined so readily. Perhaps this is due to the fact that at these eastern localities coral reefs occur at more than two horizons so that it is difficult at present to decide which of these eastern reefs are to be correlated with those farther west. Possibly none of the eastern reefs coincide exactly with the latter.

For instance, at Manitowaning, *Hebertella insculpta* is exposed within 6 feet of the lake level. Occasional specimens of *Columnaria* occur even at this low level, and continue thence upward. The first specimen of *Tetradium* was noted 21 feet above the level of the lake, and at 26 feet *Calapoecia huronensis* is common, associated with some *Columnaria* and *Tetradium.* Between 49 and 71 feet, *Beatricea undulata* comes in at various horizons, associated with *Cyrtodonta ponderosa*, *Liospira helena*, and other forms which in the vicinity of Kagawong and Gore Bay are found above the Mudge Bay *Stromatocerium* reef. Corals are not common until the level of 74 feet above the lake is reached, where *Columnaria* is common, and is associated with smaller numbers of *Calapoecia* and *Tetradium.* At 100 feet above the lake is the top of a massive *Stromatocerium* reef, for which the name *Manitowaning* reef has been proposed. The question now arises: Which of these reefs corresponds to the Gore Bay reef? Judging from the fossils in the zones above and below, this is the *Calapoecia* horizon, 26 feet above the level of the lake. If *Beatricea* suggests the Saluda horizon, its occurrence above the *Calapoecia* horizon in the eastern part of Manitoulin island would be in agreement with that fact.

Which of the Manitowaning coral horizons represents the Mudge Bay *Stromatocerium* horizon? Possibly the *Columnaria* horizon, 74 feet above the level of the lake. If the overlying beds were better exposed it might be possible to verify this correlation since certain characteristic fossils usually occur in the beds above the Mudge Bay reef. Because the Manitowaning *Stromatocerium* reef, 100 feet above the lake, consists of an abundance of *Stromatocerium* and is about the same distance above the *Hebertella insculpta* layer, it does not follow that the Manitowaning reef is identical with the Mudge Bay *Stromatocerium* reef. It is quite certain that different massive growths, including under this term *Stromatocerium*, *Tetradium*, *Calapoecia*, and *Columnaria*, predominated at different localities along the same reef zone, so that *Tetradium* at one locality may be replaced by *Stromatocerium* at another.

At Clay cliff, 3 miles north of Wekwemikongsing, the top of the *Hebertella insculpta* zone is 114 feet above the lake. The thickness of this zone probably is several feet. Thirty feet above this horizon, *Stromatocerium* is very abundant. This has been called the *Cape Smith Stromatocerium* reef. Stratigraphically it appears to correspond with the *Calapoecia* reef at Manitowaning, and with the Gore Bay reef farther westward. This conclusion, however, may be an erroneous one, since southwest of Wekwemikong there is a massive *Stromatocerium* reef overlying 9 feet of strata in the lower half of which *Beatricea undulata*, *Calapoecia huronensis*, *Columnaria alveolata*, *Columnaria calycina*, an abundance of *Tetradium huronense*, *Cyrtodonta ponderosa*, *Ctenodonta iphigenia*, *Liospira helena*, and other fossils occurring above the Mudge Bay *Stromatocerium* reef in the Kagawong and Gore Bay areas, are found.

It evidently is not safe to insist on close correlation between widely distant sections until the faunas have been worked up better. Even at this early stage of investigation, however, it may be asserted that, whenever present, the first conspicuous coral reef, found above the *Hebertella insculpta* horizon, marks the top of the Waynesville phase of the Richmond, on Manitoulin island, and that the immediately overlying strata inaugurate the Saluda or Whitewater part of the Richmond.

From this first conspicuous coral reef upward, as far as the base of the Manitoulin dolomite, all of the section is to be correlated with the Saluda or Whitewater member of the Richmond. At numerous localities on Manitoulin, where the strata between the Mudge Bay *Stromatocerium* reef and the base of the Manitoulin dolomite are well exposed, minute ostracods, including *Leperditia caegigena* and *Primitia lativia*, are common. These characteristic species are especially common in the upper Saluda of southern Indiana and at some localities on Manitoulin island have been found within 2 feet beneath the base of the Manitoulin dolomite, which here forms the lowest member of the Silurian section.

NORTHWEST OF KAGAWONG.

(Locality No. 34, Figure 7.)

About 3½ miles northwest of Kagawong, along the road to Maple point, the base of the Manitoulin (Silurian) dolomite is exposed along the road. Nearby, a small wet weather stream plunges over a falls east of the road, and the Richmond strata are well exposed. The locality is probably near the southeastern corner of lot 6 in concession XV, and here the following section was measured:

	Thickness feet.
Manitoulin dolomite (Silurian) with *Orthis flabellites*	0
Interval, at top of Richmond, poorly exposed	4
Solid limestone with *Tetradium* and *Stromatocerium* common	6½
Solid limestone	10½
Poorly exposed	23
Limestone	1
Long gradient along the road, with no exposures (Road level at top of falls).	32
Solid rock	1½
Conspicuous Gore Bay coral reef, with *Columnaria* and *Calapoecia*	3
Solid limestone, *at top of Waynesville member of Richmond*	19
Limestone	4
Rubbly argillaceous limestone, but presenting too steep a face to expose the fossils well	19
Strata with *Protarea*, *Hebertella insculpta*, and *Strophomena*	2½
Strata with *Protarea papillata*	1½
Base of Richmond section at the falls.	

This section presents the total thickness of the Richmond as at present identified on this part of Manitoulin island. The base is characterized by *Hebertella insculpta*. From this level to the *Columnaria* (Gore Bay) reef, the strata are referred to the upper part of the Waynesville section of Ohio and Indiana. This gives a thickness of 46 feet. The overlying part of the Richmond has a total thickness of 81 feet. It is poorly exposed and contains few fossils excepting at the *Tetradium* reef, near the top. It is referred to the Whitewater including under this term also the Saluda.

A short distance south of the last locality, a road leads off eastward toward the western shore of Mudge bay. Here the following Richmond section is exposed:

	Thickness feet.
Manitoulin dolomite (Silurian) with *Orthis flabellites*, *Rhipidomella hybrida*, and *Dalmanella elegantula*.	
Softer argillaceous limestone at the top of Richmond...............	8
Tetradium reef, not measured separately from the underlying stone..	..
Massive harder limestone.....................................	10
Not exposed..	26
Limestone with bryozoans.....................................	3
Not exposed..	4½
Stromatocerium (Mudge Bay) reef............................	3
Limestone in part, section poorly exposed....................	8½
Not exposed..	24½
Columnaria (Gore Bay) reef, with *Calapoecia*, *Rhynchotrema perlamellosum* and *Platystrophia clarksvillensis*........................	3
Interval *at top of Waynesville member of Richmond*, with argillaceous limestone at the top and softer layers below..................	17
Limestone with *Strophomena*, *Platystrophia clarksvillensis*, and *Streptelasma rusticum*..	5½
Softer argillaceous rock with *Streptelasma rusticum*, *Strophomena*	8

Here 30 feet of rock underlies the Gore Bay *Columnaria* reef, but the *Hebertella insculpta* horizon, belonging immediately beneath the lowest Richmond seen in the preceding section, is not exposed. The overlying part of the Richmond has a total thickness of 90 feet. The *Tetradium* reef at the top corresponds with that in the preceding section, but the *Stromatocerium* (Mudge Bay) reef, 33 feet above the *Columnaria* reef, is not exposed here.

Somewhere near the southeastern corner of lot 6 in concession XII, the *Stromatocerium* (Mudge Bay) reef is seen 58 feet below the Manitoulin dolomite. The reef here has a thickness of 5 feet. The *Tetradium* reef is not exposed.

NORTHWEST OF KAGAWONG.

(Locality No. 36, Figure 7.)

A mile and a half northwest of Kagawong, where the road to Maple point ascends the hill, the following Richmond section is exposed.

	Thickness feet.
Manitoulin dolomite (Silurian)	
Strata at top of Richmond not exposed	60
Solid limestone with *Stromatocerium*, forming reef (Mudge Bay reef)	3
Interval measured along a very long and low gradient	8
Greenish clay and rock similar to that along the road from Kagawong to Providence bay. Fossils rare. *Zygospira modesta*	9
Thin greenish argillaceous shale. Fossils few	4
Columnaria common, associated with *Calapoecia*, *Streptelasma*, and forming the Gore Bay reef. Also *Hebertella occidentalis*, *Platystrophia clarksvillensis*, and *Rhynchotrema perlamellosum*	3
Interval at *top of Waynesville member of Richmond*	5½
Solid limestone with *Columnaria*, *Strophomena*, and *Hebertella occidentalis*	4
Clay and argillaceous limestone, poorly exposed	10
Harder bluish limestone with *Streptelasma* and *Strophomena*	6
Soft argillaceous limestone rubble with *Streptelasma*, *Strophomena*, *Platystrophia clarksvillensis*, and *Rhynchotrema perlamellosum*	8

Here also the base of the known Richmond of Manitoulin island, with *Hebertella insculpta*, is not exposed: 33 feet of the Waynesville division of the Richmond is exposed beneath the Gore Bay *Columnaria* reef, and 87 feet of Richmond rock overlie the Waynesville level. The Mudge Bay *Stromatocerium* reef appears to be only 21 feet above the *Columnaria* reef, but this may be due to the difficulty of getting accurate measurements with a Locke level along a long and very low gradient.

SOUTHWEST OF KAGAWONG.

(*Locality No. 37, Figures 7 and 8.*)

A mile and a half southwest of Kagawong, along the road to Gore Bay, the following section was measured:

	Thickness feet.
Limestone, soft at the base, forming upper part of Manitoulin dolomite (Silurian) exposure	5½
Richly fossiliferous limestone	2½
Thinner bedded limestone at base of Manitoulin dolomite	13½
Upper layers of the Richmond, containing *Rhytimya kagawongensis*, *Leperditia caecigena*, *Bythocypris cylindrica*, and *Primitia lativia*. The thickness of these layers is	3

	Thickness feet.
Not exposed..	46
Thin horizon with bryozoans and a large *Cyrtodonta*	
Strata not exposed..	6
Whitish limestone with *Hebertella occidentalis, Cyrtodonta ponderosa, Ctenodonta iphigenia, Ortonella hainesi,* a large *Archinacella,* and various species of *Lophospira, Cyrtoceras* (*Cyrtorhizoceras?*) *kagawongensis*..	4
Solid limestone with *Stromatocerium* probably representing the Mudge Bay *Stromatocerium* reef of the sections northwest of Kagawong..	4

This places the Mudge Bay *Stromatocerium* reef 59 feet below the base of the Manitoulin dolomite. The richly fossiliferous zone above this *Stromatocerium* reef, and the ostracod horizons just beneath the base of the Manitoulin dolomite are noteworthy.

SOUTH OF KAGAWONG.

(*Locality No. 38, Figure 7.*)

Half a mile south of Kagawong, the road to Providence turns abruptly eastward, toward West or Honora bay. Here the following section is exposed:

	Thickness feet.
Massive limestone with interbedded shaly material containing *Hebertella occidentalis* and *Ctenodonta iphigenia*....................	8
Not exposed..	9
Spirorbis cf. *cincinnatiensis, Rhytimya kagawongensis, Lyrodesma* sp., *Leperditia caecigena, Primitia lativia*........................	5½
Cyrtodonta and *Lophospira*..	5½
Shaly limestone and clay..	4
White limestone with *Cyrtodonta ponderosa, Modiolopsis, Ischyrodonta, Ortonella hainesi, Lophospira, Archinacella, Orthoceras, Hebertella occidentalis,* and bryozoans..................................	9
Mudge Bay *Stromatocerium* reef......................................	4

Here 41 feet of strata, belonging to the Whitewater division of the Richmond, are known above the Mudge Bay *Stromatocerium* reef. The level for the base of the Manitoulin dolomite belongs at least 18 feet above the top of the section. The level for the Gore Bay *Columnaria* reef should be somewhere near the level of the bridge at the mill south of Kagawong, but it is not exposed. It is evident that the ostracods occur here at a very much lower horizon than along the road to Gore Bay, southwest of Kagawong. In fact, they occur at several horizons in different parts of Manitoulin island, indicating a considerable total vertical range. In this connexion, the light green clay and rock fragments, with ostracods, *Leperditia caecigena* and *Primitia lativia*, near lot 23, along the road from Kagawong to West Bay, concession XV, need further examination. Similar light green clay was seen northwest of Kagawong, below the Mudge Bay *Stromatocerium* reef, but the ostracods elsewhere on Manitoulin island occur usually above this reef.

KAGAWONG FALLS.

(*Locality No. 39, Figures 7 and 8.*)

The following section is exposed below the falls at the mill south of Kagawong. It belongs to the Waynesville division of the Richmond.

	Thickness feet.
Top of bluff.	
Interval. The top of *Waynesville member of Richmond* is somewhere within this interval	34
Thin horizon with *Strophomena*	..
Interval	3½
Thin horizon with one *Catazyga*, also several *Strophomena sulcata*	..
Interval	2
Thin horizon with a small specimen of *Calapoecia*, and *Bucania* cf. *capax*	..
Interval	¼
Thin horizon with *Strophomena sulcata*	..
Interval	1
Thin horizon with *Strophomena sulcata* and *Hormotoma*	..
Hebertella insculpta, *Catazyga headi* common at the base, rare above, also *Protarea*	3
Thin horizon with *Vanuxemia*, several	..
Interval	3
Thin horizon with limestone with *Strophomena*	..
Hebertella insculpta in lower half. Also *Streptelasma*. Base of Waynesville member	5½
Clay and a few fine-grained sandy limestone layers	10½

Here the vertical distribution of *Hebertella insculpta* through an interval of 11½ feet should be noted. The total thickness of the known Waynesville is about 20 feet, but there is no doubt that a part of the overlying strata, stratigraphically, also belongs to the Waynesville.

The loose blocks along the creek at the base of the section contain *Columnaria alveolata*, *Plectambonites sericeus*, *Rafinesquina alternata*, a very flat form, *Hebertella occidentalis*, *Rhynchotrema perlamellosum*, *Zygospira modesta*, *Zygospira kentuckiensis*, and *Pterinea demissa*, in addition to the species already mentioned from this locality.

SOUTH END OF KAGAWONG.

(*Locality No. 40, Figure 7.*)

Another exposure of Waynesville rock occurs directly south of the main part of the village, where the road from Kagawong to Gore Bay ascends the hill. Here the following section is exposed:

	Thickness feet.
Argillaceous limestone *near top of Waynesville member of Richmond;* with *Columnaria* rare, also with *Zygospira modesta*	5½
A large nodose branching *Ptilodictya*, accompanying numerous *Hebertella occidentalis*	5½
Streptelasma rusticum and *Strophomena* common	5½
Strophomena rare	5½
Streptelasma, *Plectambonites*, *Strophomena planumbona*, *Str. huronensis*, *Str. nutans*, *Str. sulcata*, *Platystrophia clarksvillensis*, *Zygospira kentuckiensis*, and *Pterinea demissa*	5½
Strophomena few	5½
Rubbly argillaceous rock with *Streptelasma dispandum*, and *Str. rusticum*, *Plectambonites*, *Strophomena neglecta*, *Str. sulcata*, *Cyrtodonta*, *Helicotoma brocki*, rare	5½
Rubble rock without identifiable fossils.	

Here there are evidently 38½ feet of rock belonging to the Waynesville division of the Richmond. The total thickness of this division is probably about 10 feet greater. The basal beds, with *Hebertella insculpta* and *Catazyga headi*, were not noticed.

NORTHEAST OF GORE BAY.

(*Locality No. 41, Figure 7.*)

Northeast of Gore Bay, along the road following the top of the bluff, in concession XIV, the following fossils occur above the *Stromatocerium* reef: *Girvanella richmondensis, Streptelasma rusticum, Hebertella occidentalis, Cyrtodonta ponderosa, Ctenodonta iphigenia*, and *Byssonychia radiata.* It is evident that the *Cyrtodonta* horizon above the Mudge Bay *Stromatocerium* reef is well represented in the area extending from Kagawong to the west of Gore bay. Judging from the fossils, beds equivalent to the *Cyrtodonta* horizon occur also at Clay cliff, on the eastern sides of Cape Smith, on the eastern side of Manitoulin island.

Southeast of the village of Gore Bay, along the road ascending the hill northeastward, toward East Bluff, *Primitia lativia* occurs immediately above the Mudge Bay *Stromatocerium* reef. All of these horizons belong in the Whitewater division of the Waynesville.

SOUTH END OF GORE BAY.

(*Locality No. 43, Figure 7.*)

At the southern end of Gore Bay, is the fairground. Southwest of the fairground, the base of the Manitoulin dolomite is exposed along the brow of the hill. Between these two localities, the following section was estimated, but as there is considerable dip, and the exposures are not continuous, there is opportunity for considerable error.

	Thickness feet.
Manitoulin dolomite (*Silurian*).	
Upper Richmond strata not exposed	25
Solid limestone with a few specimens of *Stromatocerium* near the middle	12
Not exposed well	25
Mudge Bay *Stromatocerium* reef, with a few specimens of *Tetradium*, in front of the fairground	3

The few specimens of *Stromatocerium* about 30 feet above the Mudge Bay *Stromatocerium* reef, may represent the upper *Tetradium* reef, 4 feet below the Manitoulin dolomite, northwest of Kagawong. All of the Richmond exposures at this locality belong to the Whitewater member of the Richmond.

WEST SIDE OF GORE BAY.

(*Locality No. 44, Figure 7.*)

The Gore Bay *Columnaria* reef is well exposed along the brow of the hill west of Gore Bay, but it was impossible to secure a fairly reliable estimate of the interval between the Gore Bay *Columnaria* reef and the Mudge Bay *Stromatocerium* reef. It is assumed to equal fully 30 feet. Five feet above this *Columnaria* reef, *Streptelasma dispandum*, which is a large mutation of *Streptelasma rusticum* with strongly divergent sides, is seen, and half a foot farther up, *Columnaria* is associated with *Calapoecia*, *Streptelasma dispandum*, *Protarea richmondensis*, also the variety *papillata*, and *Rhynchotrema capax*. *Columnaria* occurs at various horizons as far as 11 feet above the *Columnaria* reef, and *Rhynchotrema capax* is found at this locality 14 feet above the reef. The *Columnaria* reef is the base of those Richmond strata which overlie the Waynesville member of the Richmond and which are referred to the Whitewater member. Four and a half feet below the *Columnaria* reef, in the Waynesville member, *Strophomena* is common and the following fossils are seen between this level and the exposures 11 feet below the reef: *Streptelasma rusticum*, *Protarea richmondensis*, *Strophomena* of the *planumbona* type, *Hebertella occidentalis*, *Platystrophia clarksvillensis*, *Rhynchotrema perlamellosum*, *Zygospira modesta*, and *Isotelus*.

NORTHEAST OF GORE BAY.

(*Locality No. 13, Figure 7.*)

The base of the known Waynesville section, of Manitoulin island, is not exposed at the last described locality, directly west of Gore Bay, but at the exposures near Gorrel point, about 2 miles northeast of Gore Bay, *Hebertella insculpta* is found in loose slabs, associated with *Plectambonites*, *Strophomena planumbona*, *Strophomena huronensis*, *Platystrophia clarksvillensis*, *Rhynchotrema perlamellosum*, *Streptelasma*, and *Columnaria*. These slabs, although loose, evidently came from the base of the Waynesville of Manitoulin island, *Hebertella insculpta* being confined to that horizon in this area.

NORTHWEST OF GORE BAY.

(*Locality No. 46, Figure 7.*)

Nearly 2 miles northwest of Gore Bay, along the road between concessions XII and XIII, the following succession of strata is seen. The intervals, measured along the road, are practically worthless, since the measurements were made along long and low gradients where the dip apparently was considerable.

	Thickness feet.	Total thickness.
Top of hill.		
Uppermost horizons of the Whitewater member of the *Richmond* not exposed.		
Tetradium rare, *Cyrtodonta ponderosa*, *Ortonella hainesi*, *Ctenodonta* cf. *cingulata*, *Bucania* cf. *capax*, *Bellerophon* cf. *mohri*, *Lophospira*	3	
Interval measured along a very long gradient	12½	
Thin horizon with *Rhynchotrema capax*	..	
Interval measured along a very low gradient	10	
Calapoecia common, *Columnaria* common, *Streptelasma* and *Rhynchotrema capax*	3	
Columnaria, *Hebertella occidentalis*, and *Rhynchotrema capax* at *top of Waynesville member of Richmond*	7½	
Interval	2	
Thin horizon with *Columnaria*	3	
Interval	3	
Argillaceous limestone with *Columnaria* and *Rhynchotrema*	4½	

This section exposes the Gore Bay *Columnaria* reef very well. Its thickness is estimated at 3 feet. The richly fossiliferous strata at the top of the section are regarded as equivalent to the richly fossiliferous strata, containing *Cyrtodonta ponderosa* and *Ortonella hainesi*, a short distance above the Mudge Bay *Stromatocerium* reef, in the sections near Kagawong. The measured interval of only 22½ feet between the top of the *Columnaria* reef and the base of the overlying richly fossiliferous horizon evidently is too small. The Mudge Bay *Stromatocerium* reef is not exposed here, but a quarter of a mile westward there is a conspicuous *Tetradium* reef at a lower elevation above lake level, but probably corresponding stratigraphically to the same horizon as the Mudge Bay *Stromatocerium* reef in the Kagawong sections and at the fairgrounds at the south end of Gore Bay. A *Stromatocerium* reef is exposed also on Barrie island, between lots 5 and 6, in the southern part of concession V. East of the Barrie Island bridge a variety of *Byssonychia richmondensis* was found.

SOUTH OF HONORA.

(Locality No. 47, Figures 7 and 8.)

On the eastern side of Honora or West bay, about a mile south of Honora village, on the road to West Bay, the following section is exposed:

	Thickness feet.
Manitoulin dolomite (Silurian) top not exposed	16
Top of *Richmond*, not exposed	20
Massive limestone with a few specimens of *Stromatocerium*	2
Bryozoans common	½
Thin, whitish limestone	5½
Not exposed, long low gradient	18
Mudge Bay *Stromatocerium* reef with a few *Tetradium*	4

In this section, the Mudge Bay *Stromatocerium* reef is well exposed and forms a conspicuous reef. The upper horizon, at which a few specimens of *Stromatocerium* occur, may correspond to the *Tetradium* reef, or the Manitowaning reef, as exposed northwest of Kagawong. All of the Richmond strata at this locality belong to the Whitewater member.

ROAD WEST OF INDIAN VILLAGE SOUTHWEST OF LITTLE CURRENT.

(Locality No. 48, Figure 7.)

Three miles southwest of Little Current, the road to Honora and West Bay passes a straggling Indian village. Half a mile west of the village the road turns south between lots 20 and 21, and continuing along this road for half a mile southward, to the point where it ascends a steep hill, the following section is exposed:

	Thickness feet.
Manitoulin dolomite (Silurian).	
Interval, at top of the Whitewater member of the *Richmond*..........	8
Fine-grained, whitish limestone with *Cyrtodonta* species and *Byssonychia radiata*........	5½
Bryozoans abundant, the same species as those found southeast of Honora, in the preceding section........	2
Limestone. In this 20 ft. limestone section *Hebertella occidentalis* and *Byssonychia radiata* are common, and one large *Pterinea demissa* was found........	20
Interval along a hilly part of the road, difficult to measure with a Locke level........	17½
Mudge Bay *Stromatocerium* reef, with a few specimens of *Tetradium*..	6
Interval........	32½
Massive limestone with *Columnaria* and *Calapoecia* represented by a few specimens at the top. The top of this limestone probably corresponds to the Gore Bay *Columnaria* reef, here very poorly represented. A *Rhynchotrema perlamellosum* also was found at about the same level in the limestone........	8½
Exposures poor at *top of Waynesville member of Richmond*..........	14
Solid massive limestone weathering to rotten soft limestone, with *Streptelasma*........	5
Argillaceous limestone........	12
Argillaceous limestone and rubble........	31
Fairly solid sandy limestone layer........	1

In this section the Waynesville fauna has been traced downward only 27 feet below the Gore Bay *Columnaria* horizon, to the lowest horizon containing *Streptelasma*. It is evident, however, that part of the underlying argillaceous limestone section must belong to the Waynesville bed, but all of this part of the section is nearly unfossiliferous. In fact, one of the most interesting features of the Waynesville section, on Manitoulin island and along Georgian bay, is the frequency with which corresponding parts of the section at localities only very short distances from each other, differ widely in the richness and abundance of their fossil content. For instance, at Kagawong, the Waynesville section along the road in the southern part of the village differs widely in fossil content from that only a few hundred feet farther southward, just below the Kagawong falls. In the same manner, almost the entire Waynesville section, at the locality southwest of the Indian village here under discussion, is comparatively unfossiliferous, although farther eastward, south of Little Current, the corresponding section contains numerous fossils.

CROSSROAD SOUTHWEST OF LITTLE CURRENT.

(*Locality No. 49, Figures 7 and 8.*)

About 3 miles south of Little Current, an east and west road passes between concessions IV and V. The base of the Manitoulin dolomite is exposed somewhere near lot 10, and the following section is seen along a gradient extending at least over a mile eastward from locality 49, along the east and west road:

	Thickness feet.
Manitoulin dolomite (Silurian)	
Thin limestones at top of the Whitewater member of the *Richmond* with *Leperditia caecigena*, *Rhytimya kagawongensis*, and the unknown black plant-like remains found also southeast of Manitowaning	2
Massive limestone with bryozoans	14
Massive limestone with *Byssonychia radiata* at the top	5
Interval	27½
Mudge Bay *Stromatocerium* reef, containing also some *Tetradium*	9
Shaly layers and thin-bedded limestone	6½
Solid argillaceous limestone with *Lophospira tropidophora* and bryozoans	2
Not exposed	25½

	Thickness feet.
Argillaceous rubble limestone and clay. Fossils poor	3
Horizon with *Protarea, Streptelasma, Columnaria, Strophomena* like *vetusta, Rhynchotrema capax, Zygospira modesta, Ceraurinus marginatus*	1
Horizon with *Stromatocerium* apparently present formerly but little structure left at present	1½
Apparently the Gore Bay *Columnaria* reef, at any rate this coral is common here, associated with *Rhynchotrema capax* common, and *Zygospira modesta* common	5½
Rhynchotrema capax large and common, at *top of Waynesville member of Richmond*, associated with *Protarea, Hebertella occidentalis,* and *Crania scabiosa*	12½
Thin horizon with one specimen of *Columnaria alveolata* in argillaceous limestone	..
At this level there is a long flat area, where the road from Little Current to the middle of Bass lake crosses the road along which this section was measured. This is the road between lots 5 and 6. Near the crossing of this north and south road, one specimen of *Stromatocerium* and one of *Streptelasma* were found.	
Interval	17½
Thin horizon, top of argillaceous limestone with *Streptelasma, Strophomena sulcata, Hebertella occidentalis.*	
Interval consisting, at the top, of fossiliferous limestone definitely referred to the Waynesville and, beneath, of Lorraine-like strata	95
Thin horizon with *Pholadomorpha pholadiformis* in situ.	
(For a description of strata underlying this section, see page 87 of this report).	

In this section the basal part of the known Waynesville section, with *Hebertella insculpta* and *Catazyga headi*, is not exposed, although over 30 feet of rock may be definitely referred to the Waynesville bed. The basal part of the bed appears to be practically unfossiliferous, a condition observed at numerous other localities on Manitoulin island and along the southern shores of Georgian bay. The Gore Bay *Columnaria* reef apparently may be detected. The Mudge Bay *Stromatocerium* reef is very well represented, although the interval of this *Stromatocerium* reef above the Gore Bay *Columnaria* reef may not have been correctly determined, owing to the very long and low gradient. There is no trace of the upper, or Manitowaning *Tetradium* reef, so well exposed at some localities northwest of Kagawong. The most interesting feature, however, is the horizon with *Leperditia caecigena* and *Rhytimya kagawongensis*, at the top of the Richmond section, just beneath the Manitoulin dolomite. This horizon corresponds to that just beneath the Manitoulin dolomite, 1½ miles southwest of Kagawong, along the road to Gore Bay. This horizon belongs above the upper, *Tetradium* or *Manitowaning* reef. The horizon with *Leperditia caecigena*, *Primitia lativia*, and *Rhytimya kagawongensis*, immediately south of Kagawong, however, belongs between the middle or Mudge Bay *Stromatocerium* reef and the upper, or Manitowaning reef. The fossils mentioned evidently have a considerable vertical range.

BASS LAKE ROAD SOUTH FROM LITTLE CURRENT.

(Locality No. 11, Figures 7 and 8.)

Along the road from Little Current southward to the middle of Bass lake, Richmond strata are exposed where the road ascends McLean hill, about 2 miles southwest of town. The exposures are between lots 5 and 6, in concessions VI and VII.

	Thickness feet.
Limestone in place *near top of Waynesville member of Richmond*, but fossils few. *Columnaria* and *Calapoecia* occur loose, but are believed to have been in situ at or just above the base of this level, at the Gore Bay reef horizon..............................	15½
One specimen of *Strophomena* resembling *nutans* in outline, near top of section..	11
Streptelasma, *Crania scabiosa*, *Strophomena* of *planumbona* and *huronensis* types, *Zygospira modesta*, some specimens approaching *kentuckiensis*, *Rhynchotrema perlamellosum*, all in situ. Near the middle and top *Strophomena sulcata* occurs..................	21
Rhynchotrema capax occurs on large loose slabs of rock at this level	
Interval..	15
Beneath this interval occur slabs of limestone, loose, with *Strophomena huronensis* rather common and with occasional specimens of *Cyclonema bilix*. The horizon with *Hebertella insculpta* and *Catazyga headi* probably was just beneath	

	Thickness feet.
this level. This may be inferred from the slabs which contain these fossils and which are found loose at various lower intervals, evidently dropped from their original level.	
Interval	6
Beneath this interval occur loose slabs with *Rafinesquina alternata*, *Hebertella insculpta*, *Cyclonema bilix*, *Bellerophon*, and *Cornulites*	..
Interval	4
At the base of this interval occur loose slabs with *Strophomena huronensis*	..
Interval	4
At the base of this interval occurs a loose slab with *Hebertella insculpta*, *Strophomena planumbona*, *Strophomena huronensis*	..
Interval	4½
At the base of this interval was found a loose slab, with *Rhynchotrema perlamellosum*, and *Strophomena huronensis*	..
Interval	11½
At the base of this interval *Catazyga headi* was found loose.	
In the overlying 22 feet of this section, the following fossils also were found loose: *Streptelasma*, *Calapoecia*, *Hebertella occidentalis*, *Platystrophia clarksvillensis*, and *Cyclonema bilix*. Specimens of *Trematis*, occurring in a sandy, Lorraine-like rock, also occur loose at the base of this section.	
Interval	4
At the base of this interval *Hebertella insculpta* was found in loose rock.	
Interval, composed chiefly of Lorraine-like sandy rock	14
Shallow spring along the road, where it ascends the hill in a southwesterly direction.	
(For description of underlying strata see page 90 of this report).	

This section is interesting chiefly in showing that the basal parts of the known Waynesville section of Manitoulin island are present here, as inferred from the presence of *Hebertella insculpta* and *Catazyga headi*. Moreover, *Strophomena huronensis*, belonging immediately above, also occurs. It may be remembered from the previously described section, that these fossils were not found a mile farther southward, where the lower parts of the Waynesville section are practically unfossiliferous.

The Gore Bay *Columnaria* reef probably was present in this vicinity, although it can not be definitely located at present. This is inferred from the presence of numerous specimens of

Columnaria alveolata with some of *Calapoecia* farther southwestward, in the fields along the road between concessions VI and VII, near lot 6. They are not infrequent on the southern side of the road, in the open field, after plowing.

NORTHWEST OF MANITOWANING.

(*Locality No. 50, Figures 7 and 8.*)

A short distance northwest of Manitowaning, in lot 42, there is a steep gully descending the steep escarpment near the shore, formed by a small stream which may be traced back from the shore to the road leading from Manitowaning to Sheguiandah. It strikes this road a short distance west of its junction with the Providence Bay road. In the angle between the two roads is the conspicuous Manitoulin dolomite promontory known locally as "The Rock." East of the rock, a short distance west of the Providence Bay road, a conspicuous *Stromatocerium* reef, the Manitowaning reef, is exposed. It is scarcely necessary to state that elsewhere this reef may be characterized, not by the presence of *Stromatocerium*, but by the great numbers of *Tetradium*. In fact, different parts of a reef may be characterized by different species. This change of dominant species at different points along the same reef, was true of Palæozoic life as much as of that of the present seas.

