CANADA

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA

MEMOIR 295

CARBONIFEROUS STRATIGRAPHY AND RUGOSE CORAL FAUNAS OF NORTHEASTERN BRITISH COLUMBIA

By

P. K. Sutherland

EDMOND CLOUTIER, C.M.G., O.A., D.S.P.
QUEEN'S PRINTER AND CONTROLLER OF STATIONERY
OTTAWA, 1958

Price, Two Dollars No. 2541

PLATE I

Western Muskwa River Valley, looking northwest across Foothills Belt to main ranges of Rocky Mountains; 30 to 50 miles west of Alaska Highway. (Photo by U.S. Army)

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3,500—1957—1034

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PREFACE

The continuing search for oil and gas in Western Canada has given great impetus to stratigraphic and faunal studies of Palæozoic and Mesozoic rocks. Following major petroleum discoveries in Devonian and Carboniferous strata of Alberta, field investigation of these rocks has been carried into more remote areas to the north. This report describes the results of a detailed study of Carboniferous strata in the northern part of the Rocky Mountains and adjacent foothills, with special reference to the region from Peace River to the Tetsa River and Alaska Highway.

Rugose corals have long provided a practical means of classification and zonation of the Carboniferous rocks of northwestern Europe and the pioneer work of the author on the representatives of this group of fossils from northeastern British Columbia recorded in this report will provide subsequent workers with a valuable means of correlation, hitherto unavailable.

The field work was carried out by the author for, and is published with the permission of, the Phillips Petroleum Company, and was followed by extensive laboratory studies at the Sedgwick Museum, Cambridge, England, and at the Geological Survey of Canada.

GEORGE HANSON,
Director, Geological Survey of Canada

OTTAWA, August 27, 1956

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CHAPTER I

INTRODUCTION

This report is based on geological reconnaissance in the northern part of the Rocky Mountains and adjacent foothills and plains to the east. The areas studied are primarily in northeastern British Columbia and lie in a 400-mile strip along the eastern front ranges of the mountains between longitudes 120 and 125 degrees west and between latitudes 54 and 59 degrees north (*see* Figures 1 and 2). The region from Peace River north to the Alaska Highway and Tetsa River has received most attention and is considered in greater detail.

Data were collected on rocks varying from Precambrian to Cretaceous in age but the present report is primarily restricted to a discussion of the Carboniferous rocks and faunas. Some regional correlations are suggested and the corals are described in detail.

With the completion of the Alaska Highway in 1943 a large potential oil producing region, previously inaccessible, was opened for exploration. The Alaska Highway now provides easy access to an extensive area in the plains region and to the Palæozoic rocks in the Tetsa valley. The more recently completed John Hart Highway gives easy access to the Palæozoic sections of the Pine River region. Other mountain areas, however, remain inaccessible except with pack-horses.

The study of the stratigraphy of northeastern British Columbia is still largely in a preliminary state. Only the Triassic and Cretaceous formations have been investigated in detail.

Brief History of Exploration

Northeastern British Columbia is crossed by the Liard River in the north and the Peace River in the south. It was along these two trading routes, mainly the latter, that the early expeditions of the Geological Survey of Canada passed through the country. The first was by Selwyn (1877)[1] who descended the Peace River to Fort St. John in 1875 and then continued up the Pine River valley. Dawson (1881) crossed the Rocky Mountains by way of the Peace River Pass and valley in 1879 and his assistant McConnell (1893) re-visited the area and made hurried investigations of the structure of the Rocky Moun-

[1]Name of authors and/or dates in parentheses are those of reports listed in Bibliography, Chapter IV.

tains. Previously, in 1887, McConnell (1891), made a hazardous journey by canoe down the treacherous upper Liard River and wintered in the northwest. The reports written by these men make exciting reading. Following their great journeys there was little geological exploration until the extension of the railway into the Peace River area in 1916. Exploration from then until the completion of the Alaska Highway in 1943 was confined mainly to the foothills and plains of the Peace River region, the Palæozoic strata of the mountains remaining poorly known. McLearn (1918, 1921, 1930, 1937, 1940), made detailed examinations of the Cretaceous and Triassic exposures along the Peace River valley, and Williams and Bocock (1932) made a brief survey of the geology of the Peace River and Pine River areas, which included a limited examination of the Palæozoic outcrops.

Since the completion of the Alaska Highway there has been considerable geological exploration of northeastern British Columbia, primarily by oil companies, although the published information mainly concerns the vicinity of the Alaska Highway (Hage, 1944, Williams, 1944, etc.). Exceptions are a report by Kindle (1944) on the Mesozoic strata along part of the Liard River and a report by Laudon, *et al.* (1949) on the Palæozoic rocks of the Wapiti Lake area. McLearn (1945, 1946, 1947) extended his studies of the Triassic and Cretaceous faunas northward from the Peace River to the Tetsa River valley.

Hage (1945) examined the Palæozoic and Mesozoic strata in the southern part of the Mackenzie Mountains in the lower Liard River area. This region lies north of British Columbia in the Northwest Territories. His collections have been examined by the writer and his coral specimens have been included in the detailed study of that group which is recorded in Chapter III.

In a recent report, McLearn and Kindle (1950) gave a comprehensive review of all the previously published information on the geology of northeastern British Columbia.

Field Work

The field work on which this report is based was done during the five field seasons from 1945 to 1949. For most of the first two seasons the writer was the assistant in a party headed by L. D. Burling and for the following three summers he had charge of a party. An attempt was made to work out the stratigraphic section and to gain information on the thickness of beds, nature of unconformities, etc. A wide area was covered in the time available and the solution of many of the stratigraphic problems that have arisen must await detailed mapping of the region.

The Cretaceous rocks were examined at numerous points in the plains region and Triassic and Palæozoic strata were studied in five areas (*see* Figures 1 and 2) along the eastern mountain front where river valleys give access to the remote regions. These areas are described briefly as follows:

(A) *Kakwa-Jarvis Lakes Region.* This area, visited by Burling and the writer in 1945, is in British Columbia just west of the Alberta boundary about 120 miles northwest of Jasper and about 185 miles southeast of Peace River. It was reached from the northeast across the plains and foothills after a journey of five or six days by horseback from Wapiti River. Jarvis Lakes straddle the continental divide in a glaciated pass at an elevation of about 5,000 feet, and the surrounding glacier-capped mountains rise to elevations of over 10,000 feet.

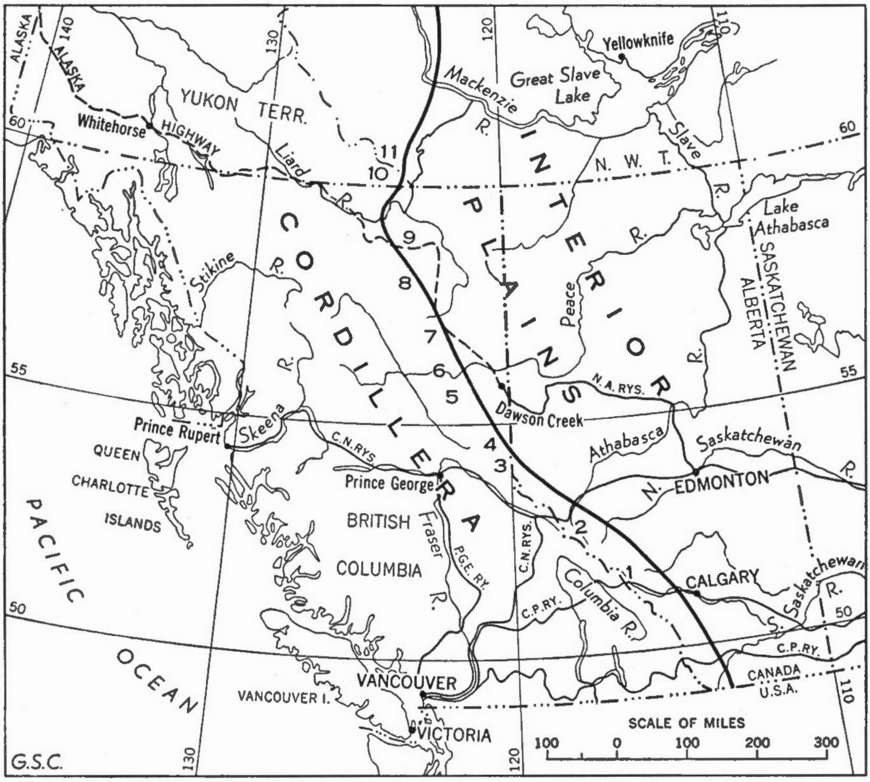
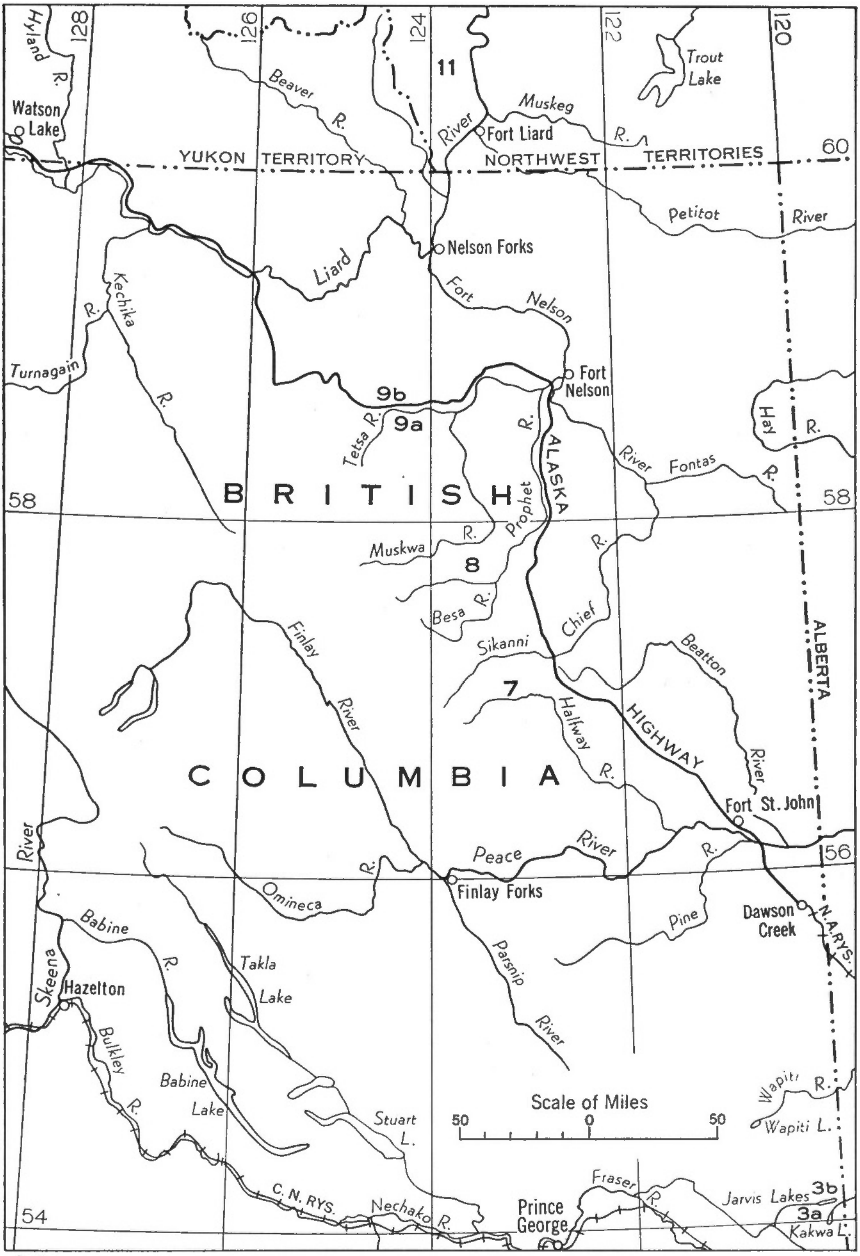


Figure 1. Index map showing area covered in this report in relation to Western Canada and the boundary between the Interior Plains and Cordillera. The numbers refer to the following areas which are discussed in Chaptei II and are shown on Figure 3. 1, Banff area, Alberta; 2, Jasper area, Alberta; 3, Kakwa-Jarvis Lakes area, British Columbia; 4, Wapiti Lake area, British Columbia; 5, Pine River area, British Columbia; 6, Peace River area, British Columbia; 7, Halfway River area, British Columbia; 8, Prophet River area, British Columbia; 9, Tetsa River-Alaska Highway area, British Columbia; 10, Mount Merrill area, Yukon Territory; 11, Liard Range, Northwest Territories.



G.S.C.

Figure 2. Map showing location of described sections. Numbers correspond to those given on Figure 1 but only those of detailed sections listed in Chapter II given here. 3a, b, Kakwa-Jarvis Lakes sections; 7, Halfway River sections; 8, Prophet-Muskwa section; 9a, b, Tetsa River-Alaska Highway section; 11, Liard River section.

The main ranges are formed by massive thrust blocks which are primarily Precambrian, Ordovician, Devonian and Carboniferous in age and which have been thrust northeastward. A Devonian block forms the east front range at the Jarvis Lakes and is thrust against the Cretaceous strata which form the foothills. Only the rocks of Devonian and Carboniferous age were examined in detail.

(B) *Pine River Region.* Pine River is about 40 miles south of Peace River and was traversed with pack-horses in the early summer of 1945 by Burling and the author. The Triassic and Cretaceous strata received detailed attention and a short reconnaissance trip into the first ranges of the mountains revealed highly faulted and contorted rocks of Mississippian and Pennsylvanian age. Other Palæozoic beds were not studied. Today the area is easily accessible by means of the John Hart Highway which connects the Peace River country with Prince George.

(C) *Halfway River Region.* The upper Halfway River valley, traversed to the headwaters by the writer in 1948, lies 80 miles north of Peace River. In the foothills good sections of Carboniferous and Triassic rocks were studied. The first range of the Rocky Mountains (*see* Plate II) is formed of a massive lower Palæozoic thrust block. There rocks of definite Ordovician age were found for the first time in the northern Rocky Mountains. A good section is exposed on an unnamed mountain that forms the divide with the Graham River drainage. The section is as follows:

	Thickness Feet
3. Sandstone and shale; alternation of grey, fine-grained, hard sandstone and black shale; no fossils observed; exposed	410
2. Shale and limestone; alternation of grey, calcareous shale with lesser thicknesses of argillaceous limestone; no fossils observed	1,250
1. Limestone and dolomite; alternation of massive cliff-forming, hard, dense, finely crystalline limestone and dolomite; more dolomite in lower part, more limestone in upper part; rare fossils in lower 1,000 feet; exposed approx.	2,430

At several horizons in the lower 1,000 feet of unit 1, particularly between 800 and 1,000 feet above the base, typically Ordovician gastropods were occasionally found. They include *Maclurites ungava* Wilson and *Maclurina manitobensis* (Whiteaves). These identifications have been checked and confirmed by Dr. Alice E. Wilson of the Geological Survey. These forms suggest a tentative Upper Ordovician, Richmondian correlation for the lower part of unit 1. It is possible that some of the apparently unfossiliferous higher beds are Silurian or Devonian in age, although the typical Silurian coral-reefs found in the Alaska Highway section 125 miles northward are missing.

In the western foothills the writer studied a well developed Triassic section over 5,000 feet thick. The marked eastward thinning of the Triassic formations observed at many localities in the foothills of northeastern British Columbia is well illustrated there for the equivalent section, penetrated by the Phillips Daiber "A" No. 1 well located about 30 miles to the east, is about 2,800 feet thick.

(D) *Prophet-Muskwa Rivers Region.* The writer made a brief reconnaissance up the upper Prophet River in 1946 where Palæozoic and Triassic formations were examined briefly. A more detailed study was made in 1948 of the Carboniferous and Triassic rocks exposed in the foothills on Bull Creek, between the Prophet and Muskwa Rivers (*see* Figure 4 and Plate I).

The Devonian is well developed in the upper Prophet River valley where it consists of an estimated 2,500 feet of massive limestone and dolomite with thick layers of quartzitic sandstone and siltstone in the lower part. This sequence is somewhat similar to the massive Middle Devonian section on the Alaska Highway. However, the highest limestone beds contain brachiopods of the *"Spirifer" jasperensis* type suggesting an early Upper Devonian age for the topmost limestone layers. A black shale sequence estimated at 2,000 feet thick directly overlies the above-mentioned limestone section, although the field relations of the two units are not clear. These shales are believed to be partly Devonian and partly Mississippian in age and are overlain by the Mississippian Prophet formation (*see* Chapter II).

(E) *Tetsa River Region.* Palæozoic rocks are most easily observed in northeastern British Columbia along the Alaska Highway which traverses the Rocky Mountains by way of the Tetsa River valley and the Summit Lake Pass. M. Y. Williams (1944) made a general traverse for the Geological Survey in 1943 along a 300-mile section of the Alaska Highway that included the Tetsa Valley. Laudon and Chronic (1947, 1949) examined the Palæozoic strata of the area in 1946. The Alaska Highway allows study of localities within the mountains where formations are generally well exposed. The author studied the area in 1947 and rocks of the following systems and series were examined: Precambrian, Pre-Silurian (probably Cambrian), Middle Silurian, Middle and Upper Devonian, Mississippian, Pennsylvanian?, Lower and Middle Triassic, and Lower and Upper Cretaceous. Rocks equivalent to the Ordovician dolomites that occur on the Halfway River are missing and Middle Silurian limestones and dolomites lie unconformably on strata of Precambrian or Cambrian? age.

Physical Features

The physiographic provinces of the Canadian Cordillera have been outlined by Bostock (1948). A more detailed survey of the physical features of northeastern British Columbia was made by McLearn and Kindle (1950). The main physiographic features of northeastern British Columbia are here summarized in order to relate them to the surface expression of the Carboniferous formations. Three physiographic divisions can be observed: (1) the Plains (eastern) Province, (2) the Foothills Belt, and (3) the Rocky Mountains.

The Plains Province is underlain by flat-lying to gently folded Cretaceous shale, sandstone and conglomerate.

The Foothills Belt, 15 to 40 miles wide, lies between the interior Plains and the main ranges of the Rocky Mountains. The contact between the Plains and Foothills Belt is generally well marked but gradational. The Foothills consist typically of gently to steeply folded and faulted rocks of Mesozoic age although upper Palæozoic strata are locally present. In the Kakwa-Jarvis Lakes area, only Cretaceous strata are exposed in the Foothills Belt and the western boundary is marked by a major thrust fault. The wide Foothills Belt in the Halfway, Prophet and Tetsa areas is dominated by high anticlinal ridges capped by massive Triassic limestones (*see* Plate III). In the western Foothills in these areas, Carboniferous formations of moderate resistance to erosion are brought to the surface by thrust faulting and erosion (*see* Figure 4 and Plates I, II, III).

The boundary between the Rocky Mountains and the Foothills Belt is well marked in all areas observed (*see* Plates I, II). The Rocky Mountains are composed of a series of folded, massive thrust blocks of Palæozoic age, thrust eastward against the more easily weathering strata that make up the Foothills Belt. In the Kakwa-Jarvis area massive Carboniferous limestones form high mountain ridges. In the northern Rocky Mountains the Carboniferous strata are less massive and have a subdued topographic expression in comparison to the more rugged mountains composed of early Palæozoic strata. This relationship is well shown near the Alaska Highway in the McDonnell River valley west of Summit Lake.

Acknowledgments

The field work for this report was carried out while the author was in the employment of the Phillips Petroleum Company, which has kindly permitted the results to be used for research and publication. The field work was done under the regional supervision of the late Dr. J. K. Knox, without whose interest the project could not have been completed. The writer is indebted to Mr. L. D. Burling, under whose stimulating direction he worked in the field during the summer of 1945 and a part of 1946 field season.

This report forms part of a thesis submitted for the degree of Doctor of Philosophy in the University of Cambridge. Most of the laboratory work was carried out in the Sedgwick Museum, Cambridge, under the supervision of Dr. O. M. B. Bulman whose continued interest and valuable criticisms are gratefully acknowledged. In the study of Rugose corals the writer is indebted to Dr. H. Dighton Thomas of the British Museum (Nat. Hist.), London, the late Dr. Stanley Smith of Bristol University, England, and Dr. Russell M. Jeffords of the Humble Oil Company, Houston, for their discussions and helpful criticisms and to Dr. Dorothy Hill of Queensland University, Australia, for useful advice on classification.

The writer would like to express his thanks to Dr. Peter Harker of the Geological Survey for information on his recent studies on Carboniferous stratigraphy and faunas in the southern Rocky Mountains and for helpful suggestions in the present work. The writer thanks the authorities of the Geological Survey of Canada, the U. S. National Museum, the British Museum (Nat. Hist.), London, and the Sedgwick Museum, Cambridge, for the opportunity of studying type specimens in their collections.

CHAPTER II

CARBONIFEROUS STRATIGRAPHY

Strata of Carboniferous age were laid down under marine conditions throughout the Rocky Mountain region. Until recently sections had been studied in detail only in southern areas, mainly in the vicinity of Banff and Jasper where railways and roads give access to the mountains. The section in the Banff area is the type for the Carboniferous of the southern Rocky Mountains and includes the Banff, Rundle, and Rocky Mountain formations. These have been examined by numerous geologists (Dowling, 1907; Kindle, 1924; Shimer, 1926; Warren, 1927; etc.) but there has been disagreement as to age and regional correlation, particularly of the Rundle and Rocky Mountain formations. Fossil identification has been based mainly on preliminary studies of small brachiopod collections which have been compared with Mississippi Valley forms. The only well described Carboniferous faunas in North America are those of the Mississippi Valley. The Rocky Mountain Carboniferous brachiopods can rarely be compared exactly with Mississippi Valley species and comparison of general characters of a few specimens has led to erroneous correlations.

This report is concerned primarily with the Carboniferous beds as observed in surface exposures in the northern part of the Rocky Mountains, but it is desirable to correlate as far as possible with the formations in the south. The sections at Banff and Jasper are, therefore, briefly described and a summary is given of all other available information on Carboniferous stratigraphy between Jasper and the Liard Range.

Variation in facies complicates the correlation of the Carboniferous rocks in the Rocky Mountains. The variation from east to west is accentuated by crustal shortening due to thrust faults, and there is also a distinct thinning eastward due primarily to erosional truncation.

Figure 3 (*in pocket*) shows a suggested southeast-northwest correlation of the different Carboniferous sections discussed below. It covers a distance of about 900 miles from Banff to the Liard River. Locations of the various sections are given on Figures 1 and 2. Information is lacking at many points and revisions will undoubtedly be necessary as more information becomes available.

Banff and Jasper Regions

The formations described below, although they vary in lithology and thickness, can be recognized over much of the southern Rocky Mountains, the type sections being near Banff. The formations were designated as lithological units, their boundaries not being placed according to palæontological zones or time breaks (Beales, 1950).

BANFF FORMATION

The Banff and Rundle formations were named by Kindle (1924) and described in greater detail by Shimer (1926, p. 19) and Warren (1927, p. 21). At its type section on Mount Rundle, the Banff formation is about 1,450 feet thick and consists of cherty dolomitic limestone interbedded with shale and shaly limestone (Beales, 1950, p. 11). The formation can be subdivided roughly into three lithological members but it shows an increase upward in carbonate content and the contact with the overlying Rundle formation is transitional, being marked by a change from argillaceous limestone and shale to more massive limestone. This change of facies is not synchronous over wide areas thus making a true time correlation with the type area impossible.

About 30 miles east of Banff, in the foothills in the Moose Mountain area, the Banff formation has thinned to less than 600 feet (Beach, 1943, p. 19).

The Banff formation can be recognized at Jasper, 120 miles north of Banff, where, on Mount Greenock, it has thinned to 675 feet (Brown, 1952, p. 19). In this area it has a two-fold lithological division. The lower part is a black shale grading upward into a thin-bedded argillaceous limestone.

The fauna of the Banff formation, which consists mainly of brachiopods, is definitely Early Mississippian. Many of its species can be compared in a general way with forms from the Mississippi Valley, although many of these apparently similar forms have different ranges in the two regions. The fauna contains in association both Kinderhook and Osage elements (Harker, 1953, p. 288). Widespread fossiliferous horizons in the middle part of the formation contain a preponderance of Kinderhook species and the strata in which they occur are believed to include beds of Kinderhook age. This fauna is characterized by *Leptaena analoga* Phillips and other typical Kinderhook brachiopods. In horizons in the upper part of the formation some Kinderhook-like species occur, but the fauna has strong Osage affinities with large brachiopods of the *Spirifer rowleyi-logani* group. This fauna persists into the overlying Rundle formation (Harker, personal communication).

Laudon and Chronic (1947, p. 1617), however, stated that the "Rundle limestone of the Banff and Jasper Park areas rests with sharp unconformity on Kinderhook beds, and no Osage rocks are present in these areas". In a later paper, Laudon (1948, p. 298) stated that in the Cordilleran region Osage rocks do not occur north of Nevada and that "they are entirely missing in the northern Rockies and in the Canadian Rockies". These views are not in agreement with faunal evidence from the Banff formation, nor has any evidence of unconformity between the Rundle and Banff formations been observed (Harker, personal communication).

RUNDLE FORMATION

In the Banff region the Rundle formation has a thickness of about 2,200 feet and can be subdivided lithologically into two members (Clark, 1949, p. 628). The lower member contains very massive cliff-forming cherty and dolomitic crinoidal limestone. The upper member consists of thin-bedded to fairly thick-bedded, dark grey to black argillaceous, fossiliferous limestone, thin sandstone, cherty limestone and dolomite. The formation varies greatly in thickness, thinning to 1,350 feet in the foothills at Moose Mountain dome 30 miles east of the type section. To the south, along the strike of the ranges, it reaches its maximum development and has a thickness of 5,300 feet (Warren, 1933, confirmed by Harker, personal communication) on the north side of Crowsnest Pass. Northward from Banff, on the other hand, it thins to about 800 feet in the Jasper area (Brown, 1952, p. 20).

The age of the Rundle formation is not well defined. Kindle (1924) considered the entire section to be Pennsylvanian in age, whereas Shimer (1926,

p. 5) later designated the upper two-thirds as Pennsylvanian and the lower one-third as Mississippian. More recent studies have indicated that the entire section is Mississippian in age. The lower Rundle is in part of Osage age and Warren (as reported in Clark, 1949, p. 629) considered the lower part of the upper Rundle to be Meramec in age and the uppermost Rundle to be a Chester equivalent.

Fossils are rare in the massive limestone beds of the lower Rundle formation but the early strata carry a fauna with Osage affinities. The upper Rundle contains a series of abundant coral faunules with reefs developed locally. The most common corals present are large caninids and several lithostrotionid species. These faunas have not as yet been studied in detail but suggest a Meramec age correlation. Colonial corals of the *Lithostrotion* type have been reported from the upper Banff and lower Rundle formations but they first appear in abundance about 600 feet below the top of the Rundle formation in the type section and this appears to be a fairly constant marker horizon in the southern mountains (Harker, 1952, p. 1258). Strata near the top of the formation contain Chester brachiopods similar to *Spirifer increbescens* Hall.

ROCKY MOUNTAIN FORMATION

The name 'Rocky Mountain quartzite' was used by Dowling (1907) but without designating a type locality. More detailed descriptions of sections in the Banff area were given by Shimer (1926, p. 11) and Warren (1927, p. 34). Beales (1950, p. 9) stated that the type locality for the formation is on Tunnel Mountain and that the formation overlies the Rundle formation with a transitional contact (ibid., p. 45). The thickness is variable, due partly to the fact that the upper surface is irregularly eroded. The lithology also varies. In the Banff area, where the Rocky Mountain formation has a thickness of over 600 feet, it consists of dolomite, dolomitic and siliceous sandstone, cherty and dolomitic quartzite, and bedded and nodular chert. The formation becomes more siliceous upward and in the upper part there are local developments of up to 70 feet of chert (Harker, personal communication). The formation pinches out rapidly eastward and is rarely found in the foothills.

The Rocky Mountain formation contains few fossils and these are generally poorly preserved. In the Banff area, Warren (1947, p. 1238) subdivided the formation into two members of which he considered the lower to be probably Pennsylvanian and the upper to be Permian in age. The formation is overlain disconformably by the Triassic Spray River formation.

In the Mount Greenock area near Jasper, Brown (1952, p. 22) proposed the name Greenock formation for beds that occupy the stratigraphic position of the Rocky Mountain formation in the Banff area. The Greenock formation can be subdivided into three members and is 526 feet thick at its type locality where it consists of bedded cherty dolomitic siltstone, massive chert, and quartzitic sandstone (ibid., p. 24). Brown (ibid., p. 77) maintains that at least the lower member of the Greenock formation is of Mississippian age.

Kakwa - Jarvis Lakes Region

About 120 miles northwest of Jasper, two sections of Upper Palæozoic strata were studied in the vicinity of Mount Hannington, the only named peak in the area just north of the Jarvis Lakes. The rocks observed can be correlated with the Banff, Rundle and Rocky Mountain formations of southern Alberta. Mount Hannington itself forms the east front scarp of the mountain range and is composed of a massive Devonian thrust slice which is overthrust onto Cretaceous rocks that form the foothills. The first mountain to the west of Mount Hannington consists of a second Devonian thrust block and the one next to it, immediately north of the Jarvis Lakes, is made up predominantly of Carboniferous strata. A section was measured up the southeast shoulder and along the skyline of the mountain. It includes the upper Banff, Rundle, Rocky Mountain and basal Triassic formations. This section is disturbed by faulting in the middle part of the Banff formation. The sequence is described as follows and the section number is that assigned to it on Figures 1 and 2.

SECTION 3A, KAKWA - JARVIS LAKES AREA

The following section is exposed on the second mountain (unnamed) west of Mount Hannington and immediately north of the Jarvis Lakes. It was measured up the southeast shoulder and along the skyline to the top of the mountain.

	Thickness in Feet: Unit	Thickness in Feet: From base of formation
TRIASSIC		
42. Shale; grey, silty, weathers chocolate, forms top saddle of mountain, fish remains and ammonites; exposed	200	—
ROCKY MOUNTAIN FORMATION		
41. Sandstone; quartzitic, white to light grey, thin-bedded, weathers almost black; estimated	50	76
40. Limestone; grey, thin chert bands	25	26
39. Conglomerate; chert pebbles	1	1
Total thickness of Rocky Mountain formation	76	—
RUNDLE FORMATION		
38. Limestone; dark grey, finely crystalline, thin-bedded, somewhat banded; estimated	100	813
37. Limestone; grey, cherty	15	713
36. Limestone; grey, weathers yellow, thin-bedded	3	698
35. Limestone; grey, partly crinoidal	75	695
34. Limestone; drab-grey, with 1-inch black chert bands	10	620
33. Limestone; partly argillaceous, weathers yellow with pits	5	610
32. Limestone; light grey, with chert nodules; ledge-forming; large solitary corals including species of *Kakwiphyllum* and *Pseudozaphrentoides; fossil locality 377*	25	605
31. Limestone; grey, thin-bedded, weathers yellow; *Pentremites* sp.; *fossil locality 376*	10	580
30. Limestone; grey, finely crystalline, irregularly bedded, with thin bands white chert that become abundant near top; estimated	150	570
29. Limestone; grey, cherty, thin-bedded; ledge-forming	35	420

	Thickness in Feet: Unit	Thickness in Feet: From base of formation
28. Limestone; grey, finely crystalline alternating with grey, crinoidal, medium-bedded, with thin fossiliferous beds; *fossil locality 375*	75	385
27. Limestone; grey, massive, interbedded with numerous chert layers	25	310
26. Limestone; grey, massive, crinoidal limestone near base; estimated	100	285
25. Limestone; grey, argillaceous, thin-bedded, forms a saddle; minute fossils common; *fossil locality 374*	25	185
24. Limestone; grey, thin-bedded, weathers yellowish grey	10	160
23. Limestone; blue-grey, thick-bedded, weathers grey; cliff-forming	75	150
22. Limestone; blue-grey, thin-bedded, weathers grey	25	75
21. Limestone and shale; alternation of grey, thin-bedded (¼ to 1 inch) limestone and yellow-grey shale; *fossil locality 373*	15	50
20. Limestone; bluish grey, platy, grey weathering. Taken as base of Rundle formation but no break in succession.	35	35
Total thickness of Rundle formation	813	—
BANFF FORMATION		
19. Shale; dark grey, platy	15	849
18. Limestone; grey, thin to irregularly bedded; *fossil locality 379*	25	834
17. Limestone; grey, argillaceous, weathers yellowish grey	5	809
16. Limestone; purplish grey, platy (½ to 1 inch) argillaceous, weathers reddish grey; with thin shale breaks; fossils common	100	804
15. Limestone; grey, argillaceous, thin-bedded; *fossil locality 372*	1	704
14. Limestone; dark grey, medium-crystalline; ridge-forming	20	703
13. Limestone and shale; alternation of grey, thin-bedded limestone and thin black shale; *fossil locality 401* 10 feet below top; *fossil locality 370* at base	35	683
12. Limestone; dark grey, thin-bedded to massive, cliff-forming; estimated	100	648
Fault, character undetermined.	////	
11. Limestone; blue-grey, hard, thin- to medium-bedded; chert bands and nodules common	(75)	—
Fault, character undetermined; marked by draw on skyline	////	

	Thickness in Feet: Unit	Thickness in Feet: From base of formation
10. Limestone; dark grey, finely crystalline, irregularly thin- to massive-bedded, partly crinoidal; rare chert nodules and bands; cliff-forming; *fossil locality 399* 75 feet below top; estimated	150	548
9. Limestone; dark to light grey, banded, thin-bedded; forming draw where stunted trees reach skyline	60	398
8. Limestone; dark grey, medium-crystalline, platy, cliff-forming, weathers grey; *fossil locality 398* 20 feet below top	40	338
7. Limestone; grey, thin-bedded, argillaceous	35	298
6. Limestone; dark grey, thin-bedded, weathers drab-grey	10	263
5. Limestone; grey, thin-bedded, argillaceous; fossils	1	253
4. Limestone; grey, thin-bedded, cryptocrystalline, argillaceous; fossils in middle	15	252
3. Limestone; dark grey, medium-crystalline, partly argillaceous, thin- to medium-bedded; more thin-bedded near top; fossils	125	237
2. Limestone; grey, argillaceous, thin-bedded	12	112
1. Limestone; dark blue-grey, finely crystalline, thin- to medium-bedded; irregular weathering, *fossil locality 402* 60 feet below top; estimated	100	100
Base of exposed section.		
Total thickness of Banff formation exposed	849	—

The lower part of the Carboniferous succession was studied on the first mountain north of Mount Hannington and was measured along the south ridge to the top of the mountain and through a saddle to the slope of a mountain to the west. The section includes the highest Devonian beds and the lower 567 feet of the overlying Banff formation. It is described as follows:

SECTION 3B, KAKWA - JARVIS LAKES AREA

	Thickness in Feet: Unit	Thickness in Feet: From base of formation
BANFF FORMATION		
Top of exposed section		
12. Limestone; grey, thin-bedded; *fossil locality 393*	2	567
11. Limestone; blue-grey, partly crinoidal, thick-bedded; estimated	50	565
10. Shale and limestone; dark to light grey shale with thin grey limestone bands; shale weathers tan; fossils	5	515
9. Limestone; blue-grey, thin- to medium-bedded, finely crystalline; *fossil locality 391* 30 feet below top; estimated	50	510
8. Limestone; grey, finely crystalline, massive, ridge-forming	10	460

	Thickness in Feet: Unit	Thickness in Feet: From base of formation
7. Limestone; blue-grey, finely crystalline, thin-bedded; brachiopods common; *fossil locality 390,* 20 feet above base; partly covered by talus; estimated	150	450
6. Shale; calcareous, platy, alternating with some shaly limestone, partly covered, forms saddle on skyline; estimated	100	300
5. Limestone; grey, finely crystalline, argillaceous, thin-bedded; exposed between saddle of unit 6 and top of mountain; estimated	50	200
4. Limestone; grey, finely crystalline, hard, medium-bedded, cherty near top; forms long strike ridge south of summit; estimated	100	150
3. Limestone; grey, thin-bedded, argillaceous; grey to tan weathering, partly covered by talus; *fossil locality 389* loose on slope but must be from unit 3 or 4; estimated	50	50
Total thickness of exposed part of Banff formation	567	—
Devonian-Mississippian contact covered by talus.		
UPPER DEVONIAN		
2. Limestone; dark grey, thin-bedded (1 inch to 6 inches); ledge-forming; *Hypothyridina* sp.; *fossil locality 388* near base	50	350
1. Limestone; blue-grey, thick-bedded to massive, upper 100 feet mostly covered; exposed, at least	300	300
Total thickness of Upper Devonian measured	350	—

BANFF FORMATION

The Banff formation in the Jarvis Lakes region consists of thin-bedded, grey limestone alternating with argillaceous limestone and minor amounts of shale, with some silty and nodular chert beds. In general, the formation weathers easily, although some of the more resistant layers stand out locally. A complete section of the formation was not seen. The stratigraphic relation between section 3B, which includes the lower 565 feet of the formation, and section 3A which includes the upper 850 feet of the formation is not clear. No individual beds could be correlated between the two sections but the general lithologies and faunas are similar and they are believed to overlap to a considerable but undetermined extent.

In section 3B the lower Banff formation overlies massive Devonian limestone containing *Hypothyridina* sp. in its upper part. The actual contact with the Devonian is not exposed, as the thin-bedded layers in the lower 50 feet of the Banff formation form a talus slope, obscuring the contact. Equivalent beds to the thin Exshaw formation may or may not be present in this basal covered interval.

In section 3A the base of the formation is not exposed and the upper part is cut by faults of undetermined character. About 550 feet of beds are exposed below the faults and consist, as in section 3B, of thin-bedded, drab-grey limestone. About 75 feet of hard, blue-grey cherty limestone of unknown age occur between two faults at the top of these beds. The first 300 feet of strata above the upper fault are tentatively referred to the Banff formation. These beds consist mainly of thin-bedded argillaceous limestone, except for a massive layer at their base. They are similar to the Banff formation in lithology but they may be equivalent to the lower part of the Rundle formation, as the faunal evidence could support either possibility. No repetition of the beds above and below the faults is suggested by the limited faunal evidence. If this is true, then the thickness of the Banff formation is at least 850 feet. An arbitrary contact with the overlying Rundle formation is indicated in section 3A, but there is no sharp lithological change between the two formations.

The Banff formation in the two sections studied is fossiliferous, though field conditions did not permit extensive collecting from any one horizon and specimens from most layers are not well preserved. Brachiopods make up the largest part of the collections. Localities 389, 390 and 393 from the lower Banff formation in section 3B include: *Amplexi-Zaphrentis* sp., *Schizophoria* cf. *chouteauensis* Weller, *Cleiothyridina lata* Shimer, *Dictyoclostus* cf. *jasperensis* Warren, *Spirifer* cf. *albertensis* Warren, *Platyrachella* ? cf. *rutherfordi* (Warren), *Platycrinites* sp. and *Palaeechinus canadensis* Kier. The last named is an exceptionally well preserved echinoid described as a new species by Kier (1953, p. 65). The Banff formation below the faulted zone of section 3A contains a similar fauna but includes in addition *Chonetes* cf. *illinoisensis* Weller and *Spirifer* cf. *centronatus* Winchell. All these forms are typical Banff species and have mainly Kinderhook with some Osage affinities. They support a comparison with the lower and middle Banff formation to the south.

The 300 feet of beds above the faults in section 3A (units 12 to 19), which are tentatively placed in the Banff formation, are only moderately fossiliferous. Fossil localities 370, 372 and 379 contain, among other species, the following: *Amplexi-Zaphrentis* sp. D, *Linoproductus* cf. *minnewankensis* (Shimer), *Spirifer* cf. *centronatus* Winchell, *Platyrachella* ? cf. *rutherfordi* (Warren), *Spirifer esplanadensis* Brown, *Cleiothyridina* cf. *obmaxima* McChesney, *Spirifer* sp. aff. *rundlensis* Warren and *Spirifer* sp. aff. *banffense* Warren. Most of these species are found in the upper part of the Banff formation and in the lower Rundle formation farther south. An Osage correlation is suggested.

RUNDLE FORMATION

A complete section of the Rundle formation was studied in the upper part of section 3A. It consists of massive, cliff-forming, grey limestones and dolomites, some cherty and some crinoidal, interbedded with more thin-bedded limestone. The formation can be divided roughly into two lithological subdivisions. The lower unit is generally massive and consists of grey, cliff-forming limestone alternating with more thin-bedded layers. The upper part, about 450 feet thick, consists mainly of relatively thin-bedded, grey limestone much of which is crinoidal and cherty. The formation in section 3A is 813 feet thick.

The lower, more massive, series is sparsely fossiliferous and individuals collected (fossil lots 373, 374 and 375) are poorly preserved and contain no diagnostic species. The upper thin-bedded series is more fossiliferous. A species of *Pentremites* that has affinities to the late Mississippian form *P. godoni* (Defrance) occurs in unit 31 and a prominent coral horizon (fossil locality 377) is to be found in unit 32, which is about 200 feet below the top of the formation.

Pseudozaphrentoides ? burlingi n.sp., a solitary coral up to 2 feet in length, is abundant at this horizon. A weathered specimen identified as *Kakwiphyllum* sp. was also collected from this locality. The following forms from talus blocks (fossil lot 366) found below the upper part of section 3A very likely come from this part of the Rundle formation: *Kakwiphyllum dux* Sutherland, *Pseudozaphrentoides* sp. A and *Lithostrotion* [*Diphyphyllum*] sp. A. This coral fauna is considered Meramec in age.

No fossils were collected in the upper 200 feet of the Rundle formation in section 3A and, therefore, it cannot be determined if beds of Chester age are present. There is an almost complete absence of colonial corals of the lithostrotion type from the formation in section 3A. This contrasts with the abundance of such forms at Banff and elsewhere. The fragment of *Diphyphyllum* listed above from a talus block is the only representative of this type collected.

ROCKY MOUNTAIN FORMATION

The Rocky Mountain formation occurs in the upper part of section 3A and consists of about 25 feet of cherty grey limestone (unit 40) overlain by 50 feet of white to light grey, more or less thin-bedded, quartzitic sandstone which weathers almost black (unit 41). A chert-pebble conglomerate (unit 39) 12 to 15 inches thick, occurs at the base.

No fossils were found in the formation but it is correlated with the Rocky Mountain formation of southern Alberta on lithological grounds.

The formation pinches out northward. Its thickness is as much as 613 feet at Banff, over 450 feet at Jasper, 75 feet in the Kakwa-Jarvis area and it is missing at Wapiti Lake 45 miles northward (Laudon, *et al.*, 1949). However, these variations in thickness are not regionally consistent. For instance, although the formation is missing at Wapiti Lake, less than 100 miles northeastward in the subsurface the possibly equivalent "Permo-Pennsylvanian" sequence is represented in the Imperial Wembley #1 well by 475 feet of cherty dolomite, quartzitic sandstone and scattered chert (*see* further discussion on age of these strata under *Prophet-Muskwa Rivers Region*).

The Rocky Mountain formation is overlain in section 3A by soft, silty, grey shale which weathers a characteristic chocolate and contains ammonites and fish remains of Triassic age. About 200 feet of these shales are present in a saddle at the top of the mountain but the contact with the underlying quartzitic sandstone is obscured by talus.

Wapiti Lake Region

Devonian and Carboniferous strata near Wapiti Lake, 45 miles northwest of Kakwa-Jarvis Lakes, were studied by L. R. Laudon and a group of graduate students in the summer of 1947 (1949, p. 1502). They stressed the cyclic nature of the Carboniferous strata, recognized major and minor cycles, and attempted to use these to correlate different sections locally.

The Carboniferous rocks in the vicinity of Wapiti Lake are similar in lithology and fauna to those found in the Kakwa-Jarvis section, except that the Rocky Mountain formation is missing. Laudon, *et al.* (p. 1540) restricted the Rundle formation to include only its upper less massive beds and proposed a new formation, the Dessa Dawn, for the lower part.

BANFF FORMATION

The Banff formation in this area is interpreted as including only the lower argillaceous beds. It exhibits essentially the same characters shown by the beds below the faults in section 3A of the Kakwa-Jarvis Lakes area. It consists of thin-bedded limestone interbedded with thin, silty shale and is said to vary in thickness locally from 495 feet to 697 feet and to thin southward (ibid., p. 1527).

The upper part of the Banff formation, as interpreted by Laudon, *et al.*, is fossiliferous and is said to contain a middle Kinderhook fauna lacking in Osage species (ibid., p. 1536).

RUNDLE AND 'DESSA DAWN' FORMATIONS

Laudon, *et al.* (1949, p. 1542) stated that a marked hiatus occurs in the upper part of the Rundle formation in the Wapiti Lake area. The lithological character is said to be markedly different above and below the 'unconformity', which represents a time of extensive erosion. The fauna of the upper beds, which contains *Lithostrotion,* is stated to have Meramecian affinities whereas the fauna below the hiatus is said to be probably late Kinderhook in age.

Laudon, *et al.* restrict the Rundle formation to the beds above the 'unconformity' which consist of soft, brown, sugary porous, cherty dolomite alternating with harder pure dolomite layers. The thickness of these upper beds varies from 192 to 290 feet in the Wapiti Lake area. This series would appear to correlate with the thin-bedded upper unit of the Rundle formation as recognized to the south, which also contains *Lithostrotion* and other coral horizons.

The beds below the 'unconformity' are designated the Dessa Dawn formation. They consist of massive limestone interbedded with thin-bedded limestone, and vary in total thickness in the Wapiti area from 1,055 to 1,360 feet. This succession is probably equivalent to the lower massive, cliff-forming strata of the Rundle formation in the Kakwa-Jarvis Lakes area, as well as to the thin-bedded unit above the faults in section 3A which, in this report, is referred to the Banff formation.

It is stated (ibid., p. 1542) that the above-mentioned erosional 'unconformity' has been recognized at the same horizon in sections studied at Jasper, Banff and in Montana. However, the writer found no indication of such a hiatus in the Rundle formation and Harker (personal communication) in a recent detailed examination of the type section of the Rundle formation at Banff, found no such break in the section there. The faunal evidence from other areas does not support the view that beds of Osage equivalent age are missing from the section and that beds of Meramec age rest unconformably on upper Kinderhook strata. In this report the Dessa Dawn formation is therefore not recognized and the Rundle formation is interpreted according to its original definition.