The following section extends from "The Rock" eastward to the *Stromatocerium* reef, immediately west of the South Bay road, and then continues farther northward across the western edge of the village where there is an area of no exposures, and descends the stream already mentioned, passing through the steep gully to the margin of the lake:

	Thickness feet.
Manitoulin dolomite (Silurian), base not exposed.	
Interval at top of Whitewater member of the *Richmond* not exposed	56
Stromatocerium (Manitowaning) reef	4
Interval not exposed	20
Clay	½
Limestone	1
Solid limestone, no fossils seen	½

	Thickness feet.
Thin horizon with *Ctenodonta*	..
Columnaria common. *Tetradium* and *Calapoecia* also present. Possibly the equivalent to the Mudge Bay coral reef horizon	¼
Solid limestone	2½
Streptelasma, Calapoecia, Hebertella occidentalis, large coarse *Bellerophon, Liospira helena*	¼
Solid limestone with *Beatricea undulata, Streptelasma, Tetradium, Rhynchotrema perlamellosum*	6½
Chiefly clay, forming a flat, with the overlying strata giving steeper outlines	7½
Flat field surface, with no exposures, probably clay	5
Solid limestone forming top of bluff at gully, with *Beatricea undulata* at top, and with *Streptelasma* and *Tetradium* at lower levels	3
Practically covered	6½
Zygospira kentuckiensis, Cyrtodonta ponderosa, and *Orthoceras*	½
Poorly exposed limestone	2½
Thin horizon with *Beatricea* loose	..
Nodose branching *Ptilodictya,* similar to that found south of Kagawong. Also *Zygospira kentuckiensis*	½
Limestone with *Byssonychia radiata*	3½
Soft argillaceous rubbly limestone	1
Blue argillaceous rubbly limestone with *Modiolodon,* and numerous specimens of *Zygospira kentuckiensis*	4
Rubble limestone with *Streptelasma, Zygospira kentuckiensis, Cyrtodonta ponderosa, Orthoceras*	2½
Solid limestone with *Calapoecia*	½
Solid limestone with *Streptelasma, Tetradium, Calapoecia* common, *Zygospira kentuckiensis, Byssonychia.* Regarded as equivalent to the Gore Bay reef horizon	2
Girvanella richmondensis, Columnaria, Calapoecia, one *Cyrtodonta ponderosa at top of Waynesville member of Richmond*	½
Interval	2½
Pterinea demissa and *Modiolodon* in solid limestone	1
Blue rubble limestone with *Tetradium*	1
Covered	7
Columnaria, Rhombotrypa quadrata, Hebertella occidentalis, Platystrophia clarksvillensis, Byssonychia radiata in rubble limestone	1
Clay and rubble limestone with *Streptelasma* and *Rhombotrypa*	1½
Rhombotrypa quadrata common	½
Interval	3½
Columnaria, Streptelasma, Hebertella insculpta, and *Platystrophia*	½
Thin horizon with *Arthraria biclavata* or dumbbell impressions fully 4 inches in length	..

	Thickness feet.
Streptelasma, Columnaria, Rhombotrypa quadrata, Hebertella insculpta, Platystrophia clarksvillensis	1
Chiefly covered. Clay with *Streptelasma, Columnaria,* and *Hebertella insculpta*	6
Lake level.	

SOUTHEAST OF MANITOWANING.

(*Locality No. 51, Figures 7 and 8.*)

Two miles directly southeast of Manitowaning, across the bay, where the road to Wekwemikongsing ascends the hill, the following section is exposed, presenting some features which are covered up in the Manitowaning section by the soil.

	Thickness feet.
Manitoulin dolomite (Silurian).	
Strata at top of Whitewater member of the *Richmond*, not exposed	22
Argillaceous limestone with *Byssonychia radiata, Rhytimya kagawongensis, Leperditia caecigena, Primitia lativia, Bythocypris cylindrica* and unknown plant-like black remains	5½
Interval	71½
At the base of this interval there is a flat plain.	
Interval	12
Beneath this interval occurs the top of massive rock crossed by road.	
Interval	22
At the base of this interval occurs a flat plain, with abandoned house on north of road.	
Interval	22
At the base of this interval is the gate into Indian reservation.	
Interval	5
Lake level.	

This section suggests the presence of *Rhytimya, Leperditia caecigena,* and *Primitia lativia* above the *Stromatocerium* (Manitowaning) reef horizon, which is typically exposed east of the "Rock," at Manitowaning. The top of the massive rock crossed by the road, on the Indian reservation, in the preceding section, probably corresponds to the top of the bluff at the gully north of the lighthouse in the Manitowaning section.

It will be noticed that there is no definite equivalent to the Cape Smith *Stromatocerium* reef in the Manitowaning section. This reef belongs beneath the *Beatricea* zone. The horizon where this reef should occur is somewhere within the massive rock forming the 3 feet of the bluff at the steep gully in the Manitowaning section. This would place it about 45 or 48 feet below the Manitowaning reef. Moreover, there is no equivalent in the Manitowaning section for the Gore Bay *Columnaria* reef. The nearest approach to such a reef is found between 25½ and 28 feet above the base of the section, where *Columnaria*, *Calapoecia*, and *Tetradium* are rather more common than elsewhere in the section. This would give an interval of about 21 feet between the *Columnaria* horizon and the base of the *Beatricea* zone at which the Cape Smith reef should come in. The total thickness of the Waynesville bed might be in excess of 26 feet, however, since the vertical range of *Hebertella insculpta* sometimes is fairly considerable at the base of the Waynesville section, as identified on Manitoulin island.

SOUTHWEST OF WEKWEMIKONG.

(*Locality No. 52, Figure 7.*)

Two miles southwest of Wekwemikong along the road from Mocasset Landing to Smith bay, the following section is exposed where the road rapidly descends the hill.

	Thickness feet.
Top of section at this locality.	
Limestone belonging to the Whitewater member of the *Richmond*..	24
Thin horizon with *Beatricea undulata*..................................	
Interval..	5
Beneath this interval occurs the top of the *Stromatocerium* reef (Cape Smith reef).	
Interval..	4
Stromatocerium, *Girvanella*, *Beatricea undulata*, *Tetradium* common and large, *Columnaria alveolata* and *calycina*, *Calapoecia*, *Streptelasma rusticum*, *Crania scabiosa*, *Zygospira kentuckiensis*, *Cyriodonta ponderosa*, *Ischyrodonta*, and *Ctenodonta iphigenia*, *Archinacella*, *Bucania* cf. *capax*, *Bellerophon* cf. *mohri*, *Liospira helena*, and *Lophospira tropidophora*..............................	5
Interval at *top of Waynesville member of Richmond*................	4
Zygospira kentuckiensis common through at least..................	5

This section is of interest chiefly for indicating the horizon of *Beatricea*. It ranges both above and below the *Stromatocerium* reef. Below this reef a short distance there is a *Tetradium* reef, with a considerable number of *Columnaria* and *Calapoecia*. This horizon is again very well exposed at Clay cliff on the eastern side of Cape Smith, but in walls too vertical for favourable study.

NORTHWEST OF WEKWEMIKONG.

(*Locality No. 53, Figures 7 and 8.*)

Northwest of Wekwemikong, along the road leading up the hill, numerous loose specimens of Richmond fossils are found. The locality is interesting as a collecting ground for some of the Waynesville species, including *Hebertella insculpta*, *Strophomena huronensis*, and *Protarea*. *Stromatocerium*, *Streptelasma rusticum*, *Tetradium*, *Columnaria alveolata*, a very flat form of *Rafinesquina*, and *Cyrtodonta ponderosa* also occur.

CLAY CLIFF.

(*Locality No. 54, Figures 7 and 8.*)

The best known locality for collecting Richmond fossils undoubtedly is Cape Smith. The exposures are known as Clay cliff, and occur 3 miles north of Wekwemikongsing, halfway to the northern termination of Cape Smith. The locality may be reached most conveniently by a boat capable of entering shallow waters. The walk along the shore is across large boulders. A woodland road permitting the use of wagons extends within a mile of the cliffs, and a good path extends the rest of the way to the southern termination of the much lower clay cliffs extending to the south of the conspicuous ones to which the name usually is confined. The lower, more southern exposures just mentioned belong to the Maysville and Eden sections. The more conspicuous Clay cliff belongs chiefly to the Richmond. At least, only the Richmond strata are well exposed here, the underlying Maysville strata being covered up by talus which has fallen from the Richmond strata. Even the *Hebertella insculpta* layers are well exposed and, at higher horizons, also the *Columnaria* reef, and the *Stromatocerium* reef; but the still higher parts of the Richmond formation are not present here. The locality is not favourable for a study of the vertical distribution of the contained fossils, since most of the fossils are found in the talus. However, it is an excellent collecting ground. The following meagre facts are presented.

A vertical wall of limestone forms the top of the Clay Cliff section. At its base, there is a conspicuous *Stromatocerium* layer. According to the measurements of Prof. Arthur M. Miller, the interval from the *Stromatocerium* reef to the top of the bluff or cliff is 31 feet. A very large branching bryozoan is common about 16 feet above the *Stromatocerium* reef. The highest layers containing *Hebertella insculpta* occur 29 feet below the *Stromatocerium* horizon. In the talus there is an abundance of forms which are known from immediately below the *Stromatocerium* reef southwest of Wekwemikong. These forms include the large thick walled species of *Cyrtodonta ponderosa*, *Ctenodonta iphigenia*, *Bucania*, and *Bellerophon*, also *Liospira helena* and the like. Most species found in the talus cannot be referred definitely to any horizons, except in a very general way. The following is a list of the fossils found here:

Streptelasma rusticum (*canadensis*).
Tetradium huronensis.
Columnaria alveolata.
Columnaria calycina.
Calapoecia huronensis (*cribriformis*).
Protarea richmondensis (also var. *papillata*).
Stromatocerium huronensis.
Cornulites.
Spirorbis cf. *cincinnatiensis*.
Batostoma.
Constellaria polystomella.
Rhombotrypa quadrata.
Crania scabiosa.
Dalmanella small, not *jugosa*.
Hebertella insculpta.
Hebertella sinuata.
Hebertella occidentalis.
Strophomena planumbona.
Strophomena huronensis.
Rafinesquina alternata, very flat form.
Platystrophia clarksvillensis.
Zygospira kentuckiensis.
Cyrtodonta ponderosa.
Modiolopsis.
Ortonella hainesi.
Rhytimya kagawongensis.
Ctenodonta iphigenia.
Ctenodonta cf. *madisonensis*.
Opisthoptera fissicosta.
Byssonychia praecursa var.
Pterinea demissa.
Archinacella.

Vallatotheca manitoulini.
Cyrtolites ornatus.
Oxydiscus.
Bucania cf. *capax.*
Bellerophon cf. *mohri.*
Clathrospira subconica.
Liospira helena.
Lophospira near *bowdeni.*
Cyclonema bilix.
Orthoceras piso.
Endoceras.
Spyroceras hammelli.
Cyrtoceras (*Cyrtorhizoceras?*) *lysander.*
Cyrtoceras (*Cyrtorhizoceras?*) *postumius.*
Discoceras?
Billingsites.
Oncoceras.
Leperditia caecigena.
Bythocypris cylindrica.

To the Richmond faunas mentioned on the preceding pages may be added the following: *Licrophycus hudsonicus* described from Manitowaning bay. *Cyclocystoides huronensis* described from the *Beatricea undulata* horizon on Rabbit island. *Vanuxemia bayfieldi* described from the upper Richmond on Bayfield sound. *Cyrtoceras ligarius* described from the Richmond on Drummond island. *Billingsites newberryi*, although described from Anticosti island, is cited also from the Ordovician (Richmond) exposures of Cape Rich.

(For the underlying Lorraine-like strata see page 82).

GENERAL REMARKS ON THE RICHMOND OF MANITOULIN ISLAND.

The Richmond strata of Manitoulin island probably were deposited near a shore-line. Sandy clays, with very few fossils, are present at many horizons. In fact, they predominate at some localities, and the rapid manner in which the strata change from richly fossiliferous to practically unfossiliferous zones along the same stratigraphical levels, suggests shore conditions.

This does not imply the immediate presence of the shore or very shallow waters. Wave and ripple-marks were not noticed at the localities so far examined, and there are no coarse sandstones or conglomerates. Judging from the prevailing fine-grained sandy and argillaceous strata, the waters probably often were muddy. Certain types of life, such as the bryozoans and crinoids, were poorly represented, excepting locally and for very limited horizons. Estuarine or delta deposits may have prevailed towards the north and the northeast. When these deposits, by some change of currents, were swept farther south or southwest, the conditions for marine life here probably proved less favourable.

BETWEEN GEORGIAN BAY AND LAKE ONTARIO.

At the localities northwest of Meaford, only the Waynesville member of the Richmond was identified among the more fossiliferous strata underlying the red Queenston clay shales. The Saluda and Whitewater members appear here to be represented by the lower half, if not by all of the Queenston red clay shales. This is true also at all of the localities southeast of Meaford, along the southern shores of Georgian bay, so far investigated. No trace of the Gore Bay or Cape Smith coral reefs overlying the strata identified as Waynesville, was noted, and of the overlying faunas present on Manitoulin island, only the ostracod fauna, to be described later, is well represented at certain horizons in the Meaford area. The same statement might be made regarding the Richmond exposures along the northern shores of Lake Ontario, near Oakville. Here the Queenston red clay shales also rest directly on fossiliferous strata all of which appear to belong to the Waynesville division of the Richmond.

The following are more detailed statements regarding certain Richmond localities in the area indicated above.

WORKMAN BROOK, SOUTHEAST OF MEAFORD.

Along the lower part of Workman brook, about 3 miles southeast of Meaford (Figure 6), there are almost continuous exposures of strata resembling the Lorraine (see page 78). At the higher horizons, as indicated by the following notes, fossil exposures belonging to the Waynesville member of the Richmond are found. *Catazyga headi* associated with *Cyclonema bilix* and a large *Hebertella* occurred 349 feet above the lake, according to Locke level measurements, which, of course, are more or less inaccurate. *Opisthoptera fissicosta* is found farther up. At 325 feet, *Catazyga* occurs associated with *Strophomena planumbona*, at the base of those richly fossiliferous strata which are correlated definitely with the Waynesville member of the Richmond. This locality is between lots 8 and 9 on concession III (locality 7).

Richmond strata belonging to the Waynesville member, occur inland from the cliffs of Eden strata along the lake shore east of the mouth of Workman brook. These cliffs have an estimated height of 148 feet. The railway level occurs about 15 feet above the top of the cliffs. Southeastward, a second narrow, steep gully ascends the hill front. The rocks exposed in the lower part of this gully have a Lorraine-like aspect. Farther up, in the same gully (locality 10) strata referred definitely to the Waynesville member of the Richmond are exposed, about 150 feet above the railway, or 313 feet above the lake. Here *Cyclonema bilix*, *Hebertella occidentalis*, *Platystrophia clarksvillensis*, and *Strophomena huronensis* are found. At one of the lower horizons, in this Waynesville part of the section, *Catazyga headi* is common in the same slabs with *Strophomena huronensis*. *Opisthoptera fissicosta* occurs farther up. Near the top of the gully, the base of the Queenston shale is well exposed. (The underlying Lorraine-like strata, half a mile southeast of Boucher point, are described on page 81 of this report.)

SOUTH OF MOUNTAIN LAKE, NORTHWEST OF MEAFORD.

The Waynesville member of the Richmond and the overlying Queenston red clay shales, which also belong to the Richmond, are displayed at a locality 8 miles northwest of Meaford. The locality (No. 26) extends half a mile south of the eastern end of Mountain lake. It may be reached most readily by taking the road from Meaford to Owen Sound for a distance of 3 miles and turning off northward for a distance of 7 miles to a school at the crossroads. This crossroad is located between concessions VIII and IX and between lots 36 and 37. South of the crossroads, the land rises. The Queenston red clay section begins at the top of the hill, extends north to the crossroad, then east along the latter for a distance of almost a mile, where the road turns first southward, and then eastward down a short and steep ravine connecting with the direct road from Meaford to Cape Rich on the eastern margin of lot 36 in concession VII (Figure 6). The immediately underlying richly fossiliferous Waynesville part of the Richmond section is exposed (at locality 15) along the stream following the southern side of the road in the ravine. Only the richly fossiliferous part of the Richmond, below the Queenston red shales, is here described. (The Queenston part of the Richmond is described on page 164 in this report.)

	Thickness feet.
Greenish shales and sandstones occurring immediately below red clay shales and forming the base of the Queenston section of the Richmond...	9
Byssonychia radiata occurs in a limestone layer, at the *top of richly fossiliferous beds referred to Waynesville.*	
Shaly rock with a few thin-bedded limestone layers with *Hebertella occidentalis* and bryozoans....................................	5½
Interval including green shales interbedded with fine-grained sandstones and some limestone..................................	15
Highest level at which *Strophomena huronensis* was seen............	..
The underlying beds grade gradually downward into strata resembling the Lorraine, and contain *Hebertella occidentalis*, *Platystrophia clarksvillensis*, *Rafinesquina alternata*, *Strophomena huronensis*, *Byssonychia radiata*, *Orthodesma* sp., *Ctenodonta* cf. *cingulata*, and *Cyclonema bilix*; thickness about............................	10

CAPE RICH ROAD, NORTH OF MEAFORD.

The character of the richly fossiliferous part of the Richmond, beneath the Queenston division of the Richmond, is shown best by the exposure on the steep eastern face of the hill, directly west of the Disciples church, on the land of John A. Cox, about 6 miles from Meaford, along the road leading along the western shore of Nottawasaga bay northward to Cape Rich on lot 32, concession VII (Figures 6 and 8). Here, the following section (at locality 28) is exposed in descending order:

	Thickness feet.
Top of hill land.	
Queenston red clay shales, representing the upper part of the Richmond. Only the lower part of the Queenston is exposed here, interbedded with some sandstone near the base, often ripple-marked........	64

	Thickness feet.
Richly fossiliferous strata correlated definitely with *the Waynesville member of the Richmond* section, containing the following fossils: *Streptelasma rusticum, Tetradium huronense, Columnaria alveolata, Calapoecia huronensis, Stromatocerium huronense, Cornulites* sp., *Rhombotrypa quadrata, Rafinesquina alternata* flat, *Hebertella occidentalis, Hebertella insculpta, Platystrophia clarksvillensis, Strophomena huronensis, Zygospira modesta, Byssonychia radiata, Pterinea demissa, Opisthoptera fissicosta, Bellerophon* sp., *Lophospira* cf. *beatrice, Clathrospira subconica, Lophospira tropidophora, Cyclonema bilix, Orthoceras* sp., *Calymene* sp.	14
Hebertella insculpta horizon, at base of the richly fossiliferous part of the Waynesville section, not measured separately.	. .
Interval, occupied by Lorraine-like strata at the top.	190
Rock full of *Plectambonites sericeus*, along the road in the form of numerous residual blocks of limestone.	

This fossiliferous Richmond horizon is regarded as being equivalent approximately to the Waynesville member of the Richmond as exposed in Ohio, Indiana, and Kentucky.

OAKVILLE.

Oakville (Figure 6) is located on the lake shore about 20 miles southwest of the Union station at Toronto. A short distance north of Oakville station a pike runs parallel to the railway, and a short distance northeast of the station a small stream crosses both this pike and the railway. Between the pike and the railway the following species were found about 5 feet below the level of the railway:

Columnaria alveolata, one specimen.
Hebertella occidentalis.
Platystrophia clarksvillensis.
Strophomena planumbona.
Modiolopsis concentrica.
Calymene sp.

Immediately north of the pike, along the same stream, a single specimen of *Tetradium huronense* was found in situ directly beneath the base of the reddish Queenston shale, which at this level contains sandy rock layers. Farther northward the stream heads in the hills whose slopes freely expose the lower parts of the Queenston, the total thickness of the Queenston equalling many times the thickness here exposed. From these lower parts of the Queenston section Ulrich described *Drepanella richardsoni-canadensis*, Oakville being the type locality.

Proceeding from the railway station three-quarters of a mile northeastward, the railway is crossed by a branch of the same stream, a short distance before reaching a road crossing the railway at right angles. South of the railway this branch exposed the following species:

Columnaria alveolata, one specimen.
Hebertella occidentalis.
Platystrophia clarksvillensis.
Rafinesquina alternata.
Pterinea demissa.
Opisthoptera fissicosta.
Modiolopsis concentrica.
Lophospira bowdeni.
Cyclonema bilix.

Following this branch down stream, both branches join east of the road just described as crossing the railway at right angles. From the point of junction to the lake shore the distance is fully a mile and the total drop from the fossil exposures south of the railway to the lake is 70 feet. Within this interval no diagnostic fossil except *Modiolopsis concentrica* was observed. This species occurred at various intervals down as far as the lake level, but is known to have a much greater vertical range below the base of the Queenston, as may be seen from the Weston section.

The occurrence of *Columnaria alveolata* and *Tetradium huronense*, although represented only by isolated specimens, suggests the presence here of an horizon approximately equivalent to the Coral zone at the base of the Whitewater division of the Richmond at Streetsville. Comparisons with exposures as far away as Manitoulin island indicate that these corals could occur also at lower horizons than the Coral zone of the Streetsville section. The underlying Lorraine-like strata, containing *Modiolopsis concentrica*, probably correspond to those strata in the Streetsville section which extend from the base of the Coral zone down to the *Strophomena sulcata* horizon. In view of the frequency of *Strophomena sulcata* in several of the layers in the lower part of the Streetsville section, their presence in the Oakville area or a short distance east of the Oakville area may be looked for.

STREETSVILLE.

Streetsville (Figure 6) is located about 17 miles west of Toronto. Here the following section is exposed on the north side of Credit river. The top of the section begins above the bridge opposite the mill north of the middle of the village. Stratigraphically, the section is located only a short distance below the Queenston red clay shales, which represent the upper part of the Richmond.

	Thickness feet.
Top of fossiliferous part of the *Richmond strata* (not red), *referred provisionally to the Whitewater member.*	
Argillaceous rock, interbedded with shaly clay, containing a few specimens of *Hebertella occidentalis* and *Byssonychia radiata*......	15
Limestone underlain by shaly clay...........................	2½
Tetradium, *Columnaria calycina* and *alveolata*, *Stromatocerium*, *Hebertella occidentalis*, *Platystrophia clarksvillensis*, *Byssonychia radiata*, *Orthoceras*. Horizon with large specimens of *Stromatocerium huronense*, *top* of Coral zone..........................	2½
Interval..	3
Bridge level at Mill north of middle of village.	
Columnaria calycina, *Platystrophia clarksvillensis*, and *Hebertella occidentalis*..	2
Tetradium huronense, *Stromatocerium huronense* common, and *Columnaria calycina*..	3
Clay section, *Stromatocerium* large and common...................	1½
Limestone with *Columnaria calycina* and *Tetradium*...............	⅓
Columnaria calycina and *Tetradium* in limestone at base of the Coral zone..	¾
Projecting solid limestone layer, forming the base of the Whitewater member..	½
Chiefly clay with few fossils excepting bryozoans at *top of strata referred here to the Waynesville member of Richmond*....................	3
Limestone with *Platystrophia clarksvillensis*, *Hebertella occidentalis*, *Zygospira modesta*, *Byssonychia*, *Lophospira bowdeni*, *and Cyclonema bilix*..	2
Clay and argillaceous limestone resembling the Lorraine, with *Platystrophia clarksvillensis* and *Byssonychia*......................	3

The basal bryozoan layer of the preceding section is an important stratigraphical horizon. It may represent a glimpse of the Waynesville bryozoan fauna. The overlying coral zone, about 13 feet thick, apparently begins the Whitewater phase of the Richmond, as exposed in the Streetsville area. Both horizons are well exposed also about a mile farther up the Credit river at the bridge northeast of the railway station at Credit Junction. Here occasional specimens of *Calapoecia huronensis* or *cribriformis* are found. Very small specimens of *Streptelasma rusticum*, one-fourth inch long, occur, but are rare. *Constellaria polystomella*, *Rhombotrypa quadrata*, *Lophospira bowdeni*, *Lophospira tropidophora*, *Clathrospira subconica*, and *Trochonema* sp., are found. To Dr. E. O. Ulrich, the general appearance of the fauna at this locality, including species not listed here, suggested Whitewater affinities.

About one-eighth of a mile south of the bridge at the mill north of the middle of Streetsville, the bryozoan layer mentioned in the preceding section attains a thickness of 5 feet and is strongly cross-bedded, with the bedding planes inclined toward the north. Along the top of this series of inclined layers there is a continuous horizontal sheet of limestone of the same coarseness of grain and containing the same fossils. This continuous sheet is about 4 inches thick, and the entire structure evidently is that of a cross-bedded rock, as already stated, and is not connected in any way with an unconformity.

In this bryozoan layer, locally cross-bedded, the following fossils have been found:

Hebertella occidentalis.
Platystrophia clarksvillensis.
Zygospira modesta.
Pterinea demissa.
Opisthoptera fissicosta.
Byssonychia sp. of *radiata* group.
Modiolopsis concentrica.
Lophospira bowdeni.
Cyclonema bilix.

In the immediately underlying clay and argillaceous limestone layers, having a total thickness of 3 feet, *Platystrophia clarksvillensis* and *Byssonychia* sp. occur. Here is the top of those layers of rock having a very Lorraine-like appearance. Strata of similar lithological appearance form all of the underlying part of the section at Streetsville described here. Their fossil content, however, indicates their Richmond affinities.

The interval from the 3-foot section of strata described in the preceding paragraph down to the exposures beneath the railway bridge, almost half a mile southward, is estimated at 19·5 feet. This interval is occupied chiefly by clay shales, with which are interbedded argillaceous limestone layers varying from 2 to 4 inches in thickness, and containing, especially at the upper horizons, the following species:

Hebertella occidentalis.
Platystrophia clarksvillensis.
Pterinea demissa.
Byssonychia grandis.
Byssonychia of *radiata* type.
Opisthoptera fissicosta.
Modiolopsis concentrica.
Pholadomorpha pholadiformis.
Ctenodonta of *cingulata* group.

From the level of the river beneath the railway bridge to the level beneath the first road bridge southward, the interval is about 5 feet; and from the latter level down to the base of the first bluff on the east side of the river, the interval is estimated at 16 feet. At the base of this bluff the rocks have the contorted pillow structure, and contain the following species:

Platystrophia clarksvillensis.
Rafinesquina alternata, cc.
Byssonychia of *radiata* group.
Modiolopsis, sp.
Lophospira bowdeni.
Orthoceras sp.
Isotelus sp.

From this level down to the base of the strongly pillow-structured argillaceous rock layers exposed on the western side of the river, farther down stream, is an interval of 6·5 feet, followed by an interval of 8·5 feet down to the base of the second bluff on the eastern side of the river, south of the road bridge. At the latter locality the following species were found:

Hebertella occidentalis.
Platystrophia clarksvillensis.
Byssonychia of *radiata* group.
Lophospira bowdeni.
Orthoceras sp.

From the latter locality down to the first high bluff exposure on the western side of the river the interval is estimated at 12 feet. At this locality the river valley approaches close to the pike following the western side of the valley, and the bluff lies northeast of the home of William Crozier. Here the following species were found:

Hebertella occidentalis.
Strophomena sulcata, cc. at base of bluff.
Pterinea demissa.
Byssonychia of *radiata* group.
Modiolopsis concentrica.
Pholadomorpha pholadiformis.
Whitella of *obliquata* group.
Lophospira bowdeni.
Lophospira tropidophora.
Cyclonema sp.
Orthoceras sp.

In addition to the specimens here listed some of the rock slabs showed impressions of some species of *Strophomena* suggesting *planumbona.*

About 10 feet below the base of this *Strophomena sulcata* horizon occurs a bluff on the east side of the river, farther down stream. At this locality most of the fossils were found in loose slabs at the foot of the bluff, but within the path of the river at times of high water, and hence there is no certainty that the slabs were not carried down from some higher level by the river. Here the slabs contained both the *Strophomena sulcata* and *Strophomena planumbona*, the latter with the characteristic strongly defined thickening of the shell along the border of the interior of the pedicel valve. Since no trace of *Strophomena planumbona* was found at any locality farther up stream there is at least a probability of this species occurring associated with the *Strophomena sulcata* at this and the immediately overlying horizon. A species of *Catazyga* is present, but whether *headi* or *erratica* could not be determined, since only pedicel valves were noticed and the pedicel valves of these two species are not readily distinguished unless well preserved. Large flat specimens of *Rafinesquina alternata* were common. *Modiolopsis concentrica* and *Opisthoptera fissicosta* occur. The *Modiolopsis* could occur here in situ since it is known at the previously described horizon, only 10 feet higher, but the *Opisthoptera fissicosta* may have been carried down stream from some point above the railway bridge.

Strophomena sulcata is known on Manitoulin island only from the lower part of the Richmond group. It has not been identified heretofore from any part of the area between Georgian bay and Lake Ontario. East of Ottawa, in the Vars area, in the Nicolet River section, and on Snake island in Lake St. John, *Strophomena sulcata* also is known only from the lower part of the Richmond. For the present, therefore, the exposures between the base of the coral zone and the base of the *Strophomena sulcata* zone are regarded as of Richmond age. According to crude Locke level measurements this interval is equal to 82 feet, but, taking into account the southward dip of the rocks, possibly an estimate of 50 feet would be sufficient.

Down stream from the exposure last mentioned there is a steep bluff on the western side of the river, southeast of the home of William Crozier. The base of this bluff lies about 14 feet below the previously described part of the section. No diagnostic fossils were found here.

CONCLUDING REMARKS.

The observations made so far in the area between Lake Ontario and Georgian bay suggest that at present no sharply defined limits can be assigned to the lower part of those Richmond strata which are included in the Queenston red clay shale. In the Meaford area and at Oakville, it is possible that the basal part of Queenston section includes strata which, although unfossiliferous at the localities mentioned, nevertheless correspond to strata which elsewhere are fossiliferous and which there include a Waynesville fauna. From this point of view, the Coral zone and overlying fossiliferous rocks at Streetsville may not represent a distinct set of strata inserted between the overlying Queenston and underlying Waynesville members of the Richmond, but may merely represent those lower horizons of the Queenston section which elsewhere usually are barren of fossils. In other words, during the deposition of those strata on Manitoulin island which are here regarded as equivalent to the Whitewater member of the Richmond, the estuarine deposits between Georgian bay and Lake Ontario were comparatively barren of life, but at Streetsville there is evidence of a local incursion of a typical Manitoulin Island fauna, such as is there regarded as Whitewater. The incursion appears to have been from the southwest, during the earlier part of the Whitewater period of deposition. The fauna soon became extinct, probably owing to a southward extension of the estuarine deposits represented by the Queenston red clay.

In the same manner, a careful search for the basal limits of those richly fossiliferous strata, here definitely referred to the Waynesville member of the Richmond, has failed to find any definite line of demarcation between the Richmond and Lorraine. On the contrary, in all parts of Ontario and Quebec, excepting perhaps locally at Streetsville, the richly fossiliferous, more calcareous strata, definitely referred to the Waynesville member of the Richmond, grade more or less gradually into those more argillaceous and more Lorraine-like strata beneath, which contain the *Pholadomorpha* fauna. Since on Manitoulin island the lowest of these richly fossiliferous strata definitely referable to the Waynesville, contain *Hebertella insculpta* and *Catazyga headi*, confined to a comparatively narrow zone, they were sought also at Meaford. In the vicinity of Meaford, however, there are several *Catazyga* zones, but *Hebertella insculpta* still served for purposes of correlation at the locality 6 miles north of town, on the Cape Rich road. It was observed, however, both here and at various other localities in Ontario, that the strata there identified as Waynesville gradually merged lithologically into the more Lorraine-like strata of the *Pholadomorpha* zone beneath, so that in the absence of good fossils the division between the Richmond and Lorraine became more or less arbitrary.

The question, therefore, arises whether it may not be necessary eventually to include the *Pholadomorpha* zone of Manitoulin island and of the area between Georgian bay and Lake Ontario, in the Richmond. Certainly it is a striking fact that three such typical Richmond lamellibranchs as *Pholadomorpha pholadiformis*, *Opisthoptera fissicosta*, and *Byssonychia grandis* should occur associated in the same upper Lorraine-like layers at Streetsville, and here the occurrence of *Strophomena sulcata* at still lower horizons certainly warrants the reference of the upper part of the Lorraine-like strata to the Richmond. While the evidence afforded by the bryozoans in the *Pholadomorpha* zone on Manitoulin island and near Meaford suggests Maysville affinities, it must be admitted that only a few species of bryozoans have been discovered in this zone so far, and that if a much larger number of species were at hand the conclusions reached might be different. This does not mean that the evidence presented by the bryozoans is of little value. On the contrary, they form the most satisfactory diagnostic fossils in strata belonging to the Cincinnatian series. The real trouble is that, so far, a sufficient number of species, whose evidence is unequivocal, has not been found.

EASTERN ONTARIO AND QUEBEC.

VARS.

East of Ottawa, in the vicinity of Vars (Figure 5), the Queenston red clay shales also appear to rest directly upon strata which may be correlated with the Waynesville phase of the Richmond. A *Zygospira* resembling *kentuckiensis*, occurs in the highest fossiliferous strata immediately under the Queenston shales. If the coral zones are present anywhere in eastern Ontario, they are not exposed. At a lower horizon *Strophomena fluctuosa* is associated with *Catazyga headi*, *Pholadomorpha pholadiformis*, *Modiolopsis concentrica*, *Pterinea demissa*, *Byssonychia radiata*, and numerous other fossils.

This, the most interesting fossil locality in the area east of Ottawa, is found west of Vars. The *Strophomena fluctuosa* locality may be reached by going from Vars half a mile directly west along the railway, to the first road crossing, and then turning southward for a quarter of a mile to the point where the road crosses a small brook. The exposures lie westward along the brook. Fine-grained limestones are abundant in places, and the breaking of a considerable quantity of rock probably would result in the finding of a considerable fauna. The following species were observed:

Cornulites sp.
Pholidops subtruncata.
Crania sp.
Lingula sp.
Rafinesquina alternata, 30 mm long.
Plectambonites sericeus.
Strophomena fluctuosa.
Catazyga headi.
Zygospira modesta.
Zygospira cf. *kentuckiensis.*
Clidophorus planulatus.
Byssonychia radiata.
Modiolopsis cf. *concentrica.*
Modiolodon poststriatus.

Whitella goniumbonata.
Pholadomorpha pholadiformis.
Rhytimya sp.
Pterinea demissa.
Lophospira cf. *bowdeni.*
Orthoceras sp.
Calymene callicephala.
Isotelus sp.
Bythocypris cylindrica.

In the Nicolet River section, the highest level for *Catazyga headi* is 100 feet below the highest *Zygospira kentuckiensis* horizon, which occurs just beneath the base of the Queenston red clay shale series, and the lowest specimens of *Strophomena planumbona* are found 60 feet below the highest *Catazyga headi* horizon. *Pholadomorpha pholadiformis* ranges from 70 feet above the highest *Catazyga headi* horizon to about 130 feet below the lowest *Strophomena planumbona* horizon. *Plectambonites* comes in about 40 feet above the highest *Catazyga headi* horizon, but it is of large size only among the *Catazyga* layers, and at lower levels. From these data it is assumed, provisionally, that the *Strophomena fluctuosa* horizon, half a mile west of Vars, belongs somewhere near the base of that part of the Waynesville member of the Richmond section in which *Strophomena planumbona* is found. Associated with *Catazyga headi,* in the Nicolet River section, this would be somewhere between 100 and 160 feet below the *Zygospira kentuckiensis* horizon, which occurs there also just beneath the base of the Queenston shales.

A third of a mile south of the *Strophomena fluctuosa* locality just described, there is a crossroad. This crossroad is about three-quarters of a mile southwest of Vars, between concessions VII and VIII, and between lots 25 and 26. A short distance west of this crossroad, a farm lane, formerly an open road, leads diagonally southwards toward a distant house. A short distance before reaching this house, fully half a mile from the crossroads, many weathered red limestone blocks are seen along the side of the lane. These evidently are residual blocks which have not been transported far from their original location. They contain the following fossils:

Hebertella occidentalis.
Zygospira kentuckiensis, very common.
Byssonychia radiata.
Pterinea demissa.

At this locality are seen the first exposures of the Queenston shales on going southward, and the reddish Queenston clays fill the soil from this point for several miles southward, along the road between concessions III and IV.

To any one familiar with the contact between the richly fossiliferous part of the Richmond section and the overlying Queenston red shales, as exposed in the Nicolet River section, the fossiliferous limestone blocks here mentioned would at once indicate that horizon at which *Zygospira kentuckiensis* is most abundant, namely, immediately below the Queenston shales.

The greater part of the richly fossiliferous Richmond section, which here is correlated with the Waynesville member of the Ohio area, and which should intervene between the *Strophomena fluctuosa* horizon, at the base, and the *Zygospira kentuckiensis* horizon at the top, is not exposed in the vicinity of Vars.

In the Nicolet River section this missing interval includes the *Strophomena hecuba* and *Strophomena sulcata* zones.

EDWARDS STATION.

Boulders of the richly fossiliferous *Zygospira kentuckiensis* beds, associated with Queenston red shale fragments, occur also at a bridge 2½ miles southwest of Edwards station (Figure 5). The locality may be found by going from Edwards station nearly 2½ miles southwest, and then over half a mile southeastward, to a bridge. Evidently, the original line of outcrop must have been farther northward, since the fossiliferous boulders certainly have been moved to their present position by the glaciers.

GENERAL OBSERVATIONS ON THE UPPER RICHMOND OF VARS AND EDWARDS STATION.

The strongly reddish colour of the limestone boulders containing *Zygospira kentuckiensis* at the localities here described, southwest of Vars and southwest of Edwards station, suggests that these limestones may have been interbedded with red clays. In other words, they may have been located in the basal parts of the Queenston red clay shales. Such a position would not be anomalous, considering the fact that the Queenston shales themselves are regarded as of upper Richmond age. They probably represent widespread estuarine deposits along the southern margin of the Laurentian highlands. They are known from the western margin of the Saugeen peninsula which separates Georgian bay from the main body of Lake Huron as far eastward as Streetsville. They line the southern shores of Lake Ontario. They occur in eastern Ontario, east of Ottawa, and in the province of Quebec extensive deposits occur northwest of St. Hyacinthe, north of St. Hugues, south of Ste. Monique, and as far east as the Bécancour river, a short distance south of the St. Lawrence. In this entire mass of strata, fossils are found only locally, chiefly toward the base. Possibly the red limestone blocks southwest of Vars and of Edwards station were located within the basal part of the Queenston section. No fossiliferous equivalent of those Manitoulin Island strata, which are correlated with the Whitewater, occurs in eastern Ontario, and in Quebec fossiliferous equivalents are represented only by the Coral zone on Snake island in Lake St. John.

NICOLET RIVER SECTION.

Fossiliferous Richmond strata are exposed in the already partly described section along the Nicolet river in the province of Quebec (Figures 1 and 2, pages 15 and 16).

Here the fossiliferous Richmond beds are overlaid by a considerable thickness of unfossiliferous clay shales, the basal part of which is of a bluish colour while all of the overlying part is of a strongly reddish colour, and on the basis of its lithological appearance is correlated with the Queenston red clay shales of southern Ontario. In the Meaford area, south of Georgian bay, the Queenston red clay shales are regarded, on the basis of included fossils, as of upper Richmond age. In order to indicate the local change in colour of the Queenston section at its base, where it comes in contact with the underlying richly fossiliferous beds, belonging to the Waynesville member of the Richmond, the following notes are added:

	Thickness feet.
Queenston red clay shales; only the basal part exposed at Section No. 1; the remainder is exposed along the river banks northward and evidently has a considerable thickness. The gas wells northwest of St. Hyacinthe have penetrated fully 1,000 feet of these red clay shales.	
Reddish and bluish clay interbedded	5
Bluish clay	3
Indurated clay rock	½
Bluish clay with indurated clay rock at base	3½
Bluish clay, forming base of Queenston	40
No fossils have been found in any part of the Queenston at this locality, but in the vicinity of Meaford, south of Georgian bay, the Queenston contains fossils regarded as of upper Richmond age.	
Richmond (*Waynesville member*). Richly fossiliferous strata, described in section 1, following.	

It is a familiar fact that the red colour more or less characteristic of the Queenston section is frequently absent in its basal members. Frequently the latter are blue for distances varying from a few feet to 50 feet or more.

In the following notes on the fossiliferous strata in the Nicolet River section which have been correlated with the Waynesville member of the Richmond, three more or less overlapping sections are described as they appear within short distances of each other in the eastern bank of the Nicolet river, 2½ miles southeast of Ste. Monique. Letters have been assigned to several of the more conspicuous horizons by means of which it will be possible to correlate the strata in these sections sufficiently to form some conception of the character of the strata which might be expected in a single continuous section. Where certain fossiliferous zones are too thin to be measured during a preliminary survey, such as the present one, the list of fossils present is inserted at the proper horizon, but no thickness of these very thin fossiliferous horizons is given (Figure 2).

Section No. 1, at Bluff Southwest of Home of Honore Auger.

		Thickness feet.	Total thickness.
	Queenston red clay shales, basal part only, underlaid by Queenston blue shales.		
	Richmond strata, referred to the Waynesville member.		
	Top of section	0	0
(Y)	Thin limestone at top of fossiliferous Richmond with *Zygospira kentuckiensis* very common, also a specimen of *Byssonychia*	..	..
	Argillaceous shale	2	2
	Limestone with *Zygospira kentuckiensis* large, and also *Byssonychia*	1/6	
	Argillaceous shale	4	6
	Thin horizon with *Zygospira* and *Byssonychia*	..	..
	Argillaceous shale	2	8
	Thin horizon with *Byssonychia* common	..	..
	Argillaceous shale with thin limestone breaking into thin layers	5	13
	Thin horizon with *Zygospira kentuckiensis* and bryozoans	..	..
	Argillaceous shale with thin limestones like those above	7	20
	Thin horizon with *Zygospira kentuckiensis*, *Byssonychia*, bryozoans	..	..
	Argillaceous shale	6	26
	Thin horizon with *Byssonychia*, gasteropoda, *Zygospira kentuckiensis*	..	..
	Argillaceous shale with thin limestone, several *Zygospira*, and many gouged out cavities several inches long and half an inch deep on the upper surface of the limestone layers, as in the Lorraine south of Clay cliff, in the Cape Smith area of eastern Manitoulin island	4½	30½
(X)	Argillaceous shale with some limestone, containing *Pterinea demissa*, large, some of the specimens over 2 inches in height; *Byssonychia*, *Pholadomorpha pholadiformis*, *Lophospira bowdeni*	7½	38
	Argillaceous shale	1	39
	Thin horizon with *Pterinea demissa*	..	..
	Argillaceous shale	3	42
	Thin horizon with *Lophospira bowdeni* common, bryozoans	..	..
	Argillaceous shale with *Whitella*, *Pholadomorpha pholadiformis*, *Pterinea demissa*, *Lophospira bowdeni*	5	47

		Thickness feet.	Total thickness.
	Argillaceous shale with bryozoans, and with both *Pterinea demissa*, and *Lophospira bowdeni* very common	6	53
	Argillaceous shale with several layers of limestone	1	54
	Argillaceous shale with one specimen of *Strophomena hecuba*, *Byssonychia*, *Pterinea demissa*, *and Whitella.* At this level a species of *Bythopora*, not *meeki*, is associated with *Hallopora subnodosa*. A species of *Clathrospira* also occurs at and within 15 feet above this horizon	3½	57½
(W)	Argillaceous shale with *Strophomena hecuba* large and very common, *Hebertella occidentalis* large, *Pholadomorpha pholadiformis* and *Cyrtolites ornatus*	2	59½
	Thin limestone layers with *Plectambonites sericeus* of medium size, *Hebertella occidentalis*	½	60

Base of exposures at water level at southern end of cliff.

Holopea sp., and *Clathrospira subconica* were found somewhere in the lower part of this section.

Section No. 2, Along Gully South of Section No. 1 (page 18).

In this section layer (W) corresponds to the top of the *Strophomena hecuba* horizon in section No. 1; layer (X) is at the top of the zone in which *Pterinea demissa* is common.

		Thickness feet.	Total thickness.
	Glaciated strata, rather hard rock layers	3	
	Argillaceous shale	3½	
	Thin horizon with Bryozoans common in clumps	..	..
	Argillaceous shale	1	
	Thin horizon with limestone layer with gouged out markings on top surface	..	..
	Argillaceous shale	2½	
(X)	Thin horizon with *Pterinea demissa* very common, *Lophospira bowdeni*	..	..
	Argillaceous shale with *Lophospira*	1½	
	Argillaceous shale with *Byssonychia*, *Pterinea demissa* very common, *Lophospira bowdeni*	2½	
	Thin horizon with *Whitella* very common	..	..
	Argillaceous shale	¾	
	Argillaceous shale with *Byssonychia*, *Pterinea demissa*, *Lophospira bowdeni*	3	
	Hard limestone layers	¾	..
	Argillaceous shale with *Pterinea demissa*	1½	

		Thickness feet.	Total thickness.
	Thin horizon with *Plectambonites sericeus* common...	..	..
	Argillaceous shale..............................	1½	
(W)	*Strophomena hecuba* large and common, *Pterinea demissa*..................................	2½	59½
	Strophomena hecuba, triangular form not rare........	1	60½
	Thin horizon with one specimen of *Streptelasma rusticum*, several of *Plectambonites sericeus*............	..	..
	Argillaceous shale..............................	2	62½
	Thin horizon with *Strophomena hecuba*, not triangular in form, *Plectambonites sericeus*, *Pterinea demissa*..	..	..
	Hard rock layer................................	..	..
	Argillaceous shale..............................	½	63
	Thin horizon with *Whitella*......................	..	..
	Argillaceous shale without fossils..................	4½	67½
	Thin horizon with *Plectambonites sericeus* common...	..	..
	Argillaceous shale..............................	1	68½
	Argillaceous shale: *Plectambonites* large and common both at top and bottom of this interval..........	½	69
	Argillaceous shale without fossils..................	3½	72½
	Argillaceous shale with *Byssonychia*, *Whitella*, small *Liospira*..................................	2	74½
	A succession of hard limestone layers, the most conspicuous in the section, and containing a few traces of trilobites..................................	3	77½
	Argillaceous shale with practically no fossils.........	5½	83
(V)	Thin horizon with *Strophomena sulcata*, one specimen.	..	..
	Argillaceous shale with one *Byssonychia*............	2	85
	Thin horizon with *Orthoceras*.....................	..	..
	Argillaceous shale..............................	½	85½
	Thin horizon with *Strophomena sulcata* common, *Platystrophia clarksvillensis*, *Strophomena* resembling *Str. precursor* but with no vertical folds along the hinge line..................................	..	..
	Argillaceous shale..............................	1	86½
	Thin horizon with *Strophomena hecuba* large.........	..	..
	Argillaceous shale..............................	3½	90
(U)	Thin horizon with *Strophomena sulcata* common, *Strophomena* resembling *precursor* and *huronensis*, but without vertical wrinkles along the hinge line; *Platystrophia clarksvillensis*, *Platystrophia cypha-versaillesensis*..............................	..	..
	Argillaceous shale with no fossils..................	3	93
	Argillaceous shale with *Platystrophia*...............	2	95
	Argillaceous shale with *Whitella*..................	1½	96½

		Thickness feet.	Total thickness.
(T)	Thin horizon with *Catazyga headi*, *Platystrophia clarksvillensis*, *Strophomena*, large and triangular, possibly *Str. hecuba*, *Whitella* large	..	..
	Argillaceous shale with no fossils	1½	98
	Thin horizon with *Catazyga headi* abundant	..	..
	Argillaceous shale	1½	99½
	Argillaceous shale, with *Catazyga headi* abundant at several levels, and with *Byssonychia* at the top	2½	102
	Argillaceous shales	3	105
	Base of measured part of gully section.		

That part of the Richmond group of rocks which extends from the highest horizon containing *Catazyga headi* (layer T) to the lowest horizon containing *Strophomena planumbona* (layer S) is exposed along the steep hill-side about 100 yards south of the gully, and is described as section No. 3. This section begins north of the western end of a long farm lane, about half-way down the hill-side.

Section No. 3, Hill-side Section, South of Gully Mouth (page 19).

		Thickness feet.	Total thickness.
	Cross-bedded limestone layer	..	..
(T)	Argillaceous shale. Highest horizon at which *Catazyga headi* occurs. *Platystrophia versaillesensis* and *Strophomena planumbona* also occur here	2	97½
	Argillaceous shale with *Cornulites flexuosus* of Lorraine form figured by Hall, at top	4½	102
	Thin horizon with *Catazyga headi* abundant	..	..
	Argillaceous shale	1	103
	Heavy limestone	½	103½
	Argillaceous shale	7½	111
	Heavy limestone layer followed by clay shale with interbedded thin limestone layers, not well exposed	17½	128½
	Hard limestone	½	129
	Thin horizon with *Catazyga headi* abundant	..	..
	Chiefly argillaceous shale	10	139
	Hard limestone interbedded with limestone containing an abundance of *Catazyga headi*, and also numerous speciments of typical forms of *Strophomena planumbona*, *Rafinesquina alternata*	1	140

		Thickness feet.	Total thickness.
	Argillaceous shale	12	152
	Thin horizon with *Catazyga headi* abundant	..	..
	Argillaceous shale	2	154
(S)	Argillaceous shale with *Catazyga headi* abundant. Several specimens of *Strophomena planumbona.* Two specimens of *Rhynchotrema perlamellosum* occur in a loose slab of sandy fine-grained limestone, also containing *Catazyga headi,* at this horizon. It is probable that this slab is almost at its original level	2	156
	Base of strata correlated definitely with *Waynesville member of the Richmond.*		
	Shaly strata	4	160
	Thin horizon with *Catazyga headi* abundant	..	..
	Argillaceous shale	9	169
	Harder limestone with *Plectambonites sericeus* common	½	169½
	Shaly strata	13	182½
	Not exposed	16½	199
	Shaly strata with *Cymatonota* intermediate between *recta* and *pholadis*, near the middle	14	213
	Poorly exposed	20	233
(R)	Shales with *Catazyga* very abundant, and with occasional specimens of *Cyrtolites ornatus* and *Byssonychia*	5½	238½
	The Lorraine-like strata underlying section No. 3 are described on page 19.		

The *Catazyga headi* horizon (R) occurs at the northern edge of a long bluff immediately south of a farm lane coming down the hill-side from the road passing the home of Honore Auger. The locality may be reached as follows. From the home of Auger southeastward to the point where a road comes in from the northeast is a distance of a quarter of a mile. Several hundred yards beyond this point there are two barns on the western side of the road. The lane passes these barns and strikes the hill slope a quarter of a mile distant. The lower *Catazyga headi* exposure here mentioned is located on the left side of the road, at the edge of the bluff, about 60 feet above the level of the river.

In the first of these three sections the base of the Queenston clay shales rests directly on strata containing numerous specimens of a species of *Zygospira* resembling *kentuckiensis.* This

Zygospira, associated with *Byssonychia radiata*, has a vertical range of 30 feet. The interval between the *Strophomena hecuba* layer (layer W) and the lowest *Zygospira kentuckiensis* horizon 30 feet above, is characterized by the abundance and large size of a thick shelled form of *Pterinea demissa*, and numerous specimens of *Lophospira beatrice* which is a rather short spired form of *Lophospira bowdeni*. A form of *Whitella*, resembling *Whitella ohioensis*, is common at several levels, and occasional specimens of *Pholadomorpha pholadiformis* occur. It will be noted that all of the forms mentioned as occurring in this interval between the *Strophomena hecuba* layer and the *Zygospira kentuckiensis* horizon are found also at lower levels. The highest level for *Strophomena hecuba* is 54 feet below the highest level for *Zygospira* cf. *kentuckiensis*. Three and a half feet lower, in layer (W), *Strophomena hecuba* is common, and is associated with *Pholadomorpha pholadiformis*. *Streptelasma rusticum* is found just beneath this abundant *Strophomena hecuba* horizon. The highest horizon for *Strophomena sulcata* is about 78 feet beneath the top of the *Zygospira* zone, but it ranges down to 90 feet, associated with *Platystrophia clarksvillensis*, and a species of *Strophomena* which resembles the more triangular typical form of *hecuba* in outline. No very good specimens of this larger *Strophomena* were collected; the same form occurs also at 97 feet. Immediately below, in layer (T), typical specimens of *Strophomena planumbona* occur, associated with *Catazyga headi*. *Platystrophia clarksvillensis* and *versaillesensis* range from about 25 to 40 feet below the *Strophomena hecuba* layer (W). Most of the fossils here mentioned have an extended vertical range, but their vertical range and order of succession in the provinces of Quebec and Ontario are so much alike that they have a measure of diagnostic value. The danger lies not in making use of these fossils after their ranges are known, but in using them for correlation before their local ranges have been determined. *Strophomena planumbona* occurs not only at the 96½-foot level but also at the 141, 154, and 156-foot levels. Between 155 and 157 feet (layer T), it is associated with *Catazyga headi* and *Rhynchotrema perlamellosum*. This *Rhynchotrema perlamellosum* layer is the lowest horizon (layer T) at which forms definitely suggesting the Waynesville phase of the Richmond are known to occur at present. From some one of the *Strophomena planumbona* zones, in the Waynesville part of the Richmond, Dr. Ulrich determined *Homotrypella hospitalis* and a *Heterotrypa* resembling *prolifica*, two very characteristic Richmond species. *Plectambonites sericeus* is common as low as 170 feet below the highest *Zygospira* layer, and *Catazyga headi* is abundant at the 240-foot level (in layer R) in the descending scale. Below this lower *Catazyga headi* horizon (layer R), the rock assumes a very Lorraine-like appearance, and in these lower strata *Pholadomorpha pholadiformis* and the *Modiolopsis* resembling *concentrica* are found, associated with *Rafinesquina mucronata*, *Pholidops subtruncata*, *Clidophorus praevolutus*, *Ctenodonta lorrainensis*, *Byssonychia radiata*, *Pterinea demissa*, and other forms.

In this Nicolet River section the correlation of the *Pholadomorpha* zone, beneath the strata definitely referred to the Waynesville, offers difficulties. That part of the Waynesville section which extends from layer Y down to layer W is distinctly calcareous. Between layers W and T the strata have a lithological resemblance to the Lorraine and between T and S this lithological resemblance becomes very marked. Lithologically there is no abrupt change between the strata above layer S and any of the underlying strata here referred to the *Pholadomorpha* zone. The general impression produced by a study of the Nicolet River and other sections in Quebec and eastern Ontario is that of a Richmond fauna gradually invading a Lorraine sea, with only a few species of Richmond fossils making their appearance in the *Pholadomorpha* zone, but with their number increasing in layer S, and becoming dominant between layers T and Y. Any attempt at a more exact correlation of the upper Ordovician sections of Quebec and eastern Ontario with those in the Cincinnatian areas of Ohio, Indiana, and Kentucky probably represents more or less of a perversion of the actual facts. Such elements of the fauna as *Strophomena hecuba* and *Strophomena fluctuosa* may have entered the province of Quebec from the north or northeast while *Strophomena planumbona*, *Strophomena sulcata*, and *Rhynchotrema perlamellosa* may have entered from southwestern sources. *Pholadomorpha pholadi-*

formis and its associates in the Streetsville area, *Opisthoptera fissicosta* and *Byssonychia grandis* also represent southern or southwestern invasions into a Lorraine sea.

When many species of a fauna enter a new territory rapidly they are likely to displace more or less of the previously existing fauna and the line of demarcation between the recently introduced fauna and the previously existing one is likely to be more or less sharply defined.

In the case of the Richmond fauna in the provinces of Ontario and Quebec, the fauna appears to have entered a territory dominated by Lorraine forms not *en masse* but a few species at a time, so that there is nowhere in these provinces any sharp demarcation between the Richmond and the Lorraine.

RIVIÈRE DES HURONS, 4 MILES NORTHEAST OF CHAMBLY BASIN.

In the collections of the Geological Survey are various specimens which are labelled as coming from the Rivière des Hurons, occasionally with a reference to St. Jean Baptiste (Figure 1). Among these, the following species have been identified:

Strophomena planumbona var.
Pterinea (Caritodens) demissa.
Pholadomorpha pholadiformis divaricata.
Psiloconcha subovalis.

From the same collection, the following species and varieties have been described by the writer as new:

Modiolopsis postplicata.
Cymatonota lenior.
Psiloconcha sinuata-borealis.
Whitella securiformis.
Whitella complanata.
Whitella goniumbonata.
Clidophorus praevolutus.
Cuneamya scapha-brevior.
Lophospira beatrice.

The horizon appears to have been distinctly above the *Proetus chambliensis* zone, and the lithological appearance of the rock suggests either the *Pholadomorpha* zone in the upper part of the Lorraine, or the lower part of the Waynesville.

The locality from which these fossils were obtained is stated by Ells in his report on the geology of the Montreal sheet, to have been well known. On the map (No. 571) accompanying his report, the fossil locality is indicated as being found a little over a mile downstream from the bridge at the southern edge of the village of St. Jean Baptiste. This bridge lies on the road leading from Mont St. Hilaire village southeastward to the river. However, no exposures occur south of this bridge, either on the river or anywhere near the river, until a point 3 miles downstream is reached. Here the Rivière des Hurons, only a very small creek in midsummer, is crossed by a cement bridge, and from this point exposures extend for at least half a mile down the river. The cement bridge is in the northeast edge of the area known as Chambly East, and lies entirely outside of the St. Jean Baptiste area.

No fossils were found anywhere near the bridge; but about a quarter of a mile down stream a fragment of *Eusarcus*, an Eurypterid, recognizable owing to its very characteristic ornamentation consisting of small oblong elevations with lunulate raised margins, was found at the first locality at which the rock appears black and shaly.

No other fossils were found until a point about half a mile below the cement bridge was reached. Here a road leading to a farm house north of the stream, descends through a cut in the bank and rock is exposed in abundance on the south side of the stream, immediately below the crossing point. Here most of the species listed from the Rivière des Hurons in the collections of the Geological Survey were found. These species include:

Hebertella occidentalis.
Strophomena planumbona.
Strophomena hecuba.
Rafinesquina alternata both flat and convex forms. The flat are more common and attain a length of 1¼ inches.
Catazyga headi.
Byssonychia "radiata."
Pterinea demissa, with thick shells as in Waynesville part of Nicolet River section.
Pholadomorpha pholadiformis.
Modiolopsis cf. *concentrica.*

Whitella securiformis.
Whitella complanata.
Whitella goniumbonata.
Cymatonota cf. *recta.*
Lophospira beatrice.

Although confined to only a small area, the locality may be said to be richly fossiliferous. On the opposite side of the stream, the rock does not rise more than a foot above the water level and fossils are few, although including *Catazyga headi*, *Strophomena planumbona*, and *Byssonychia radiata.* The dip at the richly fossiliferous locality is eastward, so that the *Eusarcus* bearing black shale, farther eastward, probably represents a higher horizon.

The richly fossiliferous horizon probably corresponds approximately to that part of the Waynesville division in the Nicolet River section in which *Strophomena hecuba* is fairly common. At this horizon the *Pterinea demissa* frequently preserves the entire thickness of its shell and is not represented merely by the impression of its exterior surface. Here also *Lophospira beatrice*, a representative of the *Lophospira bowdeni* group is common. Here *Whitella* is common and the range of *Catazyga headi* begins just below.

ST. HILAIRE.

Richmond exposures, referred to the Waynesville member of this group of rocks, occur also east of St. Hilaire village (Figure 1), on the Grand Trunk railway, about 18 miles north-east of Montreal. The station is on the eastern side of the Richelieu river, at the point marked Otterburn park on the Montreal sheet (Map No. 571). At present the Otterburn Park station is farther southward, at the eastern end of the bridge across the river.

From St. Hilaire station a road leads southeastward up the hill and continues for half a mile across a flat plain beyond which it ascends another hill rising toward the foot of the igneous mass of rock forming Mt. St. Hilaire. Near the lower part of the second rise of land an exposure of black shale occurs along the eastern side of the road and contains the fossils listed as a *Pholadomorpha* zone fauna on page 45.

Three-quarters of a mile southeast of the railway station the road turns abruptly southward and within an eighth of a mile an exposure on the south side of the road is reached. The dip of the rock is southward, away from the mountain. The total thickness of the section is 21 feet, the top terminating at a small culvert. Toward the top of the section only a few specimens of *Byssonychia radiata* were noticed, but between 5 and 10 feet above the base, there is a richly fossiliferous zone containing:

Streptelasma rusticum.
Platystrophia clarksvillensis.
Strophomena hecuba and *planumbona.*
Plectambonites sericeus.
Byssonychia radiata.
Pterinea demissa 2 inches in height.
Pholadomorpha pholadiformis.
Cuneamya brevior.
Whitella complanata.
Cymatonota lenior.
Cymatonota cf. *recta.*
Psilonychia subovalis.
Clidophorus praevolutus.
Clidophorus planulatus.
Eotomaria remotistriata, sp. nov.

No specimens of *Catazyga* were noticed at this locality. The fauna is regarded as corresponding approximately to the *Strophomena hecuba* zone in the Waynesville member of the Richmond as exposed in the Nicolet River section. The presence of *Streptelasma rusticum* in association with *Strophomena* is interesting since *Streptelasma* is not a common fossil in that part of the Richmond exposed in western Quebec and eastern Ontario.

This Richmond horizon stratigraphically occurs above the so-called Lorraine exposure occurring along the same road but nearer St. Hilaire, but how much above the latter is unknown. It is evident that the general aspect of the fauna here is Lorraine, with only a few Richmond species added. At the Lorraine fossil exposure the shales are black and thin bedded. On approaching the Richmond exposure, the shale becomes interbedded with brownish, more arenaceous rock. Overlying the fossiliferous Richmond beds, farther southeastward, on the road to Mont St. Hilaire village, is a section similar to that at the cement bridge across the Rivière des Hurons 3½ miles southwest of Mont St. Hilaire village, at which no fossils are found.

At the point where the pike three-quarters of a mile southeast of St. Hilaire turns abruptly southward, a less travelled road leads off northeastward along the western margin of the volcanic plug forming Mont St. Hilaire. On the eastern side of this road the hornstone formed by the volcanic mass is well exposed, but no fossils were seen here. Less than a mile from the pike, this road comes to an end in a farmyard, but a wood road continues in the same general direction along the hornstone front of the mountain, and then angles northwestward toward the railway station which is known as St. Hilaire East. Along this road a loose rock fragment, possibly not in situ, contained *Catazyga headi* and *Streptelasma rusticum.* This association of *Streptelasma rusticum* with *Catzayga headi* was noted also in the exposures along the Nicolet river. The horizon there is above that of the lowest strata containing *Strophomena planumbona,* and, therefore, the rock fragment east of St. Hilaire East is assigned to the lower part of the Waynesville member of the Richmond as exposed on the Nicolet river.

In one of the hornstone boulders, used for the construction of the wharf at St. Hilaire East, said to have been hauled down from the western side of the mountain, *Catazyga headi* is associated with a large *Pterinea demissa* and a well preserved specimen of *Rhynchotrema perlamellosum.* This association also indicates the lower part of the Nicolet River phase of the Waynesville member. From limestone boulders hauled down from the fields east of St. Hilaire station, west of Mont St. Hilaire, but not from the vicinity of the hornstone contact, the following species were obtained.

Catazyga headi.
Strophomena planumbona.
Plectambonites sericeus.
Rafinesquina alternata.
Byssonychia radiata.
Pholadomorpha pholadiformis.

These fossils also indicate the lower part of the Nicolet River phase of the Waynesville member. The *Zygospira kentuckiensis* horizon of the Waynesville bed is unknown so far in the St. Hilaire region, but no thorough exploration of the territory has been attempted as yet.

ST. HUGUES.

The presence of the Waynesville member of the Richmond somewhere north of St. Hugues (Figure 1) is indicated by glacial boulders containing *Strophomena planumbona*, *Strophomena hecuba*, and *Cyclonema bilix*. In one block, *Streptelasma rusticum*, *Catazyga headi*, and *Platystrophia clarksvillensis* are associated. *Rafinesquina alternata* is associated in another block with *Streptelasma rusticum* and *Catazyga headi*. St. Hugues is 37 miles northeast of Montreal, on the St. Hyacinthe and St. Guillaume branch of the Canadian Pacific railway; and 12 miles north of St. Hyacinthe.

The origin of the erratic Richmond blocks in the St. Hugues area is unknown. However, they could have come from within a short distance northward since the geological map of the area indicates that a syncline crosses the Yamaska river a number of miles below St. Hugues, retaining the Queenston red clay shales within the trough of the syncline. On each side of the central axis of this syncline, fossiliferous Richmond strata should be present.