ROCKY MOUNTAIN FORMATION

The Rocky Mountain formation is missing in the Wapiti Lake area, and Triassic shales, with a basal conglomerate in some localities, rest unconformably on the Rundle formation (Laudon, *et al.,* p. 1543).

Pine and Peace Rivers Region

No detailed studies have been made of the Carboniferous stratigraphy between Wapiti Lake and Halfway River, 210 miles northwest along the trend of the mountains. The most interesting information available from the intervening area, which includes the Pine and Peace River Valleys, is the presence of rocks of Pennsylvanian and Permian age as well as Mississippian strata. In the Wapiti area in the south and in the Halfway River area in the north, Triassic beds rest unconformably on Mississippian rocks.

PINE RIVER VALLEY

Williams and Bocock (1932) made a brief reconnaissance survey of the geology of the Pine and Peace River Valleys. In the Pine River area they reported (1932, p. 203) that rocks of Pennsylvanian age occur between the mouths of Callazon and Mountain Creeks. They give an approximate section consisting of limestone, cherty limestone, and some quartzites but do not give thicknesses. L. D. Burling and the author made a brief observation of some of the Carboniferous rocks in the same area in 1945. Outcrops of blue-grey crystalline limestone interbedded with calcareous shale were observed on the first mountain west of Mountain Creek, but the strata are too contorted and folded to permit positive determination of the stratigraphic relations. Fossils were collected from several unrelated localities. Those from localities 283 and 284 are probably of middle or upper Mississippian age as they contain *Lithostrotion* cf. *whitneyi* Meek and also a Mississippian-like species of *Chonetes*. Beds that appear to be stratigraphically higher contain a fairly well defined Pennsylvanian fauna which includes *Dictyoclostius* sp. cf. *D. americanus* Dunbar and Condra, *Buxtonia* sp., *Juresania* sp., *Derbya* sp., and *Linoproductus* sp. Both the large *Linoproductus* and the large, coarsely ribbed *Buxtonia* have distinct Pennsylvanian affinities.

PEACE RIVER VALLEY

Little information is available on the Carboniferous of the Peace River area. Rocks of Mississippian age are present but have been recorded from only one isolated outcrop in the river bed, called 'Fossil Point', which is located on the north shore of the river about 3 miles above Rapide-que-ne-parle-pas. Selwyn (1877) first collected from this locality where he described black limestone. Lambe (1901) described a new coral from this locality, *Lithostrotion macouni*, which may indicate a Mid-Mississippian age. Williams and Bocock (1932, p. 203) list a limited brachiopod fauna from the same outcrop which is definitely Mississippian in age.

Beach and Spivak (1944, p. 3) who examined the Mesozoic stratigraphy in the Peace River foothills in the vicinity of the Peace River Canyon recorded the exposure of possible Permian rocks in the core of a tightly folded and faulted anticline on the south side of Peace River west of the Canyon. The outcrop consists of 415 feet of sandstone and limestone containing a poorly preserved brachiopod and pelecypod fauna which has been tentatively identified by Dr. A. E. Wilson as of Permian age. These beds are underlain by dark grey limestone which may be of Carboniferous age.

Halfway, Prophet and Muskwa Rivers Region

The location of the Halfway River area and Prophet-Muskwa Rivers area are given in the Introduction. The Carboniferous rocks in these two regions are remarkably similar in character and thickness. They occur in the Foothills Belt in massive folds or in fault blocks and may have either a normal or faulted relation with Triassic strata. Their lower contact with strata of definite Devonian age has not been observed. They generally consist of two formational units, a lower shale unit and an upper massive limestone and chert unit which is here designated as a new formation, the Prophet formation. This has been subdivided lithologically into three members. A thin chert formation appears to occur above the Prophet formation in one locality. It is discussed below as the upper Chert unit and is presumed to be Pennsylvanian or Permian. In all other localities Triassic shale rests directly on the Prophet formation.

The most complete section of Carboniferous rocks studied in this region is located in the Prophet-Muskwa area, about 120 miles north of Peace River, on a creek known locally as Bull Creek and it is here designated the type section of the Prophet formation. This section (section 8) is approximately at lat. 57° 47′ north and long. 123° 37′ west, about 5½ miles south of the Muskwa River, on a hill to the north of a high waterfall on Bull Creek. The waterfall and section 8 are just southeast of the drainage basin shown in the foreground of Plate I and are marked on Figure 4. Bull Creek flows almost due east and joins Prophet River about 17 miles east of the waterfall.

Section 8 is continuous with a complete Triassic section, southwest of the Bull Creek waterfall. Other sections of Carboniferous strata were studied in the main valley of Prophet River southwest of this locality (*see* Figure 4 and Plate III). Section 8 is given in detail as follows:

SECTION 8, PROPHET - MUSKWA RIVERS AREA

This section on Bull Creek, constitutes the type section of the Prophet formation.

	Thickness in Feet	
	Unit	Above base of formation
TRIASSIC		
86. Shale; mostly covered		
PROPHET FORMATION		
Member C		
85. Chert and limestone; grey to black, slightly calcareous chert, in irregular nodular layers, interbedded with light to medium grey, dense limestone; chert averages 60 per cent of section; *fossil locality 85* near top	38	1,254
84. Limestone; light to medium grey, finely crystalline	1	1,216
83. Chert and limestone; grey, partly calcareous, irregularly bedded chert and thin, grey limestone beds; chert 80 per cent	8	1,215
82. Chert; medium to dark grey, partly calcareous, hard, nodular, irregularly bedded	14	1,207
81. Limestone; dark grey, medium-crystalline, partly crinoidal	37	1,193
80. Limestone and chert; medium to dark grey, medium-crystalline, partly cherty limestone, in layers 1 foot to 2 feet interbedded with grey, calcareous chert in irregular nodular layers; chert 5 to 20 per cent	36	1,156
79. Limestone; light to medium grey, medium-crystalline, irregularly bedded	8	1,120
78. Limestone and chert; grey limestone and thin irregular chert layers	3	1,112
Thickness of Member C	145	

	Thickness in Feet	
	Unit	Above base of formation
Member B		
(Top of massive cliff causing waterfalls)		
77. Chert and limestone; medium grey, partly calcareous chert in irregular nodular layers and grey, finely crystalline limestone; chert 75 per cent	18	1,109
76. Limestone and chert; grey, coarsely crystalline limestone with irregular lenses and bands of grey, calcareous chert; chert 5 to 15 per cent	25	1,091
75. Chert and limestone; grey, slightly calcareous nodular chert, and grey, medium-crystalline limestone; chert 50 to 75 per cent; *fossil locality 90,* 7 to 8 feet below top	20	1,066
74. Chert and limestone; as in unit 75 but chert 40 to 50 per cent	83	1,046
73. Chert and limestone; alternation of irregular nodular layers of grey, partly calcareous chert and medium grey, coarsely crystalline limestone; chert 65 per cent	7	963
72. Chert and limestone; as in unit 73 but chert 40 per cent	25	956
71. Covered by talus; *fossil locality 89* from talus block including phaceloid species of *Lithostrotion,* believed to be from somewhere between units 72 and 77	16	931
70. Limestone and chert; light to medium grey, coarsely crystalline, partly crinoidal limestone interbedded with irregular layers of grey to black, calcareous chert; chert 40 per cent	13	915
69. Limestone; grey, coarsely crystalline, crinoidal	3	902
68. Chert and limestone; nodular, irregularly bedded, grey, calcareous chert and coarsely crystalline, grey crinoidal limestone; chert 75 per cent	22	899
67. Chert and limestone; as in unit 68 but limestone medium grey and finely crystalline	29	877
66. Limestone and chert; coarsely crystalline limestone with thin, irregularly bedded, nodular layers of grey, hard, conchoidal fracturing chert; chert 45 per cent	11	848
65. Limestone and chert; medium grey, finely crystalline, thin-bedded limestone with nodular, thin-bedded, light grey, partly calcareous chert; chert 80 per cent	59	837
64. Chert; grey, hard, conchoidal fracturing, massive; weathers white	7	778
63. Chert and limestone; dark grey, calcareous chert and medium grey, partly cherty limestone; chert 70 per cent	44	771

	Thickness in Feet	
	Unit	Above base of formation
62. Chert and limestone; light to dark grey, calcareous chert in thin-bedded, irregular layers and grey, finely crystalline, partly highly cherty limestone; chert 50 per cent	65	727
61. Chert and limestone; as in unit 62 but chert 75 per cent	8	662
60. Limestone; medium grey, finely crystalline	2	654
59. Chert and limestone; medium grey, hard, nodular chert bands and grey, finely crystalline, thin-bedded limestone; chert 65 per cent	5	652
58. Limestone and chert; dark grey cherty limestone and nodular bands of calcareous chert	4	647
57. Chert and limestone; grey, calcareous chert in wavy layers; interbedded with medium grey, finely crystalline limestone; chert 80 per cent	23	643
56. Limestone and chert; as in unit 57 but chert 40 per cent	30	620
55. Limestone and chert; as in unit 57 but chert 25 per cent	30	590
54. Limestone; medium grey, finely crystalline, with rare thin layers cherty limestone and calcareous chert	12	560
53. Limestone and chert; medium grey limestone with wavy layers of highly calcareous chert; chert 40 per cent	30	548
52. Limestone and chert; as in unit 53 but chert 50 per cent	20	518
51. Limestone; medium grey, partly very cherty	8	498
Thickness of Member B, Prophet formation	619	
Member A		
50. Covered by talus	2	490
49. Limestone and chert; grey limestone with thin nodular bands of black chert	3	488
48. Limestone and chert; grey, finely crystalline, thin-bedded limestone interbedded with black, nodular chert bands; chert 20 per cent	13	485
47. Limestone; finely crystalline, thin-bedded with rare chert nodules	12	472
46. Covered by talus	10	460
45. Limestone and chert; medium grey, thin-bedded limestone, interbedded with thin, nodular, grey chert beds; chert 20 per cent	8	450
44. Limestone and chert; medium grey, thin- to medium-bedded, hard, limestone interbedded with nodular grey chert beds forming small cliff; chert 50 per cent	31	442
43. Covered by talus, probably thin-bedded; estimated	160	411

	Thickness in Feet: Unit	Thickness in Feet: Above base of formation
42. Limestone and chert; alternation of thin irregular layers of grey limestone and chert	2	251
41. Limestone; dark grey, finely crystalline, hard	2	249
40. Covered by talus	6	247
39. Limestone; dark grey, finely crystalline, hard	2	241
38. Limestone and shale; alternation of thin-bedded argillaceous limestone and calcareous shale; poorly preserved brachiopods; *fossil locality 87*	4	239
37. Shale; calcareous, dark grey; mostly covered	19	235
36. Limestone and chert; grey, finely crystalline limestone with thin bands grey chert	2	216
35. Limestone; alternation of dark grey, thin-bedded and argillaceous limestone	14	214
34. Limestone; dark grey, argillaceous	20	200
33. Covered by talus	4	180
32. Chert and shale; alternation of thin-bedded, black, chert bands and calcareous shale	2	176
31. Calcareous shale	4	174
30. Limestone; medium grey, finely crystalline with thin bands black chert; chert less than 5 per cent	16	170
29. Limestone; grey, finely crystalline; *fossil locality 88*	4	154
28. Covered by talus; estimated	150	150
Thickness of Member A, Prophet formation	490	
Total thickness of Prophet formation	1,254	
BASAL SHALE UNIT		
27. Shale and limestone; dark grey, calcareous shale alternating with thin-bedded argillaceous limestone	10	490
26. Covered by talus	25	480
25. Chert; black, calcareous, conchoidal fracturing	3	455
24. Limestone; dark grey, finely crystalline	4	452
23. Shale; dark grey, partly covered	15	448
22. Shale and limestone; alternation of dark grey, calcareous shale and dark grey, thin-bedded argillaceous limestone	19	433
21. Limestone; alternation of hard, dense, grey limestone and black, cherty limestone; forms cliff	9	414
20. Shale; dark grey, calcareous	1	405
19. Limestone; dark grey, finely crystalline	1	404
18. Shale; dark grey, calcareous; partly covered	35	403
17. Limestone; dark grey, argillaceous	3	368
16. Shale; dark grey, calcareous	7	365
15. Shale; dark grey, slightly calcareous; highly fractured	7	358

	Thickness in Feet: Unit	Thickness in Feet: Above base of formation
14. Shale; dark grey, calcareous	19	351
13. Limestone; dark grey, argillaceous, fractured	4	332
12. Shale; dark grey	5	328
11. Limestone; dark grey to black, hard, massive	2	323
10. Shale; dark grey	5	321
9. Limestone; dark grey to black, argillaceous; fractured	1	316
8. Shale; dark grey	2	315
7. Limestone; dark grey to black, argillaceous; fractured	2	313
6. Shale; dark grey, highly calcareous	33	311
5. Limestone; dark grey to black, argillaceous; fractured	15	278
4. Shale; dark grey to black, highly calcareous; fractured	20	263
3. Shale; dark grey, soft, easily weathered	40	243
2. Limestone; dark grey to black, weathers buff; *fossil collection 100*	3	203
1. Shale; dark grey, calcareous, friable, easily weathered; highly fractured; *fossil locality 101* from talus block of grey limestone from higher in section; exposure estimated	200	200
Base of exposed section; covered strata below probably shale for several hundred feet.		
Thickness of exposed part of Basal Shale unit	490	

On the Halfway River, about 55 miles south of the Prophet-Muskwa area and about 65 miles north of Peace River, two tightly folded but apparently unfaulted anticlines composed of Carboniferous rocks are exposed in the Rocky Mountain foothills about 40 miles west of the Alaska Highway. Their upper beds appear to be continuous with the Triassic strata but the actual contact is covered. The lower two members of the Prophet formation, Members A and B, were studied on the most easterly of the Carboniferous mountains on the north side of the river. Member C was studied above the waterfall along a creek west of the mountain, which can be seen on the right side of Plate II. The top of Member C was not exposed but few beds appear to be missing. A summary of a compiled section follows:

SECTION 7, HALFWAY RIVER AREA

Summary of Compiled Section

	Thickness Feet
PROPHET FORMATION	
Member C	
(Uppermost beds not exposed, thickness missing probably not great.)	
7. Limestone and chert; alternation of dense grey limestone, partly crinoidal, cherty limestone and thin wavy bands of black to grey chert, partly calcareous; chert estimated at 15 per cent of section; *fossil localities 73, 74, 75* exposed.	170

	Thickness Feet
Member B	
6. Chert and limestone; cliff-forming, alternation of light grey to black chert, partly calcareous, in irregular and nodular layers (½ inch to 10 inches) and light to dark grey finely crystalline limestone, partly cherty; chert averages 60 per cent of section; *fossil localities 81* and *82* in upper part	620
Member A	
5. Limestone and chert; similar in character to unit 6, but more thin-bedded and containing thin, grey shale layers that become more prominent in lower part; section easily weathered; *fossil localities 83* and *84*	260
4. Limestone and chert; cliff-forming; similar to unit 6 but thin-bedded with thin shale layers	65
3. Covered by talus; estimated	55
2. Shale, limestone and chert; alternation of grey, calcareous shale with thin-bedded limestone and irregular chert bands, shale increases and chert decreases downward; section easily weathered, mostly covered by talus	210
Total thickness of Prophet formation exposed	1,380
BASAL SHALE UNIT	
1. Shale; grey, calcareous, partly silty, interbedded with thin layers argillaceous limestone and rare thin chert layers; exposed	270
Base of exposed section.	

BASAL SHALE UNIT

The earliest Carboniferous rocks observed in these regions consist of thick, grey to black calcareous shales. They are interbedded in the upper part with soft argillaceous thin-bedded limestone, and overlain conformably by the Prophet formation. A thick transitional series between the two formations has been arbitrarily included in the higher formation. The base of the lower shale beds was not seen and the total thickness is unknown. However, several hundred feet of these beds were observed on the south side of the Prophet River valley and in view of the large area which is apparently underlain by these beds, it seems probable that their total thickness may be as much as 1,500 to 2,000 feet.

Only the upper part of the formation was examined in detail. About 275 feet are exposed at the base of Section 7 on the Halfway River, consisting of interbedded shale and argillaceous limestone with a few thin chert layers. In Section 8, at Bull Creek, about 490 feet of strata were observed. At this locality the upper 290 feet consist of interbedded shale and argillaceous limestone with a few very thin chert layers, underlain by a soft, grey, calcareous shale of which about 200 feet are exposed.

Fossils are rare in this shale unit and those found are poorly preserved and some are crushed. No fossils have been found in the shale (unit 1) at the base of Section 8, but the following collection (fossil lot 100) was made from the overlying beds (unit 2): *Chonetes* cf. *multicosta* Winchell, *Chonetes* sp. A (a very large form) and *Nudirostra* sp. aff. *N. carbonifera* (Girty). This fauna is limited but it suggests that the upper part of the formation is Early Mississippian in age. The thick talus-covered shale section below is possibly partly or all Devonian in age, in which case it would probably correlate with the Upper Devonian Fort Creek shale in the Tetsa River area.

In the western part of the Prophet River valley (*see* Figure 4) massive Devonian limestone has been thrust to the east against a black shale many hundreds of feet thick. This may be equivalent in part to the shale unit described above but it is probably mostly Devonian in age. The geologist of an oil company has reported the presence of good exposures in a thick black shale of Upper Devonian age in the Besa River valley 20 miles south of the Prophet River.

PROPHET FORMATION

The main part of the Carboniferous section in this region is included in the Prophet formation. At the type section, section 8, it has a thickness of 1,250 feet and on the Halfway River of about 1,380 feet (section 7). Wherever the formation was studied it could be subdivided into three lithological members that grade somewhat into each other. These members are designated by the letters A, B, and C, starting from the bottom of the section.

Member A. This member consists of 500 to 600 feet of thin-bedded chert and limestone beds with shale layers in the lower part. Shale decreases upwards and chert becomes more prominent in the higher beds, where it averages 60 per cent of the whole. The contact with the underlying Basal Shale unit is gradational.

Few fossils were found in Member A and most of those that do occur are poorly preserved or crushed. *Nudirostra* is the commonest form and may occur even where other genera are absent. Several species of this genus are represented in section 7, lots 83 and 84, and section 8, lot 88. None can be compared exactly with described species though two of them have general affinities with *N. carbonifera* (Girty) and *N. haguei* (Girty). A talus block of thin-bedded limestone (fossil lot 101) found on the slope of the underlying Basal Shale unit in section 8 and probably coming from this member or Member B, contains the following: *Amplexi-Zaphrentis* sp. B, *Chonetes* cf. *multicosta* Winchell, *Chonetes* sp. B and *Dictyoclostus* cf. *altonensis* (Norwood and Pratten). The fauna is limited, but is suggestive of Early Mississippian age. It should be noted that part of the fauna is similar to that occurring in the upper part of the Basal Shale unit that underlies the Prophet formation.

Member B. This intermediate member consists of 500 to 650 feet of massive, cliff-forming cherty limestone, dense grey limestone, and grey or black chert, the chert averaging 60 per cent of the member. This unit is the most prominent part of the section and generally has a distinct topographic expression. Every gradation is seen in close alternation between conchoidal fracturing chert, calcareous impure chert, siliceous limestone, and dense limestone. There is also a continuous gradation in the colour of the limestone from light to dark grey and of the chert from light grey to black. The variations make a precise description of the section almost impossible unless each inch of the section is described separately. The limestone layers are evenly bedded but the chert varies from isolated nodules to wavy, irregular nodular layers giving this member and the overlying Member C a characteristic wavy banded appearance, which can be detected from considerable distances.

Fossils are not common in Member B and have been found in place only in the upper part. In section 8 a large, mainly brachiopod, fauna (locality 90) was found in place in unit 75, about 50 feet below the top of the member.

The specimens are not well preserved. They include: *Amplexi-Zaphrentis* sp. E, *Schellwienella* sp., *Echinoconchus* cf. *biseriatis* (Hall), *Dictyoclostus* sp., *Spirifer* sp. and *Proetus* sp. In the same section *Lithostrotion* cf. *pauciradiale* (McCoy) and *Diphyphyllum* sp. B. were collected from a talus block (fossil lot 89) about 175 feet below the top of Member B that almost certainly came from this member.

Two fossil horizons were found in the upper strata of Member B in section 7. One, about 50 feet below the top (locality 81), contains a spirifer which is of the *S. centronatus* group and close to *S. greenockensis* Brown. About 65 feet lower in the section a bed of coarsely crystalline crinoidal limestone 4 feet thick contains an abundant solitary coral fauna (lot 82). This bed appears to be a detrital zone as the corals were water-worn before deposition. Most of the specimens have the epitheca, tip and part of the calyx missing. The fauna is new and includes *Canadiphyllum knoxi* Sutherland, *Ekvasophyllum enclinotabulatum* n.sp., *Ekvasophyllum* ? *harkeri* n.sp. and *Dibunophyllum* ? sp. A. These corals are interesting morphologically but being new are of limited use for regional correlation. The range of the recently described genus *Ekvasophyllum* (Parks, 1951) is as yet unknown. The type species, *E. inclinatum* Parks, described from the Meramecian lower part of the Brazer formation in Utah, is also known to occur in the upper Rundle formation at Banff and in unit 4 of the Mississippian sequence in the Liard River area (section 11). Both horizons are considered to be of Meramec age (*see* discussion under *Liard River Region*).

The following forms were collected from a talus block (lot 26) below the massive cliff face of Member B on the northeast side of the Prophet River valley several miles southwest of section 8 (*see* Figure 4): *Ekvasophyllum enclinotabulatum* n.sp., *Dibunophyllum* sp., *Echinoconchus* cf. *biseriatus* (Hall), *Dictyoclostus* aff. *tenuicostus* (Hall), *Dictyoclostus* cf. sp. A., *Dictyoclostus* sp. and *Linoproductus* sp.

Hage (1944, p. 4) observed an exposure in strata now designated as the Prophet formation along the crest of an anticline on the Sikanni River 2 miles west of Mount Withrow. He did not make a detailed study of it, but made a small fossil collection, probably from Member B. The author has examined this collection and has sectioned the two coral specimens. The following are included: *Amplexi-Zaphrentis* sp., *Ekvasophyllum* cf. *enclinotabulatum* n.sp., *Dictyoclostus* sp. A, *Spirifer* sp. aff. *S. albertense* Warren, *Spiriferella* sp. and *Phillipsia* sp.

The age and correlation of Members B and C are discussed together in the section that follows.

Member C. Member C consists of 140 to 150 feet of massive cherty limestone and dense grey limestone interbedded with grey or black chert. The chert varies from thin nodular to thick wavy layers and comprises 20 to 50 per cent of the whole. Although generally massive the beds of this member are not cliff-forming and though similar in general lithological character to Member B, they are less resistant to weathering. The junction between the two members is gradational and may vary in age from area to area.

Member C is unconformably overlain by Triassic shales in section 8, but the actual contact is concealed by Triassic shale talus.

Member C is only sparingly fossiliferous. Poorly preserved brachiopods were collected from the middle of the member in section 7 and a fragment of a poorly preserved phaceloid *Lithostrotion* was collected from near the base of the member in the same section (locality 75).

At the top of Member C in section 8, the following collection (lot 85) was made: *Amplexi-Zaphrentis* sp., *Lithostrotion* [*Lithostrotionella*] [*Thysanophyllum*] *mclareni* n.sp., *Orthotetes* ? sp., *Productella* ? sp. aff. *P. pyxidata* (Hall).

The most diagnostic features of the above-listed faunas from Members B and C are the definite presence of a phaceloid *Lithostrotion* in the lower part of Member C and of a small cerioid form in the upper part of the same member, and the probable presence of *L.* cf. *pauciradiale* (McCoy) in the upper part of Member B.

In southern Alberta colonial corals of the *Lithostrotion* type occur as early in the sequence as the middle part of the Banff formation but *Lithostrotion* cf. *pauciradiale* McCoy does not occur in abundance before the lower part of the upper Rundle formation. Some distance higher in that section a small cerioid *Lithostrotion* appears, followed still higher by larger cerioid forms and an abundance of large solitary corals. (P. Harker, personal communication.) The presence of *L.* cf. *pauciradiale* in the talus from the upper part of the Prophet formation and the occurrence of a small cerioid form at the top of the formation suggest a tentative correlation with the lower part of the upper Rundle formation. *L. pauciradiale* McCoy is common in the D_2 zone of the Viséan of western Europe and it is probable that this part of the section is of Mid-Mississippian age. The small solitary coral zone in the upper part of Member B in section 7 which contains numerous specimens of *Ekvasophyllum* also suggests a Meramecian correlation for this part of the section.

Many of the brachiopods from Members B and C are undescribed species but others are similar to described species of Mid-Mississippian age and give support to the correlation suggested by the corals. There are, however, some Early Mississippian elements present and it seems likely that the unfossiliferous lower part of Member B is of Early Mississippian age.

To summarize, the available information indicates that the upper part of the Basal Shale unit below the Prophet formation and the transitional series, Member A, are Mississippian, probably Kinderhook, in age and correlate with some part of the Banff formation farther south. The lower part of Member B is probably also Mississippian, possibly Osage, in age. The upper part of Member B and all of Member C are assigned a tentative Meramec age and probably correlate with the lower beds of the upper part of the Rundle formation of Alberta.

Beds equivalent to the uppermost Rundle appear to be missing in the region. No strata of Chester equivalence are present. The Rocky Mountain formation is also missing unless part of it is equivalent to the Chert unit which has been found, apparently overlying the Prophet formation, in one isolated outcrop.

CHERT UNIT

In the bed of the Prophet River about 8 miles southwest of section 8, an isolated sequence of thin-bedded chert was found. About 40 feet of these beds were exposed and they appeared to occur stratigraphically higher than the Prophet formation, the upper part of which is to be found nearby, although it is possible that a fault separates the two series. The chert beds consist of grey to black conchoidal fracturing chert in thin wavy layers varying from 1 inch to a foot in thickness. There are a few thin shale partings but no limestone is present.

The age of this series is unknown. If it does overlie the Prophet formation as the field evidence seems to indicate then it is probably an isolated remnant left by pre-Triassic erosion of the upper surface of the Palæozoic strata. This Chert unit may be part equivalent in age to the massive chert formation that overlies the Carboniferous section in the Tetsa River valley and which is believed to be of either Pennsylvanian or Permian age.

Eastward, in the subsurface, beds that are questionably referred to the "Permo-Pennsylvanian" are encountered at the top of the Palæozoic sequence in some wells in the vicinity of the Alaska Highway. The thickness and character of these beds are variable from one well to another. As stated earlier, in the western Halfway River valley (section 7) Triassic shales rest directly on the Mississippian Prophet formation. Less than 40 miles eastward the Phillips Daiber #A-1 well encountered 230 feet of bedded chert, dolomite and sandstone which occur stratigraphically above Mississippian limestone. About 20 miles southeast of this well, the White Loyd Sun Blueberry #3 encountered 5 feet of chert underlain by 30 feet of brown dolomite. About 40 miles southeast of this well and 20 miles north of Fort St. John, the Texaco N.F.A. Buick Creek #1 reportedly encountered no beds of possible Permo-Pennsylvanian age.

Northward, along the Alaska Highway, the Dome *et al.* Stanolind Buckinghorse #1, north of the Sikanni River encountered 15 feet of bedded chert overlying Mississippian limestone. Some 60 miles farther north the Phillips Tenaka #1, encountered 25 feet of interbedded chert and shale at the top of the Palæozoic which is questionably referred to the Permo-Pennsylvanian. The Tenaka #1 is located about 40 miles northeast of the surface exposure of the Mississippian Prophet formation (section 8) where no beds of later Palæozoic age are present.

The great variation in thickness of these beds is due presumably to pre-Triassic erosion. In most cases the evidence for Permo-Pennsylvanian age in the subsurface is scanty or lacking and the age determination is based primarily on lithological character and position in the sequence. A few problematical fusulinids and occasional other fossils have been reported.

Tetsa River Region

The Tetsa River valley is about 60 to 70 miles north of the Bull Creek locality of the Muskwa-Prophet Rivers area. The Carboniferous rocks of the Tetsa region, which have received some attention due to their accessibility from the Alaska Highway, appear to be thinner than in any other locality so far studied in northeastern British Columbia, but a complete sequence has not been observed.

The exposed strata consist of two stratigraphic units; a lower limestone, sandstone, and shale series with a total thickness of something more than 385 feet, and an upper chert sequence that varies from 120 to 255 feet in thickness. Laudon and Chronic (1949, p. 193) proposed a new formation name, the Kindle, for the entire section. There is, however, no assurance that the two parts of the section are of the same age, as there is no fossil evidence from the upper unit and the lithological character in the two parts is very distinct. The Kindle formation is here restricted to the lower unit only, and the upper chert succession is considered separately.

The lower part of the Kindle formation in the Tetsa Valley is believed to be of Meramec age. Beds of Kinderhook and Osage equivalence are either missing or may be present in the lower unexposed interval. The base of the Mississippian sequence was observed in an otherwise poorly exposed section on the east side of McDonnell River valley, west of Summit Lake Pass. In that locality calcareous sandstones containing poorly preserved Mississippian brachiopods are seen to rest, apparently unconformably, on the upper Devonian Fort Creek shale.

No unconformity was detected within the Kindle formation (restricted) but fossils of probable Early Pennsylvanian age have been collected from the upper part of the section. The overlying unfossiliferous Chert unit is tentatively considered to be either Pennsylvanian or Permian in age.

Two almost continuously exposed sections of Carboniferous age were studied in the Tetsa Valley. Section 9A is exposed in the river-bed on the south side of Tetsa River opposite Mile 380 - 381 on the Alaska Highway. Section 9B, studied also by Williams (1944, p. 20) and Laudon and Chronic (1947, p. 1614), is located on a low bluff about 0.3 mile north of Mile 381.5 on the Alaska Highway. The two sections are only 2 to 3 miles apart but they are separated by at least one major thrust fault and vary somewhat in both lithology and fauna. They are described in detail as follows:

SECTION 9A, TETSA RIVER VALLEY

South side Tetsa River bed, opposite Mile 380 - 381, Alaska Highway

	Thickness in Feet	
	Unit	Above base of formation
Top of exposed section		
CHERT UNIT		
34. Chert; black, hard, conchoidal fracturing, in thin wavy beds with few thin shale breaks; exposed	55	55
KINDLE FORMATION (restricted)		
33. Shale; grey, silty	1	381
32. Limestone; grey, very silty, dense, hard, massive	1	380
31. Shale; grey, silty	1	379
30. Limestone; grey, very silty, dense, hard, massive	20	378
29. Limestone; grey, silty, slightly argillaceous, hard, thin-bedded	4	358
28. Siltstone; grey, calcareous	8	354
27. Limestone; grey, silty, massive	10	346
26. Siltstone and shale; calcareous, hard, dense, siltstone alternating with silty shale	9	336
25. Limestone and shale; medium grey, silty limestone alternating with silty shale; *fossil locality 133*	2	327
24. Siltstone and shale; medium grey, hard, dense, calcareous siltstone alternating with scattered black shale layers	18	325
23. Shale; black, partly covered	25	307
22. Limestone and shale; buff-grey, hard, dense, very silty, limestone in layers 2 to 5 feet thick alternating with black, sandy shale in layers 0.5 to 1 foot thick	34	282

	Thickness in Feet: Unit	Thickness in Feet: Above base of formation
21. Siltstone and shale; buff-grey, hard, dense, calcareous siltstone in massive layers 2 to 3 feet thick; alternating with thin black shale layers, 0.2 to 0.3 foot thick	12	248
20. Shale; dark grey, sandy	3	236
19. Siltstone and shale; buff-grey, very fine-grained, calcareous siltstone alternating with grey, calcareous shale	24	233
18. Limestone and shale; medium to buff-grey silty limestone alternating with grey, argillaceous limestone and calcareous shale; *fossil locality 132,* 6 feet above base	30	209
17. Shale; black, calcareous, friable	2	179
16. Siltstone; brownish grey, argillaceous, calcareous	7	177
15. Shale; black, sandy, calcareous; gradational with unit above	14	170
14. Limestone; grey, argillaceous, slightly silty	2	156
13. Shale; grey, calcareous, silty	11	154
12. Limestone and shale; medium grey, very silty, calcareous shale	19	143
11. Shale; dark grey, silty, slightly calcareous	8	124
10. Limestone and shale; grey, hard, dense, silty limestone interbedded with silty, calcareous shale layers; *fossil locality 131,* 6 feet above base, in shale	10	116
9. Siltstone and shale; buff-grey, hard, dense, calcareous siltstone, in beds 1 foot to 2 feet thick, alternating with thin black shale	15	106
8. Shale; silty, slightly calcareous; *fossil locality 130,* in top 2 feet	9	91
7. Covered; estimated	15	82
6. Siltstone; buff-grey, hard, calcareous	8	67
5. Covered; estimated	50	59
4. Shale; calcareous	8	9
3. Limestone; buff-grey, dense	1	1
Total accessible thickness of Kindle formation (restricted)	381	
Thrust fault		
2. Covered; must conceal major thrust fault; estimated	50	
CHERT UNIT (repetition of higher unit by thrust faulting).		
1. Chert; black, hard, in thin wavy layers, with thin shale breaks; exposed	55	

SECTION 9B, TETSA RIVER VALLEY

North of Mile 381.5, Alaska Highway

Summary

	Thickness in Feet	
	Unit	Above base of formation
TRIASSIC?		
20. Covered shale slope		
CHERT UNIT		
19. Chert; black, hard, in thin wavy layers with rare thin shale breaks	120	
KINDLE FORMATION (restricted)		
18. Limestone; grey, thin- to medium-bedded, silty, with thin grey shale layers; *fossil localities 114,* 30 feet below top; *113,* 50 feet below top	80	365
17. Shale; grey, calcareous	20	285
16. Limestone; grey, hard, silty	14	265
15. Shale; grey	3	251
14. Limestone and shale; grey limestone alternating with thin shale layers	12	248
13. Limestone and shale; buff-grey, silty, thin- to medium-bedded limestone with thin silty shale layers	80	236
12. Shale; black, silty, calcareous	2	156
11. Limestone; buff-grey, silty	2	154
10. Shale; dark grey, calcareous	5	152
9. Limestone; buff-grey, hard, medium-bedded; *fossil locality 112*	8	147
8. Shale; grey	4	139
7. Limestone; buff-grey, hard, medium-bedded	8	135
6. Covered	12	127
5. Shale; grey, highly fractured; fossils common; *fossil locality 111;* estimated	40	115
4. Covered; estimated	50	75
3. Limestone; grey, silty; *fossil locality 110*	10	25
2. Covered	10	15
1. Limestone; grey, silty	5	5
Base of exposed section.		
Total accessible thickness of Kindle formation (restricted)	365	

KINDLE FORMATION (RESTRICTED)

The restricted Kindle formation consists of a series of interbedded dense hard limestone, silty limestone, dense calcareous siltstone, and calcareous shale. The lower part of the section is predominantly soft, grey, fossiliferous, calcareous shale beds alternating with thin massive, sandy limestone or calcareous siltstone. The amount of shale decreases upwards, and in the upper 75 feet of the formation there are only a few thin layers.

The exposed thickness in both of the Tetsa River sections is about 365 to 380 feet but, as stated earlier, the base of the formation is covered at both localities.

The Kindle formation (restricted) is fossiliferous in the lower part of the exposed section, but only moderately so in the higher beds. The following forms were collected in the lower part of section 9A from units 8 and 10, 270 feet below the base of the chert: *Amplexi-Zaphrentis cassa* n.sp., *Pustula* n.sp. A, and *Dictyoclostus* sp. From a dense limestone (unit 18, fossil lot 132), 73 feet above unit 10 and 197 feet below the base of the Chert unit *Amplexi-Zaphrentis pilata* n.sp., *Pustula* n.sp. A, *Dictyoclostus* sp., *Spirifer* cf. *arkansanus* Girty, *Reticularia* ? cf. *setigera* (Hall), and *Composita* sp. were collected.

Fossils are also common in the lower part of section 9B. From unit 5, 290 feet below the base of the chert the following collection was made: *Amplexi-Zaphrentis* cf. *cassa* n.sp., *Linoproductus* cf. *ovatus* (Hall) and *Spirifer* cf. *arkansanus* Girty. The brachiopods *Pustula* cf. n.sp. A, *Dictyoclostus* sp. aff. *D. burlingtonensis* (Hall), *Dictyoclostus* sp. aff. *D. lobatus* (Sowerby), *Avonia* cf. *moorefieldana* (Girty), *Avonia* sp., *Nudirostra* sp., and *Spirifer* sp. aff. *S. keokuk* Hall were collected from unit 9, about 40 feet above unit 5 and 220 feet below the base of the Chert unit.

The age and correlation of these lower beds are not conclusive. The two most abundant fossils in section 9A, *Amplexi-Zaphrentis cassa* n.sp. and *Pustula* n.sp. A are new but the presence in both sections of species similar to *Dictyoclostus lobatus* (Sowerby), *Avonia moorfieldana* (Girty), *Spirifer arkansanus* Girty and *Reticularia setigera* Hall suggests a Mid-Mississippian (Meramec) correlation. A possible Osage affinity is indicated by the presence of a form similar to *Spirifer keokuk* Hall. The solitary corals in the collections are of little help for correlation as they had not been described. No colonial corals were observed.

Williams (1944, p. 20) considered the fauna from the lower part of section 9B to be Osage in age, whereas Laudon and Chronic (1947, p. 1616) assigned a definite Meramec age to the fauna. They also made a fossil collection, similar to that found in the lower beds, from the upper middle part of the Kindle formation (restricted) in section 9B and on this basis they considered the entire section to be of Meramec age.

Two small fossil collections were made by the writer from unit 18 in the upper part of the formation in section 9B. Fossil lot 114, from about 30 feet below the base of the Chert unit, includes *Chonetina* cf. *flemingi* (Norwood and Pratten), *Chonetina* sp. A, *Pustula* sp., *Linoproductus* sp. A, *Spirifer* sp. aff. *S. alatus* Schlotheim, and *Spirifer* sp. X. Of these, *Chonetina* sp. A., *Linoproductus* sp. A and *Spirifer* sp. X were also collected 20 feet lower in the same section (lot 113). About 60 feet below the base of the Chert unit in section 9A, *Nudirostra* cf. *rockymontanus* (Marcou) and *Spirifer* cf. sp. X were collected.

The presence of forms similar to *Chonetina flemingi* (Norwood and Pratten), *Nudirostra rockymontanus* (Marcou), and *Spirifer alatus* Schlotheim indicates a lower Pennsylvanian age for these upper beds. *Chonetina flemingi* is a particularly distinctive Pennsylvanian species and no form similar to it is known from rocks of Mississippian age.

If the ages suggested above are correct, then it is difficult to account for the absence of Upper Mississippian beds in the section, unless there is an unconformity not detected in the field.

CHERT UNIT

A thick series of thin beds of grey to black chert with conchoidal fracture overlies the Kindle formation (restricted) in the Tetsa area. A few very thin shale partings were recorded. The unit is fractured and jointed, breaks down easily, and rarely forms a cliff. The section appears to be conformable with the underlying Kindle formation. A slope underlain by shale, probably Triassic in age, occurs above the unit. The entire series is present in section 9B where 120 feet of chert were measured. However, an incomplete section was observed on the north side of the Alaska Highway at Mile 379, where 255 feet of chert are exposed. Such wide, and apparently irregular, local variation of the formation suggests a very irregular chert surface, resulting from pre-Triassic erosion.

The precise age of this Chert unit is unknown as there is a lack of fossil evidence; from its stratigraphic position, however, Pennsylvanian or Permian can be assumed. It may correlate with the Chert unit found above the Prophet formation at one locality on the Prophet River. It also could be at least partly equivalent to the Permian ? chert described by Kindle (1944, p. 5) at Merrill Mountain in Yukon Territory, about 100 miles to the north. It is equivalent in stratigraphic position to the so called "Permo-Pennsylvanian" chert encountered in various wells in the plains area to the east (*see* discussion under *Prophet-Muskwa Rivers Region*).

Mackenzie Mountains

North of the Tetsa River valley Carboniferous rocks have been studied in the southern ranges of the Mackenzie Mountains, in the lower Liard River region. This area is about 90 to 120 miles northeast of the Tetsa River valley and lies north of British Columbia partly in Yukon Territory, but mainly in the Northwest Territories. The great Liard River gives access to the region by boat. Kindle (1944, p. 5) briefly observed one isolated locality of Upper Carboniferous or Permian strata on the Beaver River in Yukon Territory and Hage (1945) examined the Palæozoic and Mesozoic rocks along the lower Liard River valley and in the Liard Range to the west. It is of interest to summarize available information on Carboniferous stratigraphy in this area and to correlate, where possible, with equivalent rocks and faunas of northeastern British Columbia.

The Carboniferous fossil collections made in the area by Hage were available to the author for study. The specimens in these collections (except for the corals) had been given preliminary identifications by Dr. A. E. Wilson of the Geological Survey of Canada. These earlier identifications have been reviewed by the author and the corals were sectioned and have been included in the detailed study of that group.

Mount Merrill - Beaver River Region

Kindle (1944, p. 5) briefly observed a series of Upper Carboniferous or Permian rocks at one locality on Mount Merrill on the north side of Beaver River in Yukon Territory a few miles north of the British Columbia boundary. Beaver River is a tributary of Liard River. He observed that they consist of three lithological units. The lowest is a thick series of "grey to yellow sandstones with some calcareous and shaly beds". Very poorly preserved fossils were collected from the series and were identified by Dr. A. E. Wilson as indicating an Upper Carboniferous or Permian age, probably Permian. The second lithological unit consists of 150 feet of massive and roughly laminated grey to black chert which is rust-stained on the weathered surfaces and is highly fractured. The third unit consists of 30 feet of calcareous sandstone overlying the chert. A small group of poorly preserved brachiopods from this sandstone was identified by Dr. Wilson as almost certainly of Permian age.

The chert beds are probably equivalent to the Chert unit described earlier in the Tetsa Valley section. The overlying and apparently conformable Permian sandstones, observed by Kindle, must have been removed in the Tetsa section by pre-Triassic erosion, if they were ever present there. The chert series on Mount Merrill is almost certainly equivalent to the Chert unit studied by Hage 20 miles to the northeast, and described below.

Liard River Region

Hage (1945, p. 8) examined Carboniferous rocks at several places in the southeastern range of the Mackenzie Mountains over a north-south distance of about 80 miles. He did not, however, observe a complete section at any one locality, and he stressed the preliminary nature of his investigation. He also pointed out that considerable lateral change occurs in the lithology. The section given below is compiled and summarized from several of the more southerly localities listed in his report. No formation names have as yet been proposed in this area. The localities mentioned in the discussions which follow are from Hage's map.

SECTION 11, LIARD RIVER REGION
Compiled Section

	Thickness Feet
PENNSYLVANIAN OR PERMIAN	
10. Conglomerate; chert fragments, sand matrix; exposed	35
Chert Unit	
9. Chert; light grey, in irregular beds up to 1 foot thick; exposed	85
PENNSYLVANIAN	
8. Covered, possibly similar to unit 7; estimated	200
7. Sandstone and shale; fine-grained, buff to grey sandstone, interbedded with grey shale; *fossil localities 2, 3,* and *5;* estimated	700
Total thickness of Pennsylvanian sequence; estimated	900
MISSISSIPPIAN	
Limestone and Shale Unit	
6. Limestone and shale; crinoidal and crystalline limestone, interbedded with shale; *fossil locality 32;* estimated	300
5. Limestone and chert; grey limestone with some thin irregular nodular layers of grey to black chert; *fossil localities 24, 30, 37*	150
4. Shale and limestone; brown shale interbedded with brown weathering limestone; *fossil localities 28, 29, 37,* and *40*	100
3. Shale; dark grey	200
2. Limestone and shale; dark grey, finely crystalline limestone interbedded with black shale; *fossil localities 8, 42*	300
1. Shale interbedded with a few thin limestone layers; exposed	100
Base of exposed section.	
Total accessible thickness of Mississippian sequence	1,150

MISSISSIPPIAN

The limestone and shale unit consists of light to dark grey, finely crystalline but crinoidal, limestone interbedded with grey shale. In the upper middle part, (unit 5) the limestone contains some thin nodular chert layers apparently marking a locally distinctive horizon. The section is fossiliferous at several horizons. Hage did not observe a complete section of these beds at any one locality, but the lower 850 feet, including the units 1 through 5, are exposed in the Liard Range 2 miles west of Big Island and 18 miles north of Fort Liard. Fossil localities 8 and 42 (unit 2) in the lower part of the section contain typical Lower Mississippian fossils including *Leptaena analoga* Phillips, *Schellwienella* cf. *planumbona* Weller, *Chonetes illinoisensis* Meek (abundant), *Spirifer* cf. *striatiformis* Meek, *Spirifer centronatus* Winchell (abundant and typical), and *Ripidomella* sp. These beds correlate with the middle of the Banff formation and probably with the lower part of the Prophet formation.

In the upper middle part of the Mississippian sequence (unit 4) there is an abundance of cup corals found at various localities in the Liard area. Unfortunately most of the species are new. The following are included from locality 28 in the Liard Range: *Amplexi-Zaphrentis enniskilleni* cf. var. *enniskilleni* (Lewis), *Amplexi-Zaphrentis indifferens* n.sp., *Zaphriphyllum disseptum* Sutherland, *Ekvasophyllum proteus* n.sp., *Dibunophyllum* sp. B, *Liardiphyllum hagei* Sutherland. From locality 29, 60 feet stratigraphically above locality 28, *Amplexi-Zaphrentis enniskilleni* cf. var. *enniskilleni* (Lewis) and *Ekvasophyllum* cf. *inclinatum* Parks were collected. In the same lithological unit on Flett Mountain (locality 37) the following occur: *Amplexi-Zaphrentis enniskilleni* cf. var. *derbiensis* (Lewis) and *Ekvasophyllum proteus* n.sp. *Ekvasophyllum* cf. *inclinatum* Parks and *Permia* sp. A occur at locality (unit 4) on Sawmill Mountain.

Brachiopods occur in the horizons just quoted, but they cannot be compared closely with described species. The corals make up a very distinctive fauna recognizable at several localities in the Liard region. Most of the species are new but there is a suggestion of Meramec age for this horizon. The two varieties of *Amplexi-Zaphrentis enniskilleni,* with which the forms listed here closely compare, are from the Viséan of England (Meramec and early Chester equivalent). *Ekvasophyllum inclinatum* was described by Parks from the lower part of the Brazer limestone of Utah which is considered to be Meramec in age. This same species occurs in the upper Rundle formation in the Banff region. Unit 4 may also correlate in part with the *Ekvasophyllum* horizon in the upper part of the Prophet formation in the Halfway River region (section 7). Also, *Permia* sp. A compares closely with two species of this genus described by Hudson from the Viséan of England.