SNAKE ISLAND, LAKE ST. JOHN.

Lake St. John is about 120 miles northwest of Quebec. Roberval is situated on its southwestern shore, and Trenton limestones extend from this village for several miles northward, toward Blue point. Fissile black shales, usually regarded as Utica, occur near the northern end of the line of outcrops, and also south of Roberval, east of the Ouiatchouan falls. All of these strata dip eastward at rather low angles. Snake island lies 2 miles directly east of Roberval. The island is about a mile long, from north to south, but is only a few hundred yards wide. Outcrops occur only in a small patch along the southeastern shore, near the northern end of a rocky beach, but most of the fossils occur in loose and more or less rounded fragments of rock which cover the beach for a distance of 400 or 500 feet along the shore, and for 50 to 160 feet inland, as far as the most distant points reached by the waves in the roughest weather. A second area covered with fossiliferous rock fragments lines the shore a short distance north of mid-length on the eastern side of the island.

At the small patch of exposed rock, on the southeast shore, the dip is eastward at about 5 or 10 degrees. The bedded rock does not rise more than 2 feet above lake level, the surface being glaciated. The glacial striæ are approximately north and south in direction. In winter the ice freezes tight to the rock and pulls it loose. The waves break up the ice and throw it upon the shore; here the ice melts later and releases the rock. The rock which is in situ contains: *Streptelasma rusticum*, *Columnaria alveolata*, *Calapoecia huronensis*, *Lyopora goldfussi*, *Tetradium huronense*, *Stromatocerium huronense*, and *Streptelasma divaricans*.

It is probable that the loose specimens of *Beatricea undulata*, and those of *Ortonella hainesi* which occur in the same rock fragments as *Calapoecia huronensis* originate at about this same horizon.

The horizon containing the above named fossils apparently corresponds to the Gore Bay coral zone of Manitoulin island, and belongs above the Waynesville member of the Richmond. It is correlated provisionally with the Whitewater member.

It is evident, however, that another horizon must be present below water level. The rocks from this source are known only from the fragments tossed up by the waves. These strata contain quite a different fauna and some of the loose rock fragments are distinctly different lithologically from the actual exposures on the island. They are thinner bedded, more compact in texture, and bluer in colour. From the loose fragments coming from these lower horizons the following species were obtained:

Rhombotrypa quadrata.

Strophomena, of the *planumbona* type, with about the same triangular outline as those identified as *fluctuosa* at Vars, east of Ottawa, but without any evidence of concentric folds.

Strophomena resembling *sulcata.*

Platystrophia clarksvillensis.

Catazyga headi; the proposed variety *borealis* evidently has no standing whatever.

Orthodesma canaliculatum.

Modiolopsis cf. *concentrica.*
Pholadomorpha pholadiformis, Ctenodonta cf. *albertina.*
Archinacella, Cyrtolites ornatus, Oxydiscus, Liospira micula, Helicotoma.

These fossils, notwithstanding the low eastward dip of the few layers of rock seen *in situ*, are regarded as belonging to a lower horizon than the coral zone which forms the actual exposures on the island. They occur lower also at all other localities in the provinces of Ontario and Quebec, so that, no matter what their range may be elsewhere, in these provinces they indicate a lower horizon than the Coral zone. This horizon is correlated with the Waynesville member of the Ohio Richmond.

Other fossils found in the same rock fragments, from beneath the coral zone, but not considered so diagnostic, are:

Crania scabiosa.
Crania with very fine concentric striæ.
Crania with very fine radiating striæ.
Crania with coarse radiating striæ, not identical with *laelia.*
Trematis millepunctata.
Dalmanella of *testudinaria* group.
Hebertella occidentalis.
Rafinesquina alternata.
Zygospira modesta.
Rhynchotrema, a tiny new species scarcely more than 7 mm long.
Byssonychia, smaller than *suberecta* and with more plications than *radiata.*
Clidophorus.
Ctenodonta, nearest *albertina.*
Ctenodonta with shorter, more rotund outline than *albertina,* but otherwise not differing from that species, as far as known at present.
Pterinea demissa.
Archinacella, somewhat resembling *richmondensis* in size and general appearance, but with the apex more overhanging anteriorly and more depressed below the middle convexity of the shell, and without any conspicuous concentric striæ.
Cyrtolites ornatus.
Eotomaria.
Helicotoma, resembling *planulatoides* with the upper half of the lateral margins of the outer whorl making a much smaller angle with the horizontal, owing to distortion resulting from pressure.

Hormotoma? a form without the surface striæ, and, therefore, not identifiable generically.

Liospira, resembling *micula* in the closed umbilicus, but without any raised line differentiating the inner reflexed lip or callosity from the remainder of the shell.

Lophospira bowdeni.

Lophospira tropidophora, the type of this species appears to be a *Schizolopha*, but the Snake Island specimens do not preserve any indication of a long narrow slit along the peripheral angle.

Sinuites cancellata.

Oxydiscus.

Orthoceras.

Calymene callicephala.

Isotelus.

Loose specimens of *Rhynchotrema*, resembling in the distinctness of their concentric striations *perlamellosum*, occur entirely free from the rock, but they are somewhat crushed and may belong to the series of *Rhynchotrema increbescens* found in undoubted Trenton limestones several miles north of Roberval, on the western shore of Lake St. John.

This lower Richmond fauna is quite rich, and breaking up the boulders found on the island would no doubt increase the number of species considerably; but sufficient is at hand to indicate the presence of the Waynesville member of the Richmond, or rather that phase of the Waynesville which has been found at various localities in the provinces of Quebec and Ontario as far west as Manitoulin island. The upper coral horizons, with *Stromatocerium* and *Beatricea*, are known not only in the eastern part of Manitoulin but also on Rabbit and Club islands, off the eastern coast. These coral horizons are distinctly higher than the Snake Island horizons furnishing the broken up blocks of Waynesville limestone above mentioned.

It is an interesting fact that at present no outcrops of this coral horizon are known nearer to Snake island than Streetsville, west of Toronto, and Manitoulin island. This coral zone is not present on the Nicolet river, nor in the Vars section, east of Ottawa, nor on the Saugeen peninsula, between Collingwood and Owen Sound. It is unknown at corresponding horizons in New York, but possibly is represented on Frobisher bay, northwest of Labrador, and at other northern areas. The same species of coral have an extensive vertical range on Anticosti island. There probably was free connexion between Anticosti, Lake St. John, and Manitoulin island during the deposition of the coral zones in late Ordovician times.

By far the most widely distributed zone of the fossiliferous Richmond, in the provinces of Quebec and Ontario, is the fossiliferous Waynesville zone below the Gore Bay or lower Saluda coral horizon. The coral zone has been identified at almost every locality on Manitoulin island at which the proper horizon was exposed. Between Georgian bay and Lake Ontario it is absent excepting at one locality, namely, Streetsville, west of Toronto. It appears to be absent also in New York, since no clear evidence of the presence of *Columnaria* in situ in that state has been presented, so far.

The coral zone reached Indiana and Kentucky, and the striking feature of this migration is its presence only on the western side of the Cincinnati geanticline, excepting in central Kentucky, where in an extremely limited area it crossed the geanticline, appearing as far east as Ophelia, 4 miles north of Richmond.

THE ANTICOSTI ELEMENT IN THE RICHMOND FAUNAS.

On comparing the Richmondian faunas east of the Frontenac axis, in the extreme eastern part of Ontario, and throughout the province of Quebec as far northeast as Lake St. John, 120 miles north of Quebec, with those of the Anticosti section, the presence of a few characteristic Anticosti forms may be noted. Among these are the *Strophomena fluctuosa*, from the section east of Vars; the *Strophomena hecuba* from the Nicolet River section and the *Lyopora goldfussi* from the Lake St. John section. When the faunas on Anticosti have been fully described and illustrated, the number of characteristic Anticosti species found in the Richmond strata farther westward at the various localities in the province of Quebec and in the eastern part of Ontario, east of the Frontenac axis, no doubt, will be greatly increased. A close comparison of the faunas east of Ottawa, on the Nicolet river, and on Lake St. John, with those from the various divisions of the Richmondian on Anticosti island, as worked up by Professors Schuchert and Twenhofel, does not show as close a resemblance as was at first expected.

Strophomena fluctuosa has such a great range on Anticosti, that at present it has little diagnostic value in identifying parts of the more western exposures with the lesser divisions of the Anticosti section. No close resemblance between the fauna west of Vars, east of Ottawa, and any part of the Anticosti section can be noticed. With the single exception of *Strophomena fluctuosa*, the resemblances are with Richmond faunas along the northwestern part of Lake Ontario, and around the northern part of Lake Huron, rather than with those of Anticosti. I am rather inclined to believe that the Vars Richmond fauna belongs below the lowest published Richmond fauna on Anticosti.

The vertical range of *Strophomena hecuba* on Anticosti is more restricted than that of *Strophomena fluctuosa*, although equalling about 400 feet. Although *Rhynchotrema perlamellosum* has an almost equally extensive range on Anticosti, it is exceedingly rare in the lower half of the *Strophomena hecuba* zone. *Streptelasma rusticum*, on the contrary, is listed only from the lower half of this *Strophomena hecuba* zone. I am inclined to regard the Nicolet River Richmond exposure as below the base of the Charleton division of the Richmond, but how far below is quite another question. It may be lower than any Richmond fauna so far listed from Anticosti. The general facies of the Richmond fauna on the Nicolet river is western. Notwithstanding the presence of *Strophomena hecuba*, the general fauna resembles that found at Vars, east of Ottawa, and in the areas between the northwestern part of Lake Ontario and the northern part of Lake Huron. This is suggested also by the presence of *Strophomena sulcata*, a form not identified so far from Anticosti.

Lyopora goldfussi is listed by Twenhofel from the Charleton formation in Anticosti, It is listed by Lambe also from Clay cliff, on the eastern side of Cape Smith. *Streptelasma rusticum* is listed only from the lower, or English Head division of the Richmond, on Anticosti. *Tetradium* is not listed at all from Anticosti. *Columnaria halli* is not listed below the lower part of the Charleton division. *Columnaria alveolata* is mentioned first about 200 feet above the base of the Charleton. *Calapoecia cribriformis* is listed from the lower part of the Charleton, but *Calapoecia anticostiensis* begins its range in the underlying English Head division. *Beatricea* begins its range near the middle third of the Charleton.

From the general aspect of the fauna I am inclined to correlate the coral zone of Snake island (see page 156) with the Charleton division, rather than with the English Head division of the Richmond, as exposed on Anticosti. This inclination is somewhat strengthened by the presence of *Ceraurinus marginatus* immediately above the Gore Bay coral zone 3 miles south of Little Current, on Manitoulin island, and the presence, on Anticosti, of the closely related *Ceraurinus icarus* which begins its range near the base of the Charleton division. The underlying part of the Richmond, on Lake St. John, as far as known from the fragments tossed up by the waves, is regarded as belonging very low in the English Head section, if represented on Anticosti at all.

In this connexion, the absence of *Dinorthis subquadrata* in all of the area between Lake St. John, Lake Ontario, and the northern part of Lake Huron should be noted. Any close comparison of the Richmond faunas of these more western areas with those on Anticosti can not fail to demonstrate great differences. It is difficult to avoid the conclusion that the western areas belonged to basins quite distinct from the Anticosti basin, notwithstanding the fact that various Anticosti species succeeded in entering the more western territory at various times. The presence of *Streptelasma angulatum*, in association with *Dinorthis subquadrata*, and the great abundance of *Rhynchotrema perlamellosum* in the lower part of the Charleton section, suggest the possible connexion of the Anticosti with the Manitoulin basin by way of some northern passage during the deposition of this part of the Richmond. The presence of such a temporary northern channel is suggested also by the distribution of *Lyopora* *goldfussi*, as given by L. M. Lambe. *Endoceras anticostiensis* Billings was cited by its author also from Lake St. John, but it is doubtful whether this species is sufficiently distinct to suggest the presence of an additional Anticosti element in the Lake St. John fauna.

After the publication of the later studies of the Anticosti faunas by Twenhofel a much better basis for comparison will be at hand. The object of the present notes is to emphasize the comparatively small, strictly Anticosti element in the Richmond of localities east of the Frontenac axis, even as far east as the Nicolet river and Lake St. John and to contrast this with their general western aspect. That coral reefs may occur at any horizon, and in themselves have no diagnostic value, we already know. It is only the associated fauna which may be diagnostic.

Queenston Formation.

The very meagre Queenston fauna along the southern shores of Georgian bay, and the single species of ostracod found at Oakville along the northern shore of Lake Ontario represent faunas which entered a sandy delta deposit from the southwest. The ostracod element, at least, appears to be a typical representative of the Saluda of Indiana, and of a part of the Whitewater in Ohio.

WESTERN ONTARIO.

BETWEEN GEORGIAN BAY AND LAKE ONTARIO.

OAKVILLE.

Oakville (Figure 6) is a village near the shore of Lake Ontario, about 20 miles southwest of Toronto, and about 10 miles directly south of Streetsville, the locality at which the Richmond formation is so well exposed.

The reddish and purple Queenston shales are well exposed northeast of the village, on the hillsides. Here the type of *Drepanella canadensis* was found by Ulrich. A considerable

Waynesville fauna occurs here directly beneath the Queenston red clay shales (see page 130).

In the October number of the Journal of the Cincinnati Society of Natural History, published in 1890, Mr. E. O. Ulrich briefly described *Drepanella richardsoni*, var. *canadensis*. Since this description is so brief as to almost escape attention, it is given below.

"A variety of *D. richardsoni*, differing from the typical form of the species mainly in the more regular character of the superficial reticulation of the test, occurs at Oakville, Ontario, in purple shales, referred by the Canadian geologists to the Hudson River group. It might be called var. *canadensis*."

It is not stated upon what basis the Canadian geologists referred these strata to the Hudson River group, or where this reference was published, but, whatever their reasons may have been, their reference was correct, since the term Hudson River group was used by them to include the equivalent of all the Cincinnatian strata, of which the Richmond group forms the upper part.

Ulrich's views regarding the Hudson River age of the Queenston shales unquestionably were based upon the evidence offered by his new variety of *Drepanella*, since typical *Drepanella richardsoni* is abundant at the type locality on Cowans creek, northeast of Clarksville, in the western part of Clinton county, Ohio, in strata belonging to the Whitewater division of the Richmond.

In the Catalogue of Types in the U.S. National Museum, the Canadian specimens are listed as *Drepanella richardsoni canadensis*, Ulrich, Lorraine (Ord.), Oakville, Ontario, Canada. In this catalogue, however, the term Lorraine includes those Cincinnatian strata for which the name Maysville has been proposed recently. Used in this sense, the Lorraine formation underlies the Richmond, in southwestern Ohio. Evidently this single species of ostracod had not at the time of publication of this catalogue been considered sufficient to demonstrate the Richmond age of the purple shales at Oakville.

NORTHWEST OF MEAFORD.

The distance from Oakville to Meaford is about 90 miles, in a northwesterly direction. Within this intermediate area no very detailed examination has been made for fossils in the Queenston shales, but the brief examination given the exposures along the railway, from Cataract to Credit Forks and Inglewood, did not offer encouragement for future long continued search for fossils in the Queenston section. Between Collingwood and Cape Rich, however, the Queenston shale is known to be richly fossiliferous, at certain horizons, and at numerous localities.

The first discovery of this fact was made in the summer of 1911, when in company with E. J. Whittaker, the writer found several rather richly fossiliferous zones at a locality 8 miles northwest of Meaford at locality 26 (Figure 6). The locality is immediately south of the crossroads, half a mile south of the eastern end of Mountain lake. It may be reached most readily by taking the road from Meaford to Owen Sound for a distance of 3 miles, and turning off northward for a distance of 7 miles. South of the crossroads, the land rises. The section begins at the top of the hill, and extends north to the crossroad, where there is a school house, then east along the other road for a distance of almost a mile, where the road turns first southward, and then curves eastward down a short and steep ravine. The section ends along the stream following the southern side of the ravine, the description being given in descending order.

	Thickness feet.
Top of hill west of lot 36 in concession VIII, half a mile south of Mountain lake.	
Queenston red clay shales, forming the upper part of the Richmond section; top of Queenston not exposed	57
Greenish clay with thin white limestone containing *Bythopora delicatula*, *Zygospira* species, *Byssonychia radiata*, *Pterinea demissa*, *Drepanella canadensis*, *Eurychilina striatomarginata*, *Leperditia caecigena*, *Primitia lativia*, *Leperditella* cf. *glabra*	9
Road crossing with school at southwest corner of section 37, in concession VIII.	
Along road between sections 36 and 37 in concession VIII occurs the same fauna as in the overlying beds, interval..................	12

	Thickness feet.
Farther east along same road, the same ostracods occur associated with *Zygospira*. Wave marked layer at base, interval..............	5½
East to strong turn in road toward the south about a mile east of the school house..	5½
A few whitish beds interbedded in the red clay shales contain *Zygospira*, rather rare..	5½
Reddish and greenish clay shales with some interbedded reddish sandstone along road going down hill southward..................	44
Greenish shales and sandstones forming the base of the Queenston section of the Richmond..................................	9
Top of richly fossiliferous part of *Waynesville member of the Richmond* (described as locality 15 on page 129).	

Starting from the top of the same hill, as in the case of the section just described, west of lot 36 in concession VIII, but going southward instead of northward, the following section is presented.

	Thickness feet.
Top of hill.	
Interval occupied by red Queenston clay shales..................	7
Thin stratum of white unfossiliferous material.....................	
Interval..	28
Same ostracods as on north side of hill, but not as abundant, nor in as thick a section. Moreover, they occur in small greenish fragments of rock, not in thin limestone layers. The horizon still belongs in the Queenston and appears to be about 22 feet above the upper fossiliferous layers occurring on the north side of the hill, and described in the preceding section.........................	3

Similar fossiliferous horizons are exposed along the same north and south road west of concession VIII, at locality 27, less than 5 miles south of locality 15. Here the base of a massive Silurian limestone, belonging to the lower part of the Manitoulin dolomite section, is exposed along the southeast margin of lot 25 in concession IX. This massive limestone is underlaid by greenish clay, below which is reddish clay, and underneath the latter there is a thin limestone layer rising strongly northward so as to come in contact with the overlying massive limestone. In this inclined limestone layer, typical *Leptaena rhomboidalis* of the Silurian type, and not *Leptaena richmondensis*, occurs. Judging from this single locality, the top of some of the red clay shales, locally, belong to the basal part of the Manitoulin dolomite section, representing material washed along during Silurian times from neighbouring Queenston red clay shales which are of Richmond age, but the redeposited material contains fossils evidently of Silurian age belonging approximately to about the same horizon as the overlying Manitoulin dolomite.

Beginning with the Silurian limestone layer, in which the *Leptaena rhomboidalis* was found, the following section occurs following the road on the eastern margin of lot 24 in concession IX.

	Thickness feet.
Manitoulin dolomite, a single basal layer, with *Leptaena rhomboidalis*, dipping strongly southward	1
Interval chiefly covered with rock fragments from the overlying Manitoulin dolomite, but occupied evidently by the top of the Queenston red clay shale of the Richmond	44
East and west road between sections 25 and 24.	
Red clay, chiefly covered with rubble from the Manitoulin dolomite farther up	23
Red clay	5
Poorly exposed	11½
Thin limestones interbedded with greenish clay, both containing *Byssonychia radiata*, *Byssonychia* of *richmondensis* group, *Pterinea demissa* small, *Eurychylina striatomarginata*, *Bythocypris cylindrica*, *Leperditia caecigena*, *Primitia lativia*, and numerous fragments of bryozoa	2
Ostracods numerous, in thin limestone layers	5½
Thin limestones and greenish clay containing *Byssonychia radiata* and *Leperditia caecigena*	2
Poorly exposed	9
Thin limestone layers in greenish clay, with *Drepanella canadensis* common at the top, *Byssonychia radiata* and numerous fragments of bryozoans near the middle, the ostracods being common also in the lower part	16½
Red clay shales belonging to the lower half of the Queenston section.	

If the preceding sections be correlated, by assuming that the greenish horizons at which the ostracods and other fossils are fairly abundant are practically the same, then the following general section of Queenston strata in the Meaford area (Figure 8) results, in descending order.

	Thickness feet.
Manitoulin dolomite (Silurian).	
Upper part of Queenston red clay shales	85
Ostracods and other fossils, in thin limestone layers interbedded with greenish clay	35
Lower part of Queenston red clay shales	45
Greenish shales and very fine-grained arenaceous layers, unfossiliferous and resembling the strata usually identified as Lorraine	10
Similar strata with fossils few	20
Top of the more richly fossiliferous Richmond horizons in which *Strophomena huronensis* is common, and which are definitely correlated with the Waynesville member of the Richmond.	

In some sections the reddish colour sets in only a short distance above the richly fossiliferous Richmond horizon, so that the total thickness of the Queenston section in this part of Ontario, including the greenish clay shales at the base, may equal 195 feet. More accurate measurements may be made at other localities.

At the section 6 miles north of Meaford, west of the Disciples church on the road to Cape Rich, at locality 28, the Queenston red clay shales are underlaid almost immediately by greenish clays and interbedded limestones which are quite richly fossiliferous, and the base of this fossiliferous section, here referred to the Waynesville, is distinctly defined by a thin horizon containing *Hebertella insculpta*. At locality 15 along the road entering the gully a mile farther northward, neither the top nor the bottom of the so-called Waynesville zone was distinctly defined. *Hebertella insculpta* was absent. None of the horizons could be said to be richly fossiliferous, and all fossils were scarce between 9 and 30 feet beneath the level of the red Queenston shales.

In the same manner, neither the top nor the bottom of the so-called Waynesville zone is clearly defined in the gullies between 2 and 3 miles southeast of Meaford. *Hebertella insculpta* is absent. *Catazyga* occurs at the 167, 203, 325, and 349-foot levels above the lake (Locke level readings). The first specimen of *Strophomena planumbona* is seen at the 325-foot level, and the red clay makes its appearance at different distances above the fossiliferous beds. The general impression produced by the various sections is that of an invading Waynesville fauna which established itself only locally and for a very short time, and which was followed by a period during which chiefly red clays were deposited.

CORRELATION OF QUEENSTON STRATA WITH UPPER RICHMOND STRATA ON MANITOULIN ISLAND.

The fossiliferous horizon with the Queenston red clay shale section containing *Drepanella canadensis*, *Eurychilina striato-marginata*, *Leperditia caecigena*, and *Primitia lativia*, appears to correspond to the Saluda division of the Richmond, as recognized in southeastern Indiana. At least, *Eurychilina striato-marginata*, *Leperditia caecigena*, and *Primitia lativia* are known to occur in the Saluda of Indiana, this being the type horizon for the first two species and the third species is abundant there. Moreover, the nearest relative of *Drepanella richardsoni-canadensis*, as already stated, occurs in the Whitewater beds of Clinton county, Ohio, and it is very probable that the Saluda merely represents a southward more arenaceous zone in the lower part of the Whitewater bed, or an arenaceous phase of the greater part of this bed.

At the time when the Saluda bed was first described, in Indiana, it was regarded as lying above the Whitewater, since there is a thin Whitewater fauna below the typical Saluda in southern Indiana. If, therefore, a Whitewater fauna exist anywhere in Ontario, it would not be in opposition to the known order of succession in Cincinnatian areas to find this Whitewater fauna, or at least a part of it, below the ostracod horizon in the Queenston shale.

A number of facts favour such an interpretation. For instance, on Manitoulin island there are no red clay shales corresponding to those belonging to the Queenston section. However, there are ostracod horizons which apparently may be correlated with those found in the Queenston beds along the southern shores of Georgian bay. These ostracod horizons occur in the upper part of the Richmond sections, not only above the horizons here referred to the Waynesville division, but also above horizons which might be correlated with the Whitewater, or, at least, with the lower part of the Whitewater.

One of these localities is 1½ miles southwest of Kagawong, on the road to Gore Bay. Here *Leperditia caecigena*, and *Primitia lativia* occur within a distance of 3 feet beneath the base of the Manitoulin dolomite. Fifty-two feet lower, there is a 4-foot section in which *Ortonella hainesi*, a familiar species in the Whitewater beds of Ohio and Indiana, is abundant, immediately over

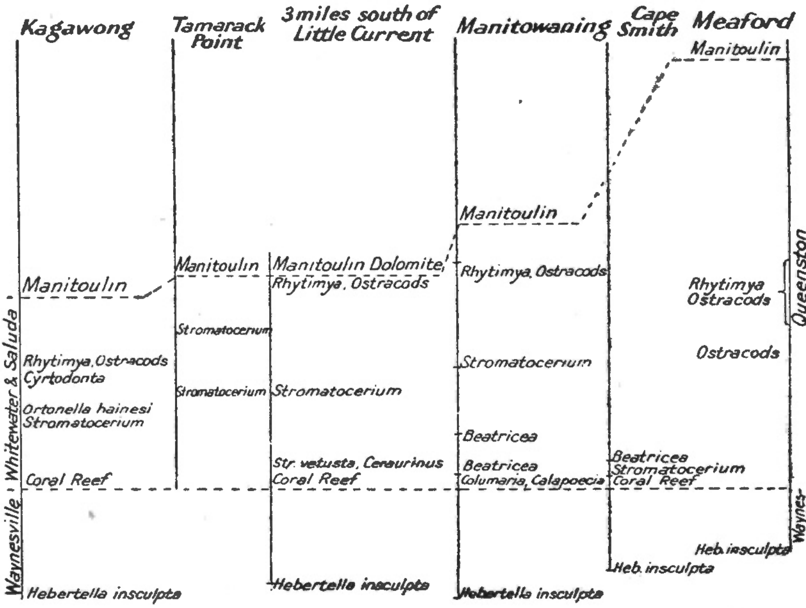

Figure 8. Diagram illustrating the supposed equivalence of the Queenston formation of Meaford with the Upper Richmond (Whitewater and Saluda) formations on Manitoulin island.

a massive *Stromatocerium* reef. Immediately south of Kagawong, the same ostracod species occur 19 feet above a massive *Stromatocerium* reef. On the road from Kagawong to West Bay, about 2 miles southeast of Kagawong, ostracods are common in a greenish fragmentary rock in the road ditch above the *Stromatocerium* horizon.

Along the east and west road passing about 3 miles south of Little Current, *Leperditia caecigena* occurs immediately below the Manitoulin dolomite. Forty-six feet lower, there is a massive *Stromatocerium* reef 9 feet thick, and 37 feet lower, occur *Strophomena vetusta* and a species of *Ceraurinus* which resembles *Ceraurinus meekanus* but which has been described recently by Barton as *Ceraurinus marginatus*. *Columnaria* is abundant immediately below this horizon, and the strata here identified as Waynesville occur still lower. *Strophomena vetusta* is common in the Liberty and Whitewater divisions of the Richmond in Ohio, Indiana, and Kentucky; and *Ceraurinus meekanus* is a Whitewater form in Indiana.

Southeast of Manitowaning, across the bay, *Leperditia caecigena* and *Primitia lativia* occur 22 feet below the base of the Manitoulin dolomite; they range through a thickness of 5 feet, and the horizon is estimated as belonging about 28 feet above the conspicuous *Stromatocerium* reef southwest of the village of Manitowaning.

From these data it appears that there is a series of ostracod horizons on Manitoulin island above the *Stromatocerium* zone which might be correlated with those in the Queenston sections south of Georgian bay. These ostracod horizons overlie beds in which Whitewater fossils occur, and the ostracods themselves suggest Saluda or Whitewater affinities. For this reason it seems possible to correlate the ostracod horizons on Manitoulin island with strata belonging above the base of the Whitewater, in Indiana.

If the ostracod horizons on Manitoulin island be regarded as Saluda, which appears to be equivalent to that part of the Whitewater section which belongs a short distance above the base of the Whitewater, then it may be possible to correlate also the ostracod horizons in the Queenston red clay shales, south of Georgian bay, with the Whitewater. This at present is the correlation favoured by the writer. At every locality (except at Streetsville) so far examined where the Queenston red clay shale was found underlaid by fossiliferous rocks, these proved to be Richmond strata which could be correlated with the Waynesville member. This is true not only in Ontario, but also in western Quebec, east of Ottawa, and also east of Montreal, along the Nicolet river. At Streetsville, the Queenston red clay shales are underlaid by the Coral zone, but since the latter is overlaid by strata containing fossils suggesting Whitewater affinities, the reference of the overlying Queenston beds to strata at least as high as the Whitewater is strengthened by this fact.

As far as may be determined from the observations so far made, the horizon at which the red colouring of the Queenston shales begins varies from place to place, but it seems always to begin above the base of the Waynesville. There is a possibility, however, that at some future time localities may be found in which the Queenston red clay shales may be regarded as replacing not only a part but actually all of the fossiliferous strata referred to the Waynesville in Ontario and Quebec.

No red shales are found among Ordovician strata on Manitoulin island which are regarded as equivalent to the Queenston shales. Not only is the red colouring absent in these strata on Manitoulin, but the number of fossil horizons and the variety of their fossil content is greatly increased.

If the red colouring and arenaceous grain of the Queenston be regarded as due to weathering of a land surface, the deposits may be estuarine or delta sands and clays. The land area from which they were derived may have been the Pre-Cambrian mass in northern Ontario and in the Adirondacks, but it certainly appears to have lain east of the Manitoulin Island area.

It may be noted that the unfossiliferous Salmon River Falls sandstone, overlying the fossiliferous Lorraine in New York, also has an eastern distribution. If there are any equivalents of the Salmon River sandstone west of the eastern border of Lake Ontario, in southern Ontario, these equivalents have not been recognized definitely, excepting possibly in the vicinity of Weston, northwest of Toronto. At present the Salmon River strata of New York are regarded as of Maysville age, but the presence of *Pholadomorpha* in the immediately underlying beds suggests the possibility of their Richmond age.

VARS.

Queenston strata occur along a farm lane crossing the middle of lot 27 in concession VIII, 1½ miles southwest of Vars in the area east of Ottawa; here they appear to rest directly upon strata containing *Zygospira kentuckiensis* which may be correlated with the Waynesville phase of the Richmond (see page 138).

Southward, at a brick house located on the road between concessions III and IV, near the line between lots 23 and 22, a well is said to have passed through 80 feet of red clay, then through about 20 feet of bluish clay, and finally into 20 feet of red clay at the bottom. The elevation of the top of the well is about 295 feet above sea-level. The elevation of the *Zygospira kentuckiensis* residual blocks at the more southern locality, with the base of the Queenston shales immediately above, is approximately 265 feet. Determining the dip of the strata in the Vars area from these data, the *Strophomena fluctuosa* horizon, half a mile west of Vars, at the northeastern edge of lot 25, in concession VIII, is at least 75 feet below the base of the Queenston shales, and may be 100 feet below. At the same rate of dip, the *Hebertella occidentalis* and *Catazyga headi* horizon along the middle of the eastern edge of lot 23 in concession VIII a quarter of a mile north of the railway west of Vars, may belong from 125 to 175 feet below the *Zygospira kentuckiensis* horizon. The exposures at the road crossing nearly 2 miles northwest of Vars between lots 20 and 21 and concessions VII and VIII lie north of a fault extending east and west through the Vars area. But it is known that they contain *Proetus* and in the Nicolet River section this *Proetus* zone extends from 700 to 1,160 feet below the base of the Queenston beds.

The probabilities are that there is a large section of strata intervening between the exposures of the *Proetus* zone at the crossroads 2 miles northwest of Vars and the strata containing *Triarthrus becki*, at the bridge across Bear brook farther northward, near the middle of the western edge of lot 16 in concession VII. Of this intervening section, so largely exposed along the

Nicolet and Bécancour rivers, and elsewhere east of Montreal, no trace has been found so far in this upper Ordovician area east of Ottawa, probably owing to faulting.

Estimating the upper Ordovician section below the Queenston shales along the Nicolet river as considerably over 3,000 feet, and the corresponding part of the upper Ordovician section on Manitoulin island at about 400 feet, it is evident that the upper Ordovician section thins rapidly westward, and it may be assumed that considerable thinning has taken place before reaching Ottawa; but no data are at hand to determine the amount of this thinning. At the well about 2 miles southwest of Vars, on lot 25 of concession IX, north of the road and west of the culvert; Trenton is said to have been struck at a depth of 700 feet, but the rock fragments brought up from this depth and identified as Trenton do not suggest Trenton limestones but fine-grained, argillaceous shale not softened by weathering; therefore, instead of a total thickness of less than 1,000 feet of upper Ordovician strata below the Queenston shale level, a much greater thickness probably is present here.