Locality 24, in the lower part of unit 5, the cherty limestone unit, includes the following brachiopods: *Dictyoclostus* cf. *tenuicostus* (Hall), *Dictyoclostus gallatinensis* (Girty), *Dictyoclostus* sp. (*burlingtonensis* type), *Girtyella* sp. From the same horizon elsewhere in the Liard range (locality 30) a very distinctive new coral, *Paracaninia* ? *wilsonae* n.sp. was collected. The brachiopod species from locality 24 suggests a tentative Meramec correlation which is in agreement with the age determination suggested by the coral fauna from the beds immediately below.

Unit 6, at the top of the limestone and shale section, is of Mississippian age but is only moderately fossiliferous, and Hage's collections from this unit (locality 32) do not contain any definitely diagnostic species. The beds are probably equivalent to some part of the upper Rundle and Prophet formations, but no evidence can be given to support this assumption. Beds deposited during Chester time may or may not be included in this unit.

PENNSYLVANIAN

The thick sandstone and shale series (unit 7), overlying the Mississippian limestone and shale sequence, consists of grey to white sandstone interbedded with grey to black shale (Hage, 1945, p. 16). Parts of the section are covered, and fossils are rare and poorly preserved. Corals are lacking except for a few poorly preserved specimens of the zaphrentid type. Five hundred feet of these beds are exposed in the Liard Range, but they are poorly fossiliferous. A collection from locality 2, near the base of the section on Labiche Mountain, contains *Dictyoclostus* cf. *portlockianus* Dunbar and Condra, and at locality 3, 100 feet higher in the same section, *Dictyoclostus* cf. *americanus* Dunbar and Condra and *Spirifer occidentalis* Girty were found. These forms suggest an early Pennsylvanian age. The upper part of the series is covered. This unit does not correlate with any horizon in the northern Rocky Mountain sections. It is believed to represent beds higher than the Rundle and Prophet formations, and it is possibly equivalent to the Rocky Mountain formation. It is almost certainly equivalent, at least in part, to the sandstone and shale series recorded by Kindle on Mount Merrill, 20 miles to the southwest and assigned a tentative Pennsylvanian or Permian age.

PENNSYLVANIAN OR PERMIAN

Eighty-five feet of bedded chert occur on Pointed Mountain above the covered area at the top of the sandstone and shale series. Its complete thickness is unknown. It is light grey and occurs in beds up to 1 foot thick. It is in turn overlain by a chert conglomerate with a sandy matrix which has a thickness of 35 feet. As Hage points out (1945, p. 17), the chert is correlated with the chert beds reported by Kindle on Mount Merrill, and probably is Pennsylvanian or Permian in age. It may also be equivalent in part to the Chert unit at the top of the Tetsa River section. The age of the overlying conglomerate is unknown. On Mount Merrill the chert is overlain by sandstones of a probable Permian age.

To summarize the information available in the Liard River region, it seems probable that units 1 and 2, and possibly 3, are Kinderhook-Osage in age and correlate with the Banff formation. Both the corals and brachiopods from units 4 and 5, in the upper middle part of the sequence, suggest a Meramec age. Fossils from unit 6 are not diagnostic, but the stratigraphic position suggests a Meramec or later Mississippian age and a possible correlation with the upper part of the Rundle formation.

The limited fossil evidence available from unit 7 suggests a Pennsylvanian age for at least the lower part of the sandstone and shale series; Permian beds may be present at the top. The bedded chert horizon (unit 8) correlates with the chert on Mount Merrill, and is believed to be of Pennsylvanian or Permian age.

CHAPTER III

SYSTEMATIC PALÆONTOLOGY

Introductory Statement on Classification of Rugose Corals

Morphologic features having primary value in the natural classification or definition of natural groups of organisms are those providing evidence of genetic relationship. Extinct fossil groups, however, can be arranged only by the arbitrary grouping of forms showing similarities in structure and by interpretation of phylogenetic development through geological time. In the classification of the Rugosa little agreement exists among workers as to the taxonomic significance of many structural differences or even as to resemblances considered sufficiently important to constitute generic or specific characters. Such difficulties arise particularly because structural features that are constant in some groups are highly variable in others. For example, in many groups the presence or absence of dissepiments is a constant feature, whereas in others a single genus or species may include specimens both with and without dissepiments. Similar examples can be noted of variable forms transitional between established genera with a simple columella and others with a complex axial column (i.e. *Ekvasophyllum* as described in this paper).

The problem is further complicated because many coral groups seem to be "aggregates of species of different parallel lineages which have reached the same structural grade in evolution" (Lang, Smith and Thomas, 1940, p. 3). As a result, many genera as currently defined cut across these lineages and thus are polyphyletic. Consequently, the literature on such variable groups as the zaphrentids and caniniids is extremely involved. In addition many important genera are based on type material that is lost, not available for study, or has never been described and illustrated adequately. A genus, as commonly accepted, is frequently based on an earlier worker's concept rather than on well described type material.

The author agrees with Soshkina and Dobrolyubova (1941, p. 153) that a natural classification in palæontology can be approached only when the phylogenetic relationships between individual members of a given group have been determined to an appreciable extent by tracing transitional forms and by the study of their ontogenies; and that in order to be fully meaningful such phylogenetic evolutionary studies require not single fossil finds but large numbers of individuals collected from all stratigraphic occurrences over large areas. Such detailed collecting has not as yet been accomplished in any Carboniferous fossil group in Western Canada or, for that matter, in western North America. Nevertheless, this ideal should be maintained as an ultimate standard towards which all workers should strive.

Scope and Methods of Study

Previously, age determinations in the Carboniferous system of Western Canada have been based primarily on brachiopods, and the rugose coral faunas have been generally neglected. Most published accounts include only lists of a few broadly interpreted coral species. Although corals do not occur in abundance all through the section, they are common at some horizons and occur sparingly in other parts of the sequence. A close examination of the available collections from the northern part of the Canadian Rocky Mountains was made in order to evaluate the usefulness of the coral faunas as relatively precise stratigraphic markers.

Many of the species and even genera are new. This discourages immediate correlation with faunas elsewhere although it does not detract from their value as regional markers. As can be seen from the previous chapter on stratigraphy, many of the coral collections on which the present study is based are from widely scattered localities. Conclusions as to stratigraphic and geographic ranges of most of the species can be reached only after much further collecting accompanied by detailed mapping of the extensive region involved.

Rugose corals have been systematically classified, and an attempt has been made to clarify some of the many taxonomic complexities involved. In this report only families and genera relevant to the collections under study are discussed. A conservative policy of generic revision and interpretation has been followed, and no satisfactory generic diagnoses are possible for some forms because the original type specimens remain unsectioned or poorly illustrated.

There is no universally accepted terminology for describing coral morphology. Several papers have included discussions on morphologic terms, but that outlined by Hill (1935) is the most clearly defined and is used as a basis for the present work. Other interesting discussions are given by Hudson (1936B), Jeffords (1942, p. 192), and Easton (1944A, p. 15). A discussion of the history and development of morphologic studies in Palæozoic corals is given by Grove (1934, p. 97).

The minute structure of the septa is a diagnostic feature of rugose corals that has been largely neglected. Hill's (1936) study of Silurian corals with acanthine septa points out the significant results that may be obtained from observations in this field. More recently Wang (1950) revised the Rugosa on the basis of their septal structure, and his discussions on several types of minute structure provide a useful basis for further work. The classification he proposes, however, seems unnatural in many respects. For example, several forms that are generally considered to be closely allied, such as *Diphyphyllum* and *Diphystrotion,* are placed in different families. It also appears probable that some of the structures described are due to recrystallization. A comprehensive evaluation of the usefulness of septal structure in the taxonomy of the rugose corals cannot be made until the constancy of these features in different groups has been more fully demonstrated. It is unfortunate that septal structure cannot be properly detected when the septa are very thin, or in recrystallized specimens. In this paper the minute structure is recorded where possible, but no attempt is made to modify Wang's classification.

Almost all the illustrations in this report are photographs of thin sections reproduced at twice natural size. In a few cases, inked and bleached photographs have been made from thin sections if unretouched photographs could not be adequately reproduced. Some recent authors have made extensive use of inked and bleached photographs of polished or oiled surfaces. This method is not recommended for the illustration of type specimens. It increases the possibility of human errors in interpreting the photographs, and an oiled surface rarely reveals all structural details, particularly when the skeletal elements are close together, as they are in the early stages of many Carboniferous corals. Also, the minute septal structure can rarely be adequately observed on a polished or oiled surface. An even more undesirable practice in the case of type specimens is that of making a longitudinal cut of a fragment after a photograph has been made of a transverse surface but of which no thin section has been made. The transverse section is thus virtually destroyed and later workers can refer only to a possibly inaccurate inked and bleached photograph to determine the characters of the form.

Attempts were made to use cellulose peels of polished acid-etched surfaces during studies of the ontogenetic development of the genus *Ekvasophyllum*. Satisfactory results were not achieved because the early dense stages of these forms provided little or no contrast when etched with acid.

Index to Fossil Locality Numbers

1. Peace River, B. C., Fossil Point, on north bank of river, about 3 miles above Ne-parle-pas Rapids; Middle? Mississippian. Coll. J. Macoun, 1875.
2. Labiche Range, Yukon, southern end range in southeast corner Yukon; near base of unit 7, Section 11, Lower Pennsylvanian? Coll. C. O. Hage, 1944.
3. Labiche Range, Yukon, 100 feet stratigraphically above locality 2, Section 11, unit 7, Lower Pennsylvanian? Coll. Hage, 1944.
5. Labiche Range, Yukon, about 200 feet above locality 3, in Section 11, unit 7, Pennsylvanian? Coll. Hage, 1944.
7. Liard River, N. W. T., east shore, 25 miles north of Fort Liard; Mississippian; G. S. C. loc. No. 16629. Coll. Hage, 1944.
8. Liard River area, N. W. T., east side of first mountain below mouth of Muskeg River, east of main Liard Range, 2 miles west of Liard River at Big Island and 18 miles north of Fort Liard, in lower part of exposure; Section 11, unit 2, Lower Mississippian; G. S. C. loc. No. 16626. Coll. Hage, 1944.
24. Liard River area, N.W.T., about 600 feet stratigraphically above locality 8, Section 11, unit 5, Middle? Mississippian; G. S. C. loc. No. 16618. Coll. Hage, 1944.
28. Liard River area, N. W. T., about 500 feet stratigraphically above locality 8, Section 11, unit 4, Middle? Mississippian; G. S. C. loc. No. 16622. Coll. Hage, 1944.
29. Liard River area, N. W. T., about 60 feet stratigraphically above locality 28, Section 11, top of unit 4 and base of unit 5, Middle Mississippian; G. S. C. loc. No. 16623. Coll. Hage, 1944.
30. Liard Range, N. W. T., 5 miles west of Liard River at Big Island and 18 miles north of Fort Liard, about 100 feet above base of exposure; Section 11, unit 5, Middle? Mississippian; G. S. C. loc. No. 16615. Coll. Hage, 1944.
32. Liard Range, N. W. T., about 200 feet stratigraphically above locality 30; Section 11, unit 6, Mississippian; G. S. C. loc. No. 16617. Coll. Hage, 1944.
34. Liard River, N.W.T., east bank, 5 miles above Flett Rapids, Lower Mississippian; G. S. C. loc. No. 16603. Coll. McConnell, 1887; Hume, 1922; Hage, 1944.

37. Flett Mountain, N. W. T., west of Liard River at Flett Rapids; Section 11, unit 4, Mississippian; G. S. C. loc. No. 16605. Coll. Hage, 1944.
38. Flett Mountain, N. W. T., about 150 feet stratigraphically above locality 37; Section 11, unit 5, Middle? Mississippian; G. S. C. loc. No. 16606. Coll. Hage, 1944.
40. Sawmill Mountain, N. W. T., about 6 miles north of Flett Mountain, in shale below cliff of cherty limestone; Section 11, unit 4, Mississippian; G. S. C. loc. No. 16627. Coll. Hage, 1944.
45. Sikanni River, B. C., core of anticline 2 miles west of Mount Withrow, approximately 28 miles west of Alaska Highway bridge over Sikanni River; Mississippian, Prophet formation, probably Member B. Coll. Hage, 1943.
56. Prophet River, B. C., talus below massive cliff, on creek ½ mile northeast from near where Prophet River crosses 57° 40′ N. lat. first time west of mouth of Besa River, approximately 25 miles west of Alaska Highway; Prophet formation, Member B. Coll. Sutherland, 1946.
57. Prophet River, B. C., near base of exposure on mountain north of river, near 123° 40′ W. long.; about 3 miles west of locality 56; Prophet formation, Member A. Coll. Sutherland, 1946.
62. Prophet River, B. C., ridge north of Prophet River about 1.5 miles east of 123° 50′ W. long., about 8 miles west of locality 56; Mississippian. Coll. Sutherland, 1946.
70. Prophet River, B. C., about 300 feet stratigraphically above locality 57; Prophet formation, Member A. Coll. Sutherland, 1946.
73. Halfway River area, B. C., 115 feet below highest stratigraphic exposure, on creek about 0.8 mile above waterfall (*see* right side, Plate III) and 1.5 miles north of Halfway River, in synclinal valley, about 40 miles west of Alaska Highway; Prophet formation; Member C; Section 7; G. S. C. loc. No. 16032. Coll. Sutherland, 1948.
74. Halfway River area, B. C., 11 feet stratigraphically below locality 73, Prophet formation, Member C; Section 7; G. S. C. loc. No. 16029. Coll. Sutherland, 1948.
75. Halfway River area, B. C., 100 feet stratigraphically below locality 73, near base Member C; Prophet formation; Section 7; G. S. C. loc. No. 16046. Coll. Sutherland, 1948.
81. Halfway River area, B. C., 50 feet stratigraphically below highest bed exposed at top of anticlinal mountain north of Halfway River, about 40 miles west of Alaska Highway; Prophet formation, near top Member B; Section 7; G. S. C. loc. No. 16050. Coll. Sutherland, 1948.
82. Halfway River area, B. C., 75 feet stratigraphically below locality 81, Prophet formation, Member B; Section 7; G. S. C. loc. No. 16038. Coll. Sutherland, 1948.
83. Halfway River area, B. C., 550 feet stratigraphically below locality 82, about 60 feet below top of Member A, Prophet formation; Section 7. Coll. Sutherland, 1948.
84. Halfway River area, B. C., 50 feet stratigraphically below locality 83, Prophet formation, Member A; Section 7; G. S. C. loc. No. 16044. Coll. Sutherland, 1948.

85. Bull Creek, Prophet-Muskwa Rivers area, B. C., at top of highest massive sequence, near waterfalls about 17 miles above (west of) junction of Bull Creek with Prophet River; 6 miles south of Muskwa River; at top of Prophet formation; Section 8, unit 85; *see* Figure 4; G. S. C. loc. No. 16034. Coll. Sutherland, 1948.
87. Bull Creek, B. C., north of waterfalls on creek, on slope of high ridge, 1,015 feet stratigraphically below locality 85, 250 feet below top of Member A, Prophet formation; Section 8, unit 38. Coll. Sutherland, 1948.
88. Bull Creek, B. C., north of creek, 92 feet stratigraphically below locality 87, lower part Member A, Prophet formation; Section 8, unit 29; G. S. C. loc. No. 16035. Coll. Sutherland, 1948.
89. Bull Creek, B. C., north of creek, 325 feet stratigraphically below locality 85, Member B, Prophet formation; Section 8; unit 71; G. S. C. loc. No. 16030. Coll. Sutherland, 1948.
90. Bull Creek, B. C., 195 feet stratigraphically below locality 85, 50 feet below top of Member B, Prophet formation; Section 8, unit 76; G. S. C. loc. No. 16045. Coll. Sutherland, 1948.
100. Bull Creek, B. C., north of creek, 440 feet stratigraphically below locality 88; Mississippian, Basal Shale unit, Section 8, unit 2; G. S. C. loc. No. 16036. Coll. Sutherland, 1948.
101. Bull Creek, B. C., north of creek, talus block on slope of lowest exposure, exact horizon unknown, Prophet formation; Section 8, unit 1; G. S. C. loc. No. 16037. Coll. Sutherland, 1948.
108. Tetsa River, B. C., vertical beds north side Alaska Highway, Mile 380.2; isolated exposure; Mississippian. Coll. Sutherland, 1947.
109. Tetsa River, B. C., 200 feet west and 40 feet uphill from locality 108; isolated exposure, apparently separated from locality 108 by thrust fault; Mississippian. Coll. Sutherland, 1947.
110. Tetsa River, B. C., in creek bank below bluff, 20 feet above base of lowest exposure, 0.2 mile north Alaska Highway, Mile 381.1; Kindle formation (restricted); Section 9B, unit 3. Coll. Sutherland, 1947.
111. Tetsa River, B. C., 60 feet stratigraphically above locality 110, Kindle formation (restricted); Section 9B, unit 5. Coll. Sutherland, 1947.
112. Tetsa River, B. C., 38 feet stratigraphically above locality 111, Kindle formation (restricted); Section 9B, unit 9. Coll. Sutherland, 1947.
113. Tetsa River, B. C., 172 feet stratigraphically above locality 112, Kindle formation (restricted); Section 9B, unit 9. Coll. Sutherland, 1947.
114. Tetsa River, B. C., 20 feet stratigraphically above locality 113 and 30 feet below top of Kindle formation (restricted); Section 9B, unit 9. Coll. Sutherland, 1947.
130. Tetsa River, B. C., south side river bed, 0.3 mile south of Mile 380, Alaska Highway; Kindle formation (restricted); Section 9A, unit 8. Coll. Sutherland, 1947.
131. Tetsa River, B. C., 21 feet stratigraphically above and west of locality 130, Kindle formation (restricted); Section 9A, unit 10. Coll. Sutherland, 1947.
132. Tetsa River, B. C., 73 feet stratigraphically above and west of locality 131, Kindle formation (restricted); Section 9A, unit 18. Coll. Sutherland, 1947.

133. Tetsa River, B. C., 142 feet stratigraphically above and west of locality 132, and 54 feet below top of Kindle formation (restricted); Section 9A, unit 25. Coll. Sutherland, 1947.

137. McDonnell River, B. C., on east side Alaska Highway, Mile 400.1, talus below massive beds near base of exposure. Kindle formation? Coll. Sutherland, 1947.

138. McDonnell River, B. C., in place, east side Alaska Highway, 275 feet stratigraphically above locality 137. Kindle formation? Coll. Sutherland, 1947.

281. Pine River, B. C., north side river about 4 miles west of mouth of Mountain Creek, isolated outcrop on trail about 1,000 feet west of large spring. Pennsylvanian?; G. S. C. loc. No. 15949. Coll. L. D. Burling and Sutherland, 1945.

283. Pine River, B. C., south side river, from westerly dipping beds at west end of first mountain west of mouth of Mountain Creek. Mississippian; G. S. C. loc. No. 15946. Coll. Burling and Sutherland, 1945.

284. Pine River, B. C., from vertical beds 500 feet east of locality 283, isolated exposure, structural relation unknown, Mississippian; G. S. C. loc. No. 15945. Coll. Burling and Sutherland, 1945.

288. Pine River, B. C., from talus block on slope 200 feet east of locality 284, position in section unknown, Pennsylvanian?; G. S. C. loc. No. 15943. Coll. Burling and Sutherland, 1945.

366. Jarvis Lakes, B. C., from talus block below upper part of Rundle formation, on south slope of second mountain west of Mount Hannington, immediately north of Jarvis Lakes which are near continental divide and drain into the Kakwa river; below upper part of Section 3A; G. S. C. loc. No. 15961. Coll. Burling and Sutherland, 1945.

370. Jarvis Lakes, B. C., 725 feet above lowest exposure on second mountain west of Mount Hannington, north of Jarvis Lakes, Banff formation, Section 3A; G. S. C. loc. No. 15968. Coll. Burling and Sutherland, 1945.

372. Jarvis Lakes, B. C., 55 feet stratigraphically above locality 370, Banff formation, Section 3A, unit 15; G. S. C. loc. No. 15970. Coll. Burling and Sutherland, 1945.

373. Jarvis Lakes, B. C., 190 feet above locality 322, lower Rundle formation, Section 3A, unit 21; G. S. C. loc. No. 15971. Coll. Burling and Sutherland, 1945.

374. Jarvis Lakes, B. C., 140 feet above locality 373, Rundle formation, Section 3A, unit 25; G. S. C. loc. No. 15972. Coll. Burling and Sutherland, 1945.

375. Jarvis Lakes, B. C., 150 feet above locality 374, Rundle formation, Section 3A, unit 28; G. S. C. loc. No. 15973. Coll. Burling and Sutherland, 1945.

376. Jarvis Lakes, B. C., 220 feet above locality 375, upper Rundle formation, Section 3A, unit 31; G. S. C. loc. No. 15974. Coll. Burling and Sutherland, 1945.

377. Jarvis Lakes, B. C., 20 feet above locality 376, upper Rundle formation, Section 3A, unit 32; G. S. C. loc. No. 15975. Coll. Burling and Sutherland, 1945.

388. Jarvis Lakes, B. C., about 300 feet above lowest exposure on south ridge of first mountain north of Mount Hannington; Upper Devonian, Section 3B, unit 2; G. S. C. loc. No. 15954. Coll. Burling and Sutherland, 1945.

389. Jarvis Lakes, B. C., loose blocks on slope about 75 feet above locality 388, lower Banff formation, Section 3B, unit 3; G. S. C. loc. No. 15955. Coll. Burling and Sutherland, 1945.

390. Jarvis Lakes, B. C., 270 feet above locality 388, Banff formation, Section 3B, unit 7; G. S. C. loc. No. 15956. Coll. Burling and Sutherland, 1945.

391. Jarvis Lakes, B. C., 50 feet above locality 390, Banff formation, Section 3B, unit 9; G. S. C. loc. No. 15957. Coll. Burling and Sutherland, 1945.

393. Jarvis Lakes, B. C., 85 feet above locality 391, at top of exposed section, Banff formation, Section 3B, unit 9; G. S. C. loc. No. 15959. Coll. Burling and Sutherland.

398. Jarvis Lakes, B. C., 320 feet above lowest exposure, second mountain west of Mount Hannington, Banff formation, Section 3A, unit 8; G. S. C. loc. No. 15963. Coll. Burling and Sutherland, 1945.

399. Jarvis Lakes, B. C., 155 feet above locality 398, Banff formation, Section 3A, unit 10; G. S. C. loc. No. 15964. Coll. Burling and Sutherland.

401. Jarvis Lakes, B. C., 25 feet above locality 370, Banff formation, Section 3A, unit 10; G. S. C. loc. No. 15966. Coll. Burling and Sutherland.

402. Jarvis Lakes, B. C., 40 feet above lowest exposure, south side second mountain west of Mount Hannington, lower Banff formation, Section 3A, unit 1; G. S. C. loc. No. 15967. Coll. Burling and Sutherland.

410. South Nahanni River area, N.W.T., 3 miles west of junction of Mattson Creek and South Nahanni River; Lower or Middle Mississippian; G. S. C. loc. No. 22129.

411. Banff Area, Alberta, on Carrot Creek, near Banff, about 50 feet below top of Banff formation; Lower Mississippian; G. S. C. loc. No. 22202.

Systematic Descriptions

Phylum COELENTERATA

Class *ANTHOZOA*

Subclass *Zoantharia*

Order Rugosa

Family Hapsiphyllidae Grabau, 1928, emend. Easton, 1944

Diagnosis. Simple, generally small straight or curved corals. The calyx is shallow to deep and commonly has a depression in its floor corresponding to the prominent cardinal fossula. The major septa may unite around the cardinal fossula forming an inner wall, or they may be withdrawn from the axial region leaving an open fossula. Minor septa, when present, are free or contratingent. No axial column is developed even when the septa extend to the axis. Tabulae are present, but dissepiments are generally lacking.

Remarks. There is some question as to which family name should be applied to the common Carboniferous zaphrentid corals. The family Hapsiphyllidae was proposed by Grabau (1928, p. 118) to include a limited group of simple corals with a pronounced inner wall around the cardinal fossula, typified by the genus *Hapsiphyllum.* This family name has been used by some later authors in a broader sense to include many of the common zaphrentids, and the diagnosis was emended accordingly by Easton (1944A, p. 34). This usage must remain tentative, however, as the genus *Hapsiphyllum* is not securely founded and may later prove to be invalid, as discussed below. In this case, the name Zaphrentoididae (Schindewolf, 1938, p. 451) could be used.

Genus *Amplexi-Zaphrentis* Vaughan, 1906

Type Species. Zaphrentis bowerbanki Edwards and Haime, Thomson, 1883, p. 368, Pl. 6, fig. 3, Lower Carboniferous, Scotland (designated by Lang, Smith and Thomas, 1940, p. 16)=*Zaphrentis curvilinea* Thomson, 1881, p. 223, Pl. 4, fig. 4, Lower Carboniferous, Scotland (*according to* Hill, 1940, p. 142).

Diagnosis. Curved, solitary, ceratoid to trochoid corals of varying size in which the major septa may or may not unite around the conspicuous cardinal fossula. The cardinal septum tends to become shortened. Alar fossulae are commonly well developed in early stages but frequently become inconspicuous in the ephebic stage. Minor septa are short or absent. The tabulae tend to be complete and are arched or flattened axially except in the cardinal fossula where they turn downward abruptly. Dissepiments are generally absent.

Remarks. No group of corals has a more confused history of study than those of the zaphrentid type. The elements of their skeletons are few and simple, but they vary greatly and have given rise to highly involved taxonomic problems, some of which are yet to be adequately solved. The genera to which these corals have been assigned at various times are briefly discussed below with tentative suggestions as to desirable usage.

(1) The genus *Zaphrentis*[1] Rafinesque and Clifford (1820, p. 234) has been widely applied to simple Carboniferous corals, but the true characters of its type species, *Z. phrygia* Rafinesque and Clifford (1820, p. 235), from the Devonian of Kentucky, are now known to include a prominent cardinal fossula, toothed carinate septa, and a peripheral zone of dissepiments (*see* Schindewolf, 1938, p. 452; O'Connell, 1914, p. 189). No Carboniferous representatives are known with these characters, and the genus appears to become extinct in the Devonian.

(2) Edwards and Haime (1850, p. lxv) considered *Caninia* Michelin and *Siphonophyllia* Scouler (1844) to be junior synonyms of *Zaphrentis*, but these genera are distinct (*see* discussion under the genus *Caninia*). In the same paper Edwards and Haime described *Menophyllum* (1850, p. lxvi, type species *M. tenuimarginatum* Edwards and Haime, described and figured, 1851B, p. 348, Pl. 3, fig. 1) as a form like *Zaphrentis* except that "a small septal fossula is situated on each side of the large one, and that one half of the central part of the calice is occupied by an elevated, smooth portion of the tabula, which resembles a crescent". *Menophyllum* may be a senior synonym of *Amplexi-Zaphrentis*, but its internal characters are unknown, as the type species, which is reported to be in the Museum de Paris, was not adequately figured and has never been sectioned. Wang (1950, p. 204) recognized it as a valid genus but the use of this name is undesirable until its characters are better understood.

(3) The genus *Heterophrentis* Billings (1875, p. 235, type species by subsequent designation of Miller, 1889, p. 193, *Zaphrentis spatiosa* Billings 1858, p. 178=*Zaphrentis prolifica* Billings 1858, p. 176 according to O'Connell, 1914, p. 183; both from Middle Devonian, Ontario) is included in the Family Zaphrentidae by Stumm (1949, p. 11) who described this form as having a prominent cardinal fossula and major septa which extend almost to the open axial area. This description could include some Carboniferous species. However, the genus was proposed by Billings (1875, p. 235) for forms similar to *Zaphrentis* but having the bottom of the calyx "either smooth or with pseudocolumella. Septa below calice sharp-edged, often with their inner edges twisted together". In *H. prolifica,* the type species, Billings included both forms without a columella and forms with a highly variable columella or with the axial ends of the septa twisted. This species cannot be properly evaluated until Billings' numerous type specimens, which form part of the collections of the Geological Survey, have been sectioned. However, the structure can be seen sufficiently in the calices of several of the type specimens to suggest that this form is genericly distinct from those included here under *Amplexi-Zaphrentis.* The characters of *H. spatiosa* Billings (1858, p. 178) are less clearly known. The type specimens, also in the Geological Survey collections, are two in number labelled 'cotypes', each with its calyx filled with matrix. Neither specimen has been sectioned nor, apparently, has it been illustrated. Lambe (1901, p. 117) considered *H. spatiosa* to belong to the genus *Streptelasma* Hall. Schindewolf (1938, p. 450) stated that the genus *Heterophrentis* is apparently more closely related to *Streptelasma* than to *Zaphrentis.* However, the type specimens must be sectioned before a final diagnosis can be made.

[1]As pointed out by Lang, Smith and Thomas (1940, p. 141) the original spelling of this generic name is *Zaphrenthis.* This name is so used by Moore and Jeffords (1945, p. 129). However, as the name *Zaphrentis* is so well known, it is recommended that a formal request for its standardization be placed before the International Commission on Zoological Nomenclature.

(4) *Zaphrentoides* was described by Stuckenberg in 1895. He listed three species from Russia and also stated that "among other already known species there belongs to it also *Zaphrentoides (Zaphrentis) Griffithi* Edwards and Haime". (Translated from German text, Stuckenberg, 1895, p. 191.) Schindewolf (1938, p. 449) designated *Z. griffithi* Edwards and Haime (1852, p. 169) as type species and accepted *Zaphrentoides* as a valid genus to include forms previously thought typical of *Triplophyllum* and many previously referred to *Zaphrentis.*

Stuckenberg's original description and illustrations of the Russian species of the genus *Zaphrentoides* correspond closely to the diagnosis given above for the genus *Amplexi-Zaphrentis,* except for the position of the cardinal septum on the convex side of the corallite. The type specimens of these species are believed lost. The holotype of *Zaphrentis griffithi,* the type species of *Zaphrentoides* as designated by Schindewolf, is believed to be in a museum in Paris, but it has never been sectioned. Stanley Smith (personal communication) points out that Edwards and Haime's figure of the type is that of a turbinate rather than a trochoid coral. Turbinate forms are unusual in Carboniferous zaphrentids. On being sectioned, the type may not prove to accord with Stuckenberg's concept of the genus which was based mainly on the Russian material that he studied. The true chaıacters of the genus are therefore not known.

Schindewolf (1938, p. 450) included most Carboniferous zaphrentid corals in his concept of the genus *Zaphrentoides* which he subdivided into two subgenera, *Zaphrentoides (Zaphrentoides)* with the cardinal fossula on the convex side of the corallite and *Zaphrentoides (Hapsiphyllum)* with the cardinal fossula on the concave side of the corallite. The writer, however, cannot agree with this usage of *Hapsiphyllum* but considers it to be a distinct genus.

Moore and Jeffords (1945, p. 130) introduced the genus *Zaphrentoides* into North American literature to include many of the common Carboniferous zaphrentids. They described a new species of this genus from the Lower Pennsylvanian of Texas, *Z. excentricus,* which is almost identical with the well known European species *Z. delanouei* (Edwards and Haime).

(5) *Amplexi-Zaphrentis* Vaughan, (1906, p. 315) was proposed as a subgenus of *Zaphrentis* with three genosyntypes listed, of which Lang, Smith and Thomas (1940, p. 16) chose one, *Z. bowerbanki* Edwards and Haime, Thomson, 1883, p. 368, Pl. 6, fig. 3, from the Lower Carboniferous of Scotland, as lectotype. This type specimen is in the Glasgow Kelvingrove Museum and has been examined by Dorothy Hill who states (personal communication) that Thomson's figured specimen "bears the number K.M.T. 2103a,b. It is in two pieces, each with a polished surface and Thomson's figure was drawn from one of these; the likeness is good. I did not section it as all that could be seen in a section is seen on the figured surface. I felt convinced at the time of study that it was of the same genus as *Z. enniskilleni.*" Hill (1940, p. 142) considered Thomson's specimen to be a junior synonym of *Z. curvilinea* Thomson, thus making this the type species of the genus *Amplexi-Zaphrentis.* Hill figured the holotype of *Z. curvilinea* (1940, Pl. 7, fig. 73) and her description of this species, which has the fossula on the concave side of the corallite, is in general accordance with the diagnosis given in this paper for the genus *Amplexi-Zaphrentis.*

(6) *Triplophyllum* Simpson (1900, p. 209; type species *Zaphrentis terebrata* Hall 1883, p. 316, Pl. 23, fig. 5, from the Devonian of Indiana) was described as differing from *Zaphrentis* in the prominence of its two alar fossulae. The genus received wide recognition based largely on *Z. centralis* Edwards and Haime, which Simpson also listed as an example of the genus. However, no specimens of the type species *Z. terebrata* were figured. Easton (1944A, p. 38) stated that only five specimens of the type species are known. The holotype remains unsectioned, but Easton was able to section the four topotypes and has shown *Triplophyllum* to have long septa which tend to form an axial vortex, an inconspicuous cardinal fossula "bounded by unfused adjacent metasepta" and sparse dissepiments. Carboniferous zaphrentid corals can therefore no longer be assigned to this genus.

(7) Simpson proposed the genus *Hapsiphyllum* (1900, p. 203) to include forms having long contratingent minor septa and a "subvertical wall of horseshoe shape" around the cardinal fossula. He designated *Zaphrentis calcariformis* Hall (1882, p. 33) from the Middle Devonian, Falls of the Ohio, Kentucky, as type species. The specimen Simpson figured, however, presumably came from the Lower Carboniferous St. Louis group, Washington country, Indiana. Worthen (1890, p. 76) suggested that Hall's type specimen was from the Warsaw beds of the St. Louis limestone of Indiana and not from the Devonian. As pointed out by Hill (1940, p. 144), Simpson's figured specimen may not be Hall's species, which Grove (1935, p. 362) considered to be conspecific with another Warsaw species, *Z. cassideyi* Edwards (1860, vol. 3, p. 341). Grabau (1928, p. 119) stated that the type specimen is from the St. Louis group, Washington county, Indiana. He interpreted *Hapsiphyllum* broadly and considered *Zaphrentis delanouei* Edwards and Haime a typical example. He also included *Zaphrentis konincki* Edwards and Haime and numerous Chinese forms in this genus, none of which has contratingent minor septa. Schindewolf (1938, p. 445) figured specimens said to be from the St. Louis limestone of Indiana, which he called *H. calcariformis* and he treated them as type material. Moore and Jeffords (1945, p. 125) stated that the specimens figured by Schindewolf probably represent a coral which is not *H. calcariformis* but they gave no reasons for their opinion. Schindewolf (1938, p. 449) apparently did not consider the inner wall or the presence of contratingent minor septa of generic importance in *Hapsiphyllum* and, as stated earlier, he listed it as a subgenus of *Zaphrentoides*. Hill (1940, p. 145) considered *Hapsiphyllum* too poorly defined for use.

Easton (1944A, p. 42) emended the genus *Hapsiphyllum* Simpson to include forms with short, free as well as contratingent, minor septa, and no dissepiments. He did not discuss the status of the holotype of the type species. He subdivided the genus into two subgenera on the basis of the location of the cardinal fossula. The subgenus *Hapsiphyllum* was restricted to those species with long contratingent minor septa and cardinal fossula on the concave side of the corallite. A new subgenus *Homalophyllites* was designated for those forms with short free minor septa and cardinal fossula on the convex side. However, in 1951, Easton (p. 389) revised his previous classification and proposed that only corals with long contratingent minor septa should be included in the genus *Hapsiphyllum*. He placed his subgenus *Homalophyllites* as a subgenus under *Triplophyllites* (1951, p. 398) (*see* below).

(8) Hudson (1941, p. 309) erected the genus *Zaphrentites,* with *Zaphrentis parallela* Carruthers (1910, p. 533) as type species, to include the *Zaphrentis delanouei* species group. The type specimen of *Z. parallela* is in the collection of the British Museum and is well figured by Carruthers (1910, Pl. 37, figs. 4a-d).

(9) Easton (1944A, p. 35) did not consider *Zaphrentoides* or any of the other simple Carboniferous zaphrentid genera well enough known for use and he proposed a new genus *Triplophyllites* (type species *T. palmatus* n.sp. from the Mississippian of Illinois) to include Carboniferous corals previously thought typical of *Triplophyllum.* He stated that the genus has sparse development of dissepiments confined largely to the lower parts of the coral. He did not figure the holotype, and his figured drawings of paratypes of the type species include only transverse sections (Pl. 8, figs. 1-6) which do not appear to show these features. However, Easton's figured drawings of some other species which he included in this genus, such as those of *T. exiguus* (Miller), do appear to show rare dissepiments (Pl. 10, figs. 1-7).

Conclusions. As noted in the discussion above, several authors have at various times separated genera or subdivided them into subgenera on the basis of the position of the cardinal fossula in relation to the curvature of the corallite. However, the consistency and value of this feature in taxonomy has not been adequately demonstrated. Although many forms appear to have the cardinal fossula consistently located on either the concave or the convex side of the corallum, others have the fossula at varying positions in relation to the plane of curvature; and still other genera may be almost straight, without consistent curvature or may be somewhat twisted. For these reasons it is suggested that corals not otherwise distinguishable except for this feature should not be separated into different genera or subgenera. The following suggestions can be made concerning the usage of various genera.

(a) The generic name *Amplexi-Zaphrentis* is based on a widely known type species of which the type specimens are well described and figured. This genus is here interpreted broadly to include many of the Carboniferous zaphrentid corals but particularly those with the internal features typified by *A. curvilinea* and *A. enniskilleni,* regardless of the position of the cardinal fossula in relation to curvature.

(b) The genus *Zaphrentites* is tentatively considered to be a junior synonym of *Amplexi-Zaphrentis* until it can be demonstrated that species of the *Z. delanouei* group can consistently be separated from those of the *A. enniskilleni* type.

(c) The genus *Triplophyllites* is a junior synonym of *Amplexi-Zaphrentis.* The possibly inconsistent presence of sparse dissepiments in the early stages of this genus are not considered to be a feature that separates this form from others included here.

(d) The genus *Hapsiphyllum,* based on an inadequately known type species, is considered to include only forms having contratingent minor septa, no dissepiments and mostly with an inner wall developed around the cardinal fossula. It is not believed to be a subgenus of *Zaphrentoides* as proposed by Schindewolf (1938, p. 450).

(e) The genus *Zaphrentoides* is considered insufficiently known until its type material has been re-studied and thin-sectioned. It may eventually prove to be a senior synonym of *Amplexi-Zaphrentis.*

(f) The genus *Menophyllum* is too poorly known to permit proper evaluation of its characters.

(g) The genus *Heterophrentis* is believed to be distinct from the genera here included in the family Hapsiphyllidae. It may include forms with axially twisted septa or with the irregular development of an axial structure.

Septal Structure. Wang (1950, p. 203) described corals similar to those included here under the family Hapsiphyllidae as having a lamellar skeleton in which the septa are "composed of a few horizontal trabeculae embedded in lamellar tissue, or composed of lamellar tissue only". Some of the species described below agree with this designation. There are, however, four other types of septal structure observable in the zaphrentid corals under study from Western Canada. The five types are as follows:

(A) Forms composed entirely of lamellar tissue as described by Wang (*see* Pl. V, fig. 2f). The following represent this group:

Amplexi-Zaphrentis enniskilleni cf. var. *derbiensis* (Lewis)

Amplexi-Zaphrentis indifferens n.sp.

Amplexi-Zaphrentis taylori n.sp.

(B) Forms in which the septa have a feather-like appearance and are apparently composed of fibrous tissue not grouped into trabeculae and at an oblique angle to the plane of the septa (Pl. VII, fig. 1c). The septa are sometimes embedded in lamellar tissue in the peripheral region and the septa themselves may be partly lamellar in the outer parts (Pl. IV, fig. 1g). Examples are:

Amplexi-Zaphrentis enniskilleni cf. var. *enniskilleni* (Lewis)

Amplexi-Zaphrentis sp. C.

(C) Forms that have what appears to be a type of septal structure distinct from any described by Wang and earlier workers and is here termed *chevron structure.* The septa in this type appear to be made up of a series of layers parallel to the plane of the septa. Each layer consists of small fibres arranged parallel to each other at an oblique angle to the plane of the septa. There are generally three layers on each side of the central line of the septum and in each layer there is a marked change in the angle of obliquity of the small fibres relative to those in the previous layer. This arrangement gives a zigzag appearance to the septa (*see* Pl. IX, fig. 2e; Pl. X, figs. 2c, 4b; Pl. XI, figs. 1c, 1d). In a longitudinal section of a septum a similar zigzag pattern is observed (poorly shown in Pl. XI, fig. 1f). The structure is not fully understood, and it is difficult to realize how the polyp could secrete layers in which there is a change in direction of the minute 'fibres' with each new layer. It is impossible to do more than note this unusual structure and a better understanding must await further investigation. The possibility should not be overlooked that this structure resulted from later recrystallization of the specimen, but this does not appear to be the case. It has been observed in several species from different localities and with various types of preservation. Chevron structure is not well shown in the illustrations but it has been observed in the following species:

Amplexi-Zaphrentis cassa n.sp.

Amplexi-Zaphrentis pilata n.sp.

Amplexi-Zaphrentis sp. A.

Amplexi-Zaphrentis sp. B.

(D) Forms with a fibro-lamellar skeleton in which the septa are composed of fibre fascicles not grouped into trabeculae and arranged at right angles to the plane of the septa (*see* Pl. XII, fig. 2f). This septal structure is typical of many forms in the family Caniniidae but it is represented among the Canadian zaphrentid corals by *Canadiphyllum knoxi* Sutherland.

(E) Forms in which the fibre fascicles are arranged at right angles to the plane of the septa and may be grouped into trabeculae (Pl. VII, fig. 6c).

It is not intended to imply that these are the only types of septal structure to be found in zaphrentid corals. The wide variation, apparent even among the limited number of species under study, indicates the marked polyphyletic nature of a group that undoubtedly includes several phylogenetic lines. However, much further information on such species from all regions will be necessary before the usefulness of these septal structures can be evaluated.

It is believed that primitive members of the Caniniidae and some groups of zaphrentids have a close relation in origin. The presence of fibro-lamellar structure (type D above) in some zaphrentid corals supports this contention. This view is also supported by a study of *Zaphriphyllum disseptum* Sutherland, which is a zaphrentid with dissepiments and fibro-lamellar septal structure.

Amplexi-Zaphrentis enniskilleni (Edwards and Haime)

Zaphrentis enniskilleni **Edwards and Haime, 1851B, p. 334.**
Zaphrentis enniskilleni **Edwards and Haime, Lewis, 1930, p. 277, Pl. 23, figs. 1-8; 1935, p. 123.**
Zaphrentis enniskilleni **Edwards and Haime, Hill, 1940, p. 140.**

Diagnosis. Solitary, large, trochoid corals, having a prominent cardinal fossula on the concave side of the corallum. The fossula generally extends beyond the axis. The axial ends of the septa may unite around the fossula or become amplexoid and withdraw from it. Alar pseudofossulae not conspicuous. The cardinal septum is long in the early stages, but soon becomes short. The counter septum sometimes shortens slightly at a later stage. Most tabulae are complete domes, flattened or even concave axially; in the fossulae they descend steeply towards the periphery (modified from Hill, 1940, p. 140).

Remarks. This common British form ranges throughout the whole of the Lower Carboniferous Viséan stage in the British Isles. Lewis (1930, p. 279) subdivided the British forms into three varieties that have a general stratigraphic consistency. *A. enniskilleni* var. *enniskilleni,* which has about 40, approximately straight, long major septa, is considered typical. It occurs in the lower Viséan C_2 and S_1 zones. The variety *A. enniskilleni* var. *ashfellensis* has about 40 flexed major septa and occurs in the S_1 zone; and from the upper Viséan D_2 zone Lewis described *A. enniskilleni* var. *derbiensis* in which the septa are reduced to about 34 in number and are amplexoid.

Later, Lewis (1935, p. 125) redefined *Zaphrentis minas* Dawson, a form occurring in the upper Windsor series of Nova Scotia, and considered it to be a variety of *Zaphrentis enniskilleni. Z. minas* differs only slightly from the British variety *A. enniskilleni enniskilleni.*

Forms that differ in minor respects from the varieties just discussed were collected from two localities (Section 11, units 4 and 5) from the middle part of the Mississippian sequence in the Liard River region in Western Canada, but too few specimens are available to determine the consistency of the variations present. They are described on following page.

Amplexi-Zaphrentis enniskilleni cf. *enniskilleni* (Lewis)

Plate IV, figures 1a-g, 2a-d, 3

Zaphrentis enniskilleni **var.** ***enniskilleni*** **Lewis, 1930, p. 277, Pl. 23, fig. 1.**

Description. The corallite is large, slightly curved, and trochoid. The largest specimen is about 40 mm. in length not including the calyx and part of the early tip which are missing. The total length would probably be 60 mm. The greatest diameter is 24 mm. The epitheca shows fine rounded interseptal ridges which are interrupted by smooth transverse undulations and rugae. A prominent cardinal fossula is located on the concave side of the corallite.

In the late neanic stage, at a diameter of 9.5 mm., 30 major septa are present (Pl. IV, fig. 1d). Those of the counter quadrants are slightly withdrawn from the axis and the cardinal fossula is prominent, U-shaped, and slightly expanded at the axial end. At this stage short minor septa can be detected only in the vicinity of the counter septum. In the ephebic stage, at a diameter of 16 to 21 mm., there are 38 to 42 major septa. They are long, but are slightly withdrawn from the axis. The pronounced open cardinal fossula extends beyond the axis and has almost parallel sides. Minor septa are present but are very short.

The tabulae are moderately spaced and usually consist of arched domes that bend down at a moderate angle into the fossula. There are no dissepiments.

Septal Structure. The septa have type B septal structure as discussed earlier. Such septa are composed of pinnately arranged fibrous material, not grouped into trabeculae. Lamellar tissue is, however, prominent in the peripheral area (*see* Pl. IV, fig. 1g).

Remarks. The Canadian specimens are very similar in the ephebic stage to *Amplexi-Zaphrentis enniskilleni* var. *enniskilleni* (Lewis, 1930, p. 279, Pl. 23, fig. 1). They differ from that variety in that the septa retreat from the axis at an earlier period and a triangular shape to the fossula at two distinct periods in the ontogeny of the individual have not been observed.

Material and Occurrence. Three well preserved specimens from Locality 28, and one incomplete specimen from Locality 29, Section 11, unit 4, Liard River region. Middle? Mississippian.

Amplexi-Zaphrentis enniskilleni cf. *derbiensis* (Lewis)

Plate V, figures 1a-e

Zaphrentis enniskilleni var. *derbiensis* Lewis, 1930, p. 279.

Description. The Liard River specimens are medium sized, curved and trochoid with transverse rugae and smooth interseptal ridges. The cardinal fossula is on the concave side of the corallite. In the late neanic stage the septa reach the axis and are joined together by the deposition of lamellar tissue and the alar pseudofossulae are conspicuous but become obscure in the adult. In the ephebic stage near the base of the calyx there are 40 major septa, at a diameter of 18 mm. The septa are two-thirds to three-fourths the length of the radius. The pronounced cardinal fossula is open and expands inwards and alar pseudofossulae are obscure. The cardinal fossula is accentuated by the down-bending of the tabulae which are domed and tend to be complete. Dissepiments are lacking.

Septal Structure. The septa are composed entirely of lamellar tissue.

Remarks. The Canadian specimens are near *A. enniskilleni* var. *derbiensis* in general structure and in the amplexoid nature of the septa but differ from that variety in having as many as 40 septa in the ephebic stages instead of 34.

Material and Occurrence. Two well preserved specimens from Locality 37, Section 11, unit 4, Liard River region. Middle? Mississippian.

Amplexi-Zaphrentis taylori n.sp.

Plate VI, figures 1a-e

Diagnosis. *Amplexi-Zaphrentis* that may have a cuneate[1] shape, and a pronounced elongated open cardinal fossula, located on the concave side of the corallite, which extends beyond the axis in the ephebic stage. There are about 40 long, thick major septa which do not reach the axis.

Description. Gently curved, trochoid corals of medium size are included in this species. The type specimen is cuneate in cross-section and has a total length of about 50 mm. and a diameter near the base of the calyx of 19 mm. by 15 mm. The calyx is deep, being almost equal to the greatest diameter at the base of the calyx and slopes into the trough of the cardinal fossula which is

[1]Easton (1951, p. 381) proposed the term 'cuneate' for corals compressed parallel to the cardinal-counter plane; he subdivided each genus where cuneate corals are present into 'species groups'. Such a feature is found in many zaphrentid corals but its value in classification has not been fully determined.

located on the concave side of the corallite. The surface of the epitheca has smooth irregular transverse undulations and rounded fine interseptal ridges. The most outstanding characteristic is the great prominence of the cardinal fossula which extends well past the axis and may have a length of almost two-thirds the diameter. It is wide and open and is accentuated by the downbending of the tabulae. There are 38 to 42 thick, but not rhopaloid, major septa in the ephebic stage. Most are two-thirds to three-fourths the radius in length, and are curved slightly towards the counter septum. The minor septa are short and tend to be obscured by the deposition of lamellar tissue which forms a slight peripheral stereozone. The thin cardinal septum is about half the radius in length in the late neanic and early ephebic stages but shortens to less than one-fifth the radius in the late ephebic stage. The counter septum is slightly shortened and lies in an inconspicuous open fossula which is marked by a slight downward deflection of the tabulae. The alar septa can be detected in the late neanic and early ephebic stages after which they become obscured.

The tabulae are complete or incomplete and are moderately spaced. Some of them are thickened on their upper surfaces by lamellar tissue. The tabulae rise from the epitheca towards the axis, and arch at about one-third the length of the radius, and then slope into the pronounced cardinal fossula. In transverse section the flatter arched part of a tabula may give the impression of a girdle or wall around the fossula (*see* Pl. VI, fig. 1a). In some cases the lamellar thickening is continuous between septa and tabulae where they are confluent.

Septal Structure. The septa are composed entirely of lamellar tissue.

Remarks. This form is not typical of *Amplexi-Zaphrentis* but it is referred to this genus until its position is better understood. The shape and pronounced size of the cardinal fossula, the presence of a counter fossula, and the oval shape of the corallite, distinguish this form from other known species.

Material. Holotype, G.S.C. No. 10579 from Locality 34, Liard River, N.W.T., Lower Mississippian. One poorly preserved specimen (Pl. VI, fig. 2) from Locality 111, Kindle formation, Tetsa River area, is doubtfully referred to this species.

Amplexi-Zaphrentis indifferens n.sp.

Plate V, figures 2a-h, 3a-d, 4a-e

Diagnosis. Small, curved trochoid corals in which the open cardinal fossula is located on the convex side of the corallite. In the ephebic stage the cardinal septum is short; the counter and two alar and occasionally one or two of the other septa are long but do not join axially and are not rhopaloid; the remainder of the septa are short. Minor septa are rudimentary or lacking and no dissepiments are present.

Description. The corallite is small, trochoid, and slightly curved with a length of 35 to 40 mm. and a diameter of 11 to 13 mm. at the base of the calyx. The calyx is 15 to 20 mm. in depth but is crushed in all specimens studied. The epitheca shows fine transverse annulations and almost no longitudinal markings. The cardinal fossula is located on the convex side of the corallite.

In the neanic stage at a diameter of 6 to 8 mm. there are 20 to 23 major septa which are long and thickened. The two alar, the counter and in some specimens one or two other septa meet at the axis. In the ephebic stage the septa become amplexoid and all become shorter except the alar, counter and occasionally one or two other septa which remain long. These septa do not join axially, and are not rhopaloid. There is an open axial tabular area and the open cardinal fossula is well marked but may be narrow. There are 24 to 26 major septa at a diameter of 9.5 and about 28 to 29 at a diameter of 11.5 to 12 mm. There is an acceleration in the insertion of the septa in the counter quadrants which are radially arranged. Those of the cardinal quadrants are concave towards the open fossula. Minor septa are lacking or rudimentary.

Tabulae are not well shown in the sections available, but are incomplete, and appear to dip gently into the axial region (Pl. V, fig. 2g). In contrast to most zaphrentids, they do not appear to be noticeably deflected downward in the vicinity of the cardinal fossula. No dissepiments are present.

Septal Structure. The septa are composed entirely of lamellar tissue (*see* Pl. V, figs. 2e, 2f).

Remarks. The generic classification of *A. indifferens* is uncertain. It is similar in general features to some species included in the *Zaphrentis omaliusi* group as described by Hill (1940, p. 135) but there is no pseudofossula developed about the counter septum which is not rhopaloid and the tabulae appear to be depressed axially instead of being conical. In having an open cardinal fossula on the convex side of curvature and long counter and alar septa it is similar to some of the lophophyllidid corals such as *Claviphyllum* Hudson (1942, p. 262=*Fasciculophyllum* of Hill, 1940, p. 130) but in that genus the counter septum is enlarged axially to form a columella.

Material and Occurrence. Three well preserved specimens from Locality 28, Section 11, unit 4, Liard River region. Middle? Mississippian. Holotype, G.S.C. No. 10576.

Amplexi-Zaphrentis cassa n.sp.

Plate VIII, figures 1a-g, 2a-e, 3a-b, 4, 5a-c;
Plate IX, figures 1a-d, 2a-e, 3a-c, 4a-b

Diagnosis. Curved trochoid corals with the cardinal fossula on the concave side of the corallite. In the neanic stage the septa join at the axis around the prominent cardinal fossula; they number 34 to 38 in the ephebic stage where they become amplexoid leaving a large open tabular area and an open fossula marked by the downbending of the tabulae. The septa may bend slightly so as to curve towards the counter septum. Minor septa are very short or lacking and dissepiments are missing.

Description. The corallite is simple, medium in size, slightly curved and trochoid. The average length is about 35 mm. with a variation from 30 mm.

to over 40 mm. The diameter at the base of the calyx ranges from 14 to 20 mm. The exterior of the epitheca is smooth except for faint interseptal ridges and fine transverse striations. The calyx is moderately deep and has a smooth floor which slopes gently into the fossular trough.

The following list gives the relation between the diameter and number of major septa in two typical specimens.

Holotype (Pl. VIII, figs. 1a-g)

Diameter - 20 mm., 38 maj. septa - Late ephebic stage.
Diameter - 14 mm., 28 maj. septa - Middle ephebic stage.
Diameter - 12 mm., 24 maj. septa - Early ephebic stage.
Diameter - 9 mm., 22 maj. septa - Early ephebic stage.

Paratype (Pl. VIII, figs. 2a-e)

Diameter - 17 mm., 34 maj. septa - Late ephebic stage.
Diameter - 15 mm., 32 maj. septa - Middle ephebic stage.
Diameter - 10 mm., 24 maj. septa - Early ephebic stage.
Diameter - 6 mm., 18 maj. septa - Late neanic stage.

The brephic and early neanic stages were lacking in all specimens studied. The earliest section available has a diameter of 6 mm. and represents the late neanic stage (Pl. VIII, fig. 2d). All 18 major septa extend to the axis in this section except the counter and counter laterals, apparently indicating an amplexoid tendency of the septa even at an early stage. In the early ephebic stage (diameter 9 to 12 mm., average 22 to 24 major septa) all of the major septa except the cardinal extend to the axis and are pinnately arranged around the prominent cardinal fossula. Alar pseudofossulae are clearly developed at this stage. The cardinal septum gradually becomes shortened and remains short throughout the remaining periods of growth. The septa are strongly dilated and may curve slightly away from the cardinal fossula in the cardinal quadrants and towards the counter septum in the counter quadrants. The tabulae are inclined from the counter to the cardinal side of the corallite steepening into the cardinal fossula.

In the middle and late ephebic stages the septa become markedly amplexoid (Pl. IX, fig. 3c) and withdrawn from the centre, leaving an axial tabular area and an open cardinal fossula. Alar pseudofossulae become obscure. The shortening of the septa coincides with a lessening in the steepness of the counter to cardinal slope of the tabulae. Both features are natural in an amplexoid trend. There is a corresponding reduction in the slope of the floor of the calyx from immature to mature corallites (*compare* Pl. IX, fig. 4b with Pl. VIII, fig. 1e). The tabulae, which tend to turn downwards near the periphery, are both complete and incomplete and may be slightly inosculating. Minor septa are absent except for the appearance in some specimens of one on each side of the counter septum in the late ephebic stage. No dissepiments are present.

One specimen (Pl. IX, fig. 5) develops an advanced amplexoid character at an earlier stage than in the specimens just described and the shortening of the septa is accelerated in the cardinal quadrants. As this variation is only represented by one specimen, it was not included in the description.

Septal Structure. The septa are composed of what is designated *chevron structure* in the introductory discussions to this genus (*see* Pl. IX, fig. 2e).

Remarks. Amplexi-Zaphrentis cassa could be included in the "*Zaphrentis delanouei* group" described by Hill (1940, p. 144) and here included in the genus *Amplexi-Zaphrentis.* The Canadian species has a parallel development to *A. disjuncta* (Carruthers) (1910, p. 534, Pl. 37, fig. 8) in having an early zaphrentid stage of the *A. delanouei* type followed by an amplexoid development. It differs from the English species in having a much larger size, many more septa, and more steeply inclined and in places incomplete tabulae.

Many Carboniferous corals show some tendency to an amplexoid development. These are difficult types to study as it is rarely possible to trace their ancestry from a particular species. Carruther's classic study (1910) is a conspicuous exception.

Material and Occurrence. Twenty-two specimens from Locality 130 and two from Locality 131, Section 9A, units 8 and 10, Kindle formation, Tetsa River area. Middle Mississippian. Holotype, G.S.C. No. 10589.

Amplexi-Zaphrentis pilata n.sp.

Plate X, figures 2a-c, 3a-b, 4a-c

Diagnosis. Like *Amplexi-Zaphrentis cassa* but has a pronounced peripheral stereozone and deep calyx.

Description. The corallite is medium in size, slightly curved and trochoid. The exterior of the epitheca is marked by prominent transverse rugae. The calyx is very deep, its depth exceeding the greatest diameter.

In the early stages the septa join at the axis around a wide cardinal fossula which expands in width axially and is located on the concave side of the corallite. Alar pseudofossulae are well shown at this stage (Pl. X, fig. 3a). However, the septa are amplexoid and withdraw from the axis in the ephebic stage. The major septa are 38 in number in the holotype at a diameter of 16 mm. A peripheral stereozone up to 2 mm. wide develops in the ephebic stage and becomes even thicker around the calyx (Pl. X, figs. 2a, b). The tabulae slope from the counter to the cardinal side of the corallite and are both complete and incomplete, slightly inosculating and downturned at the edges (Pl. X, fig. 2b). Dissepiments are lacking.

Septal Structure. The septa have chevron structure as described earlier (*see* Pl. X, figs. 2c and 4b).

Remarks. This form is similar to *A. cassa* except for the development of a pronounced peripheral stereozone, a much deeper calyx and a more prominent surface ornamentation. The two species are considered to be distinct but it is possible that the thickness of a peripheral stereozone may be governed to some extent by the availability of calcium carbonate in the water. The specimens of *A. cassa* described above are from a shale horizon whereas those of *A. pilata* were collected from a very hard dense limestone stratigraphically higher in the same section (*see* section 9A). Further collecting may indicate that *A. pilata* is a descendant of *A. cassa.* If additional study shows that the stereozone is a constant feature in *A. pilata* then this species could possibly be included in the genus *Barytichisma* described by Moore and Jeffords (1945, p. 131) for forms with a pronounced peripheral stereozone, cylindrical form and an early zaphrentoid arrangement of the septa which become amplexoid in mature stages.

Material and Occurrence. Six incomplete but well preserved specimens from Locality 131, Section 9A, Kindle formation, Tetsa River area. Middle Mississippian. Holotype, G.S.C. No. 10600.

Amplexi-Zaphrentis sp. A

Plate X, figure 5

Description. Small trochoid coral known only from a single incomplete specimen which is imbedded in hard matrix that obscures the external features. There are 34 major septa present at a diameter of 13 mm. The septa are dilated and join at the axis around a prominent fossula. Alar pseudofossulae are present. An unusual feature is the presence of five minor septa in the vicinity of the counter septa which are very long and reach the axis. This contrasts with the absence of minor septa in other parts of the corallite.

Septal Structure. The septa have chevron structure, type C, as described earlier.

Remarks. No longitudinal section could be made, and so the description is incomplete. The presence of five minor septa which extend to the axis and the absence of other minor septa are unusual characteristics. Except for this feature, the coral is not unlike early stages of *Amplexi-Zaphrentis pilata,* which occurs in the same formation but the cardinal fossula is narrower. Both forms have a similar septal structure.

Material and Occurrence. A single specimen from Locality 131, Section 9A, Kindle formation, Tetsa River area. Middle Mississippian.

Amplexi-Zaphrentis sp. B

Plate XI, figures 1a-f, 2, 3, 4a-b, 5

Description. The corallite is simple, trochoid and gently curved. The largest specimen collected has a diameter of 28 mm. at the calyx and a length of probably 65 mm. The calyx is very deep and slopes smoothly into the fossular trough which is located on the concave side of the corallite. Inconspicuous longitudinal ribbing can be observed and there are prominent transverse annulations.

The major septa are thick and tend to be long. They unite at the axis, closing the cardinal fossula in the early stages. The cardinal septum reaches the axis in the neanic stage but is short in the adult. In the ephebic stage the major septa, which number 42 to 44 at a diameter of 19 to 20 mm., tend to become amplexoid and are long only on the surface of the tabulae. In some specimens they shorten to half the radius between the tabulae. There is a marked acceleration of the septa in the counter quadrants. The cardinal fossula, which is open and varies inconsistently in width and shape, is prominent and extends to, and in some specimens beyond, the axis. Minor septa are rudimentary or absent. Alar pseudofossulae are present and at times conspicuous.

The tabulae are both complete and incomplete and tend to have a slight periaxial arching or flattening in the counter quadrants. Their general slope is from the counter to the cardinal side with a marked depression at the cardinal fossula, and their edges may be slightly downturned at the periphery. Dissepiments are lacking.

Septal Structure. The septa have chevron structure (*see* Pl. XI, figs. 1c and 1d).

Remarks. The forms described here represent a new species but the specimens are poorly preserved, and as they come from a talus block they are not given a name. It is an allied form to *Amplexi-Zaphrentis cassa* but the amplexoid tendency of the septa never reaches the advanced stages present in that species and the major septa may extend to the axis in the ephebic stage. It also differs in the larger number of septa for a given diameter, the more dilated nature of the septa, a greater elongation of the cardinal fossula which varies irregularly in shape.

The specimens described here are from a talus block from the lower or middle part of the Prophet formation in the Prophet-Muskwa area. It is believed to be a stratigraphically lower horizon than those containing *A. cassa,* located in the Kindle formation about 70 miles northward on the Tetsa River.

Material and Occurrence. Fifteen badly weathered specimens from Locality 101, Section 8, Prophet formation, Prophet-Muskwa Rivers region.

Amplexi-Zaphrentis sp. C

Plate VII, figures 1a-c, 2a-b

Description. Included here are three fragmentary, partly crushed, trochoid corals of medium size which are almost straight. The early stages are missing and the position of the cardinal fossula in relation to the curvature cannot be determined. The diameter just below the calyx is about 18 mm. but the length is unknown. The surface of the epitheca has very fine transverse annulations and occasional more pronounced constrictions. Rounded interseptal longitudinal ridges are prominent. The nature of the calyx is unknown.

There are 32 to 36 long major septa at a diameter of 17 or 18 mm. They join irregularly at the axis around a long narrow cardinal fossula. The major septa are greatly dilated throughout their length, but they become slightly thinner towards the axis. The cardinal septum is long and slender and extends to the axis at a diameter of 10 to 14 mm. but not at a diameter of 17 mm., where it is short. The counter septum is slightly shortened throughout growth. Alar pseudofossulae are obscured by a tendency to radial symmetry in the ephebic stage. Minor septa are present but short.

No satisfactory longitudinal section could be made, but the tabulae appear to be moderately spaced and dissepiments are lacking.

Septal Structure. The septa have type B septal structure as discussed earlier. They have a 'feather-like' appearance in transverse section and are composed of fibre fascicles not grouped into trabeculae and pinnate to the septal plane. No lamellar tissue is present in the peripheral area (*see* Pl. VII, fig. 1c).

Remarks. This form does not compare closely with any described species. It is characterized mainly by its elongated, narrow cardinal fossula, dilated radially arranged septa, and septal structure.

Material and Occurrence. Three incomplete specimens from Locality 32, Section 11, unit 6, Liard River area; middle or upper Mississippian; one specimen from Locality 34 (Pl. VII, fig. 3), isolated locality on Liard River, is tentatively compared with this species; one specimen from Locality 373 (Pl. VII, fig. 4), Section 3A, unit 21, Rundle formation, Kakwa-Jarvis Lakes region is tentatively referred here.

Amplexi-Zaphrentis sp. D

Plate VII, figures 5a-b, 6a-c

Description. The specimens described here are poorly preserved, straight to curved trochoid corals of medium size in which the cardinal fossula is located on the convex side of the corallite. The most complete specimen has an oval cross-section elongated at right angles to the cardinal-counter plane and is about 25 mm. long. Its diameter at the base of the calyx is 17 mm. by 20 mm. The calyx is of moderate depth and its floor slopes into a deep fossular trough. The surface of the epitheca has prominent fine interseptal ridges and regular, rather prominent, transverse rugae.

In the ephebic stage there are 52 to 58, more or less straight, long, major septa, which tend to a radial arrangement. Most are fused at their inner ends and thus close the elongated cardinal fossula which tends to have parallel sides and extends to the axis. Cardinal septum may be long in early stages but it shortens in the ephebic stage. Minor septa are prominent and have a length of 2 to 3 mm. in the ephebic stage or about a quarter of the radius. Major and minor septa are very close together, thickened and form a peripheral stereozone. In the upper part of the calyx the major septa shorten but the minor septa remain long, so that the two series are almost of equal length.

Tabulae are incomplete and arched steeply upward in the axial region but are deflected abruptly downward at the edge of the cardinal fossula. No dissepiments appear to be present.

Septal Structure. The septa are composed of fibre fascicles arranged at right angles to the plane of the septa and occasionally appear to be bunched into trabeculae (type E discussed earlier, *see* Pl. VII, fig. 6c).

Remarks. Amplexi-Zaphrentis sp. D is similar in general appearance and septal arrangement to *'Zaphrentis' konincki* Edwards and Haime, as figured by Carruthers (1908, p. 67, Pl. 5, fig. 3) from the Tournaisian of the Bristol region of England. It differs, however, in having a greater number of septa for a given diameter and a well developed peripheral stereozone. *A.* sp. D is similar in arrangement of septa, and in having prominent minor septa and a prominent cardinal fossula located on the convex side of the corallite to a form described as *Triplophyllum minnewankensis* by Shimer (1926, p. 25, Pl. 5, fig.

1) from the Rundle formation near Banff, Alberta. Shimer's holotype and paratype are in the collections of the Geological Survey of Canada and have been examined by the writer. They have not been sectioned but the main features can be seen on polished surfaces. Shimer's species differs from the specimens here under study in having a well developed peripheral zone of dissepiments and in being of larger size.

Material and Occurrence. Three poorly preserved specimens from Locality 370, Section 3A, unit 13, Banff formation, Kakwa-Jarvis Lakes region. A single, poorly preserved specimen (Pl. VII, fig. 7) from Locality 44, Prophet formation, Sikanni River region is tentatively referred here.

Amplexi-Zaphrentis sp. E

Plate VI, figure 3

Description. A single incomplete trochoid coral only is known which has most of the early part missing. About 60 thickened, closely set septa are present and the cardinal fossula is well developed and expands axially. Alar pseudofossulae are present. Nature of tabulae unknown.

Remarks. This species differs from others already described but it is poorly represented. The form is figured because it was the only coral specimen collected with a large brachiopod fauna in the upper part of Member B, Prophet formation.

Material and Occurrence. A single incomplete specimen from Locality 90, Member B, Prophet formation, Section 8, Prophet-Muskwa Rivers area.

Genus *Canadiphyllum* Sutherland, 1954

Type Species. Canadiphyllum knoxi Sutherland, 1954A, p. 362, Pl. IX, figs. 1-2, Prophet formation, Mississippian.

Diagnosis. "Simple trochoid corals in which the major septa of the cardinal quadrant are pinnate and often almost at right angles to a prominent cardinal fossula; the septa of the counter quadrant have a subparallel to radial arrangement; minor septa short or absent; tabulae numerous and no dissepiments present" (Sutherland, 1954, p. 362).

Canadiphyllum knoxi Sutherland

Plate XII, figures 1a-g, 2a-f, 3a-b, 4a-d

Canadiphyllum knoxi **Sutherland, 1954, p. 362, Pl. IX, figs. 1-2.**

Diagnosis. "Small almost straight trochoid *Canadiphyllum* with approximately 50 to 52 major septa in the ephebic stage, of which those in the counter quadrants tend to a subparallel arrangement; counter septum usually somewhat shortened; septa composed of fibre fascicles not grouped into trabeculae; no minor septa present; tabulae numerous, close together, periaxially arched and depressed into cardinal fossulae; dissepiments absent" (Sutherland, 1954A, p. 362).

Septal Structure. The septa have typical fibro-lamellar structure, type D discussed earlier, in which the fibre fascicles are perpendicular to the septal plane and are not grouped into trabeculae (Pl. XII, figs. 2c, 2f and 4d). According to Wang (1950, p. 209) such a structure is found only in the families Plerophyllidae, Caniniidae and Lonsdaleiidae. However, the simple zaphrentoid arrangement of the septa, the lack of dissepiments and the small trochoid shape in this form indicate that it should be placed in the Hapsiphyllidae.

Remarks. This species was described in detail by the writer in 1954 and the holotype and one paratype figured (1954A, p. 363, Pl. IX, figs. 1-2). These specimens are here re-illustrated for comparative purposes and additional paratypes, which show considerable variation are figured (Pl. XII, figs. 3-4). Also enlarged figures to show septal structure are given for the first time.

The very early stages are missing in all specimens studied and the corallites are almost straight. However, a close examination seems to indicate that the cardinal fossula is on the concave side of the corallite where any curvature is present, but this may not be a consistent feature.

Material and Occurrence. Eleven specimens, including the holotype, G.S.C. No. 10566, from Locality 82, Section 7, unit 6, Prophet formation, Member B, Halfway River region.

Genus *Zaphriphyllum* Sutherland, 1954

Type Species. Zaphriphyllum disseptum Sutherland, 1954, p. 363, Mississippian, Liard River region.

Diagnosis. "Solitary trochoid corals which have numerous long major septa that tend toward a radial symmetry; a prominent well-developed cardinal fossula; tabulae arched periaxially and downturned into the fossula; well-developed dissepimentarium, at least in ephebic stage" (Sutherland, 1954, p. 363).

Remarks. In 1954, this genus was tentatively placed in the family Caniniidae. However, the type species, *Z. disseptum* is, in effect, a trochoid zaphrentid coral of the *Amplexi-Zaphrentis enniskilleni* type, which has a well developed peripheral zone of dissepiments. Despite the presence of dissepiments, the genus is considered to be closely related to the zaphrentids and not to the caniniids. It is therefore classified in the family Hapsiphyllidae.

Zaphriphyllum disseptum Sutherland

Plate XIII, figures 1a-g, 2a-c

Zaphriphyllum disseptum Sutherland, 1954, p. 364, Pl. IX, figs. 3a-d.

Diagnosis. "Small to medium sized, curved, trochoid *Zaphriphyllum* with 42 to 46 major septa in the ephebic stage which tend to a radial symmetry; dissepimentarium and minor septa occupy about one-fifth of radius in ephebic stage; prominent, usually open cardinal fossula located on the convex side of the corallite; tabulae mostly incomplete and arched, but downturned steeply in axial region around cardinal fossula; septa composed of fibre fascicles not grouped into trabeculae" (Sutherland, 1954, p. 364).

Remarks. This species was described in detail in 1954 and the holotype was figured (1954, p. 364, Pl. IX, figs. 3a-d). This specimen is re-illustrated here for comparative purposes and an enlargement (Pl. XIII, fig. 1e) to show septal structure, taken from the holotype, is figured for the first time. In addition, a paratype is illustrated.

Material and Occurrence. Holotype, G.S.C. No. 10568 and paratype, G.S.C. No. 10610 from Locality 28, Liard River region, Section 11, unit 4. Middle? Mississippian.

Family Caniniidae

Diagnosis. Solitary corals that tend to be cylindrical and differ greatly in size are included in this family. The cardinal fossula is open and generally inconspicuous. The numerous major septa are typically withdrawn from the axial region and may be discontinuous in the dissepimental zone, which is commonly present and which varies greatly in width and character. The tabulae are typically flat or domed.

Septal Structure. Wang (1950, p. 208) reported that corals of this family have a fibro-lamellar skeleton (except in primitive forms in which it is all or partly lamellar) and the septa are composed of fibre fascicles not grouped into trabeculae. The Canadian specimens described here conform with this description.

Remarks. The accepted diagnosis of this family states that the tabulae are flat or domed. However, several forms described here from Western Canada, although agreeing with the characteristics of the family Caniniidae in other respects, have a marked tabular depression in the axial region that is not limited to the cardinal fossula. They are *Kakwiphyllum dux* Sutherland, *Paracaninia*? *wilsonae* n.sp., and *Pseudozaphrentoides*? *burlingi* n.sp. These species are tentatively referred here until their family relations are better known.

Genus *Caninia* Michelin in Gervais, 1840

Type Species. C. cornucopiae Michelin, 1847, p. 256, Pl. lix, fig. 5; from the Tournaisian of Tournai, Belgium.

Diagnosis. Simple, trochoid to cylindrical corals in which the septa do not extend to the axis. The cardinal fossula is open from a very early stage and the cardinal septum is shortened. Alar pseudofossulae may be present but tend to be obscured in the adult stages. A narrow peripheral ring of dissepiments is developed in late stages. The tabulae are mostly complete and flat lying.

Remarks. Discussions on the history of the study of *Caninia* and allied genera are given by Carruthers (1908, p. 158), Salée (1910, p. 27), Lewis (1924, p. 390), Hill (1939A, p. 103) and Moore and Jeffords (1945, p. 144) and such remarks are, therefore, not included here.

The genus *Caninia* has been interpreted broadly by most earlier authors in both Europe and America (Hill, 1939A, p. 105; Easton, 1944B, p. 123). Several well marked species groups have been recognized (Hill, 1939A, p. 106). A broad interpretation allows the inclusion in this genus of large forms with a wide lonsdaleoid dissepimentarium as well as small corals with a few dissepiments. Over the last 100 years various generic names have been proposed that overlap this concept of *Caninia* and there has been considerable variation of opinion on the interpretation of such names.

Recently, Moore and Jeffords (1945, p. 145) surveyed various genera associated with *Caninia* and proposed, in effect, that the 'species groups' outlined by Hill (1939A) be raised to generic rank. They made the following suggestions:

(a) that the genus *Caninia* be restricted to forms similar to the type species, *C. cornucopiae* Michelin (*in* Gervais, 1840, p. 485), which is a small form with an open cardinal fossula, septa that do not meet in the centre, and with a sparse development of dissepiments in the late ephebic stage.

(b) that the genus *Pseudozaphrentoides* (Stuckenberg, 1904, p. 91, type species, *P. jerofeewi* from the Lower Carboniferous of central Russia) be used for forms having long major septa that do not reach the axis in mature stages, a pronounced band of dissepiments that do not interrupt the septa, wide tabularium, and a weak open cardinal fossula. The well known English species *Caninia juddi* (Thomson) would be included here.

(c) that the genus *Siphonophyllia* (Scouler, *in* McCoy, 1844, type species, *S. cylindrica* Scouler from the Carboniferous limestone of Ireland) be applied to forms with a pronounced dissepimental zone that is partly or completely lonsdaleoid and has a more or less well developed siphonofossula caused by the downbending at the cardinal fossula of the numerous and otherwise flat tabulae.

This procedure is followed in this paper but with the realization that all our generic and even specific boundaries in the caniniids are highly artificial at present as we have little knowledge of their true phylogenetic relations. It has been suggested that there is probably continuous gradation between the above listed genera. Such features as the tendency in some forms for the dissepiments to become lonsdaleoid have probably appeared in various groups at different times.

Moore and Jeffords (1945, p. 146) in addition to restricting the genus *Caninia* and proposing the use of *Pseudozaphrentoides* as described above, associated these genera with the Devonian genus *Zaphrentis (sensu stricto)* Rafinesque and Clifford, in the family Zaphrentidae on the grounds that both groups have dissepiments. They followed the procedure despite the presence in *Zaphrentis* of a well developed cardinal fossula and toothed, carinate septa. The present author believes that the presence of dissepiments in this case is not sufficient reason for giving family association to forms that are otherwise distinct.

Wang (1950, p. 209) also interpreted the genus *Caninia* in a strict sense and in addition recognized a generic type similar to that included above in the genus *Pseudozaphrentoides*. However, he lists this genus as a junior synonym of *Bothrophyllum* Trautschold (1879, p. 30). This relationship is incorrect as the two genera have distinctive characters as shown in a detailed study by Dobrolyubova (1937, p. 26) of the type species of *Bothrophyllum*, *B. conicum* (Fischer von Waldheim), Trautschold, 1879, p. 30, Pl. V, fig. 1, from the

Middle Carboniferous of central Russia. Dobrolyubova figured various growth stages of many specimens of this species, which is a common form in the Middle Carboniferous of Russia. The main feature that distinguishes it from *Pseudozaphrentoides* is the early development of an axial column, which may in the ephebic stage be replaced by an irregular mesh or may disappear. In the latter case the characters of the late ephebic stage are indistinguishable from those of *Pseudozaphrentoides*. Dobrolyubova described the axial column of *B. conicum* as follows (1937, p. 33): "The central part of the coral is occupied by tabellae and also by the ends of the septa of the first order which sometimes reach the centre and form a fairly sparse irregular mesh which is cut across by a slender counter septum. At an early age the ends of the septa merge forming a fairly dense or even solid structure. Later, interweaving among themselves and with the tabellae there is formed an irregular mesh or a quite regular spider's-web which is very much like the central zone of *Dibunophyllum*. . . . This dibunophylloid structure appears in the majority and perhaps in all young stages of the specimens I am describing, but is preserved for different lengths of time, that is, to different stages. In preparing several transverse slides it is found most frequently only by one or two of the lower slides and is comparatively rarely preserved after several slides. Often in adult specimens this structure is replaced by a more regular web without a medial disk and this web reminds one of the complex central zone of some species of *Aulophyllum*." (The writer is indebted to E. R. Sands, lecturer in Russian at Cambridge University, for an oral translation from original Russian text of most of this paper.) Dobrolyubova's study of *B. conicum* did not include Trautschold's type specimens. She stated (p. 35): "Since the depiction and description of Trautschold clearly indicate the basic features of this species I find it possible to consider Trautschold's form as a lectotype despite the fact that his originals have been lost."

Genus *Paracaninia* Chi, 1937

Type Species. *P. sinensis* Chi, 1937, p. 95, from the Permian of China.

Diagnosis. Solitary corals similar to *Caninia* (*sensu stricto*) except for the complete absence of dissepiments.

Remarks. The generic name *Paracaninia* has not been widely used probably because only a few copies of the original article were distributed. Hill (1938, p. 105) stated that the holotype closely resembles *Caninia cornucopiae*, the holotype of *Caninia*, except that it never develops dissepiments. Moore and Jeffords (1945, p. 138) tentatively referred a species from the Lower Pennsylvanian of Texas to this genus. Wang (1950, p. 209) interpreted the genus *Caninia (sensu stricto)* to include forms without as well as with dissepiments, and therefore lists *Paracaninia* as a synonym of this genus.

Paracaninia is considered to be a valid genus and is classified near *Caninia* in the family Caniniidae despite the absence of dissepiments. However, the species from Western Canada, which is here tentatively referred to *Paracaninia*, is not at all typical of the genus.

Paracaninia? *wilsonae* n.sp.

Plate XIV, figures 1a-e

Diagnosis. Medium sized, solitary, ceratoid corals with long, thin major septa that do not extend to the axis in the mature stage, and a slightly shortened cardinal septum situated in an inconspicuous, shallow, open cardinal fossula located on the concave side of the corallite. The tabulae are incomplete and have a pronounced depression in the axial region, periaxial arching, and down-sloping edges. Dissepiments are lacking.

Description. The holotype is a curved ceratoid, simple, coral that is slightly crushed along the cardinal-counter line and that has a cuneate shape and a deep calyx. The exterior of the epitheca shows smooth, rounded interseptal ridges and irregular transverse rugae. It has a length of 11 cm. and a diameter at the base of the calyx of 4 cm. along the cardinal-counter and 3.5 cm. at right angles to the cardinal-counter plane.

There are about 62 long major septa near the base of the calyx and their length is about two-thirds the radius. They are thin throughout their length and their arrangement gives a well developed radial symmetry. Those in the cardinal quadrant tend to curve slightly in the direction of the cardinal septum, which lies in an inconspicuous open shallow fossula located on the concave side of the corallite. The alar septa can at times be detected but tend to be obscure. Minor septa are present but remain short throughout growth. There is a slightly longer minor septum on each side of the counter septum which is otherwise indistinguishable from the remaining septa. The axial area is occupied only by tabulae. There is a narrow peripheral stereozone formed by the deposition of lamellar tissue between the septa.

The tabulae are incomplete and appear to form deep concave floors at the axis, but bend up steeply with pronounced periaxial arching and slope gently down to the epitheca (Pl. XIV, fig. 1e). Near the periphery they are evenly spaced, but crushing partly obscures their nature in the axial region. There is a slight deflection of the tabulae at the inconspicuous cardinal fossula. Dissepiments are lacking.

Septal Structure. The septa are invested in, and at least partly composed of, lamellar tissue in the peripheral region. Axially, the septa are also partly lamellar and fibrous tissue may be present, but the septa are thin and the structure is not well shown (*see* Pl. XIV, fig. 1b).

Remarks. Paracaninia? *wilsonae* n.sp. probably represents a new genus, but the available material is not adequate for generic description and it is tentatively compared with the genus *Paracaninia.* This form differs from typical species of *Paracaninia* in being of much larger size, in having a much larger number of septa which remain thin in all quadrants, and in having tabulae with a pronounced axial depression.

P.? *wilsonae* n.sp. has some similarities with the Devonian genus *Siphonophrentis* O'Connell (1914, p. 187; type species, *Caryophyllia gigantea* Lesueur, 1821, p. 296, from the Middle Devonian of New York). Like *Siphonophrentis* it is large, has a large number of thin septa, an open cardinal fossula, short minor septa and lacks dissepiments. In transverse section there is a striking resemblance with a specimen of *S. gigantea* (Lesueur) from the Devonian of Ohio, illustrated by Stumm (1949, Pl. 5, fig. 2). However, the longitudinal sections are markedly different. Except for a shallow siphonofossula, *Siphonophrentis* has almost horizontal tabulae, most of which are complete, whereas in the Canadian specimen the tabulae have a pronounced concave floor and periaxial arching.

Material and Occurrence. A single well preserved, though slightly crushed specimen, the holotype, G.S.C. No. 10612, from Locality 30, Liard River region, Section 11, unit 5, Middle Mississippian.

Genus *Pseudozaphrentoides* Stuckenberg, 1904

Type Species. P. jerofeewi Stuckenberg, 1904, p. 91.

Diagnosis. Solitary corallites which are trochoid to cylindrical in shape and in which the major septa are mostly long to moderately long but do not reach the axis except in immature stages. The cardinal septum is generally short and lies in a weak open fossula that may be obscured by radial symmetry in advanced forms and that may be accentuated by a downward deflection of the tabulae. Alar pseudofossulae may be weakly developed but commonly are not distinguishable in the adult. Minor septa of various lengths are present in some specimens. Dissepiments are well developed. Most major septa are continuous but commonly thin in the dissepimentarium. Tabulae are numerous, complete or incomplete, and typically sub-horizontal. There is no axial column.

Remarks. The affinities and status of this genus are discussed in the remarks under the genus *Caninia*. It should be noted that most forms included here were previously thought typical of *Caninia sensu lato.*

Pseudozaphrentoides aff. *torquius* (Owen)

Plate XV, figures 1a-b, 2a-d

***Cyathophyllum torquium* Owen, 1852, tab. 4, fig. 2.**
***Caninia torquia* (Owen), Easton, 1944B, p. 125, Pl. 22, figs. 2-7.**

Description. The corals described here are solitary, medium to large in size, almost straight, and are cylindrical in shape. All specimens studied are slightly crushed. Interseptal ridges are present but subdued. Transverse markings are very conspicuous. There are numerous coarse growth lines, irregular wrinkles and sudden sharp constrictions followed by rejuvenation, giving the exterior a very rough appearance.

There are about 62 to 66 long major septa in the ephebic stage; they are thin and almost straight in the dissepimentarium and generally extend to the epitheca. Most of the septa are somewhat thickened in the tabularium and the thickening is much more pronounced in the vicinity of the cardinal septum than elsewhere. The cardinal septum is slightly shortened and lies in an open inconspicuous cardinal fossula that is difficult to detect. Minor septa are very short or represented by septal ridges only. The dissepiments form a pronounced peripheral zone about one-third the radius in width and are of both the concentric and herringbone types. They are evenly concave and steeply inclined. The specimens sectioned are crushed in the axial region but the tabulae appear to have been flat to slightly domed and they are mostly complete and slightly inosculating.

Septal Structure. Septa composed of fibro-lamellar tissue that is continuous with the dilated dissepimental parts (*see* Pl. XV, fig. 1b).

Remarks. The Liard River specimens are similar to *P. torquius* (Owen) in the general arrangement of the septa, in the width of the dissepimentarium, and in the type of dissepiments, but they differ from that species in having a much larger number of septa for the diameter, and a poorer development of minor septa. A re-description of the holotype of *P. torquius* (Owen) is given by Easton (1944B, p. 126). It has 45 major septa at a diameter of 33 to 40 mm., and it has minor septa about one-fourth as long as the major septa.

Material and Occurrence. Five large cylindrical specimens, all fragmentary and partly crushed, from Locality 7, Liard River region, Mississippian.

Pseudozaphrentoides? burlingi n.sp.

Plate XVI, figures 2a-b; Plate XVII, figures 1a-c

Diagnosis. Large, solitary cylindrical corals with long major septa that do not reach the axis in the mature stages and that are greatly thickened in the wide tabularium. An outer zone of dissepiments is well developed between the septa all of which reach the epitheca. Tabulae are complete or incomplete, numerous, and depressed axially forming a concave floor in the axial region. The dissepiments are rounded and steeply inclined.

Description. The corallite is simple, cylindrical, and very large. The average length is about 1½ feet and the diameter is 60 to 70 mm. in the adult stages. The natures of the calyx and exterior ornamentation are unknown.

In the ephebic stage in the holotype there are 74 to 76 long major septa which are three-fourths to four-fifths the radius in length. They are thin in the dissepimental zone but are strongly dilated in the tabularium. The septa are thickened equally in all quadrants. The holotype is slightly crushed along the cardinal septum which is slightly shorter than the other septa, and which probably lies in an inconspicuous open cardinal fossula. There is an open tabular area in the axial region. The major septa probably reach the epitheca, which is missing. Dissepiments occur between the septa in a well developed zone about one-third to two-fifths the radius in width. Most of them have a concentric appearance in transverse section but some of the herringbone type are present. The early stages are unknown.

As seen in longitudinal section the dissepiments are large, rounded and steeply to vertically inclined. The tabulae are complete or incomplete and have a deep concave depression in the axial region, rising steeply outward sometimes appearing to grade into the dissepiments.

Septal Structure. Most of the septa of the holotype have been recrystallized, and it is impossible to determine the septal structure with accuracy.

Remarks. The relations of this very interesting coral are uncertain. Its tremendous size is striking. It is similar to *Pseudozaphrentoides* except for the marked concave depression of the tabulae in the axial region. This important difference in the arrangement of the tabulae must reflect a basic difference in the growing habit of the polyp. The coral is believed to represent a new genus, but the material at hand is considered inadequate for generic description. It may also represent a distinct group from the family Caniniidae. It is tentatively referred to *Pseudozaphrentoides* until more material is available for study.

Material and Occurrence. One large cylindrical fragment, the holotype, G.S.C. No. 10616, about 13 cm. in length and with an average diameter of 60 mm., was collected from an exposure on the upper slope of the second mountain west of Mount Hannington. Many very large cylindrical specimens were observed partly weathered out of the limestone outcrop but field conditions did not permit the collection of more material. Some specimens up to 2 feet in length were seen but the average length appeared to be about 1½ feet. Locality 377, Section 3A, unit 32, Upper Rundle formation, Kakwa-Jarvis Lakes region.

Pseudozaphrentoides? sp. A

Plate XIII, figure 3; Plate XIV, figures 2a-b

Description. A cylindrical fragment of a single specimen of a coral from the Kakwa-Jarvis Lakes region has 88 amplexoid major septa present in the ephebic stage which may shorten to a length of one-half to three-fourths the radius between the tabulae. The major septa are all slightly deflected towards the prominent narrow open cardinal fossula. The septa are thin in the dissepimental zone which is of unknown width, and are slightly thickened in the tabularium. Minor septa cannot be observed as the epitheca and much of the dissepimentarium were removed by abrasion prior to burial. The dissepiments are small and concentrically arranged between the major septa.

The dissepiments are medium in size and almost vertically inclined. The tabulae are incomplete and more or less flat lying in the axial region but are downbent at the cardinal fossula. At their periphery some of the tabulae turn almost vertically upward before joining the dissepiments (Pl. XIII, fig. 3).

Septal Structure. Most of the specimen has been recrystallized but the septa appear to have a fibro-lamellar structure with the septa composed of thin parallel fibre fascicles which are not grouped into trabeculae.

Remarks. This specimen is too incomplete for definite comparison but it is figured as it differs from all other species under study. An unusual feature is the upturned peripheral edges of the tabulae. It is also of interest in that it appears to have been twice 'derived' or 're-worked'. The epitheca and part of the dissepimentarium were eroded away before the specimen was first incorporated in finely crystalline limestone matrix, some of which remains attached to the coral (*see* lower half of fig. 2b, Pl. XIV). After a second transportation, the specimen was redeposited in a more argillaceous matrix (*see* upper half of fig. 2b, Pl. XIV) but with some of the original limestone matrix remaining. It is possible that the specimen is older than its present horizon indicates but its features appear to be those of a Mississippian coral.

Material and Occurrence. One weathered specimen from Locality 366, talus below Rundle formation, Section 3A, Kakwa-Jarvis Lakes region.

Genus *Kakwiphyllum* Sutherland, 1954

Type Species. Kakwiphyllum dux Sutherland, 1954A, p. 366.

Diagnosis. "Large, solitary, cylindrical corals with long major septa which extend to the axial region, but do not join; major septa have overall radial symmetry which may be modified by regular or irregular grouping of septa into bunches caused by a shortening of the septa in some areas; cardinal and counter septa and the cardinal fossula may tend to be obscured in the ephebic stages by radial arrangement of septa; minor septa are short or absent; peripheral zone of dissepiments consisting of an outer series of lonsdaleoid dissepiments through which the septa are not continuous and an inner zone in which the dissepiments are small and have a herringbone or concentric arrangement between septa; dissepiments often gradational with the tabulae which are numerous, incomplete and inclined downward axially where they form a concave floor" (Sutherland, 1954A, p. 365).

Remarks. A preliminary discussion on the family relations of this genus has previously been given (Sutherland, 1954A, p. 365). In addition, it should be pointed out that this genus is similar in the axial depression of the tabulae to *Vesiculophyllum* Easton (1944A, p. 52), but the latter form develops a narrow ring of irregular lonsdaleoid dissepiments only in the late ephebic stage. In the same way it is similar to some species of the Devonian genus *Stringophyllum,* particularly *S. bipartitum* Hill (1942, p. 261), but in that genus the septal structure is very different with each septum consisting of a single series of laterally contiguous monocanths. In the type species of *Kakwiphyllum* the septa are composed of fibre fascicles arranged at right angles to the plane of the septa.

In addition to *Kakwiphyllum* various other corals show elongation in the cardinal-counter plane accompanied by a lonsdaleoid dissepimentarium, but such forms generally have horizontal or slightly domed tabulae. An example is *Aphrophyllum foliaceum* Hill (1934, p. 74), a loosely compound coral from the Lower Carboniferous of Australia.