NICOLET RIVER SECTION.

Queenston strata occur, as already mentioned, in the Nicolet River section. At this locality the basal beds of the Queenston shale, for a thickness of about 50 feet, are not red, but the overlying part which is at least several hundred feet thick and is not included in the measured section, has an almost uniformly red colour. Northwest of St. Hyacinthe, the Queenston is known from well borings to be 1,000 feet thick. At the bluff southwest of the home of Honore Auger, the following section, at the contact of the Queenston and Waynesville, may be seen.

Section No. 1, at Bluff Southwest of Home of Honore Auger.

	Thickness feet.
Queenston red clay shales, top not exposed, not measured.	
Reddish and bluish clay, interbedded	5
Bluish clay	3
Hard clay rock	½
Argillaceous shale, lowest layer of hard clay rock	3½
Clay shale, chiefly blue, base of Queenston section	40
Fossiliferous strata referred to the Waynesville.	

Here the lower part of the Queenston shales for a thickness of nearly 50 feet is not reddish.

(For the underlying parts of this section see pages 142 and 143.)

GENERAL REMARKS ON QUEENSTON SHALE.

In view of the fact that the lower part of the Queenston shale section on the Saugeen peninsula, between Collingwood and Owen Sound, has been proved to be of Richmond origin, and in view of the probability that practically all of the Queenston shale belongs to this Richmond section, as far as can be judged from its similar lithological features, a few comments on the Queenston shale of the Quebec province may be added.

In the first place the fact that throughout this province the first fossils found below the Queenston shale belong to the *Zygospira kentuckiensis* zone should be noted; next, the great thickness of the red shale section, its uniform lithological characteristics, and its considerable geographic distribution. Since it is preserved chiefly in broad synclinals, it is probable that it once extended over much of the country where it now is unknown. There is a large patch of Queenston indicated on the Three Rivers and Quebec sheets, from 25 to 40 miles east of Three Rivers. Another large patch is mapped south and southeast of Three Rivers, and this patch was examined hastily both along the Nicolet and Bécancour rivers. Another patch crosses the St. Francis river, 30 miles southwest of Three Rivers. Recently, well borings have determined the presence of fully 1,000 feet of red Queenston strata under the glacial drift area northwest of St. Hyacinthe. Then, after a long interval, come the exposures southwest of Vars east of Ottawa, the outcrops along the northwestern shore of Lake Ontario, thence northwestward to Cataract Junction, and, after another long break, the shale appears in the Saugeen peninsula from Collingwood to Owen Sound and northwestward. On Manitoulin, the stratigraphical equivalent of the Queenston section is present; however it does not consist of red shale but chiefly of bluish or brownish clay, interbedded with limestone, and contains a considerable number of easily identifiable Upper Richmond fossils.

As already noted, at Streetsville the Queenston belongs above the rich coral horizon of that locality. Since this coral horizon is regarded as of Whitewater age and is correlated with that coral horizon which, on Manitoulin island, lies at the base of the strata there referred to the Whitewater, it is evident that at Streetsville none of the Queenston is older than the Whitewater. At most other localities, for instance at Oakville, and near Meaford, the Queenston rests directly on Waynesville strata, and at these other localities the deposition of red shales may have begun before the close of the Waynesville.

The Queenston shales appear to be merely the estuarine representatives of a part of those marine strata which elsewhere are known under the term Richmond formation.

At Streetsville, the coral zone has a vertical extent of 13 feet. The associated fauna here suggests Whitewater affinities, agreeing in this respect with the faunas beginning with the Gore Bay coral reef, on Manitoulin island. At Streetsville, at least 20 feet of clay shale with some interbedded argillaceous rock overlies the coral zone. The base of the red coloured clay shales included in the Queenston appears to be at least 10 feet higher, so that the base of the red Queenston shales at Streetsville is at least 43 feet above the base of strata correlated with the Whitewater.

At all of the localities northwest of Meaford, however, there not only is no trace of a Whitewater fauna beneath the red clay Queenston shales, but even the upper part of that part of the Waynesville section which is exposed at so many localities on Manitoulin island, appears to be missing. West of the Disciples church, on the J. A. Dix farm, 6 miles north of Meaford, only 14 feet of fossiliferous strata are found above the lowest horizon containing *Hebertella insculpta*, which here is regarded as the base of that part of the section which can be referred with some confidence to the Waynesville. The upper part of this section passes so gradually into comparatively unfossiliferous clay shales that it is difficult to believe that the lower part of the latter does not represent the upper part of the Waynesville section.

Near the base, these clay shales are bluish or greenish, but between 10 and 20 feet above the fossiliferous Waynesville horizons, the red coloured shales begin to alternate with the bluish clay shales, until farther up the red colour prevails almost to the exclusion of the bluish or greenish colours. In other words, the lower part of the red coloured Queenston clay shales at this locality may correspond stratigraphically to the upper part of the Waynesville member of the Richmond.

This is the case apparently also in the vicinity of Oakville, along the northern shore of Lake Ontario.

May it not be possible that farther southward, in New York, where no representatives of the Richmond are known, that the basal part of the Queenston red clay shales may replace even the lowest strata referred to the Richmond in western Ontario?

In this sense of the term the name Queenston does not represent a definite series of strata with a definite base and top. The base, at least, probably changes in horizon more or less from place to place. Nevertheless it is a very convenient lithological term. There appears to be no very good reason, however, why this term should be confined to the red coloured shales, to the exclusion of the lithologically similar unfossiliferous bluish coloured clay shales immediately beneath.

CHAPTER IV.

DISTRIBUTION AND RANGE OF SPECIES.[1]

All of the essential data contained in the preceding pages, relating to the geographical distribution and the geological range of the species listed have been tabulated in the following tables. The localities indicated by numbers in the locality column are given in the list at the end of the table. The references of species to the subdivisions of the Lorraine and Richmond which have been defined in the Ohio valley, are in some cases more or less provisional, and represent the author's opinion in the light of his present knowledge of the faunas.

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[1] These tables have been compiled by Miss A. E. Wilson from the data scattered throughout the preceding pages.

Geographical Distribution and Geological Range of Species.

Genera and species	Page	Locality (see page 266).				Horizon.										
				Ontario.		Ordovician.										Silurian.
									Lorraine.			Richmond.				Medina.
														White-water		
		New York	Quebec	East	West	Trenton	Collingwood	Utica	Horizon undefined	Eden	Maysville	Horizon undefined	Waynesville	Saluda	Queenston	Manitoulin dolomite
SPECIES OF UNCERTAIN AFFINITIES.																
Arthraria	85	....	....	....	8	....	....	....	....	....	x					
	75	....	....	....	6	....	....	....	x							
Arthraria biclavata Miller	121	....	....	....	50	....	....	....	....	....	....	....	x			
Buthotrephis subnodosa Hall	8	6	....	....	....	....	....	....	x							
	9	7	....	....	....	....	....	....	x							
Girvanella sp.	123	....	....	....	52	....	....	....	....	....	....	....	....	x		
Girvanella richmondensis Miller	99	....	....	....	16	....	....	....	....	....	....	....	x	x		
	102	....	....	....	16	....	....	....	....	....	....	....	....	x		
	111	....	....	....	41	....	....	....	....	....	....	....	....	x		
	121	....	....	....	50	....	....	....	....	....	....	....	x			

Licrophycus hudsonicus Billings...	126	....	....	....	50	....	....	....	....	....	....	x			
PORIFERA.															
Spongiae.															
Cyathophycus reticulatum Walcott	5	10	....	....	....	....	....	x							
COELENTERATA.															
Anthozoa (*Corals*).															
Calapoecia huronensis Billings	104	....	....	....	24	....	....	....	....	....	....	....	....	x	
(Species not mentioned in text).	103	....	....	....	50	....	....	....	....	....	....	....	....	x	
	105	....	....	....	34	....	....	....	....	....	....	....	....	x	
	106	....	....	....	35	....	....	....	....	....	....	....	....	x	
	107	....	....	....	36	....	....	....	....	....	....	....	....	x	
	109	....	....	....	39	....	....	....	....	....	....	....	x		
	112	....	....	....	44	....	....	....	....	....	....	....	....	x	
	113	....	....	....	46	....	....	....	....	....	....	....	....	x	
	115	....	....	....	48	....	....	....	....	....	....	....	....	x	
	118, 119	....	....	....	57	....	....	....	....	....	....	....	....	x	
	120	....	....	....	62	....	....	....	....	....	....	....	x		
	121	....	....	....	50	....	....	....	....	....	....	....	....	x	
	123	....	....	....	52	....	....	....	....	....	....	....	x	x	

Geographical Distribution and Geological Range of Species.

Genera and Species.	Page	Locality (see page 266).				Horizon.										
						Ordovician.										Silurian.
				Ontario.					Lorraine.			Richmond.				Medina.
														White-water.		
		New York	Quebec	East	West	Trenton	Collingwood	Utica	Horizon undefined	Eden	Maysville	Horizon undefined	Waynesville	Saluda	Queenston	Manitoulin dolomite
COELENTERATA—Continued.																
Anthozoa (*Corals*)—Continued.																
Calapoecia huronensis Billings....	130	....	....	....	28	....	....	....	....	....	....	....	x			
	98	....	....	....	16	....	....	....	....	....	....	....	x			
	99	....	....	....	17	....	....	....	....	....	....	....	x			
	99	....	....	....	16	....	....	....	....	....	....	....	x	x		
	103	....	....	....	50	....	....	....	....	....	....	....	....	?		
	104	....	....	....	52	....	....	....	....	....	....	....	....	?		
	125, 156	....	....	....	54	....	....	....	....	....	....	x	....			
	156	....	5, 14	....	....	....	....	....	....	....	....	....	....	x		
Calapoecia huronensis Billings or cribriformis (Nicholson).....	133	....	....	....	60	....	....	....	....	....	....	....	....	x		

Columnaria	103	....	....	....	50	....	....	....	....	....	....	....	....	x	
(Species not mentioned in text)	105	....	....	....	34	....	....	....	....	....	....	....	....	x	
	106	....	....	....	35	....	....	....	....	....	....	....	....	x	
	107	....	....	....	36	....	....	....	....	....	....	....	x	x	
	110	....	....	....	40	....	....	....	....	....	....	....	x		
	112	....	....	....	44	....	....	....	....	....	....	....	x	x	
	113	....	....	....	64	....	....	....	....	....	....	....	x		
	113	....	....	....	46	....	....	....	....	....	....	....	x	x	
	115	....	....	....	48	....	....	....	....	....	....	....	....	x	
	117	....	....	....	49	....	....	....	....	....	....	....	....	x	
	118	....	....	....	57	....	....	....	....	....	....	....	x		
	120	....	....	....	50	....	....	....	....	....	....	....	....	x	
	121, 122	....	....	....	50	....	....	....	....	....	....	....	x		
	125	....	....	....	54	....	....	....	....	....	....	....	....	x	
Columnaria alveolata Goldfuss...	98	....	....	....	16	....	....	....	....	....	....	....	x		
	99	....	....	....	17	....	....	....	....	....	....	....	x		
	123	....	....	....	52	....	....	....	....	....	....	....	....	x	
	110	....	....	....	31	....	....	....	....	....	....	....	?		
	117	....	....	....	49	....	....	....	....	....	....	....	x		
	120	....	....	....	62	....	....	....	....	....	....	....	....	x	
	104	....	....	....	24	....	....	....	....	....	....	....	....	x	
	124	....	....	....	53	....	....	....	....	....	....	....	x		
	125	....	....	....	54	....	....	....	....	....	....	x			
	130, 131	....	....	....	25	....	....	....	....	....	....	....	x		

Geographical Distribution and Geological Range of Species.

Genera and species.	Page	Locality (see page 266).				Horizon. Ordovician.										Silurian. Medina.
				Ontario.					Lorraine.			Richmond.		White-water.		
		New York	Quebec	East	West	Trenton	Collingwood	Utica	Horizon undefined	Eden	Maysville	Horizon undefined	Waynesville	Saluda	Queenston	Manitoulin dolomite
COELENTERATA—Continued.																
Anthozoa (*Corals*)—Continued.																
Columnaria alveolata Goldfuss—Continued.	130	....	....	....	28	....	....	....	....	....	....	....	x			
	132	....	....	....	2	....	....	....	....	....	....	....	....	x		
	156	....	5	....	....	....	....	....	....	....	....	....	....	x		
Columnaria calycina Nicholson...	100	....	....	....	16	....	....	....	....	....	....	....	....	x		
	123	....	....	....	52	....	....	....	....	....	....	....	....	x		
	104	....	....	....	24	....	....	....	....	....	....	....	....	x		
	125	....	....	....	54	....	....	....	....	....	....	x				
	132	....	....	....	2	....	....	....	....	....	....	....	....	x		
Lyopora goldfussi (Billings).......	156	....	5	....	....	....	....	....	....	....	....	....	....	x		
Streptelasma divaricans Nicholson	156	....	5	....	....	....	....	....	....	....	....	....	....	x		

Protarea	105				34									x	
(Species not mentioned in text)	109				39										
	117				49								x	x	
	117				49										
	124				53								x		
Protarea papillata Foerste	98				16								x		
	99				17								x		
	105				34								x		
	112				44								x	x	
	125				54							x			
Protarea richmondensis Foerste	112				44										
	125				54							x	x	x	
Streptelasma	57		11			x									
(Species not mentioned in text)	87				49								x		
	107				36								x	x	
	109				39								x		
	110				40								x		
	113				64								x		
	113				46									x	
	115				48									x	
	117				49									x	
	117				49								x		
	118				11								x		
	119				57								x		
	121				50									x	
	121, 122				50								x		
Streptelasma dispandum Foerste	110				40								x		
	112				44									x	

Geographical Distribution and Geological Range of Species.

Genera and species.	Page	Locality (see page 266).				Horizon.										
						Ordovician.										Silurian.
				Ontario.					Lorraine.			Richmond.				Medina.
														White-water.		
		New York	Quebec	East	West	Trenton	Collingwood	Utica	Horizon undefined	Eden	Maysville	Horizon undefined	Waynesville	Saluda	Queenston	Manitoulin dolomite
COELENTERATA—Continued.																
Anthozoa (*Corals*)—Continued.																
Streptelasma rusticum Billings...	29	....	6	....	....	....	....	....	....	....	....	?				
	98	....	....	....	16	....	....	....	....	....	....	....	x			
	99	....	....	....	16	....	....	....	....	....	....	....	..x	x		
	106	....	....	....	35	....	....	....	....	....	....	....	x			
	110	....	....	....	40	....	....	....	....	....	....	....	x			
	111	....	....	....	41	....	....	....	....	....	....	....	....	..x		
	112	....	....	....	44	....	....	....	....	....	....	....	x	x		
	123	....	....	....	52	....	....	....	....	....	....	....	....	x		

	124	....	....	....	53	....	....	....	....	....	....	....	x		
	125	....	....	....	54	....	....	....	....	....	....	x			
	130	....	....	....	28	....	....	....	....	....	....	....	x	x	
	133	....	....	....	60	....	....	....	....	....	....	....			
	145	....	17	....	....	....	....	....	....	....	....	....	x		
	154	....	13	....	....	....	....	....	....	....	....	....	x	x	
	156	....	5	....	....	....	....	....	....	....	....	....			
	155	....	15	....	....	....	....	....	....	....	....	....	x		
Tetradium....................	132	....	....	....	2	....	....	....	....	....	....	....	....	x	
(Species not named in text)	103	....	....	....	50	....	....	....	....	....	....	....	....	x	
	105	....	....	....	34	....	....	....	....	....	....	....	....	x	
	106	....	....	....	35	....	....	....	....	....	....	....	....	x	
	111	....	....	....	43	....	....	....	....	....	....	....	....	x	
	113	....	....	....	46	....	....	....	....	....	....	....	....	x	
	114	....	....	....	47	....	....	....	....	....	....	....	....	x	
	115	....	....	....	48	....	....	....	....	....	....	....	....	x	
	116	....	....	....	49	....	....	....	....	....	....	....	....	x	
	120	....	....	....	50	....	....	....	....	....	....	....	....	x	
	121	....	....	....	50	....	....	....	....	....	....	....	x	....	
	123	....	....	....	52	....	....	....	....	....	....	....	....	x	
	124	....	....	....	53	....	....	....	....	....	....	....	x		
Tetradium huronense Billings....	99	....	....	....	16	....	....	....	....	....	....	....	x	x	
	102	....	....	....	16	....	....	....	....	....	....	....	....	x	
	104	....	....	....	24	....	....	....	....	....	....	....	....	x	
	125	....	....	....	54	....	....	....	....	....	....	x			

Geographical Distribution and Geological Range of Species.

Genera and species.	Page	Locality (see page 266).				Horizon.										
						Ordovician.										Silurian.
				Ontario.					Lorraine.			Richmond.				Medina.
														White-water.		
		New York	Quebec	East	West	Trenton	Collingwood	Utica	Horizon undefined	Eden	Maysville	Horizon undefined	Waynesville	Saluda	Queenston	Manitoulin dolomite
COELENTERATA—Continued.																
Anthozoa (Corals)—Continued.																
Tetradium huronense Billings—Continued.	130	....	....	....	25	....	....	....	....	....	....	x				
	130	....	....	....	28	....	....	....	....	....	....	....	x			
	132	....	....	....	2	....	....	....	....	....	....	....	....	x		
	156	....	5	....	....	....	....	....	....	....	....	....	....	x		
COELENTERATA—HYDROZOA.																
Stromatoporoidea.																
Beatricea sp.	121	....	....	....	30	....	....	....	....	....	....	....	....	x		
Beatricea undulata Billings	156	....	....	....	54	....	....	....	....	....	....	....	....	x		
	99	....	....	....	16	....	....	....	....	....	....	....	....	x		

	126	....	....	....	20	....	....	....	....	....	....	....	....	x	
	100	....	....	....	21	....	....	....	....	....	....	....	....	x	
	103	....	....	....	50	....	....	....	....	....	....	....	....	x	
	104	....	....	....	24	....	....	....	....	....	....	....	....	x	
	121	....	....	....	50	....	....	....	....	....	....	....	....	x	
	123	....	....	....	52	....	....	....	....	....	....	....	....	x	
	156	....	14	....	....	....	....	....	....	....	....	....	....	?	
Stromatocerium (Species not named in text)	169	....	....	....	40	....	....	....	....	....	....	....	....	....	x
	104	....	....	....	24	....	....	....	....	....	....	....	....	x	
	105	....	....	....	34	....	....	....	....	....	....	....	....	x	
	106	....	....	....	35	....	....	....	....	....	....	....	....	x	
	107	....	....	....	36	....	....	....	....	....	....	....	....	x	
	108	....	....	....	37	....	....	....	....	....	....	....	....	x	
	108	....	....	....	38	....	....	....	....	....	....	....	....	x	
	111	....	....	....	43	....	....	....	....	....	....	....	....	x	
	114	....	....	....	33	....	....	....	....	....	....	....	....	x	
	114	....	....	....	47	....	....	....	....	....	....	....	....	x	
	115	....	....	....	48	....	....	....	....	....	....	....	....	x	
	116, 117	....	....	....	49	....	....	....	....	....	....	....	....	x	
	117	....	....	....	49	....	....	....	....	....	....	....	x		
	120	....	....	....	50	....	....	....	....	....	....	....	....	x	
	123	....	....	....	52	....	....	....	....	....	....	....	....	x	
	124	....	....	....	53	....	....	....	....	....	....	....	x		
	108	....	....	....	8	....	....	....	....	....	....	....	....	x	
	132	....	....	....	2	....	....	....	....	....	....	....	....	x	

Geographical Distribution and Geological Range of Species.

Genera and species.	Page	Locality (see page 266).				Horizon.										
						Ordovician.										Silurian.
				Ontario.					Lorraine.			Richmond.				Medina.
														White-water.		
		New York	Quebec	East	West	Trenton	Collingwood	Utica	Horizon undefined	Eden	Maysville	Horizon undefined	Waynesville	Saluda	Queenston	Manitoulin dolomite
COELENTERATA—HYDROZOA—*Continued.*																
Stromatoporoidea—Continued.																
Stromatocerium huronense Billings	99	....	....	....	16	....	....	....	....	....	....	....	x	x		
	125	....	....	....	54	....	....	....	....	....	....	x				
	130	....	....	....	28	....	....	....	....	....	....	....	x			
	132	....	....	....	2	....	....	....	....	....	....	....	....	x		
	155	....	5	....	....	....	....	....	....	....	....	....	....	x		
Graptolitoidea.																
Climacograptus putillus Hall	5	10	....	....	....	....	....	x								
	74	....	....	....	4	....	....	....	x							
Climacograptus typicalis Hall.....	5	10	....	....	....	....	....	x								
Climacograptus typicalis Hall var	11	9	....	....	....	....	....	x								

Dicanograptus nicholsoni Hopkins	5	10						x							
Diplograptus vespertinus Ruedemann	85				8						x				
	92				13					x					
Diplograptus hudsonicus Nicholson	74				3, 6				x						
Diplograptus peosta Hall	8	6							x						
	88				49					x					
Diplograptus cf. peosta Hall	86				9					x					
	93				14					?					
Glossograptus quadrimucronatus Hall	5	10						x							
	37		24						x						
Glossograptus quadrimucronatus-approximatus Ruedemann	42		3						x						
Glossograptus quadrimucronatus-postremus Ruedemann	11	9						x							
Lasiograptus eucharis (Hall)	5	10						x							
Leptograptus annectans (Walcott)	5	10						x							
Mastigograptus simplex Walcott	5	10						x							
Mastigograptus tenuiramosus Walcott	5	10						x							
Mastigograptus cf. tenuiramosus Walcott	11	9						x							
Pleurograptus linearis (Carruthers)	5	10						x							
ECHINODERMATA.															
Cyclocystoides huronensis Billings	126				20									x	

Geographical Distribution and Geological Range of Species.

Genera and species.	Page	Locality. (see page 266).				Horizon. Ordovician.										Silurian. Medina.
		New York	Quebec	Ontario. East	Ontario. West	Trenton	Collingwood	Utica	Lorraine. Horizon undefined	Lorraine. Eden	Lorraine. Maysville	Richmond. Horizon undefined	Richmond. Waynesville	Richmond. White-water. Saluda	Richmond. White-water. Queenston	Manitoulin dolomite
ECHINODERMATA—Continued.																
Glyptocrinus columnals........	6	1	....	....	....	....	....	....	x							
	7	2, 3	....	....	....	....	....	....	x							
	7	5	....	....	....	....	....	....	x							
	15	....	1	....	....	....	....	....	x							
	24, 25	....	21	....	....	....	....	....	x							
	24	....	22	....	....	....	....	....	x							
	30, 31, 32	....	23	....	....	....	....	....	x							
	35	....	24	....	....	....	....	....	x							
	38	....	25	....	....	....	....	....	x							
	42	....	3	....	....	....	....	....	x							

	49		7						x						
	56		10						x						
	64, 65			1					x						
	65			3					x						
	66			9					x						
Heterocrinus columnals	6	1							x						
	7	2, 3							x						
	15		1						x						
	25		21						x						
	30, 31		23						x						
	35, 36		24						x						
	38		25						x						
	42		3						x						
	45		6						x						
	49		7						x						
	53		9			x									
	56		10						x						
	66			9					x						
Ohiocrinus cf. geniculatus Ulrich	55		9						x						
Taeniaster meafordensis Foerste	79				7						x				
VERMES.															
Annelida.															
Cornulites richmondensis Miller ?	47		6						x						
Cornulites	9	7							x						
	11	9						x							
	45		6						x						
	65			3					x						

Geographical Distribution and Geological Range of Species.

Genera and species.	Page	Locality (see page 266).				Horizon.										
				Ontario.		Ordovician.										Silurian.
									Lorraine.			Richmond.				Medina.
														White-water.		
		New York	Quebec	East	West	Trenton	Collingwood	Utica	Horizon undefined	Eden	Maysville	Horizon undefined	Waynesville	Saluda	Queenston	Manitoulin dolomite
VERMES—Continued.																
Annelida—Continued																
Cornulites—Continued...........	66	....	....	9	....	....	....	....	x							
	130	....	....	....	28	....	....	....	....	....	....	....	x			
	138	....	....	1	....	....	....	....	....	....	....	x				
	84	....	....	....	8	....	....	....	....	....	x					
	119	....	....	....	57	....	....	....	....	....	....	....	x			
	125	....	....	....	54	....	....	....	....	....	....	x				
	138	....	....	1	....	....	....	....	....	....	....	x				
Cornulites straight free form......	6	1	....	....	....	....	....	....	x							
	7	2, 3	....	....	....	....	....	....	x							
	15	....	1	....	....	....	....	....	x							

Cornulites flexuosus Hall	21	....	19	....	....	....	....	....	x						
	24, 25	....	22	....	....	....	....	....	x						
	25	....	21	....	....	....	....	....	x						
	31, 32	....	23	....	....	....	....	....	x						
	35, 36	....	24	....	....	....	....	....	x						
	38	....	25	....	....	....	....	....	x						
	49	....	7	....	....	....	....	....	x						
	146	....	18	....	....	....	....	....	....	....	....	....	x		
Spirorbis cf. cincinnatiensis Miller and Dyer	108	....	....	....	38	....	....	....	....	....	....	....	....	x	
	125	....	....	....	54	....	....	....	....	....	....	x			
MOLLUSCOIDEA.															
Bryozoa.															
Amplexopora persimilis Nickles	84	....	....	....	8	....	....	....	....	x					
	86	....	....	....	9	....	....	....	....	x					
	88	....	....	....	49	....	....	....	....	x					
	91	....	....	....	12	....	....	....	....	x					
Arthropora	84	....	....	....	8	....	....	....	....	x	x				
	87	....	....	....	49	....	....	....	....	....	x				
	89	....	....	....	11	....	....	....	....	....	x				
Arthropora cleavelandi (James)	86	....	....	....	9	....	....	....	....	x					
	91	....	....	....	12	....	....	....	....	x					
	92	....	....	....	13	....	....	....	....	x					
Arthropora shafferi Meek	73	....	....	....	4	....	....	....	x						
Aspidopora	31	....	23	....	....	....	....	....	....	x					
	33	....	3	....	....	....	....	....	....	x					
	39	....	25	....	....	....	....	....	....	x					
	40	....	1	....	....	....	....	....	x						

Geographical Distribution and Geological Range of Species.

Genera and Species.	Page	Locality (see page 266).				Horizon. Ordovician.										Silurian. Medina.
				Ontario.					Lorraine.			Richmond.		Whitewater.		
		New York	Quebec	East	West	Trenton	Collingwood	Utica	Horizon undefined	Eden	Maysville	Horizon undefined	Waynesville	Saluda	Queenston	Manitoulin dolomite
MOLLUSCOIDEA—Continued.																
Bryozoa—Continued.																
Aspidopora—*Continued*........	40, 42	....	3	....	....	....	....	....	x							
	71, 73	....	....	....	4	....	....	....	x							
Aspidopora cf. areolata Ulrich..	91	....	....	....	12	....	....	....	....	x						
Atactopora maculata Ulrich....	73	....	....	....	4	....	....	....	x							
Batostoma..................	125	....	....	....	54	....	....	....	....	....	....	x				
Bythopora..................	71	....	....	....	4	....	....	....	x	....						
	144	....	16	....	....	....	....	....	....	....	....	....	x			
Bythopora arctipora (Nicholson)	33, 40, 42	....	3	....	....	....	....	....	....	x						
	73	....	....	....	4	....	....	....	x							
	91	....	....	....	12	....	....	....	....	x						

Bythopora arctipora (Nicholson) —*Continued*..........	92	....	....	....	13	....	....	....	....	x					
Bythopora delicatula (Nicholson).	164	....	....	....	26	....	....	....	....	....	....	....	....	....	x
Bythopora dendrina (James)......	84	....	....	....	8	....	....	....	....	....	x				
	88	....	....	....	49	....	....	....	....	....	x				
	89, 90	....	....	....	11	....	....	....	....	....	x				
Bythopora gracilis (Nicholson)....	73	....	....	....	6	....	....	....	x						
	88				49	....	....	....	....	....	x				
	89, 90				11	....	....	....	....	....	x				
Chiloporella sp..................	73	....	....	....	4	....	....	....	x						
Coeloclema......................	36	....	24	....	....	....	....	....	x						
	41	....	1	....	....	....	....	....	x						
	80	....	....	....	7	....	....	....	....	....	x				
Coeloclema commune Ulrich......	56	....	10	....	....	....	....	....	x						
	84	....	....	....	8	....	....	....	....	x					
	86	....	....	....	9	....	....	....	....	x					
	88	....	....	....	49	....	....	....	....	x					
	51	....	8	....	....	....	....	....	x						
Constellaria polystomella Nicholson	99	....	....	....	17	....	....	....	....	....	....	....	x		
	125	....	....	....	54	....	....	....	....	....	....	x			
	133	....	....	....	60	....	....	....	....	....	....	....	....	x	
Dekayella ulrichi (Nicholson).....	33	....	23	....	....	....	....	....	x						
	40	....	1	....	....	....	....	....	x						
	73	....	....	....	4	....	....	....	x						
	84	....	....	....	8	....	....	....	....	x					
	91	....	....	....	12	....	....	....	....	x					
Dekayia appressa Ulrich.........	80	....	....	....	7	....	....	....	....	....	x				
Dekayia pelliculata Ulrich........	84	....	....	....	8	....	....	....	....	....	x				

Geographical Distribution and Geological Range of Species.

Genera and species.	Page	Locality (see page 266).				Horizon. Ordovician.										Silurian. Medina.
				Ontario.					Lorraine.			Richmond.				
														White-water.		
		New York	Quebec	East	West	Trenton	Collingwood	Utica	Horizon undefined	Eden	Maysville	Horizon undefined	Waynesville	Saluda	Queenston	Mauitonlin dolomite
MOLLUSCOIDEA—Continued.																
Bryozoa—Continued.																
Discotrypa cf. elegans (Ulrich)....	79	....	....	....	7	....	....	....	....	....	x					
Eridotrypa....................	79	....	....	....	7	....	....	....	....	....	x					
	84	....	....	....	8	....	....	....	....	x						
Hallopora sp..................	73	....	....	....	6	....	....	....	x							
Hallopora communis (James).....	71	....	....	....	4	....	....	....	x							
	84	....	....	....	8	....	....	....	....	x						
Hallopora dalei (Milne-Edwards and Haime)...............	73	....	....	....	4	....	....	....	x							
Hallopora dalei (Milne-Edwards and Haime) or nodulosa Nicholson	80	....	....	....	65	....	....	....	....	....	x					
	80	....	....	....	61	....	....	....	....	....	x					

Hallopora onealli (James)	90				11					x					
Hallopora sigillarioides Nicholson	57		11					x							
	84				8					x					
	86				9					x					
	88				49					x					
	91				12					x					
Hallopora subnodosa Ulrich	144		16										x		
Hallopora subplana Ulrich	73				4				x						
Hemiphragma sp.	57		11					x							
Hemiphragma whitfieldi (James)	86				9					x					
	88				49					x					
Heterotrypa cf. inflecta Ulrich	80				7						x				
Heterotrypa cf. prolifica Ulrich	149		18										x		
Homotrypella hospitalis (Nicholson)	149		18										x		
Leptotrypa ornata Ulrich	80				7						x				
Paleschara beani (James)	46, 47		6						x						
Paleschara cf. beani (James)	73				5				x						
Perenopora compressa Ulrich	80				7						x				
Perenopora vera Ulrich	73				4				x						
	86				9					x					
	88				49					x					
	91				12					x					
Phylloporina sp.	36		24						x						
	41		1						x						
Ptilodictya	110				40								x		
	121				50									x	
Rhombotrypa sp.	121				50								x		

Geographical Distribution and Geological Range of Species.