Range and Distribution. The genus *Kakwiphyllum* is known to occur in the upper Banff and in the Rundle formations. The species that are described here come from near the top of the Banff formation near Banff, Alberta; from an apparently equivalent horizon in the South Nahanni River, N.W.T. and from the Rundle formation in the Kakwa-Jarvis Lakes region. The horizons mentioned here range from Osage to Meramec in age.

Kakwiphyllum dux Sutherland

Plate XVIII, figures 1a-d; Plate XIX, figure 3

Kakwiphyllum dux Sutherland, 1954A, p. 366, Pl. X, figs. 1a-c.

Remarks. The holotype was described in detail in 1954. It is refigured here for comparative purposes and an additional section of the holotype not previously figured is given (Pl. XVIII, fig. 1c). It should be noted that the axial depression of the tabulae is modified, at least in the holotype, by a slight median uprising of the tabulae in the depressed axial region (*see* Pl. XVIII, fig. 1d). The consistency of this feature has not been determined.

Material and Occurrence. Holotype, G.S.C. No. 10569, from talus block, Locality 366, on slope below upper part of Section 3A, where the Rundle formation is exposed, Kakwa-Jarvis Lakes region. A poorly preserved specimen, probably conspecific with the holotype was collected from the upper Rundle in the same section.

Kakwiphyllum cf. *dux* Sutherland

Plate XIX, figures 1a-d

Kakwiphyllum cf. *dux* Sutherland, 1954A, Pl. X, figs. 2a-c.

Description. The coral described here is a large cylindrical form in which the epitheca is thin and is marked by large irregular transverse wrinkles caused by marked periods of constriction and rejuvenation. The calyx is of medium size and depth and its mouth is tilted to one side but not in a plane with the cardinal and counter septa.

The major septa are long and extend to the axial region but do not join. They have an overall radial symmetry. In the middle ephebic stage (Pl. XIX, fig. 1b) they number 72 at a diameter of 55 to 66 mm. The tabularium is slightly elongated along the cardinal-counter plane and the cardinal and counter septa are slightly shortened but no fossulae are developed and the septa do not thicken in the tabularium. A few scattered short minor septa are present and are best developed in the vicinity of the cardinal septum. In the late ephebic stage near the base of the calyx (Pl. XIX, fig. 1a) the septa number 78 at a diameter of 62 to 68 mm. The cardinal septum is shortened and a short small, shallow fossula is developed. The tabularium is further elongated but the resulting irregular bilateral symmetry is at variance with the cardinal-counter plane (Pl. XIX, fig. 1a). The axial ends of the major septa are thickened in the relatively narrow tabularium. A few very short minor septa are present.

There are two pronounced dissepimental zones. The outer area consists of small and large lonsdaleoid dissepiments which are inclined downward at a steep angle. The peripheral ends of the septa rest against these dissepiments. The dissepiments of the inner zone lie between the septa and are of both the concentric and herringbone types. They are small and incomplete, and are inclined downward. They have a gradational contact with the lonsdaleoid zone. The tabularium is relatively narrow and consists of small incomplete tabulae which are inclined downward and form a narrow concave floor in the axial region. They have a gradational contact with the dissepiments.

Remarks. This form has previously been figured (Sutherland, 1954, Pl. X, figs. 2a-c) but not described. It is similar to *Kakwiphyllum dux* in the nature of the dissepiments, the axial depression of the tabulae, and in the overall radial arrangement of the numerous long septa. It differs from that species in having a thickening of the septa in the tabularium in the late ephebic stage, the presence of a small cardinal fossula, and a difference in the bunching and shortening of the septal ends in the late ephebic stage. A satisfactory evaluation of the relation of these two forms cannot be made until the consistency of these differences can be determined. The form is described here in detail because of its occurrence some 400 miles away from the type locality of the type species *K. dux*.

Material and Occurrence. One almost complete specimen, here described, G.S.C. No. 10570, and three unsectioned specimens. Locality 410, isolated locality in unnamed formation of Mississippian age; Liard-South Nahanni Rivers area, N.W.T. The form occurs with a small phaceloid *Lithostrotion,* aff. *L. pauciradiale* (McCoy). A fossiliferous bed occurring slightly lower stratigraphically contains a brachiopod fauna, which suggests an Osage age and which correlates with the Upper Banff or Lower Rundle formation farther south.

Kakwiphyllum sp. A

Plate XIX, figure 2

Description. One partly weathered specimen about 22 cm. in length in which the calyx and very early stages are missing. The corallite is cylindrical and straight except in the early stage where it curves slightly. The curvature is not in a plane with the cardinal septum, which lies at an angle of 45 degrees away from the longer side of curvature.

A transverse section in the middle ephebic stage shows a prominent dissepimentarium similar to that found in *Kakwiphyllum dux.* At a diameter of 65 mm. there are 84 long major septa present, most of which extend to the axis but do not join. The cardinal septum is slightly shortened and an inconspicuous narrow, shallow fossula is developed. The counter septum is also slightly shortened but inconspicuous. The overall radial symmetry is modified by an irregular bunching and shortening of the septa in 5 or 6 areas which are not symmetrical with the cardinal-counter plane. The septa are thickened in the tabularium and the thickening is slightly greater in the cardinal quadrants.

Remarks. This form differs from *Kakwiphyllum dux* in having more clearly indicated cardinal and counter septa, in the difference in the irregular bunching of the major septa, and in the greater thickness of the septa in the tabularium. A longitudinal section was not made. This specimen provides interesting stratigraphic and geographic information on the distribution of the genera *Kakwiphyllum.*

Material and Occurrence. One specimen, G.S.C. No. 10617, from Locality 411, 50 feet below top and 1,440 feet above base of Banff formation on Carrot Creek, near Banff, Alberta. The specimen occurs with a large phaceloid *Lithostrotionella* [*Thysanophyllum*] sp.

Family Syringaxonidae Hill, 1939

Diagnosis. Simple rugose corals with the axial ends of the major septa united at the aulos (stereotheca of Hudson, 1943, p. 361) which is generally tabulate; with inclined tabulae between the aulos and the outer wall; with most minor septa contratingent and without dissepiments. (Modified from Hill, 1939B, p. 141.)

Remarks. The genera included in this family have been discussed by Hill (1939B, p. 141) who stated that Grabau's (1928, p. 82) family Laccophyllidae is synonymous with this family but that "as *Laccophyllum* is in all probability synonymous with *Syringaxon* I have given the earlier name of the genus to the family". The family is also considered by Hudson (1945, p. 288) and Stumm (1949, p. 9).

Genus *Permia* Stuckenberg 1895

Type Species. P. iwanowi Stuckenberg, 1895, pp. 27 and 187, Pl. 3, figs. 6a-g. Lower limestones, Carboniferous, western slopes of Ural Mountains, Russia.

Diagnosis. Small, simple, conical corals in which most major septa are rhopaloid and join axially at, or to form, an aulos. The minor septa are short and generally contratingent. The outer tabulae slope downward from the edge of the aulos to the epitheca, and the inner tabulae, if present, are more or less horizontal. Dissepiments are lacking.

Remarks. Representatives of the genus *Permia* have not previously been described from North America. Hudson (1945, p. 291) reported a stratigraphic range for the genus in western Europe from Devonian to Lower Carboniferous. It has also been reported from the Lower Carboniferous in the Ural Mountains of Russia (Stuckenberg, 1895, p. 187) and from equivalent beds in north China (Grabau, 1928).

The genus *Crassiphyllum,* described by Grove (1935, p. 368) with *Zaphrentis declinis* Miller from the Mississippian of Indiana as the type species, is similar to *Permia* in having an irregularly developed aulos, but that genus is described as having marginal dissepiments in the early stages and no tabulae. No longitudinal section was figured and from the transverse section (Grove, 1935, Pl. 12, fig. 16) the structures could be interpreted as intersections of tabulae rather than as dissepiments.

As pointed out in his review of the genus *Permia,* Hudson (1944, p. 360) stated that this genus has an almost identical structure with the Silurian genus *Syringaxon* Lindstrom. Little is known of the relationship of the two genera, but they are probably homeomorphs as the aulos, the diagnostic feature of both genera, may occur towards the end of several lineages of small rugose corals.

Permia sp. A

Plate XVI, figures 1a-c

Description. A single small curved trochoid corallite with a length of 12 mm. (calyx lacking) and a diameter slightly below the base of the calyx of 7 mm. In the late neanic stage (diameter 4 mm.) there are 18 major septa which are rhopaloid and are joined axially by stereoplasm to form a solid axial column, similar to that found in the adult stages of the genus *Rotiphyllum* Hudson (1942). The outside diameter of the axial column is 2 mm. The cardinal septum is long and conspicuous and the septa tend towards a zaphrentoid arrangement. In the early ephebic stage (diameter 5.5 mm.; 20 major septa) the axial column remains solid and has an outside diameter of 3 mm. The septa remain much thickened, and tend to a radial arrangement. In the late ephebic stage, at a diameter of 7 mm., there are 22 radially arranged, straight, rhopaloid major septa which join axially to form an aulos in place of the earlier axial column. The cardinal septum is thinner and slightly longer than the other septa and it protrudes slightly into the aulos. The aulos has an internal diameter of less than 1 mm. and an external diameter of just over 3 mm. The contratingent minor septa, which are about 1 mm. in length, tend to be buried in lamellar tissue that forms a slight peripheral stereozone.

In the ephebic stage the tabulae outside the aulos are complete and evenly spaced, and slope towards the epitheca. No axial tabulae have been observed. Dissepiments are lacking.

Remarks. Permia sp. A has similarities with both *P. caverna* and *P. carbonaria* which were described by Hudson (1944, p. 360) from the middle Viséan of northern England. *P.* sp. A agrees with *P. caverna* in the general arrangement and appearance of the straight rhopaloid major septa and the presence of a solid axial column in the early stages, but differs from it in having a thin counter septum, a more prominent and thin cardinal septum, contratingent minor septa, a much smaller size and a larger number of septa for the diameter.

P. sp. A is similar to *P. carbonaria* in having contratingent minor septa. The difference in size is not great but *P. carbonaria* has a hollow aulos from a very early stage and has a less conspicuous cardinal septum. The specimen here described is believed to represent a new species.

As pointed out by Hudson (1945, p. 295) most species of *Permia* develop an aulos at a very early stage. Species such as *P. caverna* Hudson and *P.* sp. A are unusual in that the septa meet axially in the neanic and early ephebic stages and do not develop an aulos until later in the ephebic stage.

Material and Occurrence. One well preserved specimen, G.S.C. No. 10615, Locality 40, Section 11, unit 4, Liard River region. Middle? Mississippian.

Family CLISIOPHYLLIDAE

Diagnosis. Simple rugose corals with numerous septa, an axial structure, and incomplete conical tabulae; the septa are radially arranged, and are rarely curved about the small, open cardinal fossula, which is formed by an extension of the tabularium into the dissepimentarium; the major septa may be dilated in the tabularium, particularly in the cardinal quadrants; the minor septa may be degenerate. The axial structure normally consists of straight or curved septal lamellae, a columella, and an inner series of tabellae, though the columella may be absent (Hill, 1938, p. 53).

Remarks. The phylogenetic relations of small Carboniferous columellate zaphrentoid corals are not sufficiently known to establish a natural family classification. The family Lophophyllidiidae Moore and Jeffords (1945) was proposed for corals having a simple, solid columella developed as an extension of the counter septum and lacking dissepiments. The family Lophophyllidae Grabau (1928) is generally interpreted as including forms with a simple columella but with dissepiments present. The family Clisiophyllidae, as described above, includes corals with dissepiments and a well developed complex axial column.

The species described here under the genera *Ekvasophyllum* and *Dibunophyllum* are tentatively included in the Clisiophyllidae but they are not at all typical of this family. They differ in that axial lamellae and tabellae, where present, never form a regular series. These specimens illustrate, perhaps, the artificiality of the family classification as some specimens of *Ekvasophyllum* develop no dissepiments and have a simple columella, whereas others within the same species have dissepiments and an irregularly complex axial column. Such forms appear to be transitional between the families Lophophyllidae and Clisiophyllidae and thus the family boundaries cannot be rigidly interpreted.

Genus *Ekvasophyllum* Parks, 1951
emended Sutherland

Type Species. Ekvasophyllum inclinatum Parks, 1951, p. 175. Brazer formation, Mississippian of northern Utah.

Diagnosis. Solitary, slightly curved, trochoid corals with numerous septa tending towards radial symmetry except near the prominent cardinal fossula where they are pinnately arranged. The axial column is highly variable in shape and size; in some specimens it is slightly laterally compressed, solid and rod-like, in others it is kidney-shaped or irregular in outline and may contain a sparse development of axial lamellae and tabellae which never form regular series. The tabulae are incomplete and arch upward axially to join the column. Dissepiments are generally present.

Remarks. The genus *Ekvasophyllum* was proposed by Parks (1951, p. 175) for forms with a solid, slightly laterally compressed, rod-like columella and a well developed cardinal fossula with pinnately arranged septa adjoining it. A detailed study of a large number of small solitary corals of this general type from Western Canada showed that within a given species a great variation may exist in the size and shape of the central column and in the presence or absence of irregular axial tabellae or lamellae. In the forms studied there appears to be continuous variation between those with an apparently solid, laterally compressed, simple columella, similar to that described by Parks, and those with sparse development of tabellae and an irregular outline. Thus a generic division appears impossible between forms with and without axial tabellae. The diagnosis of the genus *Ekvasophyllum* is emended to include this variation. (*See Remarks* on holotype under *Ekvasophyllum* cf. *inclinatum* Parks.)

The genus *Ekvasophyllum* may closely resemble *Lophophyllum* Edwards and Haime but there is disagreement concerning the type species. The status and relationships of this and allied genera are discussed by Hill (1939A, p. 86) and Jeffords (1942, p. 201). A summary of the taxonomic difficulties concerning such genera, taken from the original references, follows.

Lophophyllum was proposed by Edwards and Haime, (1850, p. lxvi) and its type species *Lophophyllum konincki,* from the Lower Carboniferous of Tournai, Belgium was figured in 1851 (p. 349, Pl. III, figs. 4, 4a). The genus was described as resembling *Zaphrentis* but having a cruciform columella in continuity "with a small septum, placed in the middle of the septal fossula, and by the other end with the opposite primary septum".

The genus *Koninckophyllum* Thomson and Nicholson was proposed (1876A, p. 297) for forms having a simple columella, a wide zone of fine, concentrically arranged dissepiments, and septa that withdraw from the axis.

Carruthers (1913, p. 49) after a study of large coral collections from the Tournai district of Belgium, concluded that *L. konincki* was a synonym of *Cyathaxonia tortuosa* Michelin, described 4 years earlier from the same general area, even though the type specimens of both species were believed to be lost and were never sectioned (Carruthers, 1913, p. 49). His action was based on the conclusion that only two species that have a prominent column occur in the Tournai district. One of these species is *Cyathaxonia cornu* Michelin, and Carruthers stated that the other form agrees with the figures and descriptions of both *C. tortuosa* and *Lophophyllum konincki.* He therefore regarded his specimens as topotypes for the genus *Lophophyllum* under the name *Lophophyllum tortuosum* (Michelin). However, his specimens may not have been collected from the exact locality or horizon of the specimens described by Edwards and Haime. Carruthers' specimens are small and the septa, which become amplexoid, extend to a lath-like columella, which is said to be a direct continuation of the counter septum in the earlier growth stages. In the ephebic stage the columella is sometimes fringed with small projections or septal lamellae but no tabellae are developed. There are one or two narrow rows of dissepiments present in the later stages. A cardinal fossula is present but the septa are not deflected in its vicinity.

Carruthers (1913, p. 49) listed *Koninckophyllum* as a junior synonym of *Lophophyllum* as he believed *Koninckophyllum* had essentially the same generic characters as *Lophophyllum tortuosum* (p. 52).

Vaughan (1915, p. 39) stated that Carruthers did not "show that any stage of *C. tortuosa* Mich. resembles the figures of *L. konincki*" as given by Edwards and Haime. This contention is supported by a study of the original figures of *L. konincki* Edwards and Haime (1851, Pl. III, figs. 4, 4a) which show a small turbinate coral with a compressed elongated columella which is continuous with the cardinal as well as presumably the counter septa. However, Carruthers (1909, p. 152) stated that his material from the same region shows the original type specimen of *L. konincki* to be a young form of *L. tortuosum.*

Hill (1939A, p. 86) did not agree that *L. tortuosum* Carruthers is synonymous with *L. konincki* Edwards and Haime, and she asserted that it is not necessarily true, and cannot be proved, as Carruthers concluded, that there is only one species at Tournai answering the description of *L. konincki.* The type specimens of *L. konincki* Edwards and Haime, the type species of *Lophophyllum* had previously been considered lost (Carruthers, 1913, p. 49) but Hill stated (1939A, p. 86) that Stanley Smith, "after an examination of the specimens presumably studied by Edwards and Haime, thought it possible that specimen 3, on the card labelled *Lophophyllum konincki* in the Musee d'Histoire Naturelle, Paris, was Edwards and Haime's figured specimen. None of the specimens on this card shows dissepiments; they are trochoid, with deep calices, and the arrangement of the septa is as in *Zaphrentis,* but there is a columella. Smith concluded that *Lophophyllum konincki* Edwards and Haime was in all probability distinct from *Lophophyllum tortuosum* Carruthers *ceteris exclusis,* but that possibly it was synonymous with *Cyathaxonia konincki* Edwards and Haime and *Cyathaxonia tortuosa* Michelin, as specimens so labelled in the de Verneuil Collection in l'Ecole des Mines, Paris, are probably all the same coral." Hill did not believe that the type of the genus *Lophophyllum* could be established with certainty until these specimens in Paris had been sectioned and figured.

She regarded *Koninckophyllum* as a valid genus which she stated undoubtedly has the same structural characteristics as Carruthers' specimens referred to *L. tortuosum.*

In the same paper Hill (1939A, p. 86) gave a detailed re-description of the type species of *Koninckophyllum, K. magnificum* Thomson and Nicholson including a description of the lectotype. The following characters are noteworthy. The axial column is highly variable and may be dibunophylloid or clisiophylloid in neanic stages but generally becomes simple in the ephebic stage. However, the septal lamellae are rarely continuous from one tabulae to the next. The numerous small axial tabellae are also irregularly disposed and generally disappear with the increase in discontinuity of the lamellae. The septa are numerous, long, radially arranged; they are not pinnate near the obscure open cardinal fossula and are dilated in the tabularium. Minor septa are long and the dissepimentarium is over half the radius in width and consists of numerous fine, concentrically arranged dissepiments.

Jeffords (1942, p. 201) in a detailed taxonomic survey of the lophophyllid corals, accepted (p. 208) Carruthers' specimens of *L. tortuosum* as valid topotypes of *L. konincki* and recognized *Lophophyllum* as a valid genus.

Grabau (1928, p. 99) proposed the new genus *Lophophyllidium,* with the American species *Cyathaxonia prolifera* McChesney as type species. This species lacks dissepiments, but has a columella formed by axial thickening of the counter septum. Such forms were listed by most earlier workers under *Lophophyllum.*

The validity of *Lophophyllum, Koninckophyllum, Lophophyllidium* and perhaps *Ekvasophyllum* cannot be settled with certainty until the earlier mentioned possible type material of *Lophophyllum konincki* E. & H. in Paris has been sectioned and figured. However, until this is done, it seems justifiable tentatively to base an interpretation of *Lophophyllum* on Carruthers' specimens from Tournai. *Koninckophyllum* is therefore considered to be a junior synonym of *Lophophyllum* as Hill (1939A, p. 86) stated that this coral is undoubtedly congeneric with *Lophophyllum tortuosum* Carruthers (1913). This interpretation implies that there is continuous variation between forms with a narrow dissepimentarium and a simple columella as found in Carruthers' specimens and those with a wide dissepimental zone and an irregularly complex axial column as found in the type species of *Koninckophyllum.*

Ekvasophyllum is similar to *Lophophyllum,* as interpreted above, in that both genera have an axial column that may be irregularly complex but there are structural differences. In the former genus there is a tendency for the axial column to be irregular and massive in cross-section and septal lamellae and axial tabellae never develop a regular 'spider-web' even on top of a tabula. Such axial supporting plates, where present, are not confined to the earlier stages of the coral. Also, in *Ekvasophyllum* the major septa are pinnately arranged along an unusually prominent cardinal fossula.

In 1920 Dun and Benson (1920, p. 339) proposed the genus *Amygdalophyllum* with *A. etheridgei* n.sp., from the Lower Carboniferous of Australia, as type species. Further discussions on the type species are given by Benson and Smith (1923, p. 161). This is a turbinate to trochoid species that was described as having numerous, long radially arranged major septa, which extend to the axis and touch a thick elliptical solid columella. There is no trace of a cardinal fossula and minor septa are three-quarters of the radius in length with a correspondingly wide dissepimentarium. Also, in the late ephebic stage the outer ends of the septa tend to die out in the dissepimental zone without reaching the epitheca. These features clearly separate the genus *Amygdalophyllum* from the species described in this paper under *Ekvasophyllum*.

Ekvasophyllum is similar to the genus *Cyathoclisia* Dingwall (1926, p. 12) in the curvature of the septa about the cardinal fossula but in that genus, which has a dibunophylloid axial column and which is closely related to *Dibunophyllum*, the septal lamellae are equal in number to, and continuous with, the septal ends.

Ekvasophyllum cf. *inclinatum* Parks

Plate XX, figures 1a-e, 2a-h

Ekvasophyllum inclinatum Parks, 1951, p. 175, Pl. 29, figs. 1, 3.
? *Lophophyllum* ? *cascadense* Warren 1927, p. 44, Pl. 3, fig. 1.

Diagnosis. "Medium sized corals, with 42 to 46 major septa in ephebic stage, some of which reach to axis, minor septa of one-fourth radius-length; dissepiments present; slightly laterally compressed columella; tabulae slightly inclined upward toward axis, and join columella at a large angle." (*After* Parks, 1951, p. 175.)

Remarks on Holotype. The author is indebted to Dr. James M. Parks, Jr., for discussions on the taxonomic status of the genus *Ekvasophyllum* and for the loan of thin sections of unfigured paratype material; and to the U. S. National Museum for the loan of Parks' figured type specimens which are two in number (*see* Parks, 1951, Pl. 29, figs. 1a, b, holotype; and fig. 3, paratype).

There is one transverse section of the holotype and it is in the late ephebic stage and one longitudinal section in the ephebic stage. The early stages are missing. The transverse section is too thick to show the detailed structure of the columella but it appears to be simple and solid and is laterally compressed. The axial ends of most of the major septa touch the columella but in some cases no distinct boundary can be seen between the septal ends and the columella. In longitudinal section the fibrous thickening on the upper surface of the tabulae can be seen to be continuous with the thickened vertical layers of the columella. A similar structure is shown in a Canadian specimen (Pl. XX, fig. 2h).

The holotype is partly recrystallized but the septal structure can be clearly seen in numerous places. The septa consist of very fine fibre fascicles arranged at right angles to the plane of the septa and not grouped into trabeculae.

Description of Canadian Specimens. The corals included here are small to medium in size, are slightly curved, and have a trochoid shape. They are only feebly annulated by rugae and faint interseptal ridges. The columella protrudes as a spike into the deep calyx.

In the ephebic stage there are 42 to 43 long major septa at a diameter of 18 mm., which tend to have a radial symmetry except near the cardinal fossula, where they tend to a pinnate arrangement. Most of the septa reach the axis. The minor septa have a length of about one-fourth to one-fifth the radius. The dissepimental zone is correspondingly wide, and the dissepiments are small and concentrically arranged. The cardinal fossula is prominent and is open in the late ephebic stage. In the two specimens sectioned the columella is apparently solid and is spindle-shaped in cross-section and elongated along the cardinal-counter plane. It contains layers of fibrous tissue in which the fibres are at right angles to a central median lamella. No axial tabellae or lamellae have been observed. The tabulae are incomplete and are moderately to steeply inclined upward towards the axis where they join the columella. The fibrous thickening of the upper surfaces of the tabulae is continuous with the fibrous layers of the columella. This feature is clearly shown in a longitudinal section at right angles to the plane of the columella (*see* Pl. XX, fig. 2h). The early development of the columella is unknown. Dissepiments are present in the ephebic stage and are small and steeply inclined.

Septal Structure. The septa in the Canadian specimens are composed of fibre fascicles not grouped into trabeculae, and arranged at right angles to the plane of the septa.

Remarks. The Canadian specimens here described differ from *Ekvasophyllum inclinatum* Parks in having much more steeply inclined tabulae and in the fact that more of the major septa reach the axis.

Ekvasophyllum inclinatum is probably conspecific with *Lophophyllum? cascadense* Warren (1927, p. 44, Pl. III, fig. 1) which is from "the upper beds of the Rundle limestone in the Rundle-Cascade range". The writer has examined Warren's specimens, which are in the Geological Survey collections. They consist of three incomplete specimens labelled cotypes, #8910, 8910a and 8910b. None of these has been thin-sectioned but Warren's single diagrammatic drawing of a transverse section (1927, Pl. III, fig. 1) was taken from the polished surface of the most complete specimen #8910 which is here chosen the lectotype. When this specimen is eventually thin-sectioned and its detailed characters become better known it is possible that *L.? cascadense* Warren will prove to be a senior synonym of *E. inclinatum*.

The relations of the specimens described here with *Ekvasophyllum proteus* n.sp. are discussed under that species. The thickened tabulae are continuous with the fibrous layers of the central column in both species. The specimens compared here with *E. inclinatum* Parks occur at a slightly higher horizon than that in which *E. proteus* has been found in the Liard River region.

Material and Occurrence. One well preserved specimen each from Localities 29 and 40, Liard River region, upper part and at top of unit 4, Section 11. Middle? Mississippian.

Ekvasophyllum proteus n.sp.

Plate XXI, figures 1a-o, 2a-e; Plate XXII, figures 1a-h, 2a-f;
Plate XXIII, figures 1a-k, 2a-f; Plate XXIV, figures 1a-j, 2a-c, 3;
Plate XXV, figures 1a-m, 2a-h, 3a-c; XXVI, figures 1a-i, 2, 3

Diagnosis. Small corals with 38 to 42 long major septa in the ephebic stage, most of which bunch at their inner ends and reach the axis. Those near the prominent cardinal fossula generally have a pinnate arrangement. Minor septa are short. A variable axial column is present which may be lath-like, kidney-shaped or irregular in section, and which originates from the joining of the major septa at the axis. It is simple or contains sparse tabellae. A narrow ring of dissepiments is commonly present in the ephebic stage. The cardinal septum is located on the convex side of the corallite.

Description. Small, simple, trochoid, slightly curved corals which have an almost smooth exterior except for faint inter-septal ridges and occasional low rounded transverse restrictions. The corallite varies in length from 2.5 to 3.5 cm. and the diameter of the calyx varies from 12 to 15 mm. The axial column generally protrudes as a pronounced knob or spike in the floor of the calyx which is commonly crushed. Rarely, the axial column disappears in the late ephebic stage (Pl. XXI, fig. 2a; Pl. XXV, fig. 2a).

In the ephebic stage there are 36 to 42 long major septa, at a diameter of 12 to 16 mm. which tend to have a pinnate arrangement near the prominent cardinal fossula. In other areas they have a radial symmetry. Some extend to the axis separately, but most join together in irregular flabellate bunches from which one septum continues to the axis as a single structure. They may be slightly amplexoid and withdraw from the area in the late ephebic stage. The major septa are strongly dilated in the early stages but tend to become attenuated in the adult; a few may be irregularly rhopaloid. Minor septa are present but short. The prominent cardinal fossula, located on the convex side of the corallite, extends to, or almost to, the axis and is open or closed. It is marked by a depression in the tabulae. A narrow ring of small concentrically arranged dissepiments is present in the ephebic stage but they apparently do not form at a specific time in the ontogeny, for in some specimens they are not observed until the late ephebic stage. Thus in immature specimens no dissepiments will be seen. They are introduced much later than the insertion of the minor septa. The tabulae are incomplete and moderately to steeply inclined upward, but turn up abruptly to join the central column. Thickened fibrous layers on the upper surface of some tabulae are continuous with the vertical fibrous layers of the axial column (Pl. XXI, fig. 1o).

A central column is present and varies greatly in size and character. It is generally simple but may contain irregular tabellae and rarely includes lamellae (*see* Structure of the central column *below*).

Ontogeny. The early stages of *Ekvasophyllum proteus* are similar in all specimens studied, despite the wide variation of some features in the adult. The early neanic growth stage, seen at a diameter of about one millimetre, where there are seven major septa (Pl. XXI, figs. 1f, 1l; Pl. XXV, fig. 1i) is the earliest stage observed. The septal grouping at this stage differs from the standard early zaphrentoid pattern in that there is no cardinal septum, although presumably one was present at the initiation of growth. The septa present include the counter, two counter laterals and two long alar septa, all in contact, and there are two additional septa present in the cardinal quadrants. All septa are strongly dilated.

In the middle neanic stage (diameter 2.5 to 3.5 mm., 14 to 16 major septa) the counter, alar and some of the other septa meet at the axis, but there is no indication of a central column (Pl. XXI, figs. 1e, 1k ; Pl. XXIII, fig. 1j). The septa are greatly dilated and there is an acceleration in the insertion of the septa in the counter quadrants.

In the late neanic stage at a diameter of 3.8 to 4.5 mm. (18 to 20 major septa) there is no indication of a central column, but very short minor septa are present and a short cardinal septum can be observed (Pl. XXI, figs. 1d, 1j; Pl. XXV, fig. 1g).

In the early ephebic stage (5 to 5.5 mm., 22 to 24 major septa) a central column can be seen for the first time and may show a distinct outline with the septal ends touching, but not continuous with it. The central column at this stage appears to be simple in all specimens observed (*see* Pl. XXI, fig. 1c; Pl. XXV, fig. 1f). Somewhat later (diameter 6.5 to 7.5 mm., 28 to 30 major septa) the characters of the adult, as described earlier, become marked. The cardinal fossula remains prominent, but the septa are still dilated, although they tend to become attenuated in the middle and late ephebic stages. A narrow ring of dissepiments generally appears in the middle or late ephebic stage. The dissepimentarium is never wide. In some specimens the septa are thin in the dissepimentarium and dilated in the tabularium, but this is not a constant feature.

Structure of the Central Column. There is a wide variation in the shape and size of the central column in different individuals of this species. However, it is possible to recognize three general types in the adult stages which on cursory examination would appear to be distinct. However, it can be demonstrated that there is gradation between them from specimen to specimen and in some cases even within the development of a single individual. The three types are (1) those with the axial column elongated along the cardinal-counter line, (2) those with a circular or kidney-shaped outline, and (3) those with an indistinct circular or irregular outline.

When the central column is elongated, in cross-section, along the cardinal-counter line, it tends to have a lath or cuspidate shape and consists of a medial lamella flanked by layers of fibrous tissue in which the fibres radiate at right angles to the medial lamella. The outline may become irregular or kidney shaped at some stage in its development (Pl. XXIII, figs. 2a, 2b). It commonly appears to be simple but some specimens contain irregular internal lamellae (*see* Pl. XXVI, figs. 1e, 1f). Those with a kidney shape and a definite outline also contain a central lamella, but this branches irregularly. Each of the several spider-like lines or segments appears to correspond with one of the flabellate bunches of the septa (Pl. XXII, fig. 1e). In specimens where the column is irregular in section there is commonly no definite boundary between it and the ends of the septa. A branching central lamella, similar to that just described, is present in some specimens whereas in others it shows only irregular radiating fibrous tissue (Pl. XXIII, fig. 1k).

An inspection of the ephebic stages of those forms in the first group suggests that the central column originates as an extension of the counter septum. However, as is shown in the discussion on ontogeny, the central column in all of the above groups originates by a joining of several of the septa, with the counter and two alar septa as the main constituents. But the flabellate bunching of the septa is often not symmetrical. Those of only one cardinal quadrant may be continuous with the axial column (Pl. XXIV, fig. 3).

The tabulae play an important part in the construction of the central column. They turn up abruptly and join the column at a very low angle. The fibrous thickening on their upper surfaces is continuous with the irregular fibrous layers of the column. This is particularly well shown in the longitudinal section, Pl. XXIII, fig. 2f. In some specimens there are irregular internal spaces in the axial column which appear to originate as irregular gaps between the successive fibrous layers (Pl. XXVI, fig. 1f).

Septal Structure. Ekvasophyllum proteus n.sp. has a fibro-lamellar skeleton and the septa are composed of fibre fascicles arranged perpendicularly to the septal plane, and not grouped into trabeculae (Pl. XXV, fig. 1k).

Remarks. Ekvasophyllum proteus differs from *E. inclinatum* Parks (1951, p. 175) in the greater variability and, at times, complexity of the central column. It is a much smaller species and there is a correspondingly smaller number of septa. The minor septa are shorter and there is a narrower zone of dissepiments. The Canadian specimens that were compared earlier with *E. inclinatum* occur at a slightly higher horizon in the Liard River region than that in which *E. proteus* is found.

On first inspection, it would appear that more than one species is included in the above description of *Ekvasophyllum proteus.* The number of major septa in a given diameter is remarkably constant in all specimens studied, but the central column varies with each individual. It is impossible to subdivide the species satisfactorily on the basis of the central column as the variations are not consistent. Furthermore, the early stages are similar in all specimens studied. An arbitrary division into two or three species or varieties would have little use as most of the forms occur in the same horizon.

Material and Occurrence. About 45 specimens from Locality 28, 4 specimens from Locality 37, and single specimens from several other localities, all in middle part of unit 4, Section 11, Liard River region. Middle? Mississippian.

Ekvasophyllum enclinotabulatum n.sp.

Plate XXVII, figures 1a-i, 2a-e, 3, 4a-b;
Plate XXVIII, figures 1a-h, 2a-d

Diagnosis. Small trochoid, almost straight to slightly curved corals with 36 to 40 long major septa most of which reach the axis. Minor septa are very short and dissepiments are absent or are sparsely developed in the late ephebic stage. The prominent axial column may be simple or may contain occasional tabellae. The tabulae are gently inclined upward towards the axis where they join the axial column.

Description. This species includes small, simple, almost straight to slightly curved corals in which the cardinal fossula is located on the convex side of the corallite. The detail of the surface ornamentation is not clearly shown in the specimens studied as the epitheca is partly or completely missing. The average length is 20 to 30 mm. and the diameter of the calyx is 12 to 15 mm.

There are 36 to 40 major septa in the ephebic stage. They tend to have a pinnate arrangement near the cardinal fossula and a radial arrangement elsewhere, though there is a tendency for the septal ends to join in irregular groups before reaching the axis. They are dilated at all stages of growth. Minor septa are short. The cardinal fossula is prominent but narrow and extends to the axis.

A prominent axial column is present. It develops very early in the ontogeny of the coral. The early and middle neanic stages are unknown but in the late neanic stage (diameter 4 mm., 20 major septa) a well developed simple columella can be seen (Pl. XXVII, figs. 2c, 2d; Pl. XXVIII, figs. 1c, 1d). It appears to originate from a joining of various septal ends including the counter septum but these early features cannot be seen clearly because the dilated septa are so closely set. In later growth stages the axial column is typically spindle-shaped or kidney-shaped in outline and elongated along or at an angle to the cardinal-counter plane or it may occasionally be irregular in outline. It may be simple or it may contain irregular, vertically disposed tabellae (Pl. XXVII, fig. 1h) which may not be present at all stages of growth in a single individual (Pl. XXVII, figs. 1a, 1g). The axial column generally consists of fibre fascicles arranged perpendicularly to the sometimes irregular plane of elongation which is marked by a median lamella (Pl. XXVII, fig. 1g). A single transverse section will not give a true picture of the nature of the axial column.

The tabulae are flat lying or moderately inclined upward to the axis where they turn up slightly or steeply to join with the axial column. The fibrous thickening on the upper surface of the tabulae is continuous with the fibrous layers of the axial column. The tabellae, when present, are almost vertically inclined, irregular, and do not form a continuous series. What appear to be internal tabellae probably result from the incorporation in the central column of vertically disposed axial parts of ordinary tabulae by the deposition of fibrous tissue. Dissepiments are absent, or developed sparsely, in the late ephebic stage.

Septal Structure. Ekvasophyllum enclinotabulatum n.sp. has a fibro-lamellar skeleton and the septa are composed of fibre fascicles arranged perpendicularly to the septal plane and not grouped into trabeculae (Pl. XXVII, fig. 1i).

Remarks. The corals described here were transported or possibly redeposited before deposition. The epitheca, early tip, and calyx, of most specimens are missing and they have a water-worn appearance. It is thus impossible to be certain that dissepiments are absent in some specimens.

This coral is a member of the same species group as *Ekvasophyllum proteus* n.sp. but differs from that form in being of smaller size, in having fewer or no dissepiments, and more flat-lying tabulae. The central column in the two species is similar, though in *E. enclinotabulatum* n.sp. it is more regular in shape and originates as a distinct unit at an earlier growth stage.

E. proteus is believed to be a morphologically more advanced form than *E. enclinotabulatum* because of the better developed dissepimentarium and the larger size with a correspondingly greater number of septa. On similar basis *E. inclinatum* Parks would be morphologically more advanced than *E. proteus*. The stratigraphic ranges of these species in the North American Cordillera are not as yet known. The fact that the known occurrences of *E.* cf. *inclinatum* in the Liard River area are at slightly higher horizons than those where *E. proteus* has been found would support the possibility that the degree of morphological advancement may also have stratigraphic significance. But the individual ranges of the species involved must be more clearly defined by further collecting before any conclusions can be drawn.

Material and Occurrence. Twenty specimens, of which 12 have been sectioned, from Locality 82; about 100 feet below top of Member B, Prophet formation, Section 7, Halfway River region. Middle Mississippian. Holotype, G.S.C. No. 10636.

Ekvasophyllum? harkeri n.sp.

Plate XXVIII, figures 3a-c; Plate XXIX, figures 1a-h, 2a-d

Diagnosis. Solitary, small trochoid corals with a narrow cardinal fossula located on the convex side of the corallite. There are 36 to 40 septa present in the adult which tends to have a radial symmetry. Minor septa are short and a narrow zone of dissepiments is developed in the late ephebic stage. The complex open axial column contains large irregularly disposed tabellae and occasional septal lamellae.

Description. Small, simple, slightly curved, trochoid corals in which the cardinal fossula is located on the convex side of the corallite. The details of surface ornamentation are mostly obliterated. The length of the holotype is 20 mm. but at least 4 mm. of the early tip is missing. The diameter of the calyx is 16 mm.

There are 38 long major septa present in the adult stage of the type specimen. They are long and have a radial symmetry that is slightly modified by a pinnate arrangement near the cardinal fossula and there is a slight tendency to flabellate bunching of the axial ends of the septa. Minor septa are short. A prominent axial column is present which appears to be simple in the early stages (Pl. XXIX, fig. 1f). It becomes complex in the ephebic stages where it consists of a median lamella, which may or may not be elongated along the cardinal-counter plane, reinforced by a series of widely spaced, large and irregularly disposed axial tabellae. These are commonly incorporated with the central lamella by the deposition of fibrous or lamellar tissue (Pl. XXIX, fig. 1e). A small number of irregularly disposed septal lamellae are generally present but this is an inconstant feature within a single individual.

The tabulae are incomplete and are moderately inclined upward to the axis and may be continuous with fibrous layers of the axial column. The axial tabellae are almost vertical and are irregular in arrangement and size. The dissepiments are steeply inclined and form one or two narrow peripheral series in the late ephebic stage only (Pl. XXIX, fig. 1g).

Septal Structure. The septa are composed of fibre fascicles, not grouped into trabeculae, which are arranged at right angles to the plane of the septa (Pl. XXIX, fig. 1f).

Remarks. Ekvasophyllum? harkeri n.sp. differs from *E. enclinotabulatum* n.sp. and *E. proteus* n.sp. in the better development of axial tabellae and lamellae resulting in a more complex axial column. However, these axial plates are inconsistently developed and never form a regular series. Also in *E.? harkeri* the cardinal fossula is less conspicuous and the major septa tend more to a radial symmetry although there is still some tendency for the axial ends of the septa to gather in flabellate bunches.

All the species discussed here are highly variable and there is probably continuous variation between them. *E. proteus* and *E. enclinotabulatum* include forms that have essentially simple axial columns but with the occasional presence of axial tabellae and lamellae. However, *E.? harkeri* is characterized by a more highly developed complex axial column but which does not develop regular series of axial tabellae and lamellae.

Without a knowledge of intermediate forms such as *E. proteus* and *E. enclinotabulatum, E.? harkeri* with its irregularly complex axial column and *E. inclinatum* Parks, the type species, which has a simple axial column, would not appear to be congeneric. It is possible that further study will show that *E.? harkeri* should be placed in a separate genus.

Ekvasophyllum? harkeri differs from typical species of *Dibunophyllum* in the sparse development of axial tabellae and lamellae which are irregularly disposed and never form a regular series. Furthermore, dissepiments are only slightly developed, the cardinal fossula is well marked, and the species is small in size and has a trochoid shape instead of a cylindrical one (*see Remarks* under *Dibunophyllum*).

Material and Occurrence. Three specimens including the holotype, G.S.C. No. 10643, from Locality 82; about 100 feet below top of Member B, Prophet formation, Section 7, Halfway River region. Middle Mississippian.

Genus *Dibunophyllum* Nicholson and Thomson, 1876

Type Species. Dibunophyllum muirheadi Thomson and Nicholson (1876A, p. 462).

Diagnosis. Large, simple rugose corals, whose variable axial structure is typically one-third as wide as the corallite, and consists of a long median plate, a few (usually four to eight) septal lamellae on either side, directed to the axis, and numerous tabellae, sloping steeply down at its periphery. Minor septa are degenerate; the width of the dissepimentarium is about two-thirds the length of the major septa, which is two-thirds the radius of the corallite. The tabulae are incomplete and the tabellae are of two series, the plates of the outer being fewer and less steeply inclined than those of the inner series. The septa are not curved about the small fossula. (*After* Hill, 1938, p. 67.)

Remarks. The relations of the genus *Dibunophyllum* have been discussed by Hill (1938, p. 66), Moore and Jeffords (1945, p. 153) and others. Hill pointed out that at least six different generic names have been proposed for forms that fit the above diagnosis. Of these, three were proposed earlier than *Dibunophyllum.* According to the International Rules of Zoological Nomenclature, the earliest of these, *Rhodophyllum* Thomson (1874, p. 556) should be used. However, Hill proposed that as the name *Dibunophyllum* is so well known, it should be retained despite the Rules of Nomenclature. This is surely a case that could justifiably be placed before the Commission with a formal request to abrogate the Rules. Moore and Jeffords (1945, p. 153) suggested that the genera *Rhodophyllum* and *Dibunophyllum* are distinct genera and should each be recognized as valid.

The two forms described below are represented by limited material, but they are tentatively referred to the genus *Dibunophyllum* because of the presence of an open axial column which has fairly well developed septal lamellae. However, these forms are much simpler in structure and are believed to represent a genus distinct from *Dibunophyllum* and one that has originated from a zaphrentoid ancestor. They differ from typical species of *Dibunophyllum* in the relatively small size of the axial column, the poor and inconsistent development of axial tabellae, the slight development of dissepiments that form only a narrow peripheral ring in the ephebic stage, and the presence of a prominent cardinal fossula.

These species differ from *E.? harkeri* only in the greater regularity of development of the open axial column, particularly in the prominence of axial lamellae. They all have a zaphrentoid arrangement of the septa, prominent cardinal fossula, small size, trochoid shape and narrow peripheral zone of dissepiments. When additional material can be obtained for study, it is believed that these three species will be shown to represent a new genus morphologically delineable from both *Ekvasophyllum* on the one hand and *Dibunophyllum* on the other.

Dibunophyllum? sp. A

Plate XXX, figures 1a-e

Description. One medium sized almost straight trochoid specimen about 4.5 cm. in length is available, but the surface ornamentation is obliterated. The cardinal fossula is prominent and extends to the axis at all stages of growth. In the ephebic stage there are 42 to 44 major septa at a diameter of 20 mm. They are long and radially arranged, but have a slight pinnate arrangement along the cardinal fossula. The axial ends of the septa tend to twist around the centre before joining the axial column which is not solid and consists of an irregular median lamella with about four short septal lamellae on each side and a few widely spaced axial tabellae. Some of them are continuous with the septal ends. In the late neanic stage (diameter 7 mm., 36 major septa, not figured) the axial column is spindle-shaped and appears to be solid. The septa have a zaphrentoid arrangement and join in bunches axially before touching the column. In the early ephebic stage (diameter 10 mm., 30 major septa, Pl. XXX, fig. 1d) the axial column is very small, open and inconspicuous consisting of a median lamella and several irregularly disposed septal lamellae on each side. The axial ends of the septa continue to join in flabellate bunches and have a pinnate arrangement along the fossula. In all later stages the axial column is open (Pl. XXX, fig. 1e) but remains inconspicuous and increases only slightly in size. In the late ephebic stage the width of the central column is about 2 mm., or about one-tenth the width of the coral. In this late stage the spaces between the septal lamellae are filled with porous granular tissue of unknown origin (Pl. XXX, fig. 1a). Minor septa are rarely more than 1 mm. long. The dissepimentarium is correspondingly narrow and consists of a row of small concentrically arranged dissepiments which develop only in the late ephebic stage. No longitudinal section is available.

Remarks. The specimen differs from a typical *Dibunophyllum* in the small size of the central column, the poor development of axial tabellae and the prominence of the cardinal fossula. It differs from *Ekvasophyllum harkeri* n.sp. in the presence of well developed septal lamellae and the greater regularity of the axial column.

Material and Occurrence. One specimen from Locality 82, about 100 feet below top of Member B, Prophet formation, Section 7, Halfway River region;

one unfigured specimen from Locality 26, Member B, Prophet formation, Prophet River region. Middle Mississippian.