Genera and species.	Page	Locality (see page 266).				Horizon.										
				Ontario.		Ordovician.										Silurian.
									Lorraine.			Richmond.				Medina.
														White-water.		
		New York	Quebec	East	West	Trenton	Collingwood	Utica	Horizon undefined	Eden	Maysville	Horizon undefined	Waynesville	Saluda	Queenston	Manitoulin dolomite
MOLLUSCOIDEA—Continued.																
Bryozoa—Continued.																
Rhombotrypa quadrata (Rominger)	98	....	....	....	16	....	....	....	....	....	x		x			
	99	....	....	....	17	....	....	....	....	....	....	....	x			
	130	....	....	....	28	....	....	....	....	....	....	....	x			
	121, 122	....	....	....	50	....	....	....	....	....	....	....				
	125	....	....	....	54	....	....	....	....	....	....	x				
	133	....	....	....	60	....	....	....	....	....	....	....	....	x		
	156	....	14	....	....	....	....	....	....	....	....	....	x			
Spatiopora aspera Ulrich........	79	....	....	....	7	....	....	....	....	....	x					
Spatiopora maculosa Ulrich.......	71	....	....	....	4	....	....	....	x							

Spatiopora cf. maculosa Ulrich	73				5				x						
Stigmatella	73				4				x						
	79				7						x				
	80				65						x				
Stigmatella clavis (Ulrich)	86				9					x					
Stigmatella cf. clavis Ulrich	84				8					x					
Stigmatella cf. clavis Ulrich or nana Ulrich and Bassler	88				49					x					
Stigmatella nana Ulrich and Bassler	91				12					x					
Stigmatella cf. nicklesi Ulrich and Bassler	79				7						x				
Stomatopora	47		6						x						
Brachiopoda.															
Catazyga	24, 25		22						x						
	25		21						x						
	31, 32		23						x						
	36		24						x						
	39		25							x					
	135				59							x			
	109				39								x		
	127				7								x		
			18									?			
Catazyga erratica Hall	6	1							x						
	7	2, 3							x						
	7'	5							x						
	36		24						x						

Geographical Distribution and Geological Range of Species.

Genera and species.	Page	Locality (see page 266).				Horizon.										
						Ordovician.										Silurian.
				Ontario.					Lorraine.			Richmond.				Medina.
														White-water.		
		New York	Quebec	East	West	Trenton	Collingwood	Utica	Horizon undefined	Eden	Maysville	Horizon undefined	Waynesville	Saluda	Queenston	Manitoulin dolomite
MOLLUSCOIDEA—Continued.																
Brachiopoda—Continued.																
Catazyga erratica Hall—Continued.	38	....	25	....	....	....	....	....	x							
	49	....	4	....	....	....	....	....	x							
	50, 51	....	8	....	....	....	....	....	x							
	55	....	9	....	....	....	....	....	x							
	70, 71	....	....	....	4	....	....	....	x							
	79	....	....	....	7	....	....	....	....	....	x					
	74	....	....	....	6	....	....	....	x							
Catazyga headi Billings	147	....	18	....	....	....	....	....	..?							
	146, 147	....	18	....	....	....	....	....	....	....	....	....	x			

	20	....	19	....	....	....	....	....	?						
	23, 25	....	21	....	....	....	....	....	?						
	23, 24, 25	....	22	....	....	....	....	....	x						
	30, 31	....	23	....	....	....	....	....	x						
	42	....	3	....	....	....	....	....	x						
	49	....	7	....	....	....	....	....	x						
	44	....	26	....	....	....	....	....	x						
	65	....	....	5	....	....	....	....	....	....	....	....	?		
	66	....	....	6	....	....	....	....	x						
	66	....	....	4	....	....	....	....	x						
	97	....	....	....	16	....	....	....	....	....	....	....	x		
	109	....	....	....	39	....	....	....	....	....	....	....	x		
	118, 119	....	....	....	57	....	....	....	....	....	....	....	x		
	127	....	....	....	7	....	....	....	....	....	....	....	x		
	128	....	....	....	10	....	....	....	....	....	....	....	x		
	138	....	....	1	....	....	....	....	....	....	....	x			
	146	....	17	....	....	....	....	....	....	....	....	....	x		
	18, 19	....	2	....	....	....	....	....	....	....	....	....	x		
	151, 152	....	26	....	....	....	....	....	....	....	....	....	?		
	154	....	13	....	....	....	....	....	....	....	....	....	x		
	155	....	15	....	....	....	....	....	....	....	....	....	x		
	156	....	14	....	....	....	....	....	....	....	....	....	x		
Crania........................	157	....	14	....	....	....	....	....	....	....	....	....	x		
	138	....	....	1	....	....	....	....	....	....	....	x	....		

Geographical Distribution and Geological Range of Species.

Genera and species.	Page	Locality (see page 266). New York	Quebec	Ontario. East	Ontario. West	Horizon. Ordovician. Trenton	Collingwood	Utica	Lorraine. Horizon undefined	Lorraine. Eden	Lorraine. Maysville	Richmond. Horizon undefined	Richmond. Waynesville	Richmond. White-water. Saluda	Richmond. White-water. Queenston	Silurian. Medina. Manitoulin dolomite
MOLLUSCOIDEA—Continued.																
Brachiopoda—Continued.																
Crania scabiosa Hall..........	99	....	....	....	17	....	....	....	....	....	....	....	x			
	117	....	....	....	49	....	....	....	....	....	....	....	x			
	118	....	....	....	11	....	....	....	....	....	....	....	x			
	123	....	....	....	52	....	....	....	....	....	....	....	....	x		
	125	....	....	....	54	....	....	....	....	....	....	x				
	157	....	14	....	....	....	....	....	....	....	....	....	x			
Dalmanella..................	23, 25	....	21	....	....	....	....	....	x							
	30, 31, 32		23	....	....	....	....	....	x							
	35, 36		24	....	....	....	....	....	x							

	38, 39	....	25	....	....	....	....	....	x							
	42	....	3	....	....	....	....	....	x							
	45	....	6	....	....	....	....	....	x							
	49	....	7	....	....	....	....	....	x							
	57	....	11	....	....	x	....	x								
	62	....	....	2	....	....	....	....	x							
	64	....	....	1	....	....	....	....	x							
	65	....	....	3	....	....	....	....	x							
	66	....	....	9	....	....	....	....	x							
	84	....	....	....	8	....	....	....	....	....	x					
	86	....	....	....	9	....	....	....	....	x						
	88	....	....	....	49	....	....	....	....	x	x					
	90	....	....	....	11	....	....	....	....	....	x					
Dalmanella centrilineata Hall...	8	6	....	....	....	....	....	....	x							
Dalmanella elegantula (Dalman)	106	....	....	....	35	....	....	....	....	....	....	....	....	....	....	x
Dalmanella, small, not jugosa ..	125	....	....	....	54	....	....	....	....	....	....	x				
Dalmanella testudinaria (Dalman)...................	44	....	26	....	....	....	....	....	x							
	49	....	4	....	....	....	....	....	x							
	50, 51	....	8	....	....	....	....	....	x							
	53, 55		9	....	....	....	....	....	x							
Dalmanella cf. testudinaria (Dalman)...............	56	....	10	....	....	....	....	....	x							
	6	1	....	....	....	....	....	....	x							
	7	2, 3	....	....	....	....	....	....	x							
	9	7	....	....	....	....	....	....	x							
	157	....	14	....	....	....	....	....	....	....	....	....	x			

Geographical Distribution and Geological Range of Species.

Genera and species.	Page	Locality (see page 266).				Horizon.										
						Ordovician.										Silurian.
				Ontario.					Lorraine.			Richmond.				Medina.
														White-water.		
		New York	Quebec	East	West	Trenton	Collingwood	Utica	Horizon undefined	Eden	Maysville	Horizon undefined	Waynesville	Saluda	Queenston	Manitoulin dolomite
MOLLUSCOIDEA—Continued.																
Brachiopoda—Continued.																
Glyptorthis sp.	51	....	8	....	....	....	....	....	x							
	56	....	10	....	....	....	....	....	x							
Glyptorthis crispata (Emmons)	6	1	....	....	....	....	....	....	x							
	7	2, 3	....	....	....	....	....	....	x							
Hebertella	20	....	19	....	....	....	....	....	?							
	24	....	22	....	....	....	....	....	x							
	57	....	11	....	....	x										
	66	....	....	9	....	....	....	....	x							
	126	....	....	....	7	....	....	....	....	....	....	....	x			

Hebertella insculpta Hall..........	118	....	....	....	57	....	....	....	....	....	....	....	x		
	97	....	....	....	15	....	....	....	....	....	....	....	x		
	97	....	....	....	16	....	....	....	....	....	....	....	x		
	104	....	....	....	8	....	....	....	....	....	....	....	x		
	105	....	....	....	34	....	....	....	....	....	....	....	x		
	109	....	....	....	39	....	....	....	....	....	....	....	x		
	113	....	....	....	64	....	....	....	....	....	....	....	x		
	121, 122	....	....	....	50	....	....	....	....	....	....	....	x		
	124	....	....	....	53	....	....	....	....	....	....	....	x		
	125	....	....	....	54	....	....	....	....	....	....	x			
	130	....	....	....	28	....	....	....	....	....	....	....	x		
Hebertella occidentalis Hall.......	65	....	....	5	....	....	....	....	....	....	....	....	?		
	65	....	....	3	....	....	....	....	x						
	66	....	....	6	....	....	....	....	x					x	
	132	....	....	....	2	....	....	....	....	....	....	....	....		
	134	....	....	....	2	....	....	....	....	....	....	....	x		
	84	....	....	....	8	....	....	....	....	....	x				
	129	....	....	....	15	....	....	....	....	....	....	....	x		
	98	....	....	....	16	....	....	....	....	....	....	....	x	x	
	99	....	....	....	16	....	....	....	....	....	....	....	x	x	
	100, 102	....	....	....	16	....	....	....	....	....	....	....	....	x	
	107	....	....	....	36	....	....	....	....	....	....	....	x	x	
	108	....	....	....	37	....	....	....	....	....	....	....	....	x	
	108	....	....	....	38	....	....	....	....	....	....	....	....		
	110	....	....	....	31	....	....	....	....	....	....	....	?		
	110	....	....	....	40	....	....	....	....	....	....	....	x	x	
	111	....	....	....	41	....	....	....	....	....	....	....	....		

Geographical Distribution and Geological Range of Species.

Genera and species.	Page	Locality (see page 266).				Horizon.										
						Ordovician.										Silurian.
				Ontario.					Lorraine.			Richmond.				Medina.
														White-water.		
		New York	Quebec	East	West	Trenton	Collingwood	Utica	Horizon undefined	Eden	Maysville	Horizon undefined	Waynesville	Saluda	Queenston	Manitoulin dolomite
MOLLUSCOIDEA—Continued.																
Brachiopoda—Continued.																
Hebertella occidentalis Hall—Continued....	112	....	....	....	44	....	....	....	....	....	....	....	x			
	113	....	....	....	46	....	....	....	....	....	....	....	x			
	115	....	....	....	48	....	....	....	....	....	....	....	....	x		
	117	....	....	....	49	....	....	....	....	....	....	....	x			
	119	....	....	....	57	....	....	....	....	....	....	....	x			
	121	....	....	....	50	....	....	....	....	....	....	....	....	x		
	121	....	....	....	50	....	....	....	....	....	....	....	x			
	126	....	....	....	54	....	....	....	....	....	....	x				

	128				10								x			
	130, 131				25								x			
	130				28								x			
	133				2							x				
	132				2									x		
	132, 135				2								x			
	139			5								x				
	144		16										x			
	151		26										?			
	157		14										x			
Hebertella sinuata Hall	124				54								x			
Leptaena	32		23						x							
(Species not named in text)	36		24						x							
	38, 39		25						x							
Leptaena invenusta Foerste	50, 51		8						x							
	55		9						x							
Leptaena rhomboidalis (Wilckens)	165, 166				27											x
	41								x							
Leptaena rhomboidalis var. cf. invenusta Foerste	71				4				x							
Leptaena cf. rhomboidalis (Wilckens)	35		24						x							
	49		7						x							
	70				4				x							
Leptobolus sp.	88				49					x						

Geographical Distribution and Geological Range of Species.

Genera and species.	Page	Locality (see page 266).		Ontario.		Horizon. Ordovician.			Lorraine.			Richmond.		White-water.		Silurian. Medina.
		New York	Quebec	East	West	Trenton	Collingwood	Utica	Horizon undefined	Eden	Maysville	Horizon undefined	Waynesville	Saluda	Queenston	Manitoulin dolomite
MOLLUSCOIDEA—Continued.																
Brachiopoda—Continued.																
Leptobolus insignis Hall..........	5	10	....	....	....	x	....	x								
	11	9	....	....	....	....	....	x								
	86	....	....	....	9	....	....	....	....	?						
Lingula........................	9	7	....	....	....	....	....	....	x							
	55	....	9	....	....	....	....	....	x							
	138	....	....	1	....	....	....	....	....	....	....	x				
Lingula curta Conrad............	5	10	....	....	....	x	....	x								
Lingula rectilateralis Emmons....	8	6	....	....	....	....	....	....	x							
Orthis flabellites Foerste..........	105	....	....	....	34	....	....	....	....	....	....	....	....	....	....	x

	106				35											x
Pholidops	23, 25		21						x							
	24		22						x							
	31, 32		23						x							
	35, 36		24						x							
Pholidops cincinnatiensis Hall	46		6						x							
Pholidops subtruncata Hall	6	1							x							
	7	2, 3,							x							
	7	5							x							
	15		1						x							
	20		19						?							
	23, 25		21						x							
	30		23						x							
	42		3						x							
	44		26						x							
	45, 47		6						x							
	64, 65			1					x							
	65			3					x							
	65			5									?			
	66			9					x							
	138			1								x				
	149			18					?							
Platystrophia	121				50								x			
	145		17										x			
Platystrophia clarksvillensis Foerste	132				2									x		
	129				15								x			

Geographical Distribution and Geological Range of Species.

Genera and species.	Page	Locality (see page 266).				Horizon.										
						Ordovician.										Silurian.
				Ontario.					Lorraine.			Richmond.				Medina.
														White-water.		
		New York	Quebec	East	West	Trenton	Collingwood	Utica	Horizon undefined	Eden	Maysville	Horizon undefined	Waynesville	Saluda	Queenston	Manitoulin dolomite
MOLLUSCOIDEA—Continued.																
Brachiopoda—Continued.																
Platystrophia clarksvillensis																
Foerste—Continued........	98	....	....	....	16	....	....	....	....	....	....	....	x			
	99	....	....	....	17	....	....	....	....	....	....	....	x			
	106	....	....	....	35	....	....	....	....	....	....	....	x	x		
	107	....	....	....	36	....	....	....	....	....	....	....	x	x		
	110	....	....	....	40	....	....	....	....	....	....	....	x			
	112	....	....	....	44	....	....	....	....	....	....	....	x			
	113	....	....	....	64	....	....	....	....	....	....	....	x			
	119	....	....	....	57	....	....	....	....	....	....	....	x			

	121, 122	....	....	....	50	....	....	....	....	....	....	....	x		
	125	....	....	....	54	....	....	....	....	....	....	x			
	126	....	....	....	10	....	....	....	....	....	....	....	x		
	130, 131	....	....	....	25	....	....	....	....	....	....	....	x		
	130	....	....	....	28	....	....	....	....	....	....	....	x		
	133	....	....	....	2	....	....	....	....	....	....	x			
	132, 134	....	....	....	2	....	....	....	....	....	....	....	x		
	145, 146	....	17	....	....	....	....	....	....	....	....	....	x		
	155	....	15	....	....	....	....	....	....	....	....	....	x		
	153	....	6	....	....	....	....	....	....	....	....	....	x		
	156	....	14	....	....	....	....	....	....	....	....	....	x		
Platystrophia versaillesensis Foerste	145	....	17	....	....	....	....	....	....	....	....	....	x		
	146	....	18	....	....	....	....	....	....	....	....	....	x		
Plectambonites	31, 32	....	23	....	....	....	....	....	x						
	35, 36	....	24	....	....	....	....	....	x						
	38, 39	....	25	....	....	....	....	....	x						
	110	....	....	....	40	....	....	....	....	....	....	....	x		
	113	....	....	....	64	....	....	....	....	....	....	....	x		
	145	....	17	....	....	....	....	....	....	....	....	....	x		
Plectambonites plicatellus Ulrich	57	....	11	....	....	....	....	x							
Plectambonites sericeus (Sowerby)	6	1	....	....	....	....	....	....	x						
	7	2, 3	....	....	....	....	....	....	x						
	9	9	....	....	....	....	....	....	x						
	19, 147	....	18	....	....	....	....	....	?						
	25	....	21	....	....	....	....	....	x						
	30	....	23	....	....	....	....	....	x						

Geographical Distribution and Geological Range of Species.

Genera and species.	Page	Locality (see page 266).				Horizon.										
						Ordovician.										Silurian.
				Ontario.					Lorraine.			Richmond.				Medina.
														Whitewater.		
		New York	Quebec	East	West	Trenton	Collingwood	Utica	Horizon undefined	Eden	Maysville	Horizon undefined	Waynesville	Saluda	Queenston	Manitoulin dolomite
MOLLUSCOIDEA—Continued.																
Brachiopoda—Continued.																
Plectambonites sericeus (Sowerby) —Continued.	35	....	24	....	....	....	....	....	x							
	42	....	3	....	....	....	....	....	x							
	44	....	26	....	....	....	....	....	x							
	49	....	7	....	....	....	....	....	x							
	49	....	4	....	....	....	....	....	x							
	50, 51	....	8	....	....	....	....	....	x							
	57	....	11	....	....	x	....	x								
	62	....	....	2	....	....	....	....	x							
	64, 65	....	....	1	....	....	....	....	x							

	65	....	....	3	....	....	....	....	x							
	65	....	....	5	....	....	....	....	....	....	....	....	?			
	66	....	....	9, 6	....	....	....	....	x							
	74	....	....	....	6	....	....	....	x							
	79	....	....	....	7	....	....	....	....	....	x					
	84	....	....	....	8	....	....	....	....	....	x					
	98	....	....	....	16	....	....	....	....	....	....	....	x			
	99	....	....	....	17	....	....	....	....	....	....	....	x			
	110	....	....	....	31	....	....	....	....	....	....	....	?			
	130	....	....	....	28	....	....	....	....	....	....	....	x			
	138	....		1	....	....	....	....	....	....	....	x				
	144	....	16	....	....	....	....	....	....	....	....	....	x			
	145	....	17	....	....	....	....	....	....	....	....	....	x			
	153	....	6	....	....	....	....	....	....	....	....	....	x			
	154	....	13	....	....	....	....	....	....	....	....	....	x			
Rafinesquina....................	46	....	6	....	....	....	....	....	x							
	79	....		....	7	....	....	....	....	....	x					
	84	....		....	8	....	....	....	....	....	x					
	124	....		....	53	....	....	....	....	....	....	....	x			
Rafinesquina alternata (Emmons)	6	1	....	....	....	....	....	....	x							
	7	2, 3	....	....	....	....	....	....	x							
	7	4, 5	....	....	....	....	....	....	x							
	9	7	....	....	....	....	....	....	x							
	15	....	1	....	....	....	....	....	x							
	20	....	19	....	....	....	....	....	?							
	24	....	21	....	....	....	....	....	x							

Geographical Distribution and Geological Range of Species.

Genera and species.	Page	Locality (see page 266).				Horizon. Ordovician.										Silurian. Medina.
				Ontario.					Lorraine.			Richmond.		Whitewater.		
		New York	Quebec	East	West	Trenton	Collingwood	Utica	Horizon undefined	Eden	Maysville	Horizon undefined	Waynesville	Saluda	Queenston	Manitoulin dolomite
MOLLUSCOIDEA—Continued.																
Brachiopoda—Continued.																
Rafinesquina alternata (Emmons) —Continued	24, 25	....	22	....	....	....	....	....	x							
	30	....	23	....	....	....	....	....	x							
	42	....	3	....	....	....	....	....	x							
	44	....	26	....	....	....	....	....	x							
	47	....	6	....	....	....	....	....	x							
	49	....	7	....	....	....	....	....	x							
	138	....	....	1	....	....	....	....	....	....	....	....	x			
	74	....	....	....	6	....	....	....	x							

	134	....	....	....	2	....	....	....	....	....	....	....	x		
	135	....	....	....	59	....	....	....	....	....	....	x			
	88	....	....	....	49	....	....	....	....	....	x				
	90	....	....	....	57	....	....	....	....	....	x				
	129	....	....	....	15	....	....	....	....	....	....	....	x		
	98	....	....	....	16	....	....	....	....	....	....	....	x		
	99	....	....	....	17	....	....	....	....	....	....	....	x		
	110	....	....	....	31	....	....	....	....	....	....	....	?		
	119	....	....	....	57	....	....	....	....	....	....	....	x		
	125	....	....	....	54	....	....	....	....	....	....	x			
	131	....	....	....	25	....	....	....	....	....	....	....	x		
	130	....	....	....	28	....	....	....	....	....	....	....	x		
	138	....	....	1	....	....	....	....	....	....	....	x			
	146	....	18	....	....	....	....	....	....	....	....	....	x		
	151	....	26	....	....	....	....	....	....	....	....	....	?		
	154	....	13	....	....	....	....	....	....	....	....	....	x		
	155	....	15	....	....	....	....	....	....	....	....	....	x		
	157	....	14	....	....	....	....	....	....	....	....	....	x		
Rafinesquina mucronata Foerste ..	7	3	....	....	....	....	....	....	x						
	7	4, 5	....	....	....	....	....	....	x						
	9	7	....	....	....	....	....	....	x						
	15	....	1	....	....	....	....	....	x						
	23, 24	....	21	....	....	....	....	....	x						
	24, 25	....	22	....	....	....	....	....	x						
	31, 32	....	23	....	....	....	....	....	x						
	35	....	24	....	....	....	....	....	x						

Geographical Distribution and Geological Range of Species.

Genera and species.	Page	Locality (see page 266).				Horizon.										Silurian.
						Ordovician.										Medina.
				Ontario.					Lorraine.			Richmond.				
														White-water.		
		New York	Quebec	East	West	Trenton	Collingwood	Utica	Horizon undefined	Eden	Maysville	Horizon undefined	Waynesville	Saluda	Queenston	Manitoulin dolomite
MOLLUSCOIDEA—Continued.																
Brachiopoda—Continued.																
Rafinesquina mucronata Foreste—Continued.................	42	....	3	....	....	....	....	....	x							
	64, 65	....	....	1	....	....	....	....	x							
	65	....	....	5	....	....	....	....	....	....	....	....	?			
	65	....	....	3	....	....	....	....	x							
	66	....	....	6	....	....	....	....	x							
	79	....	....	....	7	....	....	....	....	....	x					
	149	....	18	....	....	....	....	....	?							
	74	....	....	....	6	....	....	....	x							

Rafinesquina nasuta Conrad	7	3	....	....	....	....	....	....	x							
	9	7	....	....	....	....	....	....	x							
Rhipidomella hybrida (Sowerby)	106	....	....	....	35	....	....	....	....	....	....	....	....	....	....	x
Rhynchotrema	57	....	11	....	....	x	....	x								
	113	....	....	....	46	....	....	....	....	....	....	....	x			
	157	....	14	....	....	....	....	....	....	....	....	....	x			
Rhynchotrema capax (Conrad)	112	....	....	....	44	....	....	....	....	....	....	....	....	x		
	113	....	....	....	46	....	....	....	....	....	....	....	x	x		
	117	....	....	....	49	....	....	....	....	....	....	....	x	x		
	118	....	....	....	57	....	....	....	....	....	....	....	x			
Rhynchotrema increbescens (Hall)	158	....	20	....	....	x										
Rhynchotrema perlamellosum (Whitfield)	23	....	21	....	....	....	....	....	....	....	....	....	x			
	98	....	....	....	16	....	....	....	....	....	....	....	x			
	99	....	....	....	16	....	....	....	....	....	....	....	x	x		
	100	....	....	....	16	....	....	....	....	....	....	....	....	x		
	106	....	....	....	35	....	....	....	....	....	....	....	....	x		
	107	....	....	....	36	....	....	....	....	....	....	....	x	x		
	110	....	....	....	31	....	....	....	....	....	....	....	?			
	112	....	....	....	44	....	....	....	....	....	....	....	x			
	113	....	....	....	64	....	....	....	....	....	....	....	x			
	115	....	....	....	48	....	....	....	....	....	....	....	....	x		
	118	....	....	....	11	....	....	....	....	....	....	....	x			
	119	....	....	....	57	....	....	....	....	....	....	....	x			
	121	....	....	....	50	....	....	....	....	....	....	....	....	x		
	19, 147	....	2	....	....	....	....	....	....	....	....	....	x			

Geographical Distribution and Geological Range of Species.

Genera and species.	Page	Locality (see page 266).				Horizon.										
				Ontario.		Ordovician.										Silurian.
									Lorraine.			Richmond.				Medina.
														White-water.		
		New York	Quebec	East	West	Trenton	Collingwood	Utica	Horizon undefined	Eden	Maysville	Horizon undefined	Waynesville	Saluda	Queenston	Manitoulin dolomite
MOLLUSCOIDEA—Continued.																
Brachiopoda—Continued.																
Rhynchotrema perlamellosum (Whitfield)—Continued	154		13										x			
	158		14									?				
Rhynchotrema cf. perlamellosum (Whitfield)	158		14			?										
Schizocrania filosa Hall	9	7							x							
	11	9						x								
Strophomena	105				34								x			
	106				35									x		
	107				36								x			

	109	....	....	....	39	....	....	....	....	....	....	....	x		
	110	....	....	....	40	....	....	....	....	....	....	....	x		
	112	....	....	....	44	....	....	....	....	....	....	....	x		
	146	....	17	....	....	....	....	....	....	....	....	....	x		
Strophomena fluctuosa Billings...	138	....	....	1	....	....	....	....	....	....	....	x			
	138	....	....	1	....	....	....	....	....	....	....	....	x		
Strophomena cf. fluctuosa Billings	156	....	14	....		....	....	....	x						
Strophomena hecuba Billings......	25	....	22	....	....	....	....	....	....	....	....	....	x		
	18, 144	....	16	....		....	....	....	....	....	....	....	x		
	18, 145	....	17	....		....	....	....	....	....	....	....	?		
	151	....	26	....		....	....	....	....	....	....	....	x		
	29, 153	....	6	....	....	....	....	....	....	....	....	....	x		
	155	....	15	....	....	....	....	....	....	....	....	....	x		
Strophomena huronensis Foerste..	129	....	....	....	15	....	....	....	....	....	....	....	x		
	98	....		....	16	....	....	....	....	....	....	....	x		
	99	....		....	17	....	....	....	....	....	....	....	x		
	110	....		....	40	....	....	....	....	....	....	....	x		
	113	....		....	64	....	....	....	....	....	....	....	x		
	118, 119	....	....	....	57	....	....	....	....	....	....	....	x		
	124	....		....	53	....	....	....	....	....	....	x			
	125	....		....	54	....	....	....	....	....	....	....	x		
	128	....		....	10	....	....	....	....	....	....	....	x		
	167	....		....	27	....	....	....	....	....	....	....	x		
	130	....		....	28	....	....	....	....	....	....	....	x		
Strophomena neglecta (James)....	99	....		....	17	....	....	....	....	....	....	....	x		
	110	....	....	....	40	....	....	....	....	....	....	....	x		
Strophomena nutans Meek.......	99	....		....	17	....	....	....	....	....	....	....	x		
	110	....	....	....	40	....	....	....	....	....	....	....	x		

Geographical Distribution and Geological Range of Species.

Genera and species.	Page	Locality (see page 266).				Horizon.										
						Ordovician.										Silurian.
				Ontario.					Lorraine.			Richmond.				Medina.
														White-water.		
		New York	Quebec	East	West	Trenton	Collingwood	Utica	Horizon undefined	Eden	Maysville	Horizon undefined	Waynesville	Saluda	Queenston	Manitoulin dolomite
MOLLUSCOIDEA—Continued.																
Brachiopoda—Continued.																
Strophomena cf. nutans Meek....	118	....	....	....	11	....	....	....	....	....	....	....	x			
	19	....	2	....	....	....	....	....	....	....	....	....	x			
Strophomena planumbona Hall...	146, 147	....	18	....	....	....	....	....	....	....	....	....	x			
	23	....	21	....	....	....	....	....	....	....	....	....	x			
	25	....	22	....	....	....	....	....	x	....	....	....				
	43	....	26	....	....	....	....	....	x	....	....	....				
	29, 153	....	6	....	....	....	....	....	....	....	....	....	x			
	135	....	....	....	59	....	....	....	....	....	....	x				
	99	....	....	....	17	....	....	....	....	....	....	....	x			
	110	....	....	....	40	....	....	....	....	....	....	....	x			

	113				64										
	119				57								x		
	125				54							x	x		
	127				7								x		
	130				25								x		
	154		13										x		
	155		15										x		
	151, 152		26										?		
Strophomena planumbona Hall var	150		26										?		
	112				44								x		
Strophomena cf. planumbona Hall or huronensis Foerste	118				11								x		
Strophomena cf. precursor Foerste	145		17										x		
Strophomena sulcata (Verneuil)	65			5									?		
	99				17								x		
	109				39								x		
	110				40								x		
	87, 117				49								x		
	118				11								x		
	145		17										x		
	135				2, 59								x		
Strophomena cf. sulcata (Verneuil)	156		14										x		
Strophomena vetusta James	100				49									x	
Strophomena cf. vetusta James	117				49									x	
Trematis	90				57						x				
	119				57								x		
Trematis millepunctata Hall	157		14										x		
Zygospira	8	6							x						

Geographical Distribution and Geological Range of Species.

Genera and species.	Page	Locality (see page 266).				Horizon.										
						Ordovician.										Silurian.
				Ontario.					Lorraine.			Richmond.				Medina.
														White-water.		
		New York	Quebec	East	West	Trenton	Collingwood	Utica	Horizon undefined	Eden	Maysville	Horizon undefined	Waynesville	Saluda	Queenston	Manitoulin dolomite
MOLLUSCOIDEA—Continued.																
Brachiopoda—Continued.																
Zygospira—Continued..........	11	9	....	....	....	....	....	x								
	57	....	11	....	....	....	....	x								
	100	....	....	....	16	....	....	....	....	....	....	....	....	x		
	143	....	16	....	....	....	....	....	....	....	....	....	x			
	164, 165	....	....	....	26	....	....	....	....	....	....	....	....	....	x	
Zygospira kentuckiensis James....	99	....	....	....	17	....	....	....	....	....	....	....	x			
	110	....	....	....	31	....	....	....	....	....	....	....	?			
	110	....	....	....	40	....	....	....	....	....	....	....	x			
	121	....	....	....	50	....	....	....	....	....	....	....	....	x		

	123	....	....	....	52	....	....	....	....	....	....	....	x	x	
	125	....	....	....	54	....	....	....	....	....	....	x			
	138	....	....	1	....	....	....	....	....	....	....	....	x		
	139	....	....	5	....	....	....	....	....	....	....	x			
	140	....	....	4	....	....	....	....	....	....	....	x			
	143	....	16	....	....	....	....	....	....	....	....	....	x		
Zygospira cf. kentuckiensis James	118	....	....	....	11	....	....	....	....	....	....	....	x		
	139	....	....	1	....	....	....	....	....	....	....	x			
	147	....	18	....	....	....	....	....	....	....	....	....	x		
Zygospira modesta Hall........	23, 25	....	21	....	....	....	....	....	x						
	23, 24, 25	....	22	....	....	....	....	....	x						
	31, 32	....	23	....	....	....	....	....	x						
	42	....	3	....	....	....	....	....	x						
	45, 47	....	6	....	....	....	....	....	x						
	55	....	9	....	....	....	....	....	x						
	64	....	....	1	....	....	....	....	x						
	65	....	....	5	....	....	....	....	....	....	....	....	?		
	65	....	....	3	....	....	....	....	x						
	66	....	....	9	....	....	....	....	x						
	84	....	....	....	8	....	....	....	....	....	x				
	98	....	....	....	16	....	....	....	....	....	....	....	x		
	99	....	....	....	16	....	....	....	....	....	....	....	x	x	
	102	....	....	....	16	....	....	....	....	....	....	....	....	x	
	107	....	....	....	36	....	....	....	....	....	....	....	....	x	
	110	....	....	....	40	....	....	....	....	....	....	....	x		
	110	....	....	....	31	....	....	....	....	....	....	....	?		
	112	....	....	....	44	....	....	....	....	....	....	....	x		
	117	....	....	....	49	....	....	....	....	....	....	....	x	x	

Geographical Distribution and Geological Range of Species.

Genera and species.	Page	Locality (see page 266).				Horizon. Ordovician.										Silurian. Medina.
				Ontario.					Lorraine.			Richmond.		White-water.		
		New York	Quebec	East	West	Trenton	Collingwood	Utica	Horizon undefined	Eden	Maysville	Horizon undefined	Waynesville	Saluda	Queenston	Manitoulin dolomite
MOLLUSCOIDEA—Continued.																
Brachiopoda—Continued.																
Zygospira modesta Hall—Continued....................	118	....	....	....	11	....	....	....	....	....	....	....	x			
	130	....	....	....	28	....	....	....	....	....	....	....	x			
	132	....	....	....	2	....	....	....	....	....	....	x	x			
	133	....	....	....	2	....	....	....	....	....	....	x	....			
	138	....	....	1	....	....	....	....	....	....	....	....				
	157	....	14	....	....	....	....	....	....	....	....	....	x			
Zygospira cf. modesta Hall.......	15	....	1	....	....	....	....	....	x							

MOLLUSCA.															
Pelecypoda.															
Byssonychia....................	20	....	19	....	....	....	....	....	?						
	25	....	21	....	....	....	....	....	x						
	30, 31	....	23	....	....	....	....	....	x						
	35, 36	....	24	....	....	....	....	....	x						
	42	....	3	....	....	....	....	....	x						
	121	....	....	....	50	....	....	....	....	....	....	....	x		
	143, 144	....	16	....	....	....	....	....	....	....	....	....	x		
	145, 146	....	17	....	....	....	....	....	....	....	....	....	x		
	19, 147	....	18	....	....	....	....	....	....	....	....	?			
			13	....	....	....	....	....	....	....	....	....			
	157	....	14	....	....	....	....	....	....	....	....	....	x		
	132	....	....	....	2	....	....	....	....	....	....	....	x		
Byssonychia borealis Foerste.....	74	....	....	....	6	....	....	....	x						
Byssonychia grandis Ulrich.......	134	....		....	2	....	....	....	....	....	....	....	x		
Byssonychia praecursa Ulrich var	125	....		....	54	....	....	....	....	....	....	x			
Byssonychia radiata (Hall).......	6	1	....	....	....	....	....	....		x					
	7	2,3,4	....	....	....	....	....	....		x					
	7	5	....	....	....	....	....	....		x					
	9	7	....	....	....	....	....	....	x						
	15	....	1	....	....	....	....	....	x						
	19, 149	....	18	....	....	....	....	....	?						
	20	....	19	....	....	....	....	....	?						
	24, 25	....	21	....	....	....	....	....	x						

Geographical Distribution and Geological Range of Species.

Genera and species.	Page	Locality (see page 266).				Horizon.										
						Ordovician.										Silurian.
				Ontario.					Lorraine.			Richmond.				Medina.
														White-water.		
		New York	Quebec	East	West	Trenton	Collingwood	Utica	Horizon undefined	Eden	Maysville	Horizon undefined	Waynesville	Saluda	Queenston	Manitoulin dolomite
MOLLUSCA—Continued.																
Pelecypoda—Continued.																
Byssonychia radiata (Hall)—Continued	24	....	22	....	....	....	....	....	x							
	31	....	23	....	....	....	....	....	x							
	35, 36	....	24	....	....	....	....	....	x							
	38	....	25	....	....	....	....	....	x							
	42	....	3	....	....	....	....	....	x							
	44	....	26	....	....	....	....	....	x							
	45	....	6	....	....	....	....	....	x							
	51	....	8	....	....	....	....	....	x							
	53, 55	....	9	....	....	....	....	....	x							

56	....	10	....	....	....	....	....	x						
64	....	....	1	....	....	....	....	x						
66	....	....	6	....	....	....	....	x						
66	....	....	9	....	....	....	....	x						
75	....	....	....	6	....	....	....	x						
32	....	....	....	2	....	....	....	....	....	....	....	....	x	
85	....	....	....	8	....	....	....	....	....	x				
88	....	....	....	49	....	....	....	....	....	x				
129	....	....	....	15	....	....	....	....	....	....	....	x		
102	....	....	....	16	....	....	....	....	....	....	....	....	x	
111	....	....	....	41	....	....	....	....	....	....	....	....	x	
115	....	....	....	48	....	....	....	....	....	....	....	....	x	
116	....	....	....	49	....	....	....	....	....	....	....	....	x	
121	....	....	....	50	....	....	....	....	....	....	....	....	x	
121	....	....	....	50	....	....	....	....	....	....	....	x		
122	....	....	....	51	....	....	....	....	....	....	....	....	x	
130	....	....	....	28	....	....	....	....	....	....	....	x		
133	....	....	....	2	....	....	....	....	....	....	x			
134, 135	....	....	....	2	....	....	....	....	....	....	....	x		
138	....	....	1	....	....	....	....	....	....	....	....	x		
138	....	....	1	....	....	....	....	....	....	....	x			
139	....	....	5	....	....	....	....	....	....	....	x			
144	....	....	....	....	....	....	....	....	....	....	....	x		
151	....	....	26	....	....	....	....	....	....	....	....	?		
153	....	6	....	....	....	....	....	....	....	....	....	x		x
154	....	13	....	....	....	....	....	....	....	....	....	x	....	x
164	....	....	....	26	....	....	....	....	....	....	....	....	....	
166	....	....	....	27	....	....	....	....	....	....	....	....	....	

Geographical Distribution and Geological Range of Species.

Genera and species.	Page	Locality (see page 266). New York	Quebec	Ontario. East	West	Horizon. Ordovician. Trenton	Collingwood	Utica	Lorraine. Horizon undefined	Eden	Maysville	Richmond. Horizon undefined	Waynesville	White-water. Saluda	Queenston	Silurian. Medina. Manitoulin dolomite
MOLLUSCA—Continued.																
Pelecypoda—Continued.																
Byssonychia richmondensis Ulrich	114	....	....	....	33	....	....	....	....	....	....	....	....	x		
—Continued..................	166	....	....	....	27	....	....	....	....	....	....	....	....	....	x	
Byssonychia richmondensis Ulrich	47	....	6	....	....	....	....	....	x							
Byssonychia suberecta Ulrich.....	46	....	6	....	....	....	....	....	x							
Byssonychia cf. suberecta Ulrich	86	....	....	....	9	....	....	....	....	x						
Byssonychia vera Ulrich.........	88	....	....	....	49	....	....	....	....	x						
	24, 25	....	21	....	....	....	....	....	x							
Clidophorus....................	24	....	22	....	....	....	....	....	x							
	38, 39	....	25	....	....	....	....	....	x							

16

	46, 48		6						x						
	49		4						x						
	56		10						x						
	157		14										x		
Clidophorus brevis Foerste	55		9						x						
Clidophorus cf. neglectus Hall	50		8						x						
Clidophorus planulatus (Conrad)	6	1							x						
	7	2, 3							x						
	7	5							x						
	9	7							x						
	31		23						x						
	51		8						x						
	55		9						x						
	85				8						x				
	75				6				x						
	139			1								x			
	150		6										x		
Clidophorus praevolutus Foerste	15		1						x						
	23		21						x						
	42, 43		3						x						
	44		26						x						
	64, 65			1					x						
	65			5									?		
	149		18						?						
	150		26										?		
	153		6										x		
Clidophorus planulatus (Conrad) or praevolutus Foerste	45		6						x						

Geographical Distribution and Geological Range of Species.

Genera and species.	Page	Locality (see page 266).				Horizon.										Silurian.
						Ordovician.										Medina.
				Ontario.					Lorraine.			Richmond.				
														White-water.		
		New York	Quebec	East	West	Trenton	Collingwood	Utica	Horizon undefined	Eden	Maysville	Horizon undefined	Waynesville	Saluda	Queenston	Manitoulin dolomite
MOLLUSCA—Continued.																
Pelecypoda—Continued.																
Clionychia curta Foerste	53, 55	....	9	....	....	....	....	....	x							
Colpomya faba (Conrad)	75	....	....	....	6	....	....	....	x							
	51	....	8	....	....	....	....	....	x							
	55	....	9	....	....	....	....	....	x							
Colpomya faba-pusilla Foerste	6	1	....	....	....	....	....	....	x							
	6	2, 3	....	....	....	....	....	....	x							
	9	7	....	....	....	....	....	....	x							
	42	....	3	....	....	....	....	....	x							
Ctenodonta	25	....	21	....	....	....	....	....	x							

	39		25						x						
	48		6						x						
	120				50									x	
Ctenodonta cf. albertina Ulrich..	42		3						x						
	157		14										x		
Ctenodonta cf. cingulata Ulrich ..	113				46									x	
	129				15								x		
	134				2								x		
Ctenodonta cf. filistriata Ulrich...	30		23						x						
	42		3						x						
	84				8						x				
Ctenodonta iphigenia Billings.....	102				16									x	
	104				24									x	
	108				37,38									x	
	111				41									x	
	123				52									x	
	125				54							x			
Ctenodonta lorrainensis Foerste...	6	1							x						
	6	2, 3							x						
	15		1						x						
	24		21						x						
	24, 25		22						x						
	31		23						x						
	42		3						x						
	44		26						x						
	45		6						x						
	65			3					x						
	149		18						?						

Geographical Distribution and Geological Range of Species.

Genera and species.	Page	Locality (see page 266).				Horizon.										
				Ontario.		Ordovician.										Silurian.
									Lorraine.			Richmond.				Medina.
														White-water.		
		New York	Quebec	East	West	Trenton	Collingwood	Utica	Horizon undefined	Eden	Maysville	Horizon undefined	Waynesville	Saluda	Queenston	Manitoulin dolomite
MOLLUSCA—Continued.																
Pelecypoda—Continued.																
Ctenodonta cf. madisonensis Ulrich	125	....	....	....	54	....	....	....	....	....	....	x				
Ctenodonta pectunculoides Hall..	48	....	6	....	....	....	....	....	x							
Ctenodonta cf. pectunculoides Hall	46	....	6	....	....	....	....	....	x							
	85	....	....	....	8	....	....	....	....	....	x					
Ctenodonta cf. simulatrix Ulrich..	42	....	3	....	....	....	....	....	x							
Cuneamya cf. elliptica Miller.....	9	7	....	....	....	....	....	....	x							
Cuneamya cf. neglecta Meek.....	64	....	....	1	....	....	....	....	x							
Cuneamya scapha H. and W......	32	....	23	....	....	....	....	....	x							
Cuneamya scapha-brevior Foerste.	6	1	....	....	....	....	....	....	x							

	6	2, 3	....	....	....	....	....	....	x						
	55	....	9	....	....	....	....	....	x						
	150	....	26	....	....	....	....	....	....	....	....	....	?		
Cymatonota....................	153	....	6	....	....	....	....	....	....	....	....	....	x		
	15	....	1	....	....	....	....	....	x						
	24	....	22	....	....	....	....	....	x						
	36	....	24	....	....	....	....	....	x						
Cymatonota lenior Foerste.......	150	....	26	....	6	....	....	....	....	....	....	....	?		
	153	....	6	....	....	....	....	....	....	....	....	....	x		
	75	....	....	6	....	....	....	....	x						
Cymatonota parallela (Hall)......	8	6	....	....	....	....	....	....	x						
	9	7	....	....	....	....	....	....	x						
Cymatonota pholadis (Conrad)...	9	7	....	....	....	....	....	....	x						
	38	....	25	....	....	....	....	....	x						
	51	....	8	....	....	....	....	....	x						
	53, 55	....	9	....	....	....	....	....	x						
	64	....	....	1	....	....	....	....	x						
Cymatonota recta Ulrich.........	42	....	3	....	....	....	....	....	x						
	45, 47	....	6	....	....	....	....	....	x						
Cymatonota cf. recta Ulrich......	31	....	23	....	....	....	....	....	x						
	152	....	26	....	....	....	....	....	....	....	....	....	?		
	153	....	6	....	....	....	....	....	....	....	....	....	x		
Cymatonota cf. recta Ulrich or pholadis (Conrad)...........	19, 147	....	18	....	....	....	....	....	?						
	23	....	21	....	....	....	....	....	x						
Cymatonota semistriata Ulrich ...	48	....	6	....	....	....	....	....	x						
Cyrtodonta.....................	107	....	....	....	37	....	....	....	....	....	....	....	....	x	

Geographical Distribution and Geological Range of Species.

Genera and species.	Page	Locality (see page 266).				Horizon.										
						Ordovician.										Silurian.
				Ontario.					Lorraine.			Richmond.				Medina.
														White-water.		
		New York	Quebec	East	West	Trenton	Collingwood	Utica	Horizon undefined	Eden	Maysville	Horizon undefined	Waynesville	Saluda	Queenston	Manitoulin dolomite
MOLLUSCA—Continued.																
Pelecypoda—Continued.																
Cyrtodonta—Continued	108	....	....	....	38	....	....	....	....	....	....	....	....	x		
	110	....	....	....	40	....	....	....	....	....	....	....	x	x		
	115	....	....	....	48	....	....	....	....	....	....	....	....	x		
Cyrtodonta ponderosa Billings....	102	....	....	....	16	....	....	....	....	....	....	....	....	x		
	104	....	....	....	24	....	....	....	....	....	....	....	....	x		
	108	....	....	....	37	....	....	....	....	....	....	....	....	x		
	108	....	....	....	38	....	....	....	....	....	....	....	....	x		
	111	....	....	....	41	....	....	....	....	....	....	....	....	x		
	113	....	....	....	46	....	....	....	....	....	....	....	....	x		

	121	....	....	....	50	....	....	....	....	....	....	....	x	x	
	123	....	....	....	52	....	....	....	....	....	....	....	x	x	
	124	....	....	....	53	....	....	....	....	....	....	x			
	125	....	....	....	54	....	....	....	....	....	....	x			
Ischyrodonta..................	108	....	....	....	38	....	....	....	....	....	....	....	....	x	
	123	....	....	....	52	....	....	....	....	....	....	....	....	x	
Ischyrodonta curta (Conrad).....	7	2, 3	....	....	....	....	....	....	x						
	7	5	....	....	....	....	....	....	x						
	9	7	....	....	....	....	....	....	x						
	68, 75	....	....	....	6	....	....	....	x						
Lyrodesma sp..................	108	....	....	....	38	....	....	....	....	....	....	....	....	x	
Lyrodesma poststriatum (Emmons)................	7	1	....	....	....	....	....	....	x						
	7	2,3,4	....	....	....	....	....	....	x						
	7	5	....	....	....	....	....	....	x						
	9	7	....	....	....	....	....	....	x						
	42	....	3	....	....	....	....	....	x						
	50	....	8	....	....	....	....	....	x						
	53, 55	....	9	....	....	....	....	....	x						
	64	....	....	1	....	....	....	....	x						
	65	....	....	3	....	....	....	....	x						
	75	....	....	....	6	....	....	....	x						
	85	....	....	....	8	....	....	....	....	....	x				
Modiolon......................	121	....	....	....	50	....	....	....	....	....	....	....	....	x	
	121	....	....	....	50	....	....	....	....	....	....	....	x		

Geographical Distribution and Geological Range of Species.

Genera and species.	Page	Locality (see page 266).				Horizon.										
						Ordovician.										Silurian.
				Ontario.					Lorraine.			Richmond.				Medina.
														White-water.		
		New York	Quebec	East	West	Trenton	Collingwood	Utica	Horizon undefined	Eden	Maysville	Horizon undefined	Waynesville	Saluda	Queenston	Manitoulin dolomite
MOLLUSCA—Continued.																
Pelecypoda—Continued.																
Modiolon poststriatum Foerste ...	138	....	....	1	....	....	....	....	....	....	....	x				
Modiolopsis..................	53	....	9	....	....	....	....	....	x	....	....	....	....	....	....	x
	56	....	10	....	....	....	....	....	x							
	134	....	....	....	2	....	....	....	....	....	....	....	x			
	108	....	....	....	38	....	....	....	....	....	....	....	....	x		
	126	....	....	....	54	....	....	....	....	....	....	x				
Modiolopsis anodontoides Conrad cf. sinuata (Emmons)........	8	6	....	....	....	....	....	....	x							

Modiolopsis concentrica Hall and Whitfield	24, 25		22						x						
	47		6						x						
	90				11						x				
	90				57						x				
	91				32,48						x				
	130, 131				25								x		
	138			1									x		
	75				6				x						
	133				2							x			
	134				2								x		
	135				2, 59							x			
Modiolopsis cf. concentrica Hall and Whitfield	7	1							x						
	7	2, 3							x						
	23, 24		22						x						
	42		3						x						
	80				19				x						
	85				8						x				
	89, 90				11						x				
	90				57						x				
	92				64						x				
	138			1								x			

Geographical Distribution and Geological Range of Species.

Genera and species.	Page	Locality (see page 266).				Horizon.										
						Ordovician.										Silurian.
				Ontario.					Lorraine.			Richmond.				Medina.
														White-water.		
		New York	Quebec	East	West	Trenton	Collingwood	Utica	Horizon undefined	Eden	Maysville	Horizon undefined	Waynesville	Saluda	Queenston	Manitoulin dolomite
MOLLUSCA—Continued.																
Pelecypoda—Continued.																
Modiolopsis cf. concentrica Hall and Whitfield—Continued ...	149	....	18	....	....	....	....	....	?							
	151	....	26	....	....	....	....	....	....	....	....	....	?			
	157	....	14	....	....	....	....	....	....	....	....	....	x			
Modiolopsis modiolaris Conrad ...	7	3	....	....	....	....	....	....	x							
	7	5	....	....	....	....	....	....	x							
	9	7	....	....	....	....	....	....	x							
Modiolopsis postplicata Foerste..	150	....	26	....	....	....	....	....	....	....	....	....	?			
Opisthoptera fissicosta Meek	127	....	....	....	7	....	....	....	....	....	....	....	x			

	133	....	....	....	2	....	....	....	....	....	....	x		
	134	....	....	....	2	....	....	....	....	....	....	....	x	
	135	....	....	....	59	....	....	....	....	....	....	x		
	125	....	....	....	54	....	....	....	....	....	....	x		
	131	....	....	....	25	....	....	....	....	....	....	....	x	
	130	....	....	....	28	....	....	....	....	....	....	....	x	
	128	....	....	....	10	....	....	....	....	....	....	....	x	
Opisthoptera cf. fissicosta Meek..	69	....	....	....	2	....	....	....	....	....	....	x		
Orthodesma sp.................	129	....	....	....	15	....	....	....	....	....	....	....	x	
Orthodesma approximatum Foerste	43	....	3	....	....	....	....	....	x					
Orthodesma canaliculatum Ulrich	79	....	....	....	7	....	....	....	....	....	x			
	156	....	14	....	....	....	....	....	....	....	....	....	x	
Orthodesma nasutum (Conrad)...	7	3, 4	....	....	....	....	....	....	x					
	68, 75	....	....	....	6	....	....	....	x					
Orthodesma pulaskiense Foerste ..	9	7	....	....	....	....	....	....	x					
Ortonella hainesi (Miller).........	108	....	....	....	37	....	....	....	....	....	....	....	....	x	
	108	....	....	....	38	....	....	....	....	....	....	....	....	x	
	113	....	....	....	46	....	....	....	....	....	....	....	....	x	
	125	....	....	....	54	....	....	....	....	....	....	x		
	156	....	14	....	....	....	....	....	....	....	....	....	x	?
	169	....	....	....	37	....	....	....	....	....	....	....	....	....	x
Pholadomorpha chambliensis Foerste.....................	43	....	3	....	....	....	....	....	x					

Geographical Distribution and Geological Range of Species.

Genera and species.	Page	Locality (see page 00).				Horizon.										
						Ordovician.										Silurian.
				Ontario.					Lorraine.			Richmond.				Medina.
														White-water.		
		New York	Quebec	East	West	Trenton	Collingwood	Utica	Horizon Undefined	Eden	Maysville	Horizon undefined	Waynesville	Saluda	Queenston	Manitoulin dolomite
MOLLUSCA—Continued.																
Pelecypoda—Continued.																
Pholadomorpha pholadiformis (Hall)........................	7	4	....	....	....	....	....	....	x							
	7	5	....	....	....	....	....	....	x							
	24, 25	....	22	....	....	....	....	....	x							
	44	....	26	....	....	....	....	....	x							
	45, 47	....	6	....	....	....	....	....	x							
	75	....	....	....	6	....	....	....	x							
	134	....	....	....	2	....	....	....	....	....	....	....	x			
	80	....	....	....	19	....	....	....	x							

	87	....			9	....	....	....	....	....	x				
	90	....			57	....	....	....	....	....	x				
	92	....			64	....	....	....	x	....	x				
	87, 117	....			49	....	....	....	....	....	x	....			
	135	....			2	....	....	....	....	....	....	x			
	138	....		1	....	....	....	....	....	....	....	....	x		
	139	....		1	....	....	....	....	....	....	....	x			
	143, 144	....	16	....	....	....	....	....	....	....	....	....	x		
	149	....	18	....	....	....	....	....	?	....					
	154	....	13	....	....	....	....	....	....	....	....	....	x		
	157	....	14	....	....	....	....	....	....	....	....	....	x		
	44	....	26	....	....	....	....	....	x						
	151	....	26	....	....	....	....	....	....	....	....	....	?		
	153	....	6	....	....	....	....	....	....	....	....	....	x		
Pholadomorpha pholadiformis-divaricata Hall and Whitfield..	150	....	26	....	....	....	....	....	....	....	....	....	?		
Psiloconcha..................	46	....	6	....	....	....	....	....	x						
Psiloconcha inornata Ulrich......	45, 47	....	6	....	....	....	....	....	x						
Psiloconcha sinuata Ulrich........	21	....	19	....	....	....	....	....	x						
	46, 47	....	6	....	....	....	....	....	x						
	64	....		1	....	....	....	....	x						
Psiloconcha sinuata-borealis Foerste..................	150	....	26	....	....	....	....	....	....	....	....	....	?		

Geographical Distribution and Geological Range of Species.

Genera and species.	Page	Locality (see page 266).		Ontario.		Horizon. Ordovician.			Lorraine.			Richmond.		White-water.		Silurian. Medina.
		New York	Quebec	East	West	Trenton	Collingwood	Utica	Horizon undefined	Eden	Maysville	Horizon undefined	Waynesville	Saluda	Queenston	Manitoulin dolomite
MOLLUSCA—Continued.																
Pelecypoda—Continued.																
Psiloconcha subovalis Ulrich......	150	....	26	....	....	....	....	....	....	....	....	....	?			
	47, 153	....	6	....	....	....	....	....	....	....	....	....	x			
Pterinea demissa Conrad.........	9	7	....	....	....	....	....	....	x							
	20	....	19	....	....	....	....	....	?							
	23, 24	....	22	....	....	....	....	....	x							
	31	....	23	....	....	....	....	....	x							
	42	....	3	....	....	....	....	....	x							
	44	....	26	....	....	....	....	....	x							

45, 47	....	6	....	....	....	....	....	x						
65	....	....	1	....	....	....	....	x						
65	....	....	3	....	....	....	....	x						
66	....	....	9	....	....	....	....	x						
134	....	....	....	2	....	....	....	....	....	....	....	x		
84	....	....	....	8	....	....	....	....	....	x				
85	....	....	....	8	....	....	....	x						
90	....	....	....	57	....	....	....	....	....	x				
98	....	....	....	16	....	....	....	....	....	....	....	x		
102	....	....	....	16	....	....	....	....	....	....	....	....	x	
110	....	....	....	31	....	....	....	....	....	....	....	?		
110	....	....	....	40	....	....	....	....	....	....	....	x		
115	....	....	....	48	....	....	....	....	....	....	....	....	x	
121	....	....	....	50	....	....	....	....	....	....	....	x		
125	....	....	....	54	....	....	....	....	....	....	x			
131	....	....	....	25	....	....	....	....	....	....	....	x		
130	....	....	....	28	....	....	....	....	....	....	....	x		
133	....	....	....	2	....	....	....	....	....	....	x			
74	....	....	....	6	....	....	....	x	....	....				
135	....	....	....	2	....	....	....	....	....	....	....	x		
138	....	....	1	....	....	....	....	....	....	....	....	x		
139	....	....	1, 5	....	....	....	....	....	....	....	x			
143, 144	....	16	....	....	....	....	....	....	....	....	....	x		
144, 145	....	17	....	....	....	....	....	....	....	....	....	x		
149	....	18	....	....	....	....	....	?	....	....	....			
150	....	26	....	....	....	....	....	....	....	....	....	?		

Geographical Distribution and Geological Range of Species.

Genera and species.	Page	Locality (see page 266).				Horizon.										
						Ordovician.										Silurian.
				Ontario.					Lorraine.			Richmond.				Medina.
														White-water.		
		New York	Quebec	East	West	Trenton	Collingwood	Utica	Horizon undefined	Eden	Maysville	Horizon undefined	Waynesville	Saluda	Queenston	Manitoulin dolomite
MOLLUSCA—Continued.																
Pelecypoda—Continued.																
Pterinea demissa Conrad—Continued	153	....	6	....	....	....	....	....	....	....	....	....	x			
	154	....	13	....	....	....	....	....	....	....	....	....	x			
	157	....	14	....	....	....	....	....	....	....	....	....	x			
	164	....	....	....	26	....	....	....	....	....	....	....	....	....	x	
	166	....	....	....	27	....	....	....	....	....	....	....	....	....	x	
Rhytimya	45	....	6	....	....	....	....	....	x							
	139	....	....	1	....	....	....	....	....	....	....	x				
Rhytimya cf. compressa Ulrich	42	....	3	....	....	....	....	....	x							

Rhytimya kagawongensis Foerste	107				37									x	
	108				38									x	
	116				49									x	
	122				51									x	
	125				54							x			
Rhytimya oehana Ulrich	42		3						x						
Rhytimya granulosa Wilson	64			1					x						
Rhytimya radiata Ulrich	47		6						x						
Rhytimya cf. radiata Ulrich or compressa Ulrich	45		6						x						
Vanuxemia	109				39								x		
Vanuxemia bayfieldi Billings	126				55									?	
Whitella	35, 36		24						x						
	46, 47		6						x						
	51		8						x						
	143, 144		16										x		
	144, 146		17										x		
	148		18						x						
Whitella complanata Foerste	51		8						x						
	150, 152		26										?		
	153		6										x		
Whitella goniumbonata Foerste	150, 152		26										?		
	139			1									x		
Whitella hindi Billings	74				63 ?				x			x			
Whitella cf. obliquata Ulrich	23		22						x						
	32		23						x						
	47		6						x						
	135				2								x		

Geographical Distribution and Geological Range of Species.

Genera and species.	Page	Locality (see page 266).				Horizon.										
						Ordovician.										Silurian.
				Ontario.					Lorraine.			Richmond.				Medina.
														White-water.		
		New York	Quebec	East	West	Trenton	Collingwood	Utica	Horizon undefined	Eden	Maysville	Horizon undefined	Waynesville	Saluda	Queenston	Manitoulin dolomite
MOLLUSCA—Continued.																
Pelecypoda—Continued.																
Whitella	47	....	6	....	....	....	....	....	x							
Whitella securiformis Foerste	150, 152	....	26	....	....	....	....	....	....	....	....	....	?			
Whitella cf. sterlingensis Meek and Worthen	47	....	6	....	....	....	....	....	x							

Gastropoda.															
Archinacella	102	....	....	....	16	....	....	....	....	....	....	....	....	x	
	108	....	....	....	37	....	....	....	....	....	....	....	....	x	
	108	....	....	....	38	....	....	....	....	....	....	....	....	x	
	123	....	....	....	52	....	....	....	....	....	....	....	....	x	
	125	....	....	....	54	....	....	....	....	....	....	x			
	157	....	14	....	....	....	....	....	....	....	....	....	x		
Archinacella pulaskiensis Foerste	7	1	....	....		....	....	....	x						
	7	2,3,4	....	....	....	....	....	....	x						
	9	7	....	....	....	....	....	....	x						
	15	....	1	....	....	....	....	....	x						
	31	....	23	....	....	....	....	....	x						
	42	....	3	....	....	....	....	....	x						
	51	....	8	....	....	....	....	....	x						
	55	....	9	....	....	....	....	....	x						
Archinacella cf. richmondensis Ulrich	157	....	14	....	....	....	....	....	....	....	....	....	x		
Bellerophon	100	....	....	....	16	....	....	....	....	....	....	....	....	x	
	119	....	....	....	57	....	....	....	....	....	....	....	x		
	121	....	....	....	50	....	....	....	....	....	....	....	....	x	
	125	....	....	....	54	....	....	....	....	....	....	x			
	130	....	....	....	28	....	....	....	....	....	....	....	x		
Bellerophon cf. mohri Miller	113	....	....	....	46	....	....	....	....	....	....	....	....	x	
	123	....	....	....	52	....	....	....	....	....	....	....	....	x	
	126	....	....	....	54	....	....	....	....	....	....	x			
Bucania or Salpingostoma	100	....	....	....	16	....	....	....	....	....	....	....	....	x	
Bucania sp.	125	....	....	....	54	....	....	....	....	....	....	x			
Bucania cf. capax Ulrich	109	....	....	....	39	....	....	....	....	....	....	....	x		

Geographical Distribution and Geological Range of Species.

Genera and species.	Page	Locality (see page 266).				Horizon.										
						Ordovician.										Silurian.
				Ontario.					Lorraine.			Richmond.				Medina.
														White-water.		
		New York	Quebec	East	West	Trenton	Collingwood	Utica	Horizon undefined	Eden	Maysville	Horizon undefined	Waynesville	Saluda	Queenston	Manitoulin dolomite
MOLLUSCA—Continued.																
Gastropoda—Continued.																
Bucania cf. capax Ulrich—Continued	113	....	....	....	46	....	....	....	....	....	....	....	....	x		
	123	....	....	....	52	....	....	....	....	....	....	....	....	x		
	126	....	....	....	54	....	....	....	....	....	....	x				
Clathrospira sp.	144	....	16	....	....	....	....	....	....	....	....	....	x			
Clathrospira subconia Hall	9	7	....	....	....	....	....	....	x							
	19	....	18	....	....	....	....	....	?							
	21	....	19	....	....	....	....	....	?							
	65	....	....	5	....	....	....	....	....	....	....	....	....	?		

	126				54							x			
	130				28								x		
	133				60									x	
	144		16										x		
	75				6				x						
Cyclonema sp.	135				2								x		
Cyclonema bilix Conrad	25		22						x						
	129				15								x		
	98				16								x		
	118, 119				57								x		
	126				54							x			
	127				7								x		
	128				10								x		
	131				25								x		
	130				28								x		
	132				2								x		
	133				2							x	x		
	154		15										x		
	75				6				x						
Cyrtolites carinatus Miller	84				8						x				
	88				49					x					
Cyrtolites ornatus Conrad	7	1							x						
	7	2, 3							x						
	7	5							x						
	9	7							x						
	19, 147		18						?						
	45, 48		6						x						
	50		8						x						

Geographical Distribution and Geological Range of Species.

Genera and species.	Page	Locality (see page 266). New York	Quebec	Ontario. East	West	Horizon. Ordovician. Trenton	Collingwood	Utica	Lorraine. Horizon undefined	Eden	Maysville	Richmond. Horizon undefined	Waynesville	White-water. Saluda	Queenston	Silurian. Medina. Manitoulin dolomite
MOLLUSCA—Continued.																
Gastropoda—Continued.																
Cyrtolites ornatus Conrad—Continued....................	75	....	....	....	6	....	....	....	x							
	85	....	....	....	8	....	....	....	....	....	x					
	90	....	....	....	57	....	....	....	....	....	x					
	126	....	....	....	54	....	....	....	..,.	....	....	x				
	144	....	16	....	....	....	....	....	....	....	....	....	x			
	156, 157	....	14	....	....	....	....	....	....	....	....	....	x			
Cyrtolites cf. parvus Ulrich......	55	....	9	....	....	....	....	....	x							
Cyrtolites subplanus Ulrich.......	53	....	9	....	....	....	....	....	x ?							

Eotomaria	21		19						x						
	36		24						x						
	49		7						x						
	157		14										x		
Eotomaria cf. canalifera Ulrich	64			1					x						
	43		3						x						
Eotomaria remotistriata Foerste	153		6										x		
Helicotoma sp.	157		14										x		
Helicotoma brocki Foerste	99				17								x		
	110				40								x		
Helicotoma cf. planulatoides Ulrich	158		14										x		
Holopea sp.	144		16										x		
Hormotoma	43		3						x						
	109				39								x		
	158		14										x		
Hormotoma gracilis-angusta Hall	91				12					x					
Hormotoma sublaxa Ulrich and Scofield	7	1							x						
	7	2, 3							x						
	9	7							x						
	36		24						x						
	38		25						x						
Hormotoma cf. sublaxa Ulrich and Scofield	36		24						x						
Liospira sp.	145		17										x		
Liospira helena (Billings)	100				16									x	
	121				50									x	
	104				52									x	

Geographical Distribution and Geological Range of Species.