Dibunophyllum? sp. B

Plate XXX, figures 2a-f

Description. One well preserved specimen about 30 mm. in length on which the surface of the epitheca shows fine interseptal ridges and faint transverse markings. In the late neanic stages (28 to 30 major septa, diameter 17 to 18 mm.; Pl. XXX, figs. 2e, 2d) the axial column is small, solid and oval in cross-section elongated along the cardinal-counter plane. The septa are pinnately arranged along the cardinal fossula and gather in bunches before reaching the axial column. In the ephebic stage the axial column is not solid and consists of a straight median lamella with 4 or 5 septal lamellae on each side and widely spaced axial lamellae. These features do not develop clearly until the later ephebic stage (38 major septa, diameter 31 mm., Pl. XXX, fig. 2a) in which the major septa are straight and radially arranged. The cardinal fossula is well developed at all stages. Minor septa are short and the dissepiments, present only in the ephebic stage, form a narrow peripheral zone.

In longitudinal section (Pl. XXX, fig. 2f) the tabulae can be seen to be incomplete and slope moderately upward to the axis. Tabellae appear only in the late ephebic stage. The dissepiments are small to medium in size and are steeply inclined.

Remarks. The late neanic growth stage of *Dibunophyllum*? sp. B. (Pl. XXX, figs. 2d, e) in which there is a small simple rod-like columella, pinnately arranged septa along a prominent cardinal fossula and a bunching of the axial ends of the septa, shows a striking resemblance to the ephebic stage of some specimens of *Ekvasophyllum proteus* n.sp. which occur at the same locality. It is believed that *D.* sp. B represents a late development of a trend affecting *E. proteus* in which a simple solid columella gives rise to an open axial column through the appearance of axial tabellae and lamellae.

The species is related to *Dibunophyllum?* sp. A but differs in having straight major septa and a more regular axial column. It differs from typical species of *Dibunophyllum* in the smallness of the size of the axial column in relation to the diameter of the specimen, in the zaphrentoid arrangement of the septa and in the prominence of the cardinal fossula.

Material and Occurrence. One well preserved specimen from Locality 28, middle part of unit 4, Section 11, Liard River region. Middle? Mississippian.

Family Halliidae Chapman

Diagnosis. Solitary corals in which the septa are dilated in the tabularium, and thin in the dissepimentarium, where this is developed. The cardinal fossula is prominent, against which septa in the cardinal quadrants are pinnately directed. In some forms the cardinal septum is elongated and may give rise to a columella.

Remarks. The Carboniferous specimens here described are not typical of the family Halliidae, which has a known geological range from Silurian to

Devonian. They are tentatively referred here because of the prominent development of the cardinal septum. Such a feature is not found in all members of the family Halliidae but is known in such forms as the Silurian genus ***Pycnactis*** Ryder and the Devonian genus *Hallia* Edwards and Haime.

Genus and species undetermined — A

Plate XXXI, figures 1a-f

Description. The specimen consists of a single small trochoid coral with an almost smooth epitheca and major septa that are long and extend to the axial region throughout growth. There are 20 to 22 major septa present in the early ephebic stage at a diameter of 6.5 mm., 24 at a diameter of 9 mm., and 26 at a diameter of 10 mm. The septa have a zaphrentoid arrangement. A rounded simple columella is present and is attached to the elongated cardinal septum throughout growth. In the early ephebic stage the septa are greatly thickened and the septal ends tend to be fused to the columella by lamellar tissue but are not, except for the cardinal septum, continuous with it. There is an irregular radiation of 4 to 5 fine dark lines within the columella the more prominent of which lies in the direction of the cardinal septum. Not one of these faint lines extends in the direction of the counter septum. In the late ephebic stage the septa are long but do not touch the columella. Minor septa are lacking and no dissepiments are present. The nature of the tabulae is not fully known. The tabulae appear in transverse section to be widely spaced and inclined upward axially to meet the columella.

Septal Structure. The septa are composed of lamellar tissue.

Remarks. Few small solitary columellate Carboniferous corals have been reported in which the columella is associated with the cardinal septum. The type species of ***Lophophyllum, L. konincki,*** was described by Edwards and Haime (1851B) as having a columella continuous with the cardinal septum. However, the type specimens may be lost and the species is generally interpreted on possible topotype material described by Carruthers (1913, p. 49) which lack this structure (*see Remarks* under the genus *Ekvasophyllum*). It is believed that the Canadian specimen here described represents a new genus but it is not given a new name until further material is available for study.

Material and Occurrence. One specimen, from Locality 28, Section 11, unit 4, Liard River region. Middle? Mississippian.

Genus and species undetermined — B

Plate XXXI, figures 2a, b

Description. A fragment about 22 mm. in length of an almost straight solitary coral of which the tip and part of the calyx are missing. The original length was probably 30 mm. The epitheca was removed before deposition exposing the septal ends.

In the late ephebic stage there are 38 to 40 thick major septa most of which extend almost to the axis but do not join. They tend to be slightly curved, twisted and dilated but are not rhopaloid and have pointed axial ends. The cardinal septum is generally prominent and extends to the axis throughout growth. It is more dilated than the other septa but does not form a columella. The zaphrentoid arrangement of the septa is apparent but no cardinal fossula or alar pseudofossulae are developed. The counter septum is slightly shortened throughout growth. Minor septa are short except for those on each side of the counter septum which are long. Dissepiments are apparently lacking. There are 32 to 33 major septa in the early ephebic stage at a diameter of 11 mm. and the above-described characters are already clearly marked.

Septal Structure. The septa are partly recrystallized, but they appear to be composed entirely of lamellar tissue.

Remarks. The specimen here figured does not fit the description of any described species. The prominence of the cardinal septum with a corresponding absence of a cardinal fossula are distinctive features.

Material and Occurrence. One specimen from Locality 370, Section 3A, unit 13, upper Banff formation, Kakwa-Jarvis Lakes area.

Family Lithostrotionidae (Grabau, 1927) Chi, 1931

Diagnosis. Phaceloid and cerioid corals that typically have a simple columella though it may be discontinuous or absent. Major and minor septa may or may not be continuous in the dissepimentarium and tabulae are present. Diphymorphs are common.

Remarks. The diagnosis of the family Lithostrotionidae was first published by Chi in 1931 (p. 25) who stated that it had been proposed by Grabau in 1927 in a printed but unpublished Syllabus in Palæontology, National University of Peking.

Hill (1940, p. 164) interpreted the family as including only forms in which the major and minor septa are continuous in the dissepimentarium. However, at least some species of *Lithostrotionella* and *Thysanophyllum,* both of which have a lonsdaleoid dissepimentarium, seem to be justifiably included in this family. These species are shown in the discussion on *Lithostrotion* to be actual genomorphs of *Lithostrotion.*

Colonial corals of the *Lithostrotion* type are relatively rare in the Mississippian formations of the northern Rocky Mountains and the Liard Range. This is in contrast to the abundance of such forms in the upper Rundle formation in southwestern Alberta (*see* Chapter II).

Trends and the Genomorph Concept. The concept of trends in corals was proposed by Lang (1923, 1938) to assist in explaining the fact that a given structure in any rugose coral group was likely, because of some unknown stimulus, to develop in one, or a few, definite directions. This is a case of observation, not speculation, for particular trends of development have been observed in several different coral groups and one may expect to find others evolving along the same lines. Thus, "a trend is the expression of that quality in virtue of which organisms of different lineages follow similar lines of evolution during their ontogeny or phylogeny" (Lang, 1938, p. 149). Colonial corals of the *Lithostrotion* type are particularly important in the study of trends because of the plastic nature of their structures and the fact that evolutionary changes took place very rapidly often resulting in marked development of a trend even within a single corallum. Forms which have thus been affected and which show the resulting variations within an individual corallum have been termed genomorphs by Smith and Lang (1930, p. 179).

Thus, if one species, as seen in a single corallum, contains two or more morphologic stages of development each of which has the characters of a different genus of the standard classification, then these orthodox genera as previously understood are seen to "cut across the lineages, and embrace those terms of the different lineages which have reached the same stage of evolution; or in other words, the genera are structural grades rather than systematic categories" (Lang, 1938, p. 153).

The genomorph concept forms the most reasonable basis which has thus far been proposed for studying the marked variations which have been noted in *Lithostrotion* and allied 'genera'. McLaren and Sutherland (1949) have discussed in detail the implications of this concept as a result of their study of the genomorphic form *Lithostrotion* [*Lithostrotionella*] [*Thysanophyllum*] *mclareni* n.sp., from the Prophet formation, which is described below. In this case a single corallum contains corallites with structures that were previously thought to be typical of three different genera. Although such a wide variation had not previously been noted within one corallum, it is in reality only an extreme example of what has been recognized to a lesser degree in numerous species of this group from all parts of the world. It is believed that many apparently related species are polyphyletic forms which, having been affected by the same trends, have separately reached the same stage of development.

Evidence of several trends may be found in a single species or individual colony, but it is more common for only one or two to be pronounced at any given time. Two of the most important trends that have affected the lithostrotion structure (Hill, 1934, p. 83) are (1) the lonsdaleoid trend in which the septa withdraw from the epitheca, and (2) the diphyphylloid trend in which the columella becomes discontinuous or absent, the septa shortened and the tabulae become flattened. Thus, various species of *Lithostrotion* may give rise to species of the genus *Lithostrotionella* if they have been affected by a lonsdaleoid trend and to species of *Diphyphyllum* if the diphyphylloid trend is in evidence. In the latter case, Smith and Lang (1930, p. 180) have shown several species of *Diphyphyllum* to be genomorphs of *Lithostrotion*. In turn, a lonsdaleoid trend acting on *Diphyphyllum* would lead to a species of *Thysanophyllum* (ibid., p. 184). But a diphyphylloid trend acting on *Lithostrotionella* would also result in a structure similar to the genus *Thysanophyllum*, as is the case in the coral just mentioned from the Prophet formation.

In contrast, some species having a *Thysanophyllum* structure are closely related to the genus *Lonsdaleia* McCoy which has a compound axial column and a lonsdaleoid dissepimentarium. Smith (1916, p. 235) has suggested that *Lonsdaleia* may have developed phylogenetically from *Thysanophyllum* but Hill (1940, p. 151) suggests that there was an equal possibility that the reverse could have occurred at least in some species.

Dobrolyubova (1952, p. 108) made a recent study of what she terms 'form-building' in the genera *Lithostrotion* and *Lonsdaleia*, based on a large number of specimens from the Lower Carboniferous rocks of the Moscow basin. By form-building she presumably means 'trends' or perhaps 'evolutionary changes'. She discussed the genomorph concept and referred to the study of the specimen from the Prophet formation described by McLaren and Sutherland as follows: "Liquidation of genera in the case of finding corallites with one particular structure in a colony with a different structure has found its followers in America (McLaren and Sutherland, 1949). There was found a fragment of a massive colony of a *Lithostrotion* which included in addition to the typical corallites, the corallites with the structure of two more genera — *Thysanophyllum* and *Lithostrotionella.* Following Smith and Lang they have abolished these genera considering them to be genomorphs of the genus *Lithostrotion.* Should I follow this example I would have to abolish the genus *Lonsdaleia* as corallites with the structure of this genus occur in the same colonies of *Lithostrotionella, Thysanophyllum,* etc. Therefore, as the study progresses all Carboniferous colonial corals probably could be unified in one genus and then in one species, as their species have apparently originated in the same way as the genera. Such taxonomic treatment of colonial corals would answer the requirements of phylogenetic systematics but would not reflect the real state of affairs. Besides, it would be still necessary to name somehow all these different forms which are often restricted to a certain horizon and area and consequently to place them into subspecific system categories." (The writer is indebted to Dr. J. A. Jeletzky of the Geological Survey for an oral translation of the original Russian text.)

McLaren and Sutherland (1949, p. 627) did not suggest, as Dobrolyubova implied, that all genomorphic names be abolished for they stated: "although the genomorph concept undermines the zoological reality of many of the rugose coral genera, nevertheless the use of existing names must continue since they are convenient for describing the various forms and are useful in stratigraphy." Her observations of corallites with a *Lonsdaleia* structure in the same colonies with those of other generic types are of great interest. She illustrated (1952, p. 104, fig. 6) a form showing corallites of *Lonsdaleia* and *Thysanophyllum* in association and another (p. 105, fig. 7, and p. 106, fig. 8) showing adult corallites of the *Lonsdaleia* type in association with immature corallites with a *Lithostrotionella* structure.

The specimen described by McLaren and Sutherland indicates that *Thysanophyllum* and *Lithostrotionella* are in this instance genomorphs of *Lithostrotion.* But this one example does not prove all species of these 'genera' to be genomorphs of *Lithostrotion* as can be seen from the above-mentioned association of *Lithostrotionella* or *Thysanophyllum* with *Lonsdaleia.*

Smith and Lang (1930, p. 180) in their original discussion of the genomorph concept, showed several species of *Diphyphyllum* to be genomorphs of *Lithostrotion.* They proposed that the name *Diphyphyllum* be restricted to the diphymorphs of *Lithostrotion.* They did not suggest what name should be applied to other corals with a similar structure that are not associated as diphymorphs with *Lithostrotion* but that could have developed from this or some other genus. As Dobrolyubova suggested, although such a procedure attempts to use a genomorphic name in a phylogenetic way, it raises great difficulties in practical application. If carried to its logical conclusion, this procedure would require a different genomorphic name each time a particular structure, such as the *Thysanophyllum* type, is found in association with a different generic structure, as discussed above; and what name would be used in the absence of knowledge concerning its relationships? Such additional names would only further confuse the study of colonial corals until we have a better understanding of the whole problem.

It is proposed therefore, that, at least for the present, a generic name be listed as a genomorph of another genus only in cases where there is evidence to support such an association. *Thysanophyllum,* for example, might in various instances be listed as a genomorph of *Lithostrotion* or *Lithostrotionella* or *Lonsdaleia* or perhaps some other genus or possibly vice versa. In species of *Thysanophyllum* where no other generic type is present, and its relationship therefore unknown, one would list the name as a genus and not a genomorph.

Generic and genomorphic names used in this way are, of course, polyphyletic and artificial but this procedure seems to provide a more realistic basis for further work than the earlier discussed alternative which would burden taxonomy with more artificial names long before the true phylogenetic relations of such forms are understood. But even with further knowledge it is doubtful if a truly phylogenetic grouping of Carboniferous colonial rugose corals can ever be achieved that can also be applied stratigraphically.

Genomorphs can be pictured as transitional steps in the rapid evolution of colonial rugose corals. New 'generic' types thus arose by the appearance in a colony of a new structure (genomorph) which in the course of time presumably increased in number and replaced the corallites of the old type.

Little information is as yet available from Western Canada concerning the stratigraphic consistency of the appearance of particular genomorphic types in corals. Dobrolyubova (1952, p. 110) stated, as a conclusion to her study of form-building in *Lithostrotion* and *Lonsdaleia,* that the appearance of particular morphological changes in these genera "cannot be used as time indications; in different parts of the basin they could appear at different times. All the more they would be heterochronous in different basins which are far from one another."

Septal Structure. Wang (1950), in his classification of the corals based primarily on their minute septal structure, proposed a considerably different classification of the forms that are here placed in the Lithostrotionidae. He did not recognize the family, but placed the genera *Lithostrotion* and *Diphyphyllum* in the suborder Streptelasmacea, family Clisiophyllidae, subfamily Koninckophyllinae (p. 222). The septa in these two forms are said to be composed of "very slender subparallel trabeculae". The forms *Diphystrotion, Lithostrotionella* and *Thysanophyllum* are placed by Wang in the suborder Caniniacea, family Lonsdaleiidae and subfamily Lonsdaleiinae. *Diphystrotion* is placed as a synonym of *Lonsdaleia* and *Lithostrotionella* and is listed as a subgenus of *Lonsdaleia.* Both forms are said to have septa composed of fibre fascicles perpendicular to the septal plane. The septa in *Thysanophyllum,* which is listed as a separate genus in the same subfamily, are described as having lamellar or fibro-lamellar structure.

It is difficult to see how *Diphystrotion* can be considered a synonym of *Lonsdaleia.* The two forms have almost no features in common. The first has no columella and shortened septa which extend to the epitheca whereas the second has a compound columella and lonsdaleoid dissepiments.

In all of the specimens studied from Western Canada, which are included in the Lithostrotionidae, the septa are too thin or too much recrystallized to ascertain accurately what septal structure is present.

Genus *Lithostrotion* Fleming, 1828

Type Species (opinion 117, International Commission on Zoological Nomenclature). *Lithostrotion striatum* Fleming, 1828, p. 508=*Lithostrotion sive basaltes minimus striatum et stellatus* Lhwyd (1699, p. 124; 1760, p. 125).

Diagnosis. Phaceloid and cerioid rugose corals, which have, typically, a columella, long major septa, and large tent-shaped tabulae, usually supplemented at the theca by smaller and nearly horizontal tabulae. Dissepiments are well developed in the larger species, but absent in the very small forms.

Remarks. Hill (1940, p. 166) gave a detailed review of the complicated history of the type species of *Lithostrotion* and also a discussion of allied genera.

The genus *Lithostrotion* shows a wide variation, but it is not considered advisable to attempt to subdivide it until a comprehensive survey and study can be made of the stratigraphic and geographic significance of its variations.

The type species of *Lithostrotion* is a cerioid form, but the genus is interpreted by most workers as also including phaceloid forms as it seems inadvisable to separate two genera on a single progressive character such as the form of the corallum. Thus, *Siphonodendron* McCoy, 1849, is identical with a small phaceloid form of *Lithostrotion* (Lang, Smith and Thomas, 1940, p. 119) and is, therefore, interpreted as a junior synonym of *Lithostrotion.* Following the same reasoning, *Diphystrotion* Smith and Lang, 1930, should be considered a junior synonym of *Diphyphyllum* Lonsdale, 1845.

Lithostrotion cf. *pauciradiale* (McCoy)

Plate XXXII, figures 1, 2, 3a-c

Lithodendron pauciradialis **McCoy, 1844, p. 189, Pl. 27, fig. 7.**
Lithostrotion pauciradiale **(McCoy), Hill, 1940, p. 169, Pl. 9, figs. 1, 2.**

Description. The specimens here described show a phaceloid corallum of unknown size. The corallites tend to be more or less straight and parallel and are close together though rarely in contact. The epitheca is almost smooth and with only very faint fine annulations. The corallites show little variation in diameter, and range from 3 to 3.5 mm. Increase is lateral.

There are about 18 to 22 septa of each order. In corallites of two coralla they vary from 18 to 20 and in another corallum they vary from 20 to 22 in number. The major septa vary in length from one-third to two-thirds the radius though they are typically over one-half the radius, with the counter septum slightly longer than the others. Occasionally the cardinal and counter septa may be continuous with the columella and in rare instances one or two other septa may extend to, or almost to, the columella. The columella is styliform and generally thin and elongated along the cardinal-counter plane.

The tabulae are tent-shaped, rising steeply to the columella and are complete and evenly spaced at about one per millimetre. No incomplete periaxial tabulae have been observed. There is one row of small regular dissepiments. No tendency to a diphymorphic trend (e.g., the columella becoming discontinuous or absent) has been observed.

Remarks. The specimens described here are close to *L. pauciradiale* (McCoy) from the D_2 zone in the Viséan of Great Britain, but differ from that species in the following ways:

(1) The corallites have a smaller diameter. The average is 3 to 3.5 instead of 4 to 5.5 mm.

(2) The major septa are shorter. In *L. pauciradiale* the major septa are typically long and in some specimens all of them may extend to the columella; the cardinal and counter septa are almost always continuous with it.

(3) There is an absence of incomplete periaxial tabulae.

These differences are probably sufficient for distinguishing the Canadian form as a new species, but this procedure is not followed at present due to the wide variation known to exist in *L. pauciradiale* and to the fact that the specimens under study were not collected in place.

Material and Occurrence. Fragments of five different, well preserved coralla from Locality 89, from talus on upper part of Member B, but could be from Member C, Prophet formation, Section 8, Prophet-Muskwa area. Middle Mississippian.

Lithostrotion cf. *whitneyi* Meek

Plate XXXI, figure 3

Lithostrotion whitneyi Meek, 1877, p. 58, Pl. 6, figs. 1, 1c.
? *Lithostrotion whitneyi* Meek, Shimer, 1926, p. 26.

Description. One fragment about 8 cm. in diameter and 3 to 4 cm. in height, is from a corallum of unknown size. The corallites are more or less parallel and closely to widely set. They have been recrystallized and some are poorly preserved. A conspicuous feature is the frequent lateral budding.

The diameters of the corallites vary from 6.5 to 9 mm. and there are 26 to 28 major septa. They are one-half to three-fifths the radius in length and many of them are slightly thickened in the tabularium. Minor septa are long, about one-half the length of the major septa. A thin, lath-like, though in places irregularly shaped, simple columella is present and sometimes the cardinal and counter septa are continuous with it. The columella appears to be continuous. The other septa never extend to the axis.

The tabulae, as seen on an unfigured polished longitudinal surface, are almost flat but most rise slightly to meet the columella. At their periphery they bend downwards abruptly. One row of regular dissepiments is present.

Remarks. This species is similar to smaller forms that have been referred to the highly variable *L. whitneyi* Meek (1877, p. 58). It differs from the figured type of the species, from limestones of Mississippian age in the Wasatch Range, Utah, in having a more closely packed phaceloid form instead of a loose dendroid habit, shorter major septa which are fewer in number, and never more than one series of dissepiments.

Kelley (1942, p. 360, Pl. 51, figs. 2, 5) figured but did not describe a specimen reported to have been collected from near Meek's type locality. The corallites are about 12 to 16 mm. in diameter and the dissepiments are well developed. The form of the corallum is not indicated. He stated that this specimen does not have a columella but that the axial structure is formed by the upraised tent-shaped tabulae. Such a feature does not show in Meek's figure of the holotype.

Parks (1951, p. 180, Pl. 33, figs. 3-5) figured but did not describe a form which he assigned to this species from the Brazer formation of northern Utah, from a locality only a few miles from Meek's type locality in the Wasatch Mountains. In his specimen, said to be typical of the species, there are 32 major septa at a diameter of about 15 mm. A columella is present but apparently discontinuous. The form of the corallum is not indicated. This coral and that illustrated by Kelley, both from Utah, are much larger forms than the specimen under study; they have much better developed dissepiments and the columella differs in structure. They possibly represent a species different from that here described.

Shimer (1926, p. 26) assigned a small number of specimens to this species from the middle Rundle formation of the Lake Minnewanka area, near Banff, Alberta, but he did not describe or figure them. His specimens have been examined. They are in the Geological Survey collections but they have never been thin sectioned. The corallites are 6 to 7 mm. in diameter and some appear to have no columella. The corallum is loosely phaceloid but does not show the high frequency of lateral budding seen in Pine River specimen described above. However, Shimer's form is probably conspecific with the Pine River specimen.

Material and Occurrence. One fragment of a corallum from Locality 284, isolated exposure, Pine River area. Middle? Mississippian.

Lithostrotion macouni Lambe

Lithostrotion macouni **Lambe, 1901, p. 176, Pl. 14, figs. 11, 11a, 11b.**

Remarks. Lambe described this coral from an isolated outcrop called Fossil Point (Locality 1) in the upper Peace River valley. The species has not been reported elsewhere but the accompanying brachiopod fauna is distinctly Mississippian in age.

Kelley (1942, p. 357) suggested, after a study of Lambe's illustrations, that *L. macouni* is possibly a *Lithostrotionella* and not a *Lithostrotion.* This is not believed to be the case. The writer has examined the type specimens in the Geological Survey collections. They consist of several small fragments, possibly all from the same cerioid corallum in which the corallites are only 2 to 3 mm. in diameter. No thin sections have been made but a study of various polished surfaces did not reveal discontinuous septa.

Genus *Lithostrotionella* Yabe and Hayasaka, 1915

Type Species. Lithostrotionella unicum Yabe and Hayasaka, 1915, p. 133; and 1920, Pl. 9, figs. 12a, b. Permian of South China.

Diagnosis. A compound coral in which the septa are separated from the epitheca by a zone of dissepiments. The tabulae and columella are identical with those in the genus *Lithostrotion.*

Remarks. The genomorphic relations of *Lithostrotionella* have already been discussed in the earlier statement on *Trends and the Genomorph Concept.* As stated there, at least some of its species develop from species of *Lithostrotion* and in turn lead on to *Thysanophyllum.*

Hill (1940, p. 161) implied that *Lithostrotionella* may be a synonym of *Thysanophyllum,* but in an earlier paper (1934, p. 82) she suggested that it might be a genomorph of *Lithostrotion* which had followed a lonsdaleoid trend.

Wang (1950, p. 212) listed *Lithostrotionella* as a subgenus of *Lonsdaleia* apparently because both forms have a lonsdaleoid dissepimentarium. In contrast to the compound axial column of *Lonsdaleia* the columella of *Lithostrotionella* is a simple median plate not combined with septal lamellae or axial tabellae (Hayasaka, 1936, p. 51). But *Lithostrotionella* is apparently a polyphyletic form because Dobrolyubova (1952, p. 108), as stated earlier, reported the presence of corallites with a *Lithostrotionella* structure in the same corallum with those of *Lonsdaleia.* It has previously been noted that *Lithostrotionella* is known to occur with *Lithostrotion* and *Thysanophyllum.*

The genotype of *Lithostrotionella* is a cerioid form. Applying the same reasoning as used earlier in the case of *Lithostrotion,* the genus is here interpreted as including phaceloid as well as cerioid forms. The genus *Dorlodotia* described by Salée (1920, p. 145) appears to be identical in internal structure with *Lithostrotionella* and it may well be a phaceloid form of this genus.

Genus *Thysanophyllum* Nicholson and Thomson, 1876

Type Species. Thysanophyllum orientale Nicholson and Thomson (1876B, p. 150; Thomson, 1880, p. 257, Pl. 3, figs. 11 and 14); lectotype chosen Gregory, 1917, p. 238, from Lower Carboniferous, Viséan, Scotland.

Diagnosis. Phaceloid and cerioid forms which do not have a columella and in which the septa are separated from the epitheca by a zone of dissepiments. The tabulae are typically complete, well spaced, and almost flat.

Remarks. The lectotype of the type species was described and figured for the first time by Thomson (1880, p. 257). Garwood (1912, p. 562) in a description of a late Tournaisian (Early Mississippian) species from northwest England, remarked on the great variation in the size of the corallites and on the fact that in young individuals there is a tendency for some of the septa to extend across the outer zone of dissepiments and touch the epitheca. Hill (1940, p. 161) suggested that the genus might be polyphyletic and considered that *Diphystrotion,* is a synonym of *Thysanophyllum.* This author considers *Diphystrotion* a likely synonym of *Diphyphyllum.* The genus *Thysanophyllum* is certainly a polyphyletic one and genomorphic relations to *Lithostrotion, Lithostrotionella, Diphyphyllum,* and *Lonsdaleia* have already been discussed under *Trends and the Genomorph Concept.* Its relation to the first two of these is well shown by the species described below.

Lithostrotion [*Lithostrotionella*] [*Thysanophyllum*] *mclareni* n.sp.

Plate XXXIII, figures 1a-g

Lithostrotion sp., McLaren and Sutherland, 1949, p. 631, Pl. 103, figs. 1-9.

Remarks. This species has been described in detail by McLaren and Sutherland (1949, p. 631). Its most striking feature is that the variation between individual corallites embraces structures that are typically developed in *Lithostrotion, Lithostrotionella* and *Thysanophyllum.* This appears to be a striking confirmation of the genomorph concept and its full implications are discussed in the section on *Trends and the Genomorph Concept.*

Smith (1945, p. 22), supported by McLaren and Sutherland (1949, p. 627), proposes that a genomorphic name be enclosed in square brackets, following the genus, in the position of a subgeneric name, when assigning a species to its correct genus. It can be used as a normal generic name in discussions.

Material and Occurrence. One large fragment of a cerioid corallum, G.S.C. No. 9666, from Locality 85, near the top of the Prophet formation, Section 8, Prophet-Muskwa area. Middle Mississippian.

Genus *Diphyphyllum* Lonsdale, 1845

Type Species. Diphyphyllum concinnum Lonsdale, 1845, p. 624. The type of *D. concinnum* is lost and Smith and Lang (1930, p. 180) "therefore base *Diphyphyllum* on *D. lateseptatum,* which if not conspecific, is certainly congeneric with *D. concinnum*".

Diagnosis. Phaceloid and cerioid corals similar to *Lithostrotion* except that the columella is discontinuous, present only as spines on successive tabulae, or absent. The septa are amplexoid and the axial tabulae are flat or convex, but have downturned edges. The outer smaller tabulae, if present, are flat or concave and lie against the inner tabulae. The dissepiments are small and may be well developed in the larger forms.

Remarks. Many species of *Lithostrotion* have a tendency to develop diphymorphs of *Diphyphyllum* due to the columella becoming discontinuous or absent. In such forms *Diphyphyllum* can be used conclusively as a genomorph of *Lithostrotion.*

However, some species of *Diphyphyllum* show no indication of a columella and in these individuals it is inadvisable to assume, though it may well be true, that they are genomorphs of *Lithostrotion.* Possibly they developed along some other line.

Smith and Lang (1930, p. 184) proposed the genomorphic name *Diphystrotion* for cerioid diphymorphs of *Lithostrotion.* Following the reasoning of not recognizing *Siphonodendron* for phaceloid forms of *Lithostrotion, Diphystrotion* is here interpreted as a synonym of *Diphyphyllum.* Smith and Lang mentioned the possibility that both types give rise to cerioid and phaceloid forms of *Thysanophyllum.*

Lithostrotion [*Diphyphyllum*] aff. *mutabile* Kelley

Plate XXXIII, figures 2a, b

Diphyphyllum mutabile **Kelley, 1942, p. 358, Pl. 51, figs. 7, 8.**

Description. The corallum is phaceloid and of unknown size. The corallites tend to be crooked and irregularly spaced. Some may touch but most are widely separated.

The mature corallites vary in diameter from 3.5 to 5 mm. but are typically 4 to 5 mm. There are 17 to 20 major septa, which are half the radius or slightly less in length, and none of which extends to the axis. Alternating with the major septa are inconspicuous minor septa which are either short or represented only by septal ridges. A small laterally compressed columella is present in some of the corallites. It is impersistent and commonly represented only by spines on successive tabulae.

In those parts of the corallites where a columella is present the tabulae, which are complete, tend to be tent-shaped. Where no columella is present the tabulae are almost flat and evenly spaced, except peripherally where they bend downward. A single series of small dissepiments is generally present, though it may be missing in some parts of the corallite and there the tabulae extend to the epitheca.

Remarks. This species is similar to *L.* [*D.*] *mutabile* Kelley (1942, p. 358) from the Rundle limestone, Mountain Park area, Alberta, in the size of the corallites and the length of major septa, but Kelley's form has a larger number of septa for the diameter (24 instead of 17 to 20) and is said to have a columella consisting of 'conical projections' in the centre of the tabulae. The latter feature is not well shown in his figures, but if present, would distinguish his species from the Liard River form described here in which the columella, where present, is represented by simple spines on the surface of the tabulae.

The form described above is like *L.* [*D.*] *gracile* (McCoy) of the Viséan of northern England in number of septa, but the Canadian species has slightly longer septa and larger, less closely packed corallites.

The coral described here is one of only two colonial coral specimens included in the numerous fossil collections made by Hage (1945) from the Carboniferous rocks of the Liard River region. This specimen is reported to be from Locality 34, an isolated outcrop on the Liard River 5 miles above Flett Rapids, where both McConnell (1887) and Hume (1922) collected. The large brachiopod fauna from this locality, which includes typical specimens of *Spirifer centronatus* Winchell, indicates an early Mississippian age, possibly correlating with the middle or late Banff formation of Alberta. Colonial corals of the lithostrotion type are rare in the early Mississippian rocks of Western Canada, and they do not occur in abundance in the section until the middle Mississippian. The other colonial coral specimen collected by Hage, *L.* [*D.*] aff. *proliferum,* is from Middle Mississippian rocks on Flett Mountain.

Material and Occurrence. One fragment containing numerous corallites from a phaceloid corallum of unknown size reportedly from Locality 34, isolated locality, Liard River area.

Lithostrotion [*Diphyphyllum*] aff. *proliferum* (Thomson and Nicholson)

Plate XXXII, figure 5

? ***Koninckophyllum proliferum*** **Thomson and Nicholson, 1876A, Pl. 12, fig. 1.**
? ***Lithostrotion proliferum*** **(Thomson and Nicholson), Hill 1940, p. 174, Pl. 9, figs. 11-14.**

Description. A fragment of phaceloid corallum of unknown size with parts of five well preserved corallites is here described. The corallites, which tend to be evenly and widely spaced, vary in diameter from 6.5 to 8 mm. and there are 24 to 25 major septa which vary in length from less than one-half to three-fourths the radius. A thin lath-like columella may be present but is generally discontinuous or absent. Where the columella is present the tabulae are tent-shaped but become flat or slightly domed in diphymorphic corallites where the columella is missing. There are one or two rows of small dissepiments which are confined to a narrow peripheral zone.

Remarks. The characters of this species vary considerably in different corallites of the same corallum, but there are some general similarities with *L. proliferum* (*see* Hill, 1940, p. 174) from the late Viséan, upper Lower Carboniferous of Scotland. It differs from that species, which is also very variable, in having a much narrower zone of dissepiments and more widely spaced corallites.

Material and Occurrence. A fragment of a phaceloid corallum from Locality 38, Section 11, unit 5, Liard River region. Middle Mississippian.

Lithostrotion [*Diphyphyllum*] sp. A

Plate XXXII, figures 4a-d

Description. The specimen here described is a small fragment of a phaceloid corallum in which the mature corallites vary in diameter from 6 to 7 mm. and have 20 to 21 major septa. They are about one-half the radius in length. Minor septa are very short or absent. The inner margin of the single row of dissepiments is well marked and gives the false impression of an inner wall in transverse section. A simple, thin, straight or irregularly shaped columella is intermittently present and may be represented only by spines on the upper surfaces of successive tabulae.

In those parts of the corallite where there is no columella the tabulae are flat to slightly domed and bend down at their edges. Where a columella is present, they become slightly tent-shaped in the immediate vicinity of the columella. Most of the tabulae are complete. The dissepiments are regular, rounded, and steeply inclined and they number vertically about 6 in the space of 5 mm.

Remarks. This form appears to be distinct from the described species but the material is inadequate for satisfactory description. It differs from *L.* [*D.*] aff. *proliferum* in having corallites of greater diameter but with a correspondingly smaller number of septa.

Material and Occurrence. A fragment of a phaceloid corallum of unknown size from Locality 366, a talus block below the Rundle formation, upper part of Section 3A, Kakwa-Jarvis region. No compound corals were found in place in the Rundle formation of Section 3A.

Diphyphyllum sp. B

Plate XXXII, figures 1, 2

Description. The size and shape of this phaceloid corallum are unknown, but its corallites are widely spaced and somewhat crooked. They vary in diameter from 8 to 9.5 mm. and there are 27 to 28 straight major septa which are one-half to two-thirds the radius in length. No columella has been observed.

The tabulae are flat or slightly domed and downturned at the edges. There is generally one, though in some specimens two, rows of small and irregular dissepiments in the peripheral region.

Remarks. Corallites of this species occur in close association with those of *L.* cf. *pauciradiale* in three different specimens collected in the Bull Creek area. Corallites from the two different species would appear to have interwoven. This form cannot be closely compared with any described species but the material is not sufficient for satisfactory description.

Material and Occurrence. Fragments of three corals of unknown sizes from Locality 89, from talus on upper part of Member B, but could be from Member C, Prophet formation, Section 8, Prophet-Muskwa region. Middle Mississippian.

INCERTAE SEDIS

Genus *Liardiphyllum* Sutherland

Type Species. *Liardiphyllum hagei* Sutherland, 1954, p. 368. Middle? Mississippian, Liard River area, Western Canada.

Diagnosis. "Simple, small to medium, trochoid to cylindrical corals in which the major septa are discontinuous and appear as a vertical series of plates on the upper surface of the tabulae and dissepiments; the complete and incomplete tabulae, which are gradational with a peripheral zone of lonsdaleoid dissepiments, are inclined downward axially and form a series of irregular, inverted cones with cup-shaped depressions in the axial region." (Sutherland, 1954, p. 368.)

Remarks. This genus, which was described in 1954, is apparently unrelated to any known coral. It has a slight resemblance to *Pseudouralinia* Yü (1931, p. 21), from the Lower Carboniferous of China, which also has discontinuous septa. However, the type species, *P. tangpakouensis* Yü (1931, p. 22), has a peripheral zone of very small dissepiments, flat-lying tabulae and a wide open tabular area.

Liardiphyllum hagei Sutherland

Plate VI, figures 4a-g

Liardiphyllum hagei Sutherland, 1954, p. 368, text-figs. 3a-c, Pl. 9, figs. 4a, b.

Septal Structure. The septa in the holotype are composed entirely of lamellar tissue which is continuous with the thickening of the tabular parts.

Remarks. A detailed description of this species was given in 1954. The holotype is here re-figured for comparative purposes and an enlargement to show septal structure, taken from the holotype, is given for the first time (Pl. VI, fig. 4c).

Material and Occurrence. One specimen, the holotype, G.S.C. No. 10571, from Locality 28, middle part of unit 4, Section 11, Liard River region. Middle? Mississippian.

CHAPTER IV

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PLATES II - XXXIII

Western Halfway River Valley, looking southwest across Foothills Belt to the Rocky Mountains; 40 to 60 miles west of Alaska Highway. Note folded Mississippian and Triassic ridges in foreground. (Photo by U.S. Army)

Western Prophet River Valley, looking southeast across Foothills Belt to Plains Province. Note Mississippian thrust eastward against Triassic in foreground and Triassic anticlinal ridges in distance. (Photo by U.S. Army)

Plate IV

(All figures twice natural size unless otherwise stated)

Figures 1-3. *Amplexi-Zaphrentis enniskilleni* cf. *enniskilleni* (Lewis). Localities 28 and 29, Section 11, unit 4, Liard River region. Middle? Mississippian. (Page 51.)

1*a-g*. G.S.C. No. 10572. *a-d*, transverse section, ephebic and late neanic stages. *e*, exterior view, x1. *f*, longitudinal section along cardinal-counter plane. *g*, enlargement of *c* to show septal structure, x8. Locality 28.

2*a-d*. G.S.C. No. 10573. *a-b*, transverse sections, ephebic stage (*b*, drawing from polished surface, not from thin section). *c*, longitudinal section along cardinal-counter plane. *d*, exterior view of weathered calyx, x1. Locality 28.

3. G.S.C. No. 10574. Transverse section at base of calyx, late ephebic stage. Locality 29.

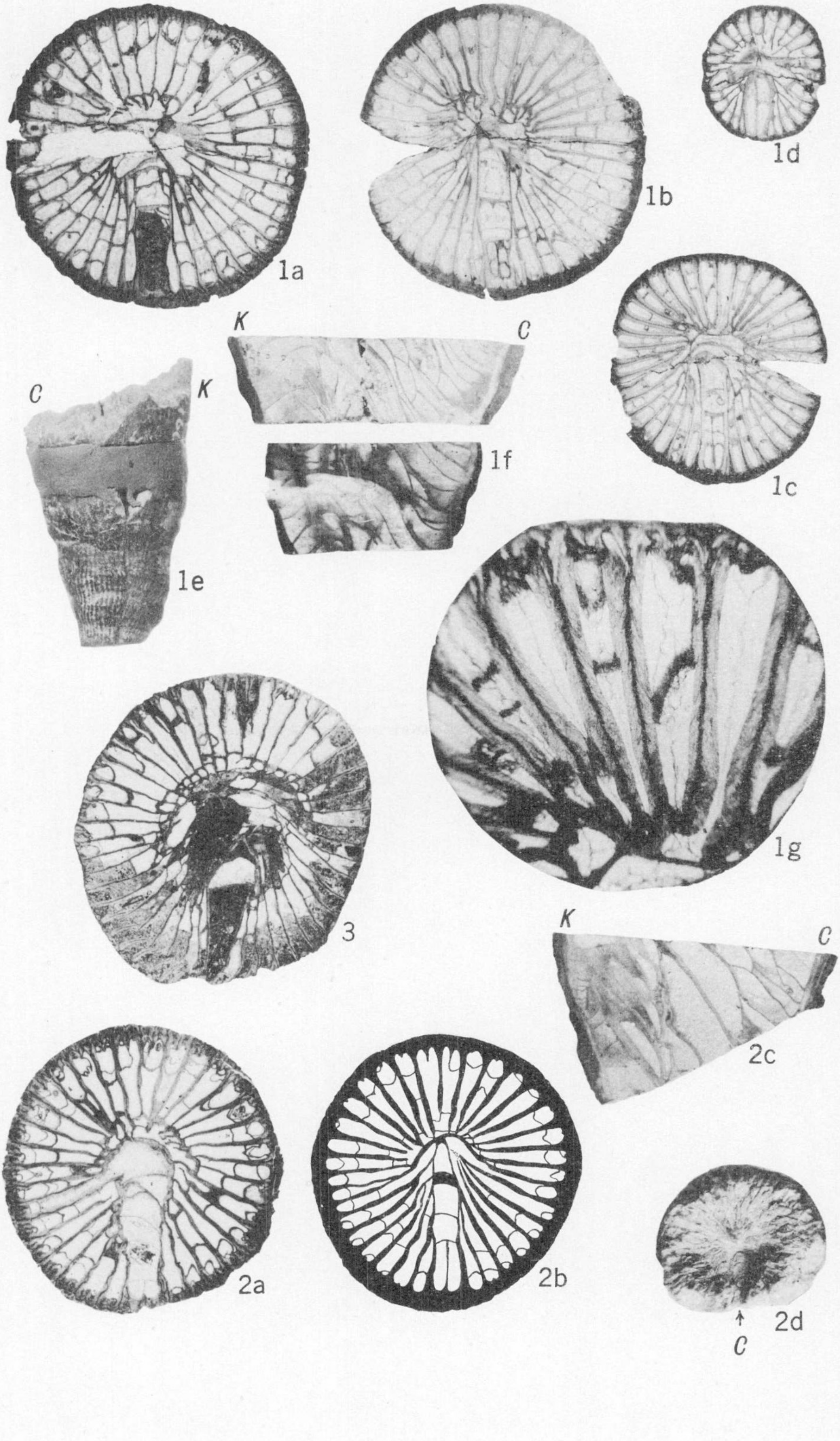
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PLATE V

(All figures twice natural size unless otherwise stated)

Figure 1. *Amplexi-Zaphrentis enniskilleni* cf. *derbiensis* (Lewis). Locality 37, Section 11, unit 4, Liard River region. Middle? Mississippian. (Page 52.)

1*a-e*. G.S.C. No. 10575. *a-d*, transverse sections, ephebic and late neanic stages. *e*, longitudinal section along cardinal-counter plane.

Figures 2-4. *Amplexi-Zaphrentis indifferens* n.sp. Locality 28, Section 11, unit 4, Liard River region. Middle? Mississippian. (Page 53.)

2*a-h*. Holotype—G.S.C. No. 10576. *a-d*, transverse sections, ephebic and late neanic stages. *e*, enlargement of *d* to show septal structure, x6. *f*, enlargement of *b* to show septal structure, x8. *g*, longitudinal section along cardinal-counter plane. *h*, exterior view, x1.

3*a-d*. Paratype—G.S.C. No. 10577. *a-c*, transverse sections, ephebic and late neanic stages. *d*, exterior view, calyx crushed, x1.

4*a-e*. Paratype—G.S.C. No. 10578. *a-c*, transverse sections, ephebic and late neanic stages. *d*, longitudinal section along cardinal-counter plane. *e*, exterior view, calyx crushed, x1.

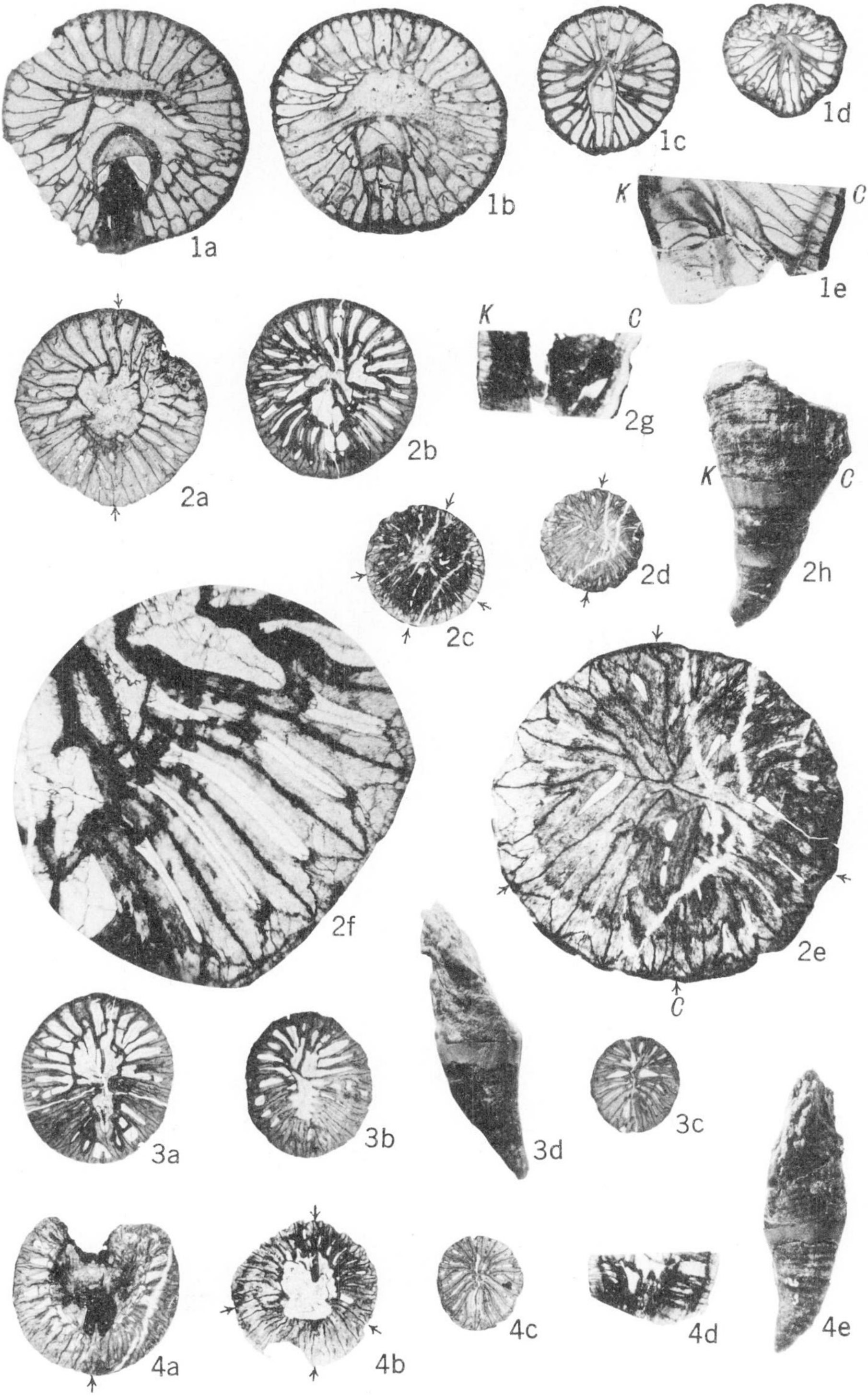
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PLATE VI

(All figures twice natural size unless otherwise stated)

Figure 1. *Amplexi-Zaphrentis taylori* n.sp. Locality 34, Liard River, N.W.T. Lower Mississippian. (Page 52.)

1*a*-*e*. Holotype—G.S.C. No. 10579. *a*-*c*, transverse sections, ephebic and late neanic stages. *d*, longitudinal section along cardinal-counter plane. *e*, exterior view, calyx partly broken, x1.

Figure 2. *Amplexi-Zaphrentis* cf. *taylori* n.sp. Locality 111, Kindle formation, Tetsa River area. G.S.C. No. 10580. Transverse section at base of calyx; specimen slightly crushed. (Page 53.)

Figure 3. *Amplexi-Zaphrentis* sp. E. Locality 90, Prophet formation, Member B, Prophet-Muskwa Rivers area. G.S.C. No. 10581. Transverse section at base of calyx. Middle Mississippian. (Page 60.)

Figure 4. *Liardiphyllum hagei* Sutherland. Locality 28, Section 11, unit 4, Liard River region. Middle? Mississippian. (Page 99.)

4*a*-*g*. Holotype—G.S.C. No. 10571. *a*-*b*, transverse sections, late and middle ephebic (*after* Sutherland, 1954A). *c*, enlargement of *a* to show septal structure. *d*, longitudinal section along cardinal-counter plane through calyx (*after* Sutherland). *e*, longitudinal section through axis at right angle to cardinal-counter plane (*after* Sutherland). *f*, longitudinal section parallel to *e* but offset from axis to show amplexoid nature of septa (*after* Sutherland). *g*, longitudinal section parallel and reversed to figure *d* but offset from axis, through calyx.

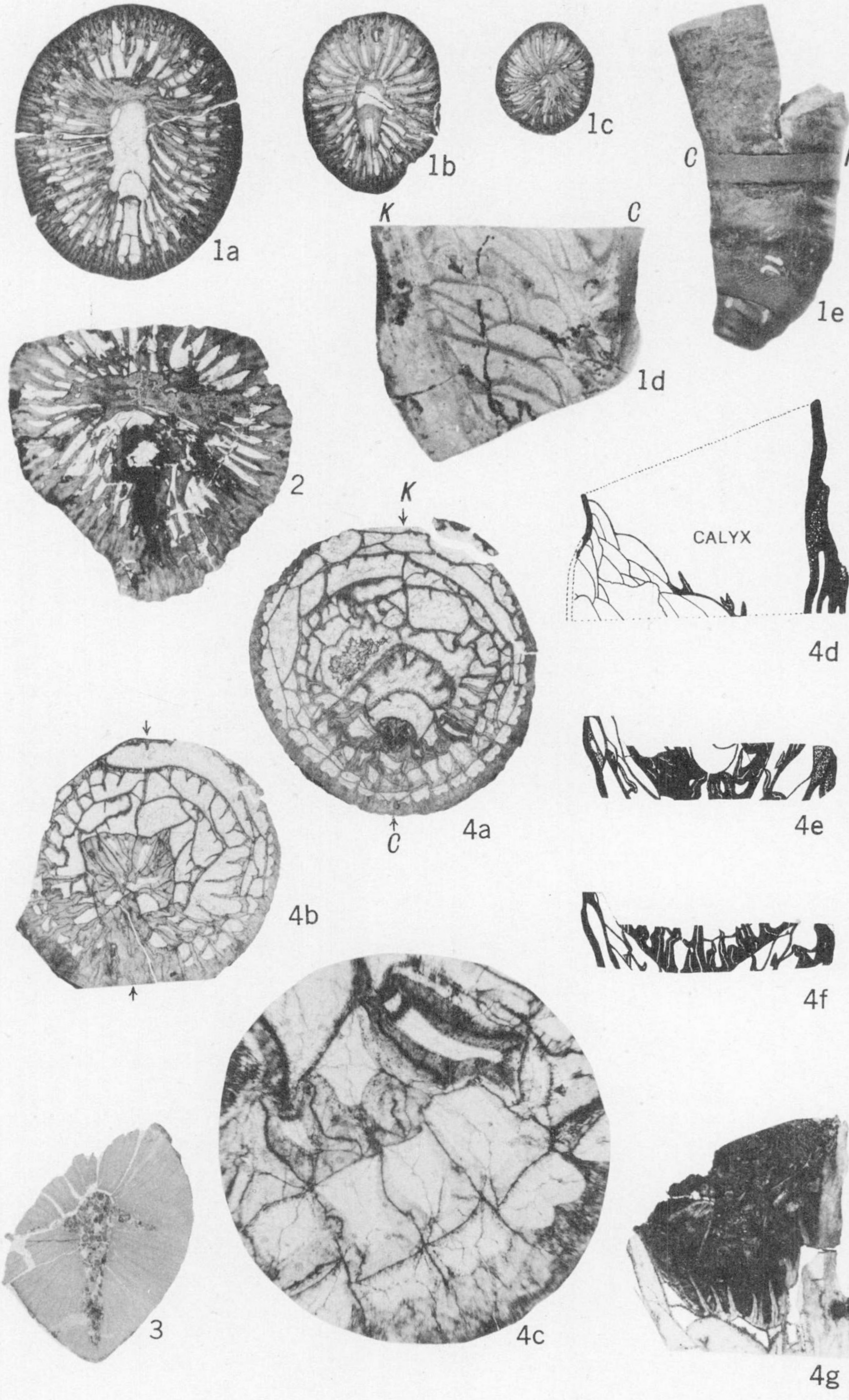
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Plate VII

(All figures twice natural size unless otherwise stated)

Figures 1-2. *Amplexi-Zaphrentis* sp. C. Locality 32, Section 11, unit 6, Liard River area. Upper? Mississippian. (Page 58.)

1*a-c*. G.S.C. No. 10582. *a-b*, transverse sections, ephebic stage. *c*, enlargement of *b* to show septal structure, x8.

2*a-b*. G.S.C. No. 10583. Transverse sections, ephebic and late neanic stages.

Figures 3-4. *Amplexi-Zaphrentis* cf. sp. C. (Page 59.)

3*a-c*. G.S.C. No. 10584. Locality 34, Liard River area. *a-b*, transverse sections, ephebic and late neanic stages. *c*, longitudinal section at right angle to cardinal-counter plane.

4. G.S.C. No. 10585. Locality 373, Section 3A, unit 21, Rundle formation, Kakwa-Jarvis Lakes region. Transverse section, ephebic stage.

Figures 5-6. *Amplexi-Zaphrentis* sp. D. Locality 370, Section 3A, unit 13, Banff formation, Kakwa-Jarvis Lakes region. (Page 59.)

5*a-b*. G.S.C. No. 10586. Transverse sections, ephebic stage.

6*a-c*. G.S.C. No. 10587. *a-b*, transverse sections, ephebic and late neanic stages, *c*, enlargement of *a* to show septal structure.

Figure 7. *Amplexi-Zaphrentis* cf. sp. D. Locality 44, Prophet formation, Sikanni River region. G.S.C. No. 10588. Transverse section, ephebic stage. (Page 60.)

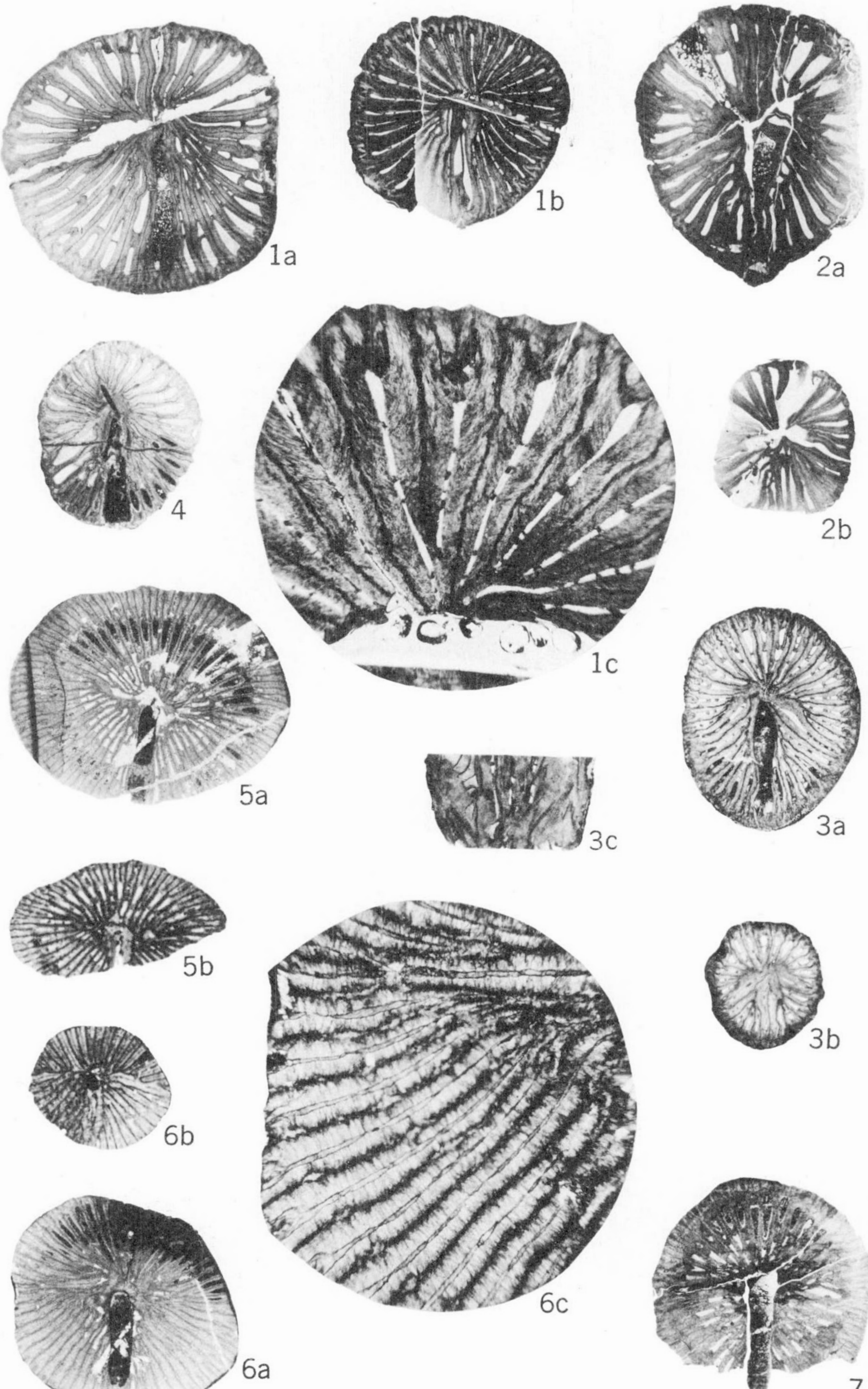
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PLATE VIII

(All figures twice natural size unless otherwise stated)

Figures 1-5. *Amplexi-Zaphrentis cassa* n.sp. Locality 130, Section 9A, unit 8, Kindle formation. Tetsa River area. (Page 54.)

1*a-g*. Holotype—G.S.C. No. 10589. *a-d*, transverse sections, ephebic stage. *e*, longitudinal section along cardinal-counter plane. *f*, longitudinal section parallel to *e* but offset from axis to show amplexoid nature of septa. *g*, longitudinal section of half of corallum at right angle to cardinal-counter plane.

2*a-e*. Paratype—G.S.C. No. 10590. *a-d*, transverse sections ephebic and late neanic stages. *e*, enlargement of *d* to show septal structure.

3*a-b*. Paratype—G.S.C. No. 10591. Transverse sections, ephebic stage.

4. Paratype—G.S.C. No. 10592. Transverse section, late ephebic stage.

5*a-c*. Paratype—G.S.C. No. 10593. *a-b*, transverse sections, ephebic stage (*a* is an oblique section). *c*, longitudinal section along cardinal-counter plane.

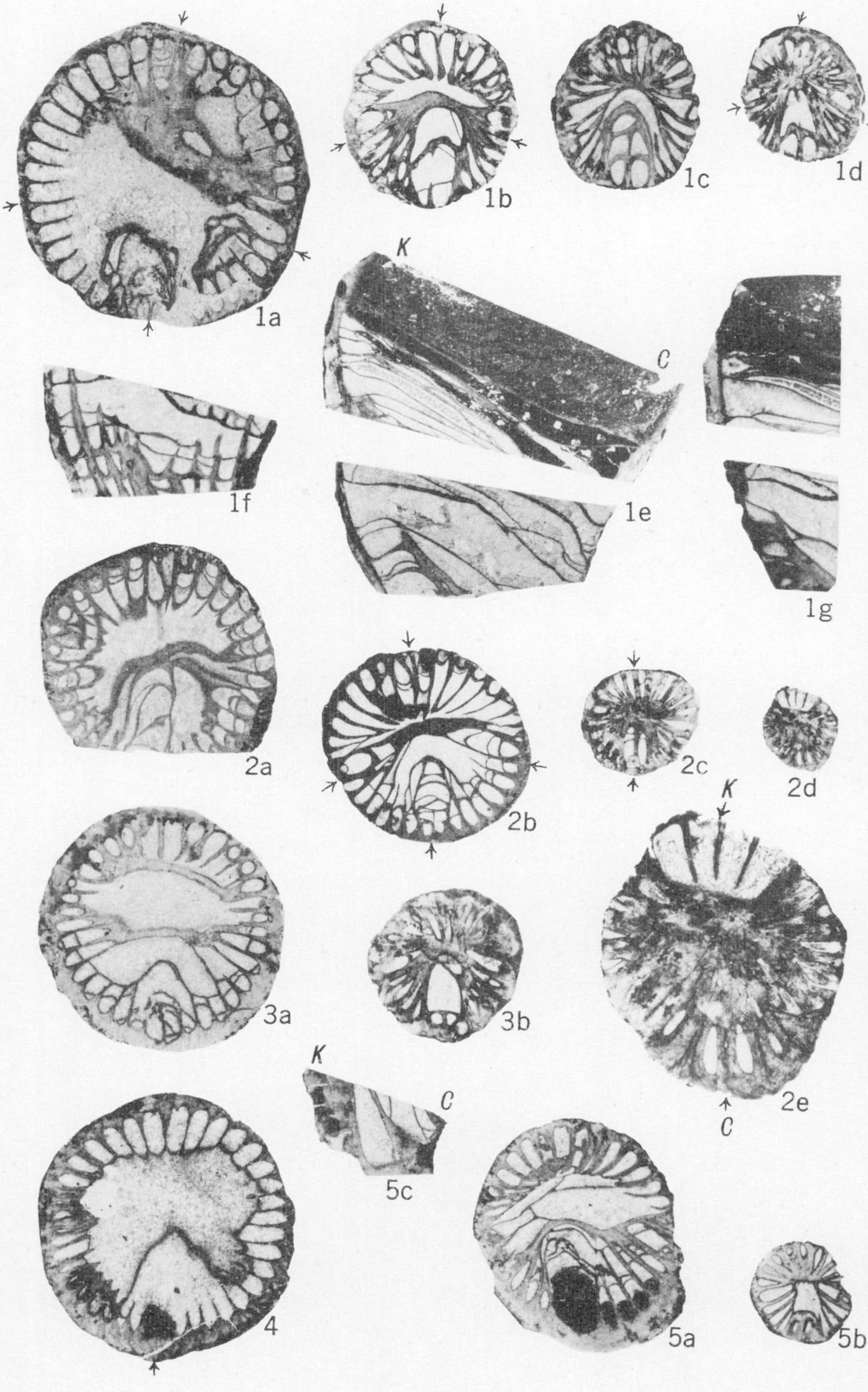
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PLATE IX

(All figures twice natural size unless otherwise stated)

Figures 1-4. *Amplexi-Zaphrentis cassa* n.sp. Locality 130, Section 9A, unit 8, Kindle formation, Tetsa River area. (Page 54.)

1*a-d*. Paratype—G.S.C. No. 10594. *a-c*, transverse sections ephebic and late neanic stages. *d*, longitudinal section along cardinal-counter plane.

2*a-e*. Paratype—G.S.C. No. 10595. *a-b*, transverse section, ephebic stage. *c*, longitudinal section at right angle to cardinal-counter plane. *d*, longitudinal section along cardinal counter-plane. *e*, enlargement of *a* to show septal structure, x12.

3*a-c*. Paratype—G.S.C. No. 10596. *a*, transverse section, early ephebic stage. *b*, longitudinal section along cardinal-counter plane. *c*, longitudinal section parallel but offset from *b* to show amplexoid nature of septa.

4*a-b*. Paratype—G.S.C. No. 10597. *a*, transverse section, early ephebic stage. *b*, longitudinal section along cardinal-counter plane through calyx.

Figure 5. *Amplexi-Zaphrentis* cf. *cassa* n.sp. Locality 130, Section 9A, unit 8, Kindle formation, Tetsa River area. (Page 55.)

5*a-e*. G.S.C. No. 10598. *a-d*, transverse sections, ephebic and late neanic stages (*c* taken from polished surface). *e*, longitudinal section along cardinal-counter plane.

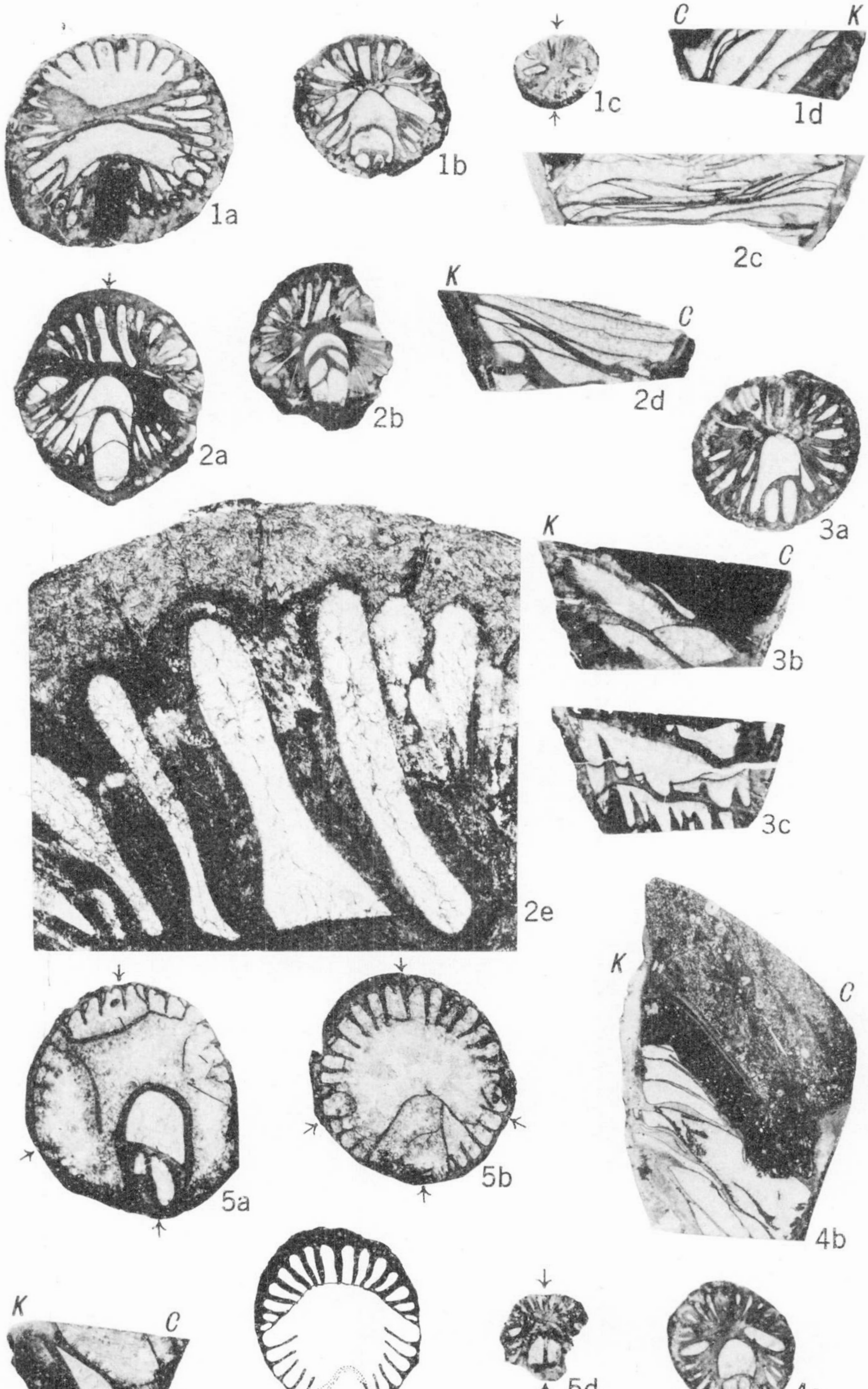
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Plate X

(All figures twice natural size unless otherwise stated)

Figure 1. *Amplexi-Zaphrentis* cf. *cassa* n.sp. Locality 131, Section 9A, unit 10, Kindle formation, Tetsa River area. (Page 55.)

1*a-e*. G.S.C. No. 10599. *a-c*, transverse sections, ephebic stage (*b* from polished surface). *d-e*, longitudinal sections along cardinal-counter plane.

Figures 2-4. *Amplexi-Zaphrentis pilata* n.sp. Locality 132, Section 9A, unit 18, Kindle formation, Tetsa River area. (Page 56.)

2*a-c*. Holotype—G.S.C. No. 10600. *a*, transverse section, late ephebic stage. *b*, longitudinal section along cardinal-counter plane. *c*, enlargement of *a* to show septal structure, x12.

3*a-b*. Paratype—G.S.C. No. 10601. *a*, transverse section, early ephebic stage. *b*, longitudinal section through calyx along cardinal-counter plane.

4*a-c*. Paratype—G.S.C. No. 10602. *a*, transverse section, middle ephebic stage. *b*, enlargement of *a* to show septal structure, x12. *c*, longitudinal section along cardinal-counter plane.

Figure 5. *Amplexi-Zaphrentis* sp. A. Locality 131, Section 9A, unit 10, Kindle formation, Tetsa River area. G.S.C. No. 10603. Transverse section, ephebic stage. (Page 57.)

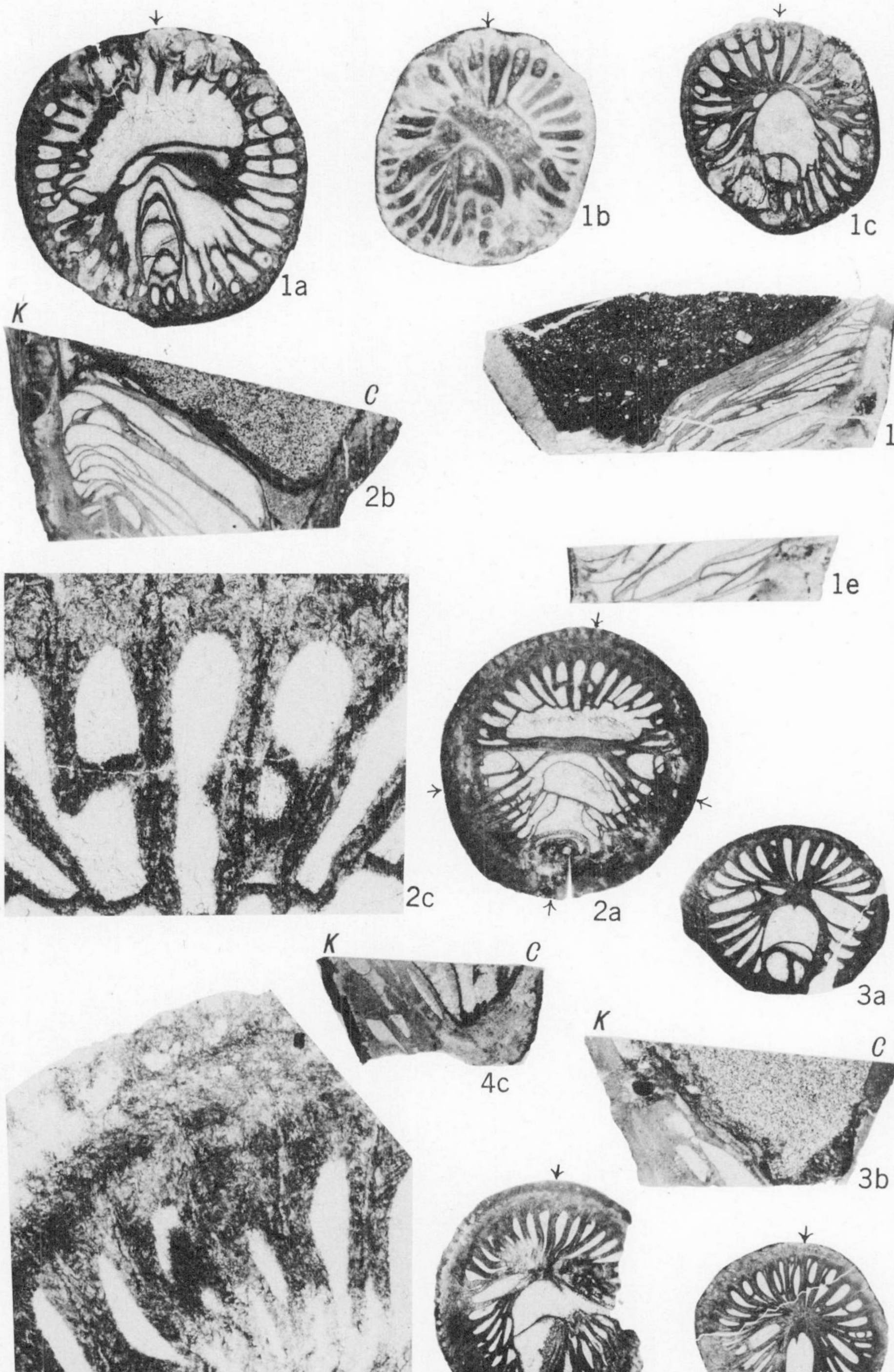
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PLATE XI

(All figures twice natural size unless otherwise stated)

Figures 1-5. *Amplexi-Zaphrentis* sp. B. Locality 101, Section 8, Prophet formation, Prophet-Muskwa Rivers region. (Page 57.)

1*a*-*f*. G.S.C. No. 10604. *a*-*b*, transverse sections, early and late ephebic stages. *c*, enlargement to show septal structure, x12. *d*, enlarged drawing of part of a single septum from *c*, to show septal structure. *e*, longitudinal section along cardinal-counter plane. *f*, enlargement of *e* to show septal structure, x12.

2. G.S.C. No. 10605. Transverse section, ephebic stage showing amplexoid nature of septa.

3. G.S.C. No. 10606. Transverse section, late ephebic stage.

4*a*-*b*. G.S.C. No. 10607. *a*, transverse section, late ephebic stage. *b*, transverse section along cardinal-counter plane.

5. G.S.C. No. 10656. Transverse section, late ephebic stage.

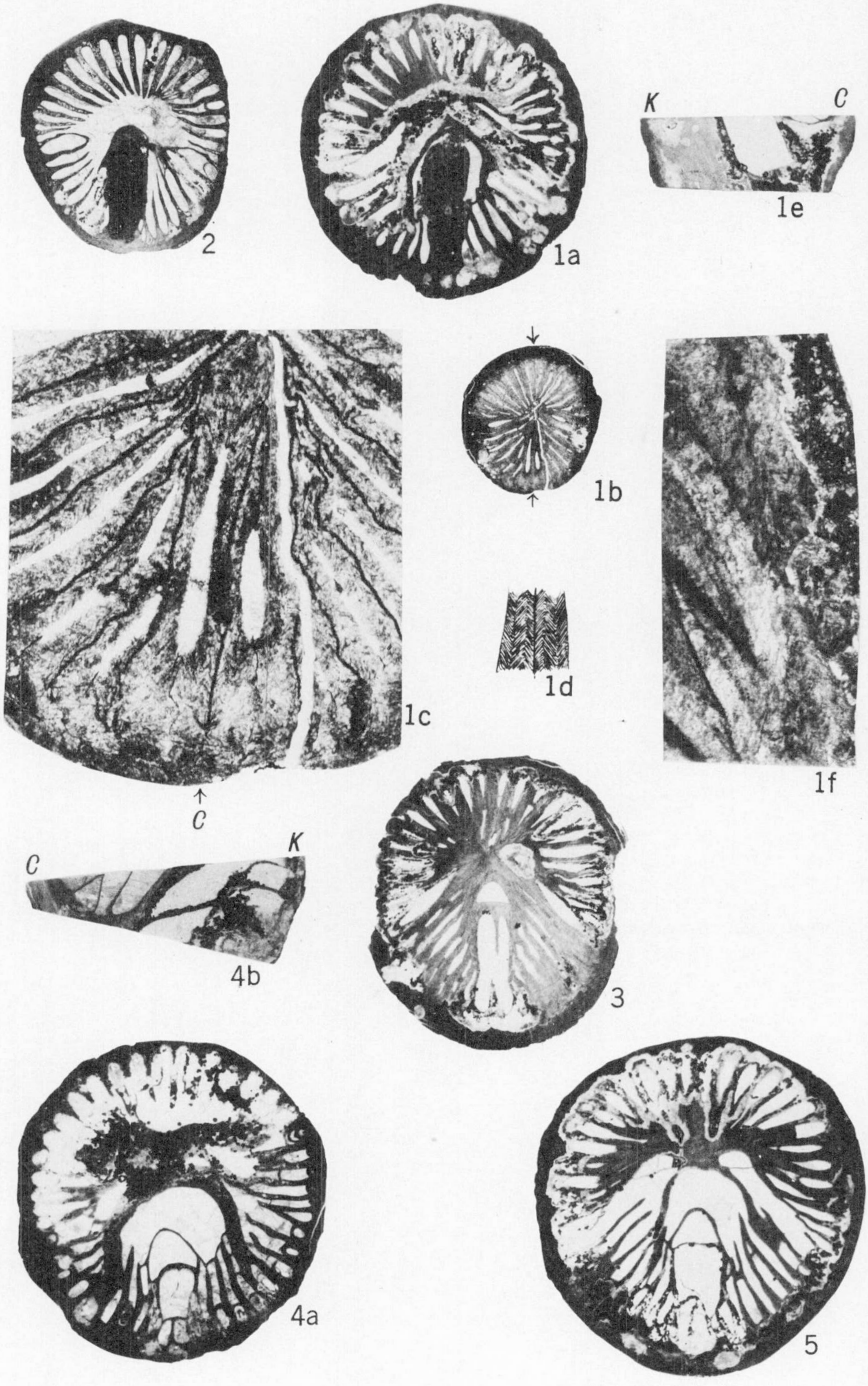
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PLATE XII

(All figures twice natural size unless otherwise stated)

Figures 1-4. *Canadiphyllum knoxi* Sutherland. Locality 82, Section 7, unit 6, Prophet formation, Halfway River region. (Page 60.)

1*a-g*. Holotype—G.S.C. No. 10566. *a-e*, transverse sections, ephebic and late neanic stages (*a*, enlarged drawing of *b*, x3). *f*, longitudinal section along cardinal-counter plane. *g*, exterior view of water-worn corallite, x1 (*after* Sutherland).

2*a-f*. Paratype—G.S.C. No. 10567. *a-b*, transverse sections, late ephebic and late neanic stages (*after* Sutherland). *c*, enlargement of *b* to show septal structure, x6. *d*, longitudinal section along cardinal-counter plane (*after* Sutherland). *e*, exterior view of water-worn corallite, x1. *f*, enlargement of *a* to show septal structure, x12.

3*a-b*. Paratype—G.S.C. No. 10608. *a*, transverse section, early ephebic stage, immature specimen. *b*, exterior view showing almost straight, water-worn corallite, x1.

4*a-d*. Paratype—G.S.C. No. 10609. *a-c*, transverse sections, early ephebic and late neanic stages (*b*, drawing from polished surface). *d*, enlargement of *c* to show septal structure, x6.

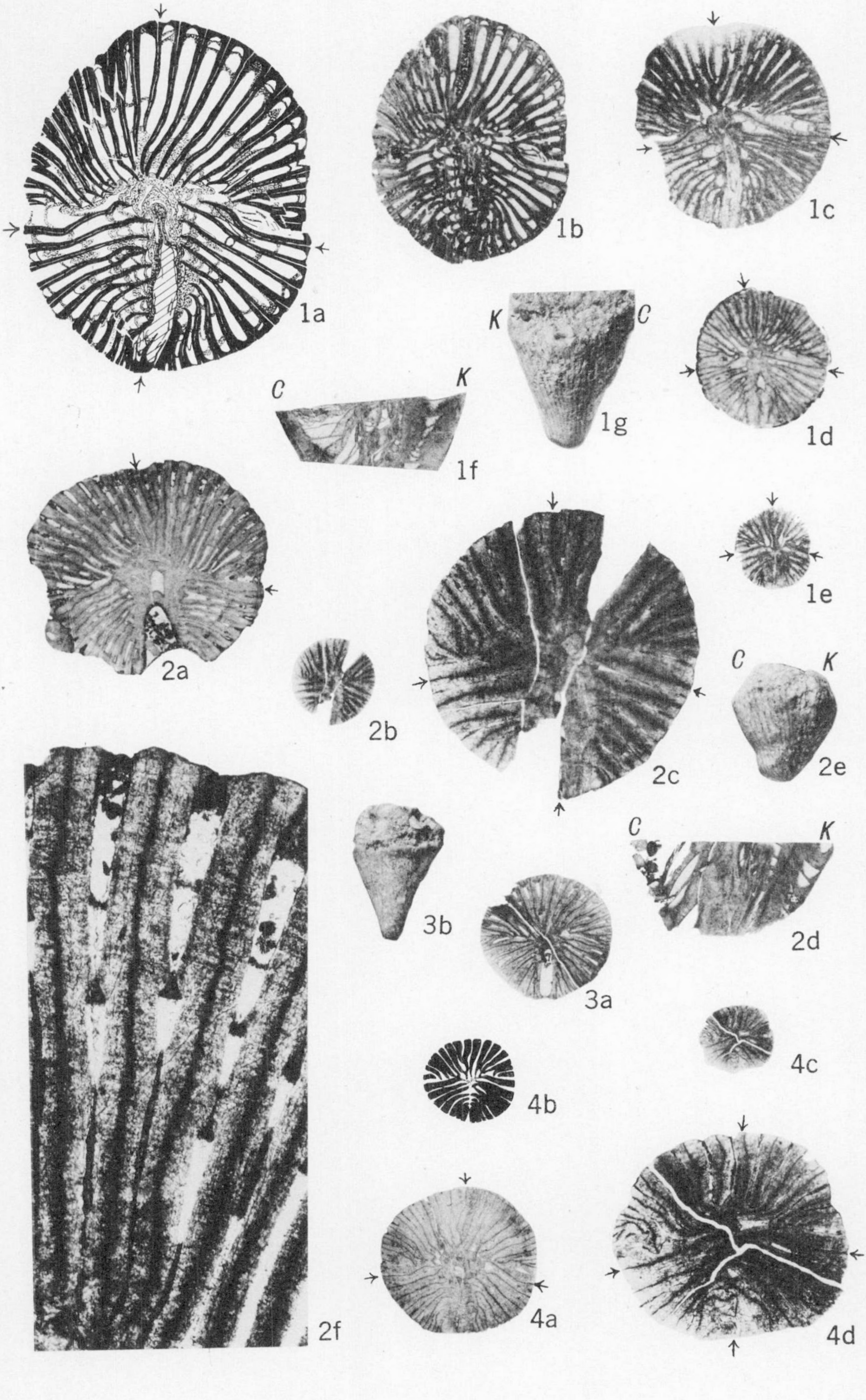
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PLATE XIII

(All figures twice natural size unless otherwise stated)

Figures 1-2. *Zaphriphyllum disseptum* Sutherland. Locality 28, Section 11, unit 4, Liard River region. Middle? Mississippian. (Page 61.)

1*a*-*g*. Holotype—G.S.C. No. 10568. *a*-*d*, transverse sections, late, middle and early ephebic stages. *e*, enlargement of *d* to show septal structure, x8. *f*, longitudinal section along cardinal-counter plane. *g*, exterior view, calyx missing, x1, (all *after* Sutherland, 1954A, except *e*).

2*a*-*c*. Paratype—G.S.C. No. 10610. *a*-*b*, transverse sections, middle and early ephebic stages. *c*, longitudinal section at right angle to cardinal-counter plane.

Figure 3. *Pseudozaphrentoides*? sp. A. Locality 366, Rundle formation, Kakwa-Jarvis Lakes region. G.S.C. No. 10611. Longitudinal section along cardinal-counter plane. *See* Plate XIV, fig. 2 for transverse sections. (Page 68.)

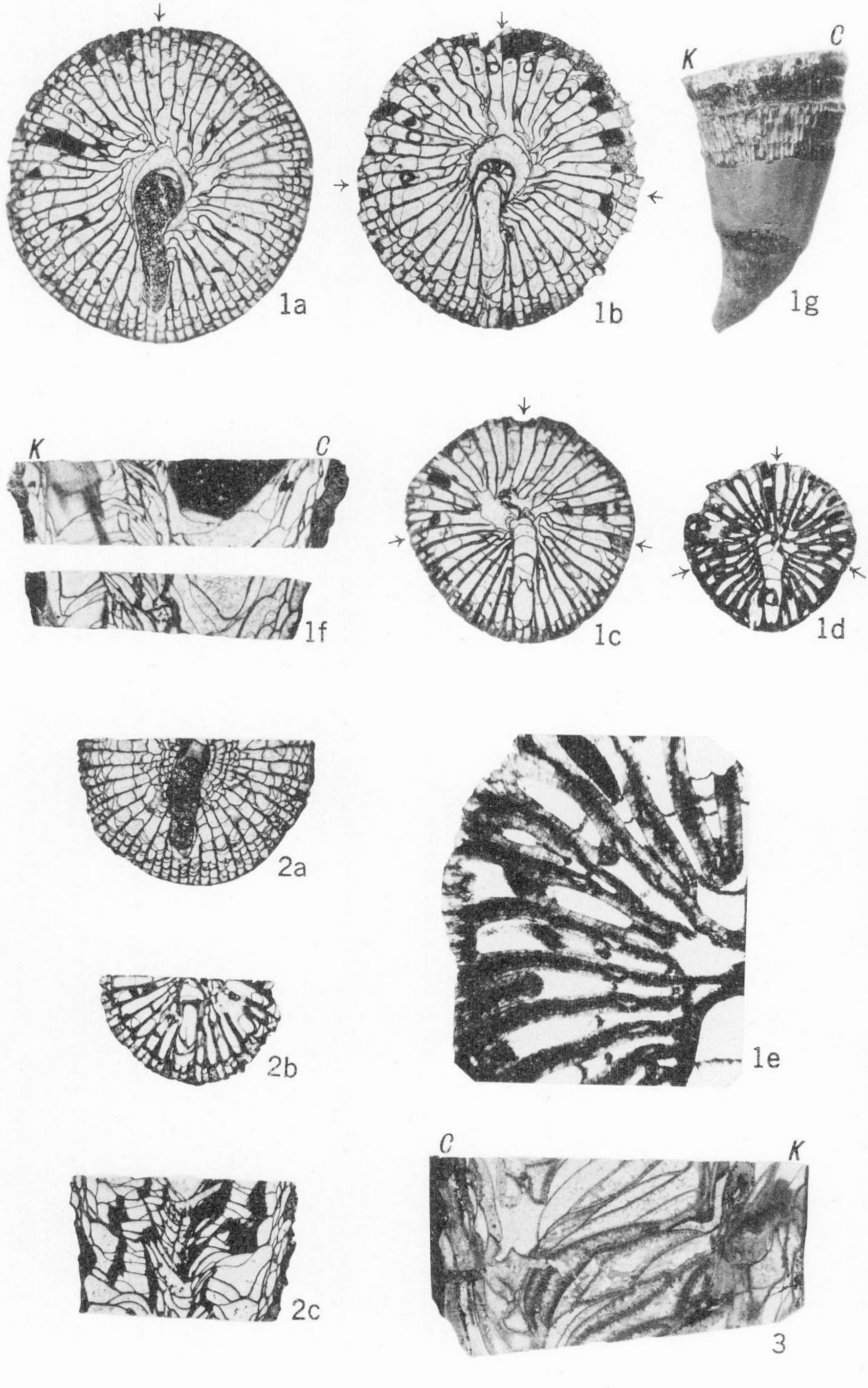
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PLATE XIV

(All figures twice natural size unless otherwise stated)

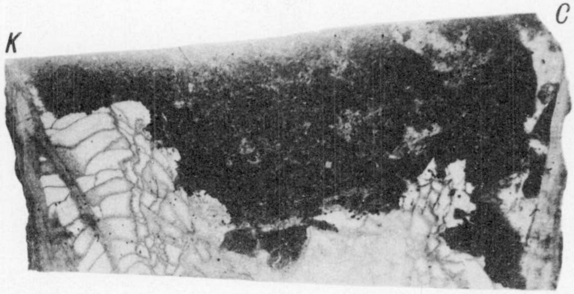
Figure 1. *Paracaninia*? *wilsonae* n. sp. Locality 30, Section 11, Liard River region. (Page 65.)

1*a-e*. Holotype—G.S.C. No. 10612. *a*, transverse section, late ephebic stage. *b*, enlargement of *a* to show septal structure, x8. *c*, longitudinal section through lower part of calyx along cardinal-counter plane. *d*, longitudinal section along cardinal-counter plane. *e*, longitudinal section at right angle to cardinal-counter plane showing axial depression of tabulae; slightly crushed axially.

Figure 2. *Pseudozaphrentoides* sp. A. Locality 366, Rundle formation, Kakwa-Jarvis Lakes region. (Page 68.)

2*a-b*. G.S.C. No. 10611. *a-b*, transverse sections, middle and late ephebic stages. *See* Plate XIII, fig. 3 for longitudinal section.


1d



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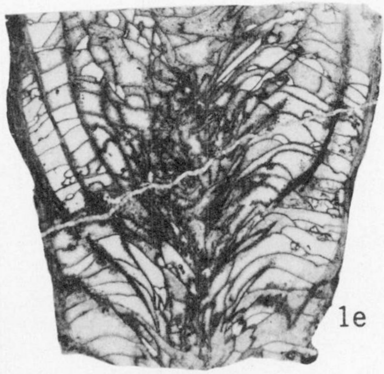
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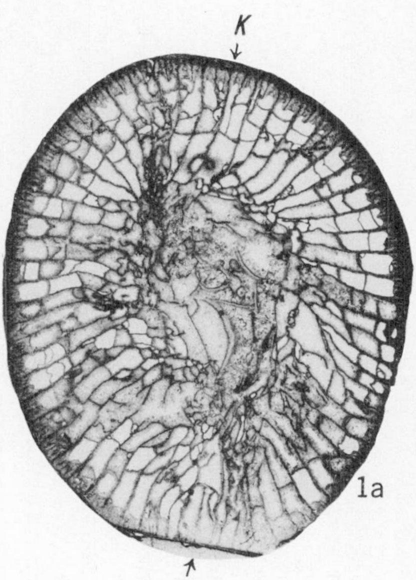

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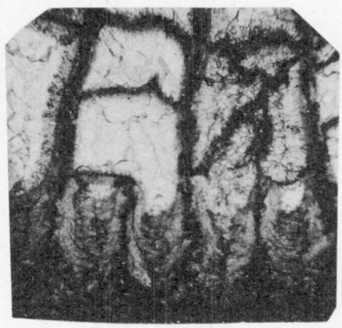
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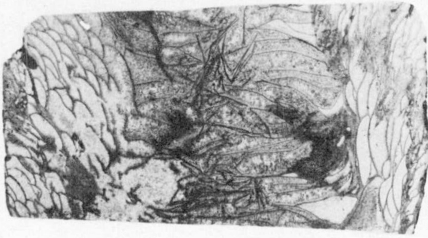
PLATE XV

(All figures twice natural size unless otherwise stated)

Figures 1-2. *Pseudozaphrentoides* aff. *torquius* (Owen). Locality 7, Liard River region. Mississippian. (Page 66.)

1*a*-*b*. G.S.C. No. 10613. *a*, transverse section, late ephebic stage, crushed. *b*, part of *a* enlarged to show septal structure, x12.

2*a*-*d*. G.S.C. No. 10614. *a*-*b*, transverse sections, late and middle ephebic stages. *c*, longitudinal section, at angle from cardinal-counter plane, slightly crushed. *d*, exterior view showing rejuvenescence.



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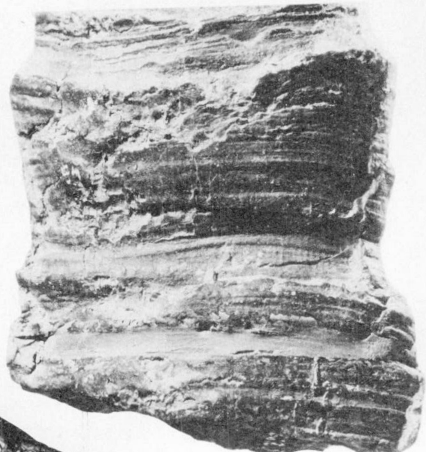

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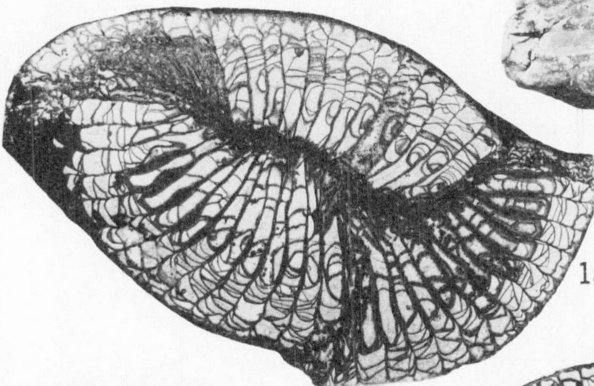

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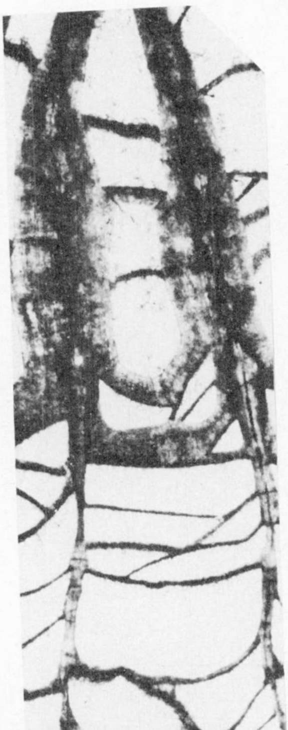
↑C?