Genera and species.	Page	Locality (see page 266).				Horizon.										
						Ordovician.										Silurian.
				Ontario.					Lorraine.			Richmond.				Medina.
														White-water.		
		New York	Quebec	East	West	Trenton	Collingwood	Utica	Horizon undefined	Eden	Maysville	Horizon undefined	Waynesville	Saluda	Queenston	Manitoulin dolomite
MOLLUSCA—Continued.																
Gastropoda—Continued.																
Liospera helena (Billings)—Continued	123				52									x		
	126				54							x				
Liospira micula (Hall)	157		14										x			
Liospira cf. micula (Hall)	158		14										x			
Lophospira	53		9						x							
	102				16									x		
	108				37									x		

	108				38									x	
	113				46									x	
	144		17										x		
Lophospira beatrice Foerste	25		22						x						
	150, 152		26										?		
	148		18										x		
Lophospira cf. beatrice Foerste	130				28								x		
Lophospira bowdeni Safford	131				25								x		
	133				60									x	
	132, 134, 135				2								x		
	133				2							x			
	143, 144		16										x		
	144		17										x		
	158		14										x		
Lophospira cf. bowdeni Safford	15		1						x						
	126				54							x			
	139			1								x			
Lophospira tropidophora Meek	84				8						x				
	116				49									x	
	123				52									x	
	130				28								x		
	133				60									x	
	135				2								x		
	158		14										x		
Oxydiscus	126				54							x			
	157, 158		14										x		

Geographical Distribution and Geological Range of Species.

Genera and species.	Page	Locality (see page 266).				Horizon.										
				Ontario.		Ordovician.										Silurian.
									Lorraine.			Richmond.				Medina.
														White-water.		
		New York	Quebec	East	West	Trenton	Collingwood	Utica	Horizon undefined	Eden	Maysville	Horizon undefined	Waynesville	Saluda	Queenston	Manitoulin dolomite
MOLLUSCA—Continued.																
Gastropoda—Continued.																
Sinuites..........................	25	....	21	....	....	....	....	....	x							
	35, 36	....	24	....	....	....	....	....	x							
	7	2, 3	....	....	....	....	....	....	x							
Sinuites cancellata (Hall)........	9	7	....	....	....	....	....	....	x							
	15	....	1	....	....	....	....	....	x							
	31	....	23	....	....	....	....	....	x							
	35	....	24	....	....	....	....	....	x							
	43	....	3	....	....	....	....	....	x							
	51	....	8	....	....	....	....	....	x							

	55	....	9	....	....	....	....	....	x						
	88	....	....	....	49	....	....	....	....	x					
	91	....	....	....	12	....	....	....	....	x					
	158	....	14	....	....	....	....	....	....	....	....	....	x		
Trochonema sp.	133	....	....	....	60	....	....	....	....	....	....	....	....	x	
Vallathotheca manitoulini Foerste	125	....	....	....	54	....	....	....	....	....	....	x			
Pteropoda.															
Pterotheca sp.	51	....	8	....	....	....	....	....	x						
Pterotheca pentagona ? Foerste	35	....	24	....	....	....	....	....	x						
	43	....	3	....	....	....	....	....	x						
Cephalopoda.															
Actinoceras crebriseptum Hall	9	7	....	....	....	....	....	....	x						
Billingsites sp.	126	....	....	....	54	....	....	....	....	....	....	x			
Billingsites newberryi (Billings)	126	....	....	....	29	....	....	....	....	....	....	x			
Cyrtoceras sp.	108	....	....	....	37	....	....	....	....	....	....	....	....	x	
Cyrtoceras ligarius Billings	126	....	....	....	56	....	....	....	....	....	....	x			
Cyrtoceras lysander Billings	126	....	....	....	54	....	....	....	....	....	....	x			
Cyrtoceras postumius Billings	126	....	....	....	54	....	....	....	....	....	....	x			
Discoceras sp.	126	....	....	....	54	....	....	....	....	....	....	x			
Endoceras sp.	75	....	....	....	6	....	....	....	x						
	126	....	....	....	54	....	....	....	....	....	....	x			
Loxoceras sp.	75	....	....	....	6	....	....	....	x						
Oncoceros sp.	126	....	....	....	54	....	....	....	....	....	....	x			
Orthoceras	11	9	....	....	....	....	....	x							
	25	....	21	....	....	....	....	....	x						
	134, 135	....	....	....	2	....	....	....	....	....	....	....	x		
	79	....	....	....	7	....	....	....	....	....	x				
	88	....	....	....	49	....	....	....	....	x					

Geographical Distribution and Geological Range of Species.

Genera and species.	Page	Locality (see page 266).				Horizon.										
						Ordovician.										Silurian.
				Ontario.					Lorraine.			Richmond.				Medina.
														White-water.		
		New York	Quebec	East	West	Trenton	Collingwood	Utica	Horizon undefined	Eden	Maysville	Horizon undefined	Waynesville	Saluda	Queenston	Manitoulin dolomite
MOLLUSCA—Continued.																
Cephalopoda—Continued.																
Orthoceras—Continued..........	86	....	....	....	9	....	....	....	....	?						
	108	....	....	....	38	....	....	....	....	....	....	....	....	x		
	121	....	....	....	50	....	....	....	....	....	....	....	....	x		
	130	....	....	....	28	....	....	....	....	....	....	....	x			
	132	....	....	....	2	....	....	....	....	....	....	....	....	x		
	139	....	....	1	....	....	....	....	....	....	....	x				
	145	....	17	....	....	....	....	....	....	....	....	....	x			
	158	....	14	....	....	....	....	....	....	....	....	....	x			
Orthoceras coralliferum Hall......	9	7	....	....	....	....	....	....	x							

Orthoceras lamellosum Hall	8	6							x						
	9	7							x						
Orthoceras piso Billings	126				54							x			
Spyroceras cf. bilineatum (Hall)	43		3						x						
Spyroceras hammelli Foerste	99				17								x		
	126				54							x			
Trocholites planorbiformis Conrad	9	7							x						
ARTHROPODA-CRUSTACEA.															
Trilobita.															
Acidaspis	64			1					x						
	66			9					x						
Calymene	7	1							x						
	7	2, 3							x						
	9	7							x						
	24, 25		22						x						
	25		21						x						
	31, 32		23						x						
	36		24						x						
	38		25						x						
	49		7						x						
	50		8						x						
	64			1					x						
	65			3					x						
	84				8						x				
	86				9					x					
	130				25								x		

Geographical Distribution and Geological Range of Species.

Genera and species.	Page	Locality (see page 266).				Horizon.										
				Ontario.		Ordovician.										Silurian.
									Lorraine.			Richmond.				Medina.
														White-water.		
		New York	Quebec	East	West	Trenton	Collingwood	Utica	Horizon undefined	Eden	Maysville	Horizon undefined	Waynesville	Saluda	Queenston	Manitoulin dolomite
ARTHROPODA-CRUSTACEA—Continued.																
Trilobita—Continued.																
Calymene—Continued	130				28								x			
	75				6				x							
Calymene callicephala Green	49		4						x							
	55		9						x							
	139			1								x				
	158		14										x			
Calymene granulosa Foerste	88				49					x						
Ceraurinus marginatus Barton	100, 117				49									x		

Isotelus	7	5							x						
	24		21						x						
	31		23						x						
	51		8						x						
	66			6					x						
	134				2								x		
	112				44								x		
	139			1								x			
	158		14										x		
Isotelus gigas DeKay?	48		6						x						
Isotelus cf. gigas DeKay	46		6						x						
Proetus	31		23						x						
	35		24						x						
Proetus chambliensis Foerste	31, 32		23						x						
	35		24						x						
	43		3						x						
	44		26						x						
	64, 65			1					x						
	65			3					x						
Triarthrus becki Green	5	10						x							
	10	8						x							
	11	9						x							
	38		25						x						
	50, 51		8						x						
	55		9						x						
	56		10						x						
	57		11					x							

Geographical Distribution and Geological Range of Species.

Genera and species.	Page	Locality (see page 266).				Horizon.										
						Ordovician.										Silurian.
				Ontario.					Lorraine.			Richmond.				Medina.
														White-water.		
		New York	Quebec	East	West	Trenton	Collingwood	Utica	Horizon undefined	Eden	Maysville	Horizon undefined	Waynesville	Saluda	Queenston	Manitoulin dolomite
ARTHROPODA-CRUSTACEA—Continued.																
Trilobita—Continued.																
Triarthrus becki Green—Continued....................	58	....	12	....	....	....	....	x								
	62	....	....	2	....	....	....	....	x							
	86	....	....	....	9	....	x									
	88	....	....	....	49	....	....	....	x							
Triarthrus spinosus Billings......	62	....	....	2	....	....	x									
Trinucleus (=Cryptolithus)......	38, 39	....	25	....	....	....	....	....	x							
	57	....	11	....	....	....	....	x								
	81	....	....	....	1	....	....	....	....	x						

Trinucleus concentricus Eaton	38, 39	....	25	....	....	....	....	....	x						
=Cryptolithus tessellatus, Green	7	1	....	....	....	....	....	....	x						
	7	2, 3	....	....	....	....	....	....	x						
	9	7	....	....	....	....	....	....	x						
	11	9	....	....	....	....	....	x							
	49	....	4	....	....	....	....	....	x						
	50, 51	....	8	....	....	....	....	....	x						
	53, 55	....	9	....	....	....	....	....	x						
	56	....	10	....	....	....	....	....	x						
	70, 71	....	....	....	4	....	....	....	x						
Branchiopoda.															
Technophorus quincuncialis Foerste	43	....	3	....	....	....	....	....	x						
	44	....	26	....	....	....	....	....	x						
Ostracoda.															
Bythocypris sp.	88	....	....	....	49	....	....	....	....	x					
Bythocypris cylindrica (Hall)	21	....	19	....	....	....	....	....	x						
	43	....	3	....	....	....	....	....	x						
	64	....	....	1	....	....	....	....	x						

Geographical Distribution and Geological Range of Species.

Genera and species.	Page	Locality (see page 266).				Horizon. Ordovician.										Silurian. Medina.
				Ontario.					Lorraine.			Richmond.		White-water.		
		New York	Quebec	East	West	Trenton	Collingwood	Utica	Horizon undefined	Eden	Maysville	Horizon undefined	Waynesville	Saluda	Queenston	Manitoulin dolomite
ARTHROPODA-CRUSTACEA—Continued.																
Ostracoda—Continued.																
Bythocypris cylindrica (Hall)—Continued	65	....	....	3	....	....	....	....	x							
	92	....	....	....	13	....	....	....	....	x						
	107	....	....	....	37	....	....	....	....	....	....	....	....	x		
	121	....	....	....	51	....	....	....	....	....	....	....	....	x		
	126	....	....	....	54	....	....	....	....	....	....	x				
	139	....	....	1	....	....	....	....	....	....	....	x				
	166	....	....	....	27	....	....	....	....	....	....	....	....	....	x	
Ceratopsis oculifera (Hall)........	45	....	6	....	....	....	....	....	x							

Ctenobolbina ciliata (Emmons).	21	....	19	....	....	....	....	....	x						
	24	....	22	....	....	....	....	....	x						
	45, 47, 48	....	6	....	....	....	....	....	x						
Ctenobolbina cf. ciliata (Emmons)	64	....	....	1	....	....	....	....	x						
Drepanella canadensis Ulrich...	131, 162	....	....	....	25	....	....	....	....	....	....	....	....	....	x
	164	....	....	....	26	....	....	....	....	....	....	....	....	....	x
	166	....	....	....	27	....	....	....	....	....	....	....	....	....	x
Eurychilina striatomarginata (Miller)	164	....	....	....	26	....	....	....	....	....	....	....	....	....	x
	166	....	....	....	27	....	....	....	....	....	....	....	....	....	x
Jonesella crapidiformis Ulrich...	92	....	....	....	13	....	....	....	....	x					
Leperditia caecigena Miller.....	107	....	....	....	37	....	....	....	....	....	....	....	....	x	
	108	....	....	....	38	....	....	....	....	....	....	....	....	x	
	116	....	....	....	49	....	....	....	....	....	....	....	....	x	
	122	....	....	....	51	....	....	....	....	....	....	....	....	x	
	126	....	....	....	54	....	....	....	....	....	....	x			
	164	....	....	....	26	....	....	....	....	....	....	....	....	....	x
	166	....	....	....	27	....	....	....	....	....	....	....	....	....	x
	169	....	....	....	37	....	....	....	....	....	....	....	....	....	x
	109	....	....	....	58	....	....	....	....	....	....	....	....	x	
Leperditella cf. glabra Ulrich...	164	....	....	....	26	....	....	....	....	....	....	....	....	....	x
Primitia sp..................	86	....	....	....	9	....	....	....	....	?	....	....	....		
Primitia centralis Ulrich........	91	....	....	....	12	....	....	....	....	x	....	....	....		
	92	....	....	....	13	....	....	....	....	x	....	....	....		

Geographical Distribution and Geological Range of Species.

Genera and species.	Page	Locality (see page 266).				Horizon. Ordovician.											Silurian.
				Ontario.					Lorraine.			Richmond.					Medina.
														White-water.			
		New York	Quebec	East	West	Trenton	Collingwood	Utica	Horizon undefined	Eden	Maysville	Horizon undefined	Waynesville	Saluda	Queenston		Manitoulin dolomite
ARTHROPODA-CRUSTACEA—Continued.																	
Ostracoda—Continued.																	
Primitia lativia Ulrich..........	169	....	....	....	37	....	....	....	....	....	....	....	....	x			
	108	....	....	....	37, 38	....	....	....	....	....	....	....	....	x			
	109	....	....	....	58	....	....	....	....	....	....	....	....	x			
	111	....	....	....	42	....	....	....	....	....	....	....	....	x			
	121	....	....	....	51	....	....	....	....	....	....	....	....	x			

	164	....	....	....	26	....	....	....	....	....	....	....	....	....	x
	166	....	....	....	27	....	....	....	....	....	....	....	....	....	x
	107	....	....	....	37	....	....	....	....	....	....	....	....	....	x
Euripterida.															
Eusarcus sp....................	151	....	26	....	....	....	....	....	....	....	....	?			
Cirripedia.															
Lepidocleus jamesi Hall and Whitfield......................	91	....	....	....	12	....	....	....	....	x					

LIST OF LOCALITIES.

NEW YORK STATE.

1. Lorraine, Jefferson county.
2. Two miles east of Lorraine, Jefferson county.
3. Worthville and neighbourhood, Jefferson county.
4. Bennett Bridge, one mile down (west) from Salmon River falls.
5. Near base of Salmon River falls.
6. General—from Lorraine village eastward to Worthville, Jefferson county.
7. Pulaski village to railway bridge, one mile east of the town.
8. Lorraine gulf, northwest of Lorraine village, Jefferson county.
9. South of Allandale, a short distance west of mouth of Lorraine gulf.
10. New York—general.

QUEBEC.

1. Nicolet river, east bank, 2½ miles due south of Ste. Monique station, 14 miles south of Three Rivers.
2. Loose at 18.
3. Chambly Canton, along west side of Richelieu river, 15 miles southeast of Montreal.
4. A quarter of a mile south of Petite Caroline, along the road to Rougemont, 26 miles east of Montreal.
5. Snake island, 2 miles east of Roberval, in Lake St. John.
6. St. Hilaire, along road southeast of station, also east of village centre, 18 miles northeast of Montreal.
7. Petite Caroline station, same as locality 4.
8. St. Hugues, 39 miles northeast of Montreal, 1½ miles northwest of station, on Yamaska river.
9. St. Hyacinthe in bed of Yamaska river, south of railway bridge, 30 miles northeast of Montreal.
10. Breault, ¾ mile east of station, on west bank of Bécancour river, 14 miles southeast of Three Rivers.
11. St. Augustin along the railway, east of the station, 12 miles southwest of Quebec.
12. Montmorency falls, along the hill-side southeast of the falls, 6 miles northeast of Quebec.
13. Boulders at locality 6, from the hill-side due east of St. Hilaire station, Quebec.
14. Loose at 5, Quebec.
15. Boulders at locality 8, Quebec.

16. Nicolet River section No. 1, east bank, 2½ miles southwest of Ste. Monique station (see locality 1).
17. Nicolet River section No. 2, along gully, south of section No. 1.
18. Nicolet River section No. 3, hill-side section, south of gully, at western end of long farm lane.
19. Nicolet River section No. 4.
20. Between 3 and 4 miles north of Roberval on west shore of Lake St. John.
21. Nicolet River section No. 5.
22. Nicolet River talus at section No. 5.
23. Nicolet River section No. 6.
24. Nicolet River section No. 7.
25. Nicolet River section No. 8.
26. Rivière des Hurons, 4 miles northeast of Chambly basin.

ONTARIO—EAST.[1]

1. Vars, 15 miles east of Ottawa. The localities lie chiefly along the road crossing the railway one mile west of the station.
2. Navan and along the road for 2 miles northeast, 11 miles east of Ottawa.
3. Northwest of Hawthorne, along the railway about 3 miles east of Ottawa.
4. Southwest of Ramsay Station, about 2½ miles, and then southeast half a mile at a small bridge; southeast of Ottawa.
5. Loose blocks at locality 1.
6. Loose at locality 3.
7. Boulders at locality 4.
8. Eastern Ontario—general.
9. One mile west of Ramsay station, 5 miles southeast of Ottawa.

ONTARIO—WEST.[1]

1. Two miles southeast of Meaford. On the south side of Georgian bay, at mouth of Workman brook.
2. Streetsville, along the Credit river, 17 miles west of Toronto.
3. Toronto.
4. Toronto—Don Valley brick-yard, at northeastern margin of city.
5. Toronto—unknown locality.
6. Weston about 3 miles northwest of the northwestern boundary of Toronto.
7. Workman brook, between 2 and 3 miles southeast of Meaford.
8. South of Clay cliff between 2 and 3 miles north of Wekwemikongsing, Manitoulin island. This is the Lorraine exposure, south of locality 54, which is the Cape Smith locality of Billings.
9. Burnett hill, 3 miles south of Little Current along eastern road to Sheguiandah, Manitoulin island.

[1] The Frontenac axis (see page 67) is used as the line of division between eastern and western Ontario. It extends in a general north and south direction through the Thousand Island region, east of Lake Ontario.

10. Gully south of the Collingwood pike, half a mile east from the mouth of Workman brook, 2½ miles east of Meaford.
11. McLean hill, 2 miles southwest of Little Current, along western road to Sheguiandah, Manitoulin island.
12. Tamarack point, north of Honora on northeast margin of West bay, Manitoulin island.
13. Gorrel point, 2 miles northeast of Gore bay, Manitoulin island.
14. Fields, west of Collingwood, and about 12 miles east of Meaford.
15. Eight miles northwest of Meaford, west of the lake shore road to Cape Rich, in the eastern part of lot 36, in concession VII.
16. Manitoulin island, general.
17. Gore Bay reef, a coral reef in Richmond strata, typically exposed between Gore bay, Kagawong, and Little Current, Manitoulin island.
18. Localities 18 and 49 have been treated as a single locality. See 49.
19. Loose at locality 7.
20. Rabbit island, 5 miles south of James bay off eastern shore of Manitoulin island.
21. Club island, 10 miles south of James bay, off eastern shore of Manitoulin island.
22. Stromatocerium reef or Mudge Bay reef, a reef in Richmond strata, typically exposed, between Gore bay, Kagawong, Honora, and Little Current.
23. Kagawong and Gore bay, two localities on Manitoulin island, about 10 miles apart.
24. Two miles southwest of Wekwemikong, on the road to Manitowaning, on Manitoulin island (see section 52).
25. Oakville, about 20 miles southwest of Toronto.
26. Localities 15 and 26 have been treated as a single locality. See 15. One mile west of section 15; exposure half mile south of Mountain lake extending along the roads on the western and northern margins of lot 36 in concession VIII.
27. West of concession VIII, 4 miles northwest of Meaford and less than 5 miles south of locality 26, south of a church at the crossroads between concessions VIII and IX, and lots 24 and 25.
28. Six miles from Meaford, west of the road to Cape Rich, west of Nottawasaga bay. John A. Cox farm, lot 32, concession VII.
29. Cape Rich, north of Meaford, 9 miles.
30. Loose at locality 50.
31. Loose blocks at locality 39.
32. Loose slabs in the neighbourhood of locality 48.
33. East of Barrie Island bridge, Manitoulin island.
34. 3½ miles northwest of Kagawong, southeast corner of lot 6, con. XV, on road to Maple point.
35. Northwest of Kagawong, south of locality 34.
36. 1½ miles northwest of Kagawong,

37. $1\frac{1}{2}$ miles southwest of Kagawong, on road to Gore Bay.
38. One-half mile south of Kagawong, south of the mill at the falls.
39. Below the falls at the mill south of Kagawong.
40. Directly south of Kagawong village, where the road to the mill ascends the hill.
41. Northeast of Gore Bay, about 2 miles, at concession XIV, along the road on top of the bluff.
42. Southeast of Gore Bay, along the road leading toward East bluff.
43. South end of Gore Bay village.
44. West side of Gore Bay village.
45. Along east and west road, 3 miles due south of Little Current.
46. Nearly 2 miles northwest of Gore Bay along an east and west road between concessions XII and XIII.
47. Eastern side of West bay about a mile south of Honora village, at a steep hill on the road to West Bay village.
48. Southwest of Little Current southwest of Indian village, on north and south road.
49. Three miles southwest of Little Current on east and west road. This section is about $1\frac{1}{2}$ miles in length.
50. From "The Rock" southwest of Manitowaning, northward to gully north of lighthouse.
51. Two miles southeast of Manitowaning, where the road to James bay ascends the steep hill.
52. Two miles southwest of Wekwemikong, along the road to Manitowaning (see section 24).
53. Northwest of Wekwemikong, loose, along the road leading over the hill.
54. Three miles northeast of Wekwemikongsing at Clay cliff. This is the Cape Smith locality of Billings.
55. Bayfield sound, south and west of Barrie island.
56. Drummond island.
57. Loose at locality 11.
58. Lot 23, concession XIV, road between Kagawong and West Bay.
59. Loose at locality 2, Streetsville.
60. One mile up Credit river from Streetsville at bridge north of Credit Junction.
61. At mouth of Workman brook, 2 miles southeast of Meaford.
62. Road between concessions VI and VII, near lot 6, southwest from Little Current, Manitoulin island.
63. Humber river, in northwestern part of Toronto.
64. Loose at locality 13.

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PUBLICATIONS OF THE GEOLOGICAL SURVEY.

The Geological Survey was established in 1842 and "Reports of Progress" were issued, generally in annual volumes, from that date to 1885, the first report being that for the year 1843 published in 1845. Beginning with the year 1885, "Annual Reports" (new series) were published in volumes until 1905, the last being Vol. XVI, 1904. Many of the individual reports and maps published before 1905 were issued separately and from 1905 to the present, all have been published as separates and no annual volume has been issued. Since 1910, the reports have been issued as Memoirs and Museum Bulletins, each subdivided into series, thus:—

Memoir 41, *Geological Series 38.*
Memoir 54, *Biological Series 2.*
Museum Bulletin 5, *Geological Series 21.*
Museum Bulletin 6, *Anthropological Series 3.*

In addition to the publications specified above, a Summary Report is issued annually; and miscellaneous publications of various kinds including Reports of Explorations, Guide Books, etc., have been issued from time to time.

Publications Issued 1910-1915 Inclusive.

MEMOIRS.

MEMOIR 21. *Geological Series 15.* The geology and ore deposits of Phoenix Boundary district, British Columbia, 1912—by O. E. LeRoy

MEMOIR 22. *Geological Series 27.* Preliminary report on the serpentines and associated rocks, in southern Quebec, 1914—by J. A. Dresser.

MEMOIR 23. *Geological Series 23.* Geology of the coast and islands between the Strait of Georgia and Queen Charlotte sound, B.C., 1914—by J. Austen Bancroft.

MEMOIR 24. *Geological Series 16.* Preliminary report on the clay and shale. deposits of the western provinces, 1912—by Heinrich Ries and Joseph Keele.

MEMOIR 25. *Geological Series 21.* Report on the clay and shale deposits of the western provinces, Part II, 1914—by Heinrich Ries and Joseph Keele.

MEMOIR 26. *Geological Series 34.* Geology and mineral deposits of the Tulameen district, B.C., 1913—by C. Camsell.

MEMOIR 27. *Geological Series 17.* Report of the Commission appointed to investigate Turtle mountain, Frank, Alberta, 1911, issued 1912.

MEMOIR 28. *Geological Series 18.* The Geology of Steeprock lake, Ontario—by Andrew C. Lawson. Notes on fossils from limestone of Steeprock lake, Ontario, 1912—by Charles D. Walcott.

MEMOIR 29. *Geological Series 32.* Oil and gas prospects of the northwest provinces of Canada, 1913—by W. Malcolm.

MEMOIR 30. *Geological Series 40.* The basins of Nelson and Churchill rivers, 1914—by William McInnes.

MEMOIR 31. *Geological Series 20.* Wheaton district, Yukon Territory, 1913—by D. D. Cairnes.

MEMOIR 32. *Geological Series 25.* Portions of Portland Canal and Skeena Mining divisions, Skeena district, B.C., 1914—by R. G. McConnell.

MEMOIR 33. *Geological Series 30.* The geology of Gowganda Mining Division, 1913—by W. H. Collins.

MEMOIR 34. *Geological Series 63.* The Devonian of southwestern Ontario, 1915—by C. R. Stauffer.

MEMOIR 35. *Geological Series 29.* Reconnaissance along the National Transcontinental railway in southern Quebec, 1913—John A. Dresser.

MEMOIR 36. *Geological Series 33.* Geology of the Victoria and Saanich map-areas, Vancouver island, B.C., 1914—by C. H. Clapp.

MEMOIR 37. *Geological Series 22.* Portions of Atlin district, B.C., 1913—by D. D. Cairnes.

MEMOIR 38. *Geological Series 31.* Geology of the North American Cordillera at the forty-ninth parallel, Parts I and II, 1913—by Reginald Aldworth Daly.

MEMOIR 39. *Geological Series 35.* Kewagama Lake map-area, Quebec, 1914—by M. E. Wilson.

MEMOIR 40. *Geological Series 24.* The Archæan geology of Rainy lake, 1914—by Andrew C. Lawson.

MEMOIR 41. *Geological Series 38.* The "Fern Ledges" Carboniferous flora of St. John, New Brunswick, 1914—by Marie C. Stopes.

MEMOIR 42. *Anthropological Series 1.* The double-curve motive in northeastern Algonkian art, 1914—by Frank G. Speck.

MEMOIR 43. *Geological Series 36.* St. Hilaire (Beloeil) and Rougemont mountains, Quebec, 1914—by J. J. O'Neill.

MEMOIR 44. *Geological Series 37.* Clay and shale deposits of New Brunswick, 1914— by J. Keele.

MEMOIR 45. *Anthropological Series 3.* The inviting-in feast of the Alaska Eskimo, 1914—by E. W. Hawkes.

MUSEUM BULLETINS.

The Museum Bulletins, published by the Geological Survey, are numbered consecutively and are given a series number in addition, thus: Geological Series No. 1, 2, 3, etc.; Biological Series No. 1, 2, 3, etc.; Anthropological Series No. 1, 2, 3, etc.

In the case of Bulletins 1 and 2, which contain articles on various subjects, each article has been assigned a separate series number.

The first Bulletin was entitled *Victoria Memorial Museum Bulletin;* subsequent issues have been called *Museum Bulletins.*

Geological Series 12. Prehnite from Adams sound, Admiralty inlet, Baffin island, Franklin—by R. A. A. Johnston.

Biological Series. 1. The marine algæ of Vancouver island—by F. S. Collins.

Biological Series 2. New species of mollusks from the Atlantic and Pacific coasts of Canada—by W. H. Dall and P. Bartsch.

Biological Series 3. Hydroids from Vancouver island and Nova Scotia—by C. McLean Fraser.

Anthropological Series 1. The archæology of Blandford township, Oxford county, Ontario—by W. J. Wintemberg.

MUS. BULL. 2. (*Issued 1914*). *Geological Series 13.* The origin of granite (micropegmatite) in the Purcell sills—by S. J. Schofield.

Geological Series 14. Columnar structure in limestone—by E. M. Kindle.

Geological Series 15. Supposed evidences of subsidence of the coast of New Brunswick within modern time—by J. W. Goldthwait.

Geological Series 16. The Pre-Cambrian (Beltian) rocks of southeastern British Columbia and their correlation by S. J. Schofield.

Geological Series 17. Early Cambrian stratigraphy in the North American Cordillera, with discussion of Albertella and related faunas—by L. D. Burling.

Geological Series 18. A preliminary study of the variations of the plications of Parastrophia hemiplicata, Hall—by A. E. Wilson.

Anthropological Series 2. Some aspects of puberty fasting among the Ojibwa—by Paul Radin.

MUS. BULL. 3. *Geological Series 19.* The Anticosti Island faunas, 1914—by W. H. Twenhofel.

MUS. BULL. 4. *Geological Series 20.* The Crowsnest volcanics, 1914—by J. D. MacKenzie.

MUS. BULL. 5. *Geological Series 21.* A Beatricea-like organism from the middle Ordovician, 1914—by P. E. Raymond.

MUS. BULL. 6. *Anthropological Series 3.* Prehistoric and present commerce among the Arctic Coast Eskimo, 1915—by V. Stefansson.

MUS. BULL. 7. *Biological Series 4.* A new species of Dendragapus (Dendragapus Obscurus Flemingi) from southern Yukon Territory, 1914—by P. A. Taverner.

MUS. BULL. 8. *Geological Series 22.* The Huronian formations of Timiskaming region, Canada, 1914—by W. H. Collins.

MUS. BULL. 9. *Anthropological Series 4.* The Glenoid Fossa in the skull of the Eskimo, 1915—by F. H. S. Knowles.

MUS. BULL. 10. *Anthropological Series 5.* The social organization of the Winnebago Indians, an interpretation, 1915—by P. Radin.

MUS. BULL. 11. *Geological Series 23.* Physiography of the Beaverdell map-area and the southern part of the Interior plateaus of British Columbia, 1915—by L. Reinecke.

MUS. BULL. 12. *Geological Series 24.* On Eoceratops Canadensis, gen. nov., with remarks on other genera of Cretaceous horned dinosaurs, 1915—by L. M. Lambe.

MUS. BULL. 13. *Biological Series 5.* The double-crested Cormorant (Phalacrocorax Auritus) and its relation to the salmon industries on the Gulf of St. Lawrence, 1915—by P. A. Taverner.

MUS. BULL. 14. *Geological Series 25.* The occurrence of glacial drift on the Magdalen islands, 1915—by J. W. Goldthwait.

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MUS. BULL. 16. *Anthropological Series 6.* Literary aspects of North American mythology, 1915—by P. Radin.

MUS. BULL. 17. *Geological Series 27.* The Ordovician rocks of Lake Timiskaming, 1915—by M. Y. Williams.

MUS. BULL. 18. *Geological Series 28.* Structural relations of the Pre-Cambrian and Palæozoic rocks north of the Ottawa and St. Lawrence valleys, 1915—by E. M. Kindle and L. D. Burling.

MUS. BULL. 19. *Anthropological Series 7.* A sketch of the social organization of the Nass River Indians, 1915—by E. Sapir.

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UNCLASSIFIED.

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Report on the geological position and characteristics of the oil-shale deposits of Canada, 1910—by R. W. Ells.

A reconnaissance across the Mackenzie mountains on the Pelly, Ross, and Gravel rivers, Yukon and North West Territories, 1910—by Joseph Keele.

Summary Report for the calendar year 1909, issued 1910.

Report on a traverse through the southern part of the North West Territories, from Lac Seul to Cat lake, in 1902, issued 1911—by Alfred W. G. Wilson.

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Report on the geology of an area adjoining the east side of Lake Timiskaming, 1911—by Morley E. Wilson.

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Guide Book No. 1. Excursions in eastern Quebec and the Maritime Provinces, parts 1 and 2, 1913.

Guide Book No. 2. Excursions in the Eastern Townships of Quebec and the eastern part of Ontario, 1913.

Guide Book No. 3. Excursions in the neighbourhood of Montreal and Ottawa, 1913.

Guide Book No. 4. Excursions in southwestern Ontario, 1913.

Guide Book No. 5. Excursions in the western peninsula of Ontario and Manitoulin island, 1913.

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Prospector's Handbook No. 1. Notes on radium-bearing minerals, 1914—by Wyatt Malcolm.

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