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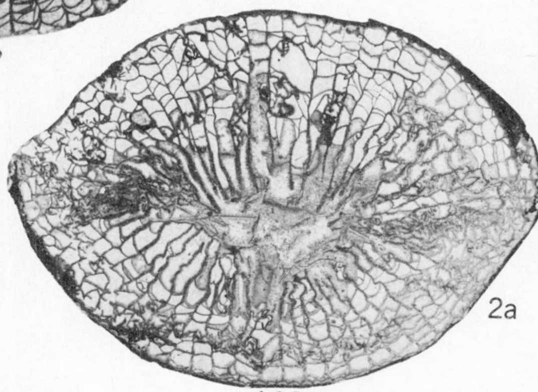

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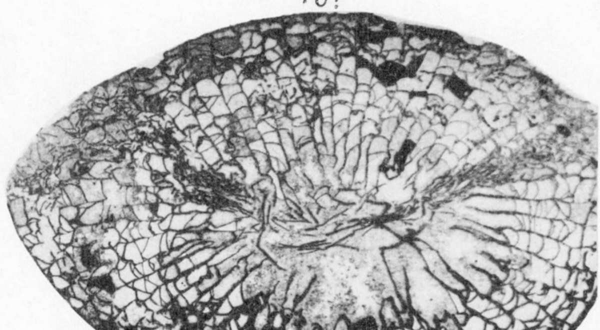

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PLATE XVI

(All figures twice natural size unless otherwise stated)

Figure 1. *Permia* sp. A. Locality 40, Section 11, unit 4. Middle? Mississippian. (Page 72.)

1*a-c*. G.S.C. No. 10615. *a-b*, transverse sections, late ephebic and late neanic stages. *c*, longitudinal section at right angle to cardinal-counter plane; right side of section intersects a septum.

Figure 2. *Pseudozaphrentoides*? *burlingi* n. sp. Locality 337, Section 3A, unit 32, Upper Rundle formation, Kakwa-Jarvis Lakes region. (Page 67.)

2*a-b*. Holotype—G.S.C. No. 10616. *a*, exterior view of fragment of corallite, epitheca lacking, x1. *b*, longitudinal section, at angle to cardinal-counter plane, x1½; upper part of axial region slightly crushed.


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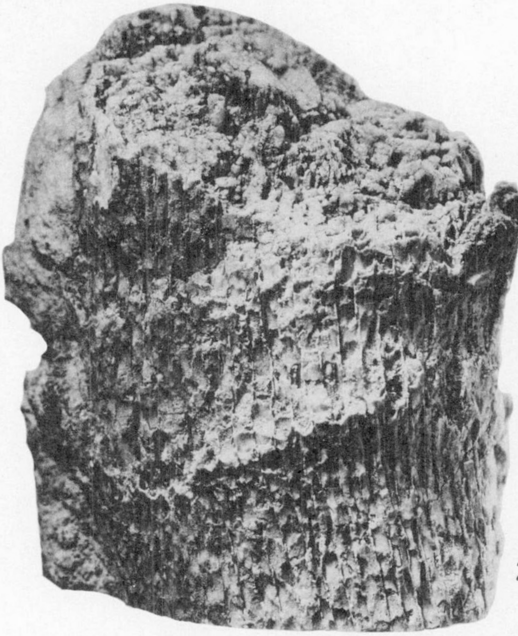
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PLATE XVII

(All figures one and one-half natural size)

Figure 1. *Pseudozaphrentoides*? *burlingi* n. sp. Locality 337, Section 3A, unit 32, Upper Rundle formation, Kakwa-Jarvis Lakes region. (Page 67.)

1*a-c*. Holotype—G.S.C. No. 10616. *a-c*, transverse sections, late and middle ephebic stages.

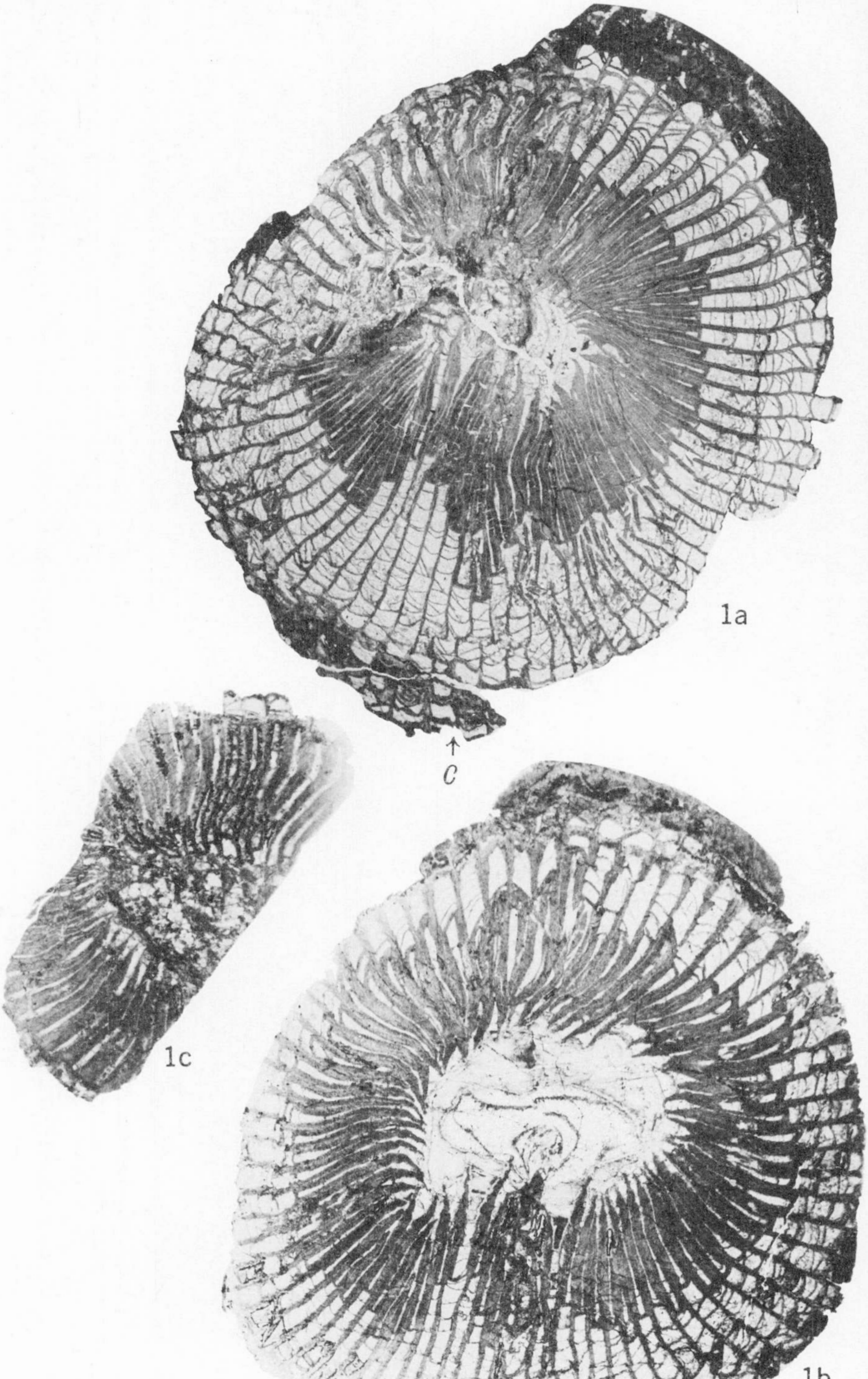
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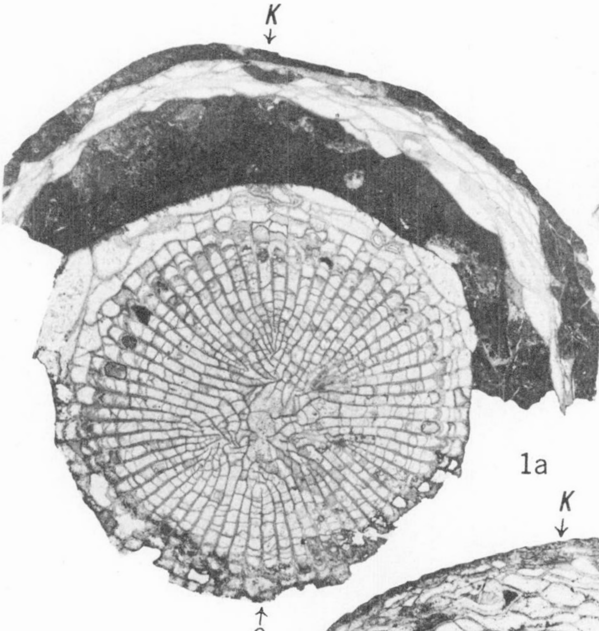
Plate XVIII

(All figures one and one-half natural size)

Figure 1. *Kakwiphyllum dux* Sutherland. Locality 366, Section 3A, Rundle formation, Kakwa-Jarvis Lakes region. (Page 69.)

1*a*-*d*. Holotype—G.S.C. No. 10569. *a*-*c*, transverse sections, late, middle and early ephebic stages. *d*, longitudinal section, at right angle to cardinal-counter plane; drawing taken from thin section. (*a*, *b* and *d after* Sutherland, 1954A.)



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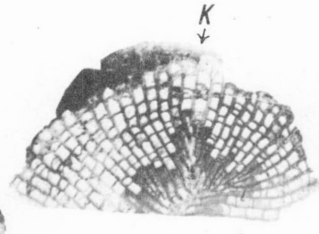

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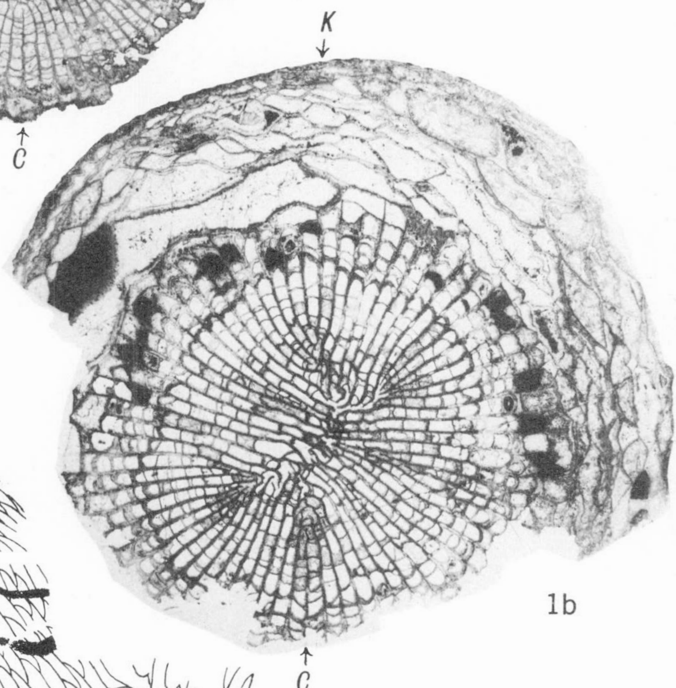

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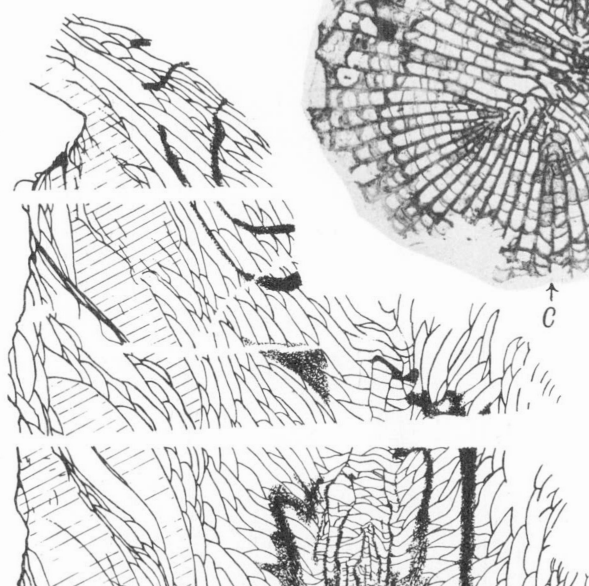

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PLATE XIX

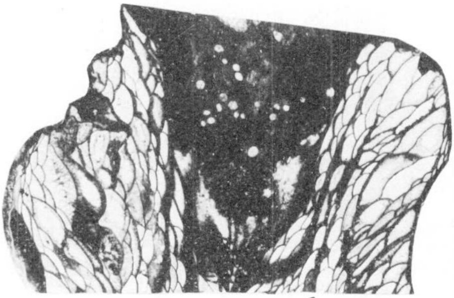
(All figures are natural size)

Figure 1. *Kakwiphyllum* cf. *dux* Sutherland. Isolated locality near South Nahanni River, N.W.T. Mississippian. (Page 70.)

1*a*-*d*. G.S.C. No. 10570. *a*-*b*, transverse sections, late and middle ephebic stages. *c*-*d*, longitudinal sections at right angle to cardinal-counter plane. (*a*, *b* and *d* *after* Sutherland, 1954A.)

Figure 2. *Kakwiphyllum* sp. A. Near top of Banff formation, Carrot Creek, near Banff, Alberta. G.S.C. No. 10617. Transverse section, late ephebic stage. (Page 71.)

Figure 3. *Kakwiphyllum dux* Sutherland. Holotype—G.S.C. No. 10569. Weathered exterior view. (*after* Sutherland, 1954A.) (Page 69.)



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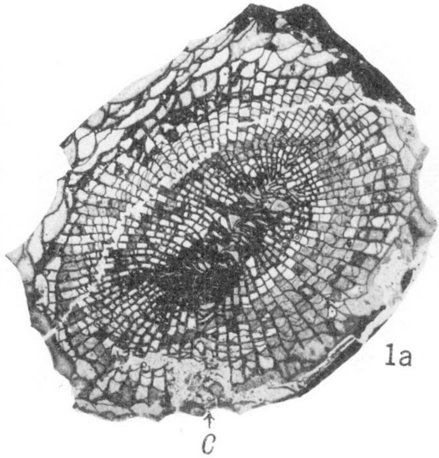

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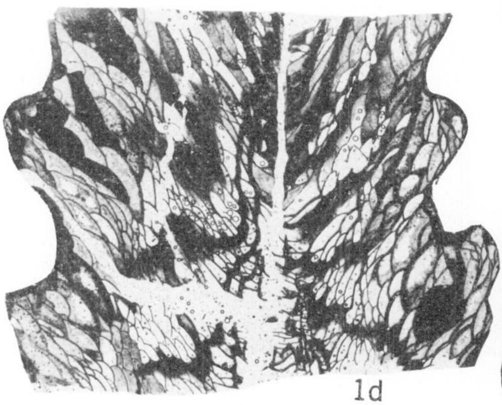

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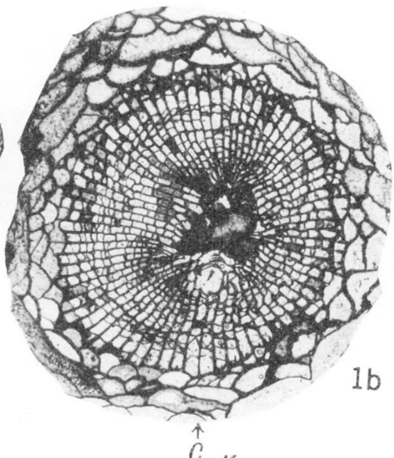

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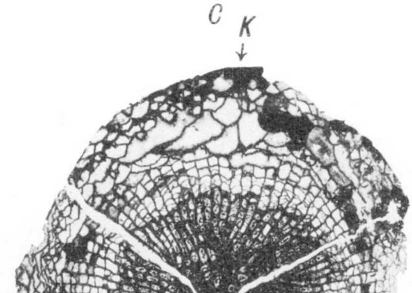

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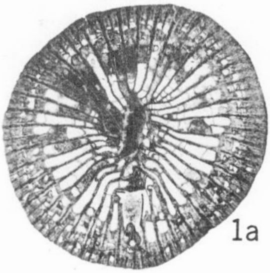
PLATE XX

(All figures twice natural size unless otherwise stated)

Figures 1-2. *Ekvasophyllum* cf. *inclinatum* Parks. Localities 40 and 29, near top Section 11, unit 4, Liard River region. Middle? Mississippian. (Page 77.)

1*a*-*e*. G.S.C. No. 10618. *a*-*d*, transverse sections, late, middle, and early ephebic stages. *e*, part of *b* enlarged to show structure of axial column, x16. Locality 40.

2*a*-*h*. G.S.C. No. 10619. *a*-*d*, transverse sections, ephebic and late neanic stages. *e*, part of *a* enlarged to show structure of axial column, x16. *f*, longitudinal section along cardinal-counter plane. *g*, longitudinal section at right angle to cardinal-counter plane. *h*, part of *g* enlarged to show structure of axial column, x16; note continuation of thickened tabulae with fibrous layers of axial column. Locality 29.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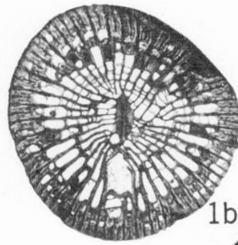
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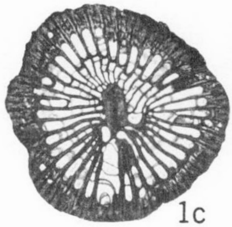
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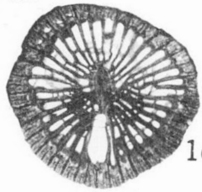
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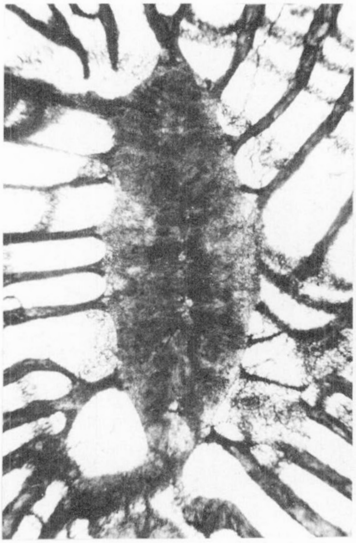
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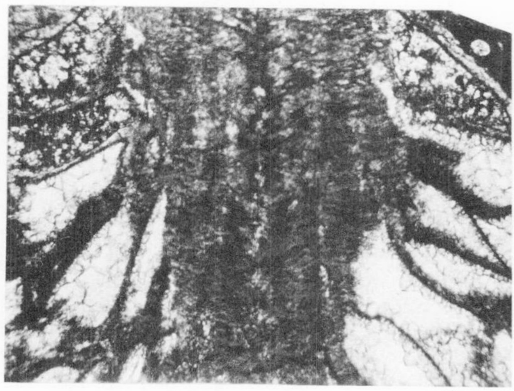
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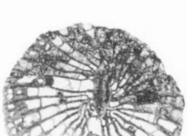
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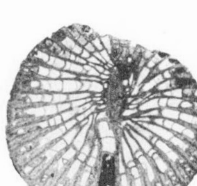
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Plate XXI

(All figures twice natural size unless otherwise stated)

Figures 1-2. *Ekvasophyllum proteus* n. sp. Locality 28, Section 11, unit 4, Liard River region. Middle? Mississippian. (Page 78.)

1*a-o*. Holotype—G.S.C. No. 10620. *a-f*, transverse sections ephebic and late neanic stages; *f* x8. *g*, enlargement of part of *a* to show irregular nature of axial column, x16. *h-k*, enlargement of *b-e* to show development of axial column; *h*, *i*, x6, *j*, *k*, x8. *l*, enlarged drawing of *f*, late neanic stage to show origin of axial column x12. *m*, exterior view x1. *n*, longitudinal section along cardinal-counter plane. *o*, enlargement of *n* to show structure of axial column; note continuation of thickened tabular layers with fibrous layers of axial column.

2*a-e*. Paratype—G.S.C. No. 10621. *a-d*, transverse sections, ephebic and late neanic stages, showing the abrogation, in this instance, of the axial column in the late ephebic stage. *e*, exterior view x1.

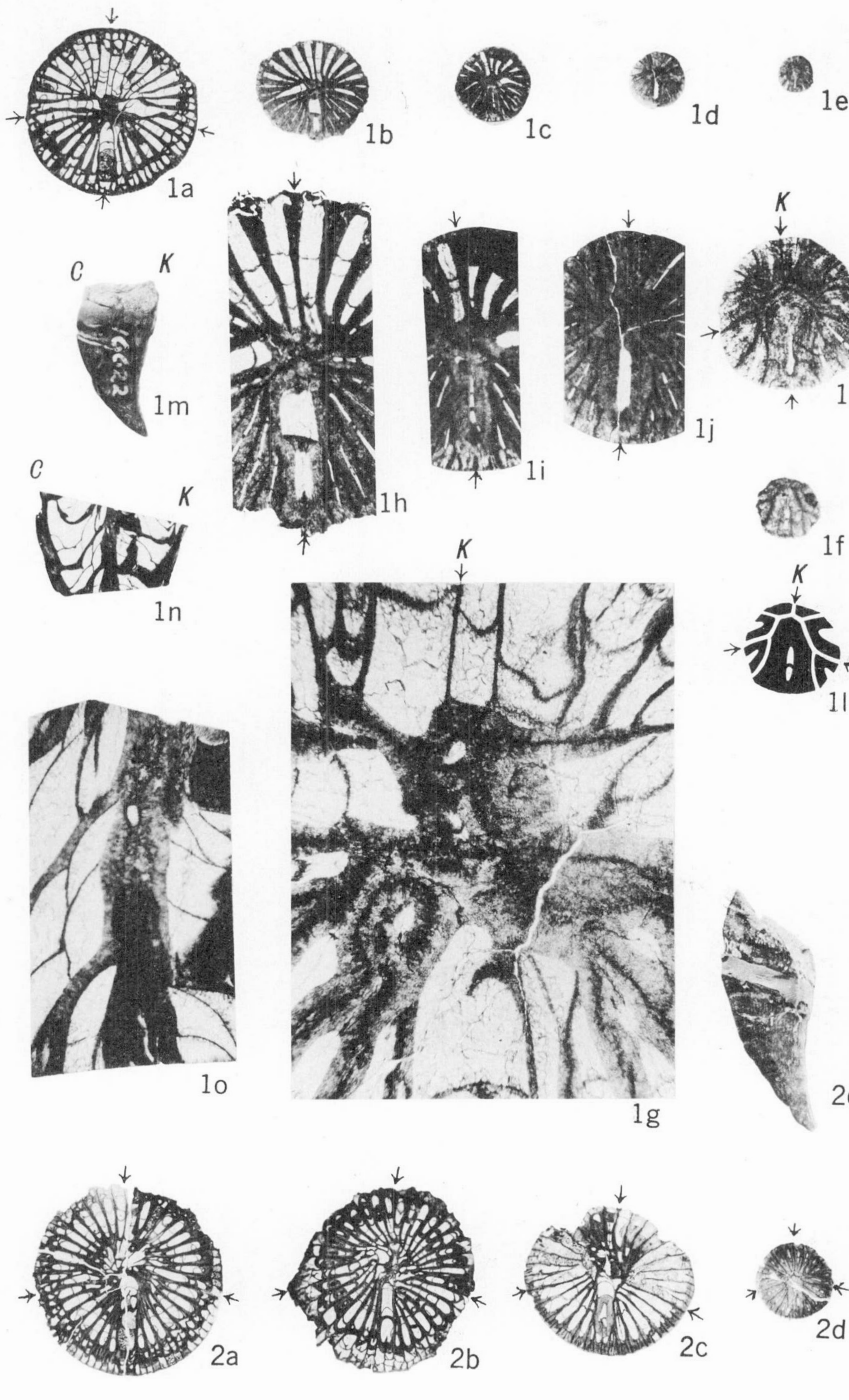
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PLATE XXII

(All figures twice natural size unless otherwise stated)

Figures 1-2. *Ekvasophyllum proteus* n. sp. Locality 28, Section 11, unit 4, Liard River region. Middle? Mississippian. (Page 78.)

1*a-h*. Paratype—G.S.C. No. 10622. *a-d*, transverse sections, ephebic stages. *e*, enlargement of *a*, to show structure of septa and axial column; note flabellate bunching of axial ends of septa, x14. *f*, enlargement of *d* to show structure of axial column in early ephebic stage, x6. *g*, longitudinal section along cardinal-counter plane. *h*, exterior view x1.

2*a-f*. Paratype—G.S.C. No. 10623. *a-c*, transverse sections, ephebic stage. *d-e*, enlargements of *a* and *b* to show development of irregular axial column; note relation of internal lamellae in column to septal ends, x6. *f*, longitudinal section along cardinal-counter plane.

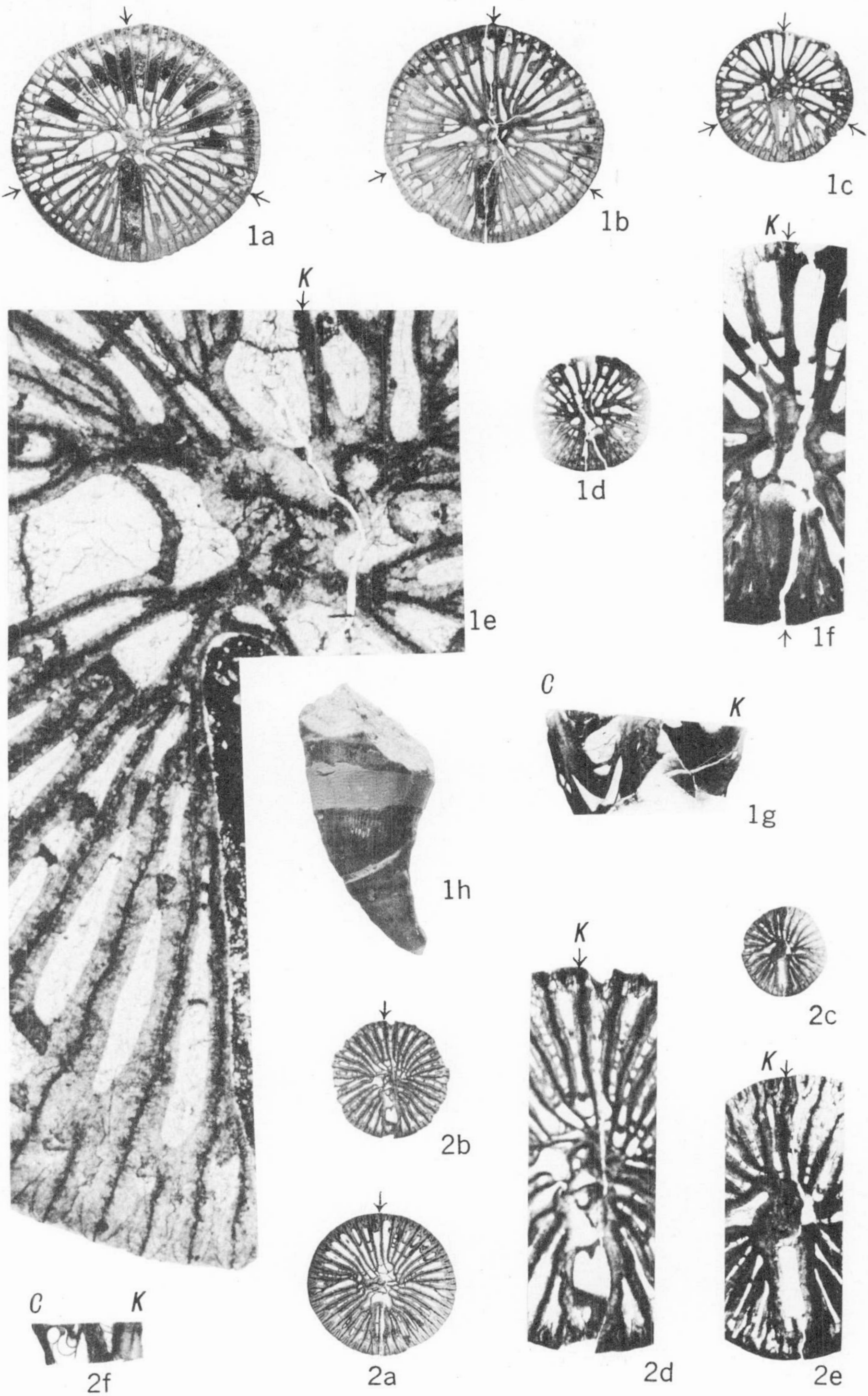
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Plate XXIII

(All figures twice natural size unless otherwise stated)

Figures 1-2. *Ekvasophyllum proteus* n. sp. Locality 28, Section 11, unit 4, Liard River region. Middle? Mississippian. (Page 78.)

1*a*-*k*. Paratype—G.S.C. No. 10624. *a*-*i*, transverse sections, ephebic and late neanic stages. *j*, enlargement of *i*, late neanic stage, note joining of septa at axis, but lack of an axial column, x8. *k*, enlargement of *c* to show septal ends joining irregular axial column.

2*a*-*f*. Paratype—G.S.C. No. 10625. *a*-*c*, transverse sections, ephebic stage; note change in shape of axial column from elongated in *c* to kidney-shaped in *b* to elongated in *a*. *d*, enlargement of *a* to show structure of axial column, x16. *e*, longitudinal section through calyx, at right angle to cardinal-counter plane. *f*, enlargement of *e* to show structure of axial column; note continuation of tabulae with fibrous layers of axial column and amplexoid nature of septa in late ephebic stage.

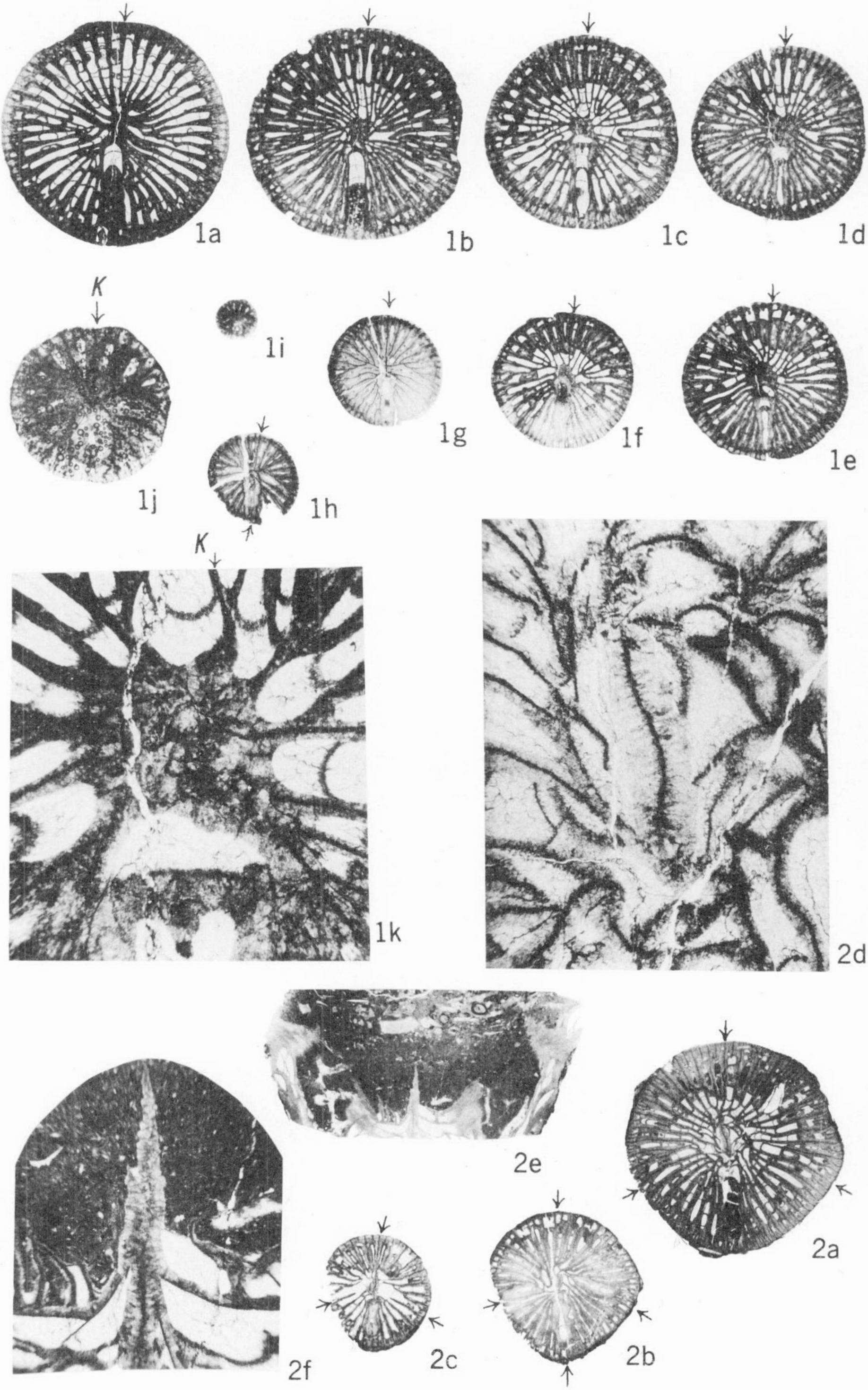
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PLATE XXIV

(All figures twice natural size unless otherwise stated)

Figures 1-3. *Ekvasophyllum proteus* n. sp. Locality 28, Section 11, unit 4, Liard River region. Middle? Mississippian. (Page 78.)

1*a-j*. Paratype—G.S.C. No. 10626. *a-f*, transverse sections, ephebic and late neanic stages. *g-h*, enlargements of *a* and *d* to show structure of axial column; note flabellate bunching of septal ends before reaching axial column, x16. *i*, longitudinal section at right angle to cardinal-counter plane. *j*, enlargement of *i* to show structure of axial column, which in this case appears simple in structure, x8.

2*a-c*. Paratype—G.S.C. No. 10627. *a-b*, transverse sections, late and early ephebic stages. *c*, exterior view, x1.

3. Paratype—G.S.C. No. 10628. Transverse section, late ephebic stage; note union of septal ends from one cardinal quadrant with axial column.

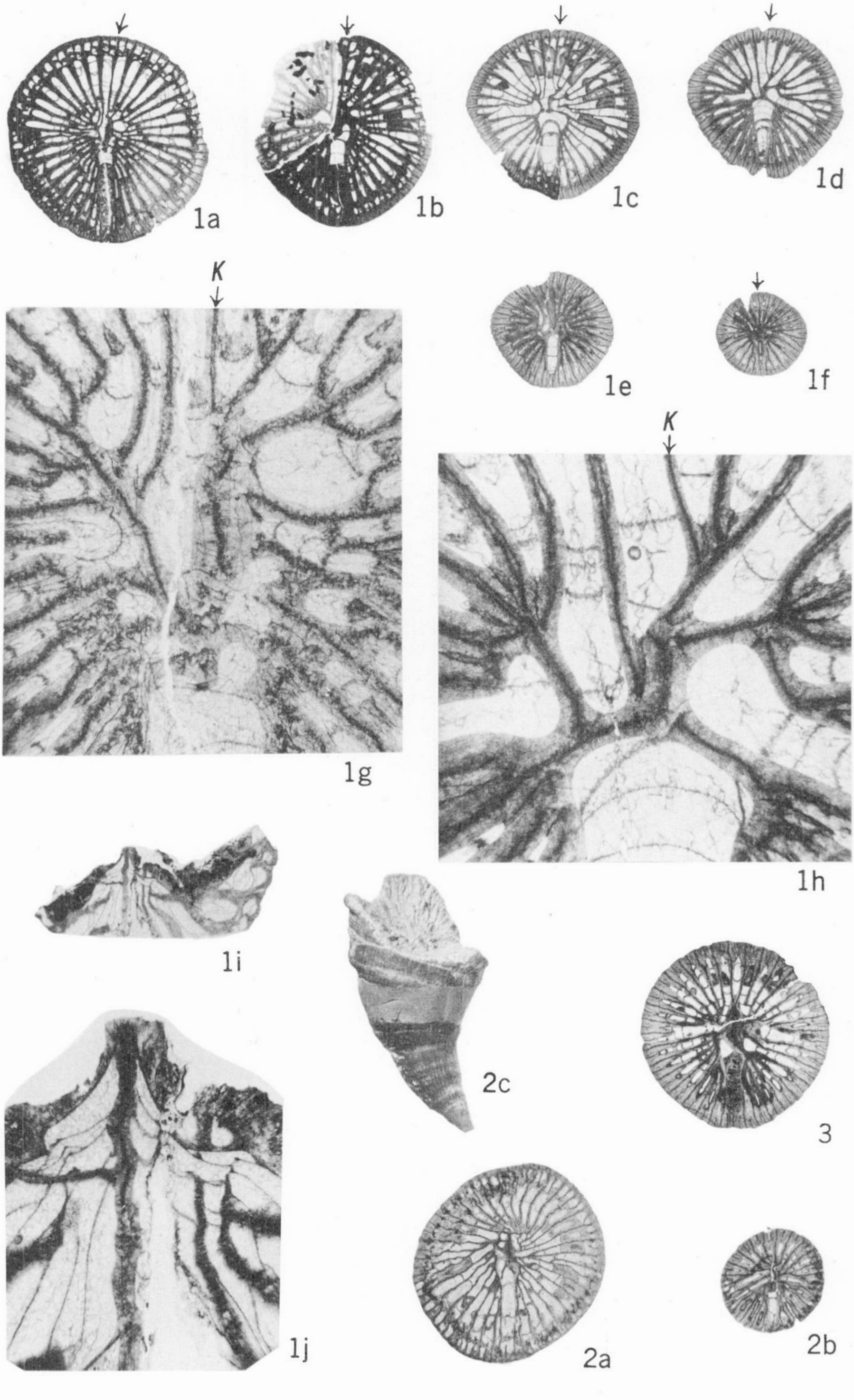
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PLATE XXV

(All figures twice natural size unless otherwise stated)

Figures 1-3. *Ekvasophyllum proteus* n. sp. Locality 28, Section 11, unit 4, Liard River region. Middle? Mississippian. (Page 78.)

1*a*-*m*. Paratype—G.S.C. No. 10629. *a*-*i*, transverse sections, late, middle, early ephebic, late and middle neanic stages; *f*-*h*, at x3; *i*, at x8; note joining of septa at axis in early stages but lack of axial column until *f*. *j*-*k*, enlargements of *c* at x16 and x8 to show structure of axial column and septa. *l*, longitudinal section along cardinal-counter plane. *m*, exterior view of earlier part of specimen, x1.

2*a*-*h*. Paratype—G.S.C. No. 10630. *a*-*e*, transverse sections, late, middle, early ephebic and late neanic stages; *e* at x3; note presence of axial column in early stages but absence of a column in *a* and *b*. *f*. enlargement of *d* to show irregular shape of axial column in early ephebic stage, x6. *g*, longitudinal section along cardinal-counter plane; note abrogation of axial column in middle of section. *h*, exterior view, x1.

3*a*-*c*. Paratype—G.S.C. No. 10631. Transverse sections, late, middle, and early ephebic stages; note joining of septa axially but lack of an axial column.

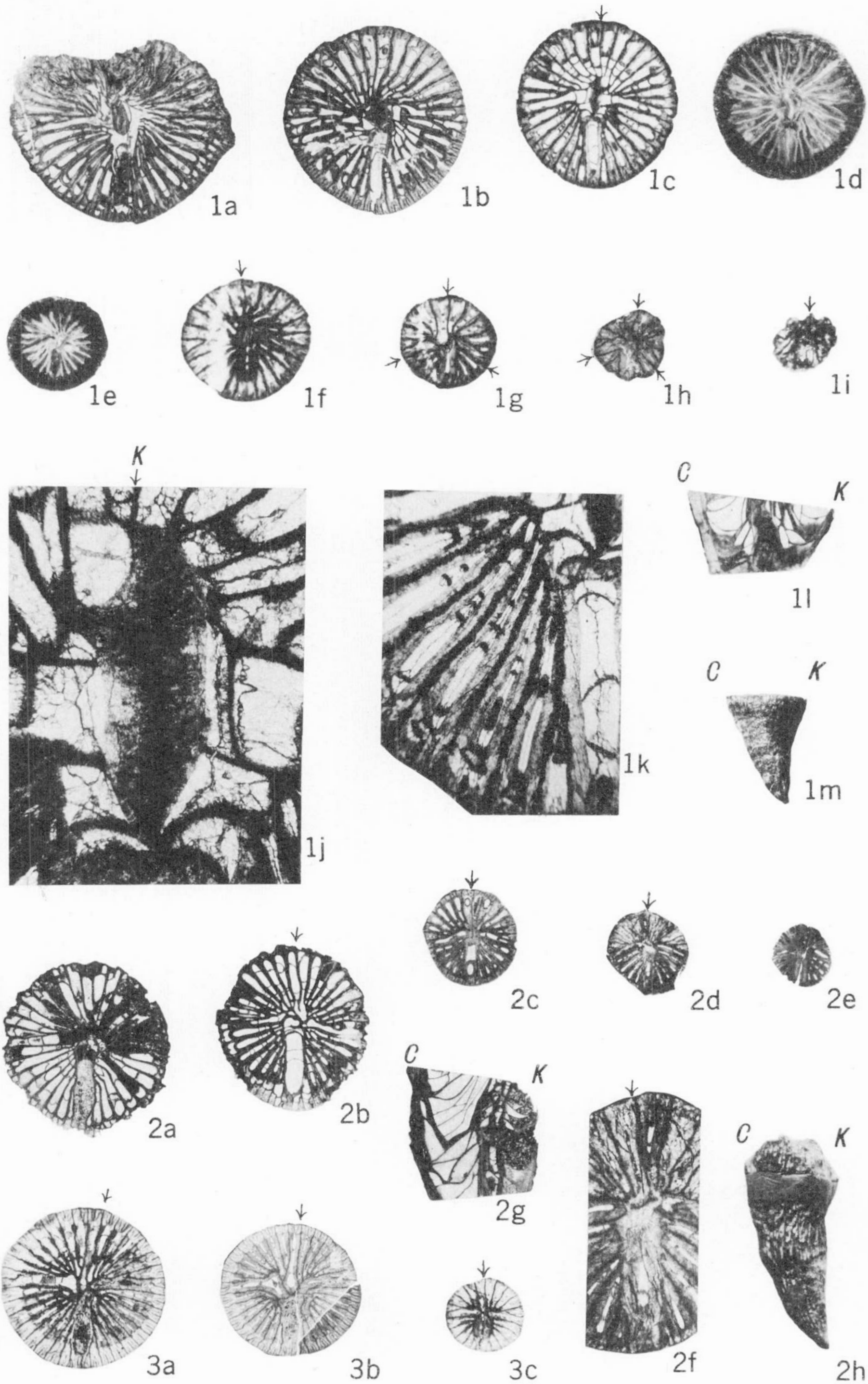
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Plate XXVI

(All figures twice natural size unless otherwise stated)

Figures 1-3. *Ekvasophyllum proteus* n. sp. Locality 28, Section 11, unit 4, Liard River region. Middle? Mississippian. (Page 78.)

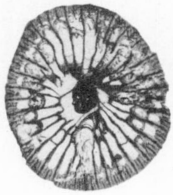
1*a*-*i*. Paratype—G.S.C. No. 10632. *a*-*d*, transverse sections, late, middle, and early ephebic and late neanic stages. *e*-*h*, enlargements of *a*-*d* to show changes in structures in development of axial column; note lack of column in *h*, neanic stage, presence of irregular column in *g* and *f*, and the appearance of *e*, late ephebic stage, of septal lamellae; *e*-*g* at x16 and *h* at x8. *i*, longitudinal section along cardinal-counter plane.

2. Paratype—G.S.C. No. 10633. Transverse section, early ephebic stage, showing lamellae-like projections from axial column which otherwise appears simple. Specimen not mature.

3. Paratype—G.S.C. No. 10634. Transverse section, ephebic stage showing lamellae-like projections from otherwise simple axial column.

Figure 4. *Ekvasophyllum* cf. *enclinotabulatum* n. sp. Locality 45, Prophet formation, Sikanni River region. Middle? Mississippian. (Page 81.)

4*a*-*b*. G.S.C. No. 10635. *a*, transverse section, ephebic stage. *b*, enlargement of *a* to show structure of axial column, x16.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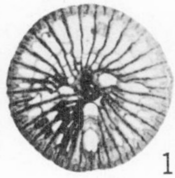
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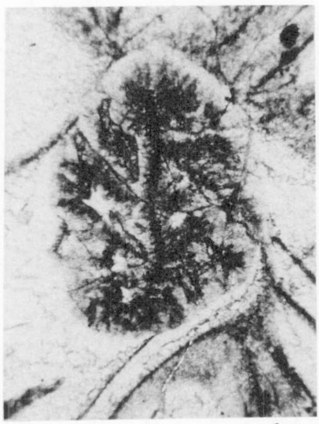
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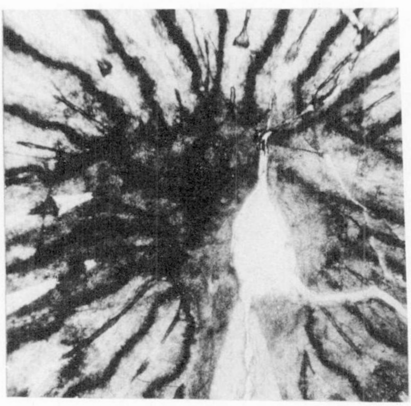
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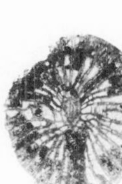
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PLATE XXVII

(All figures twice natural size unless otherwise stated)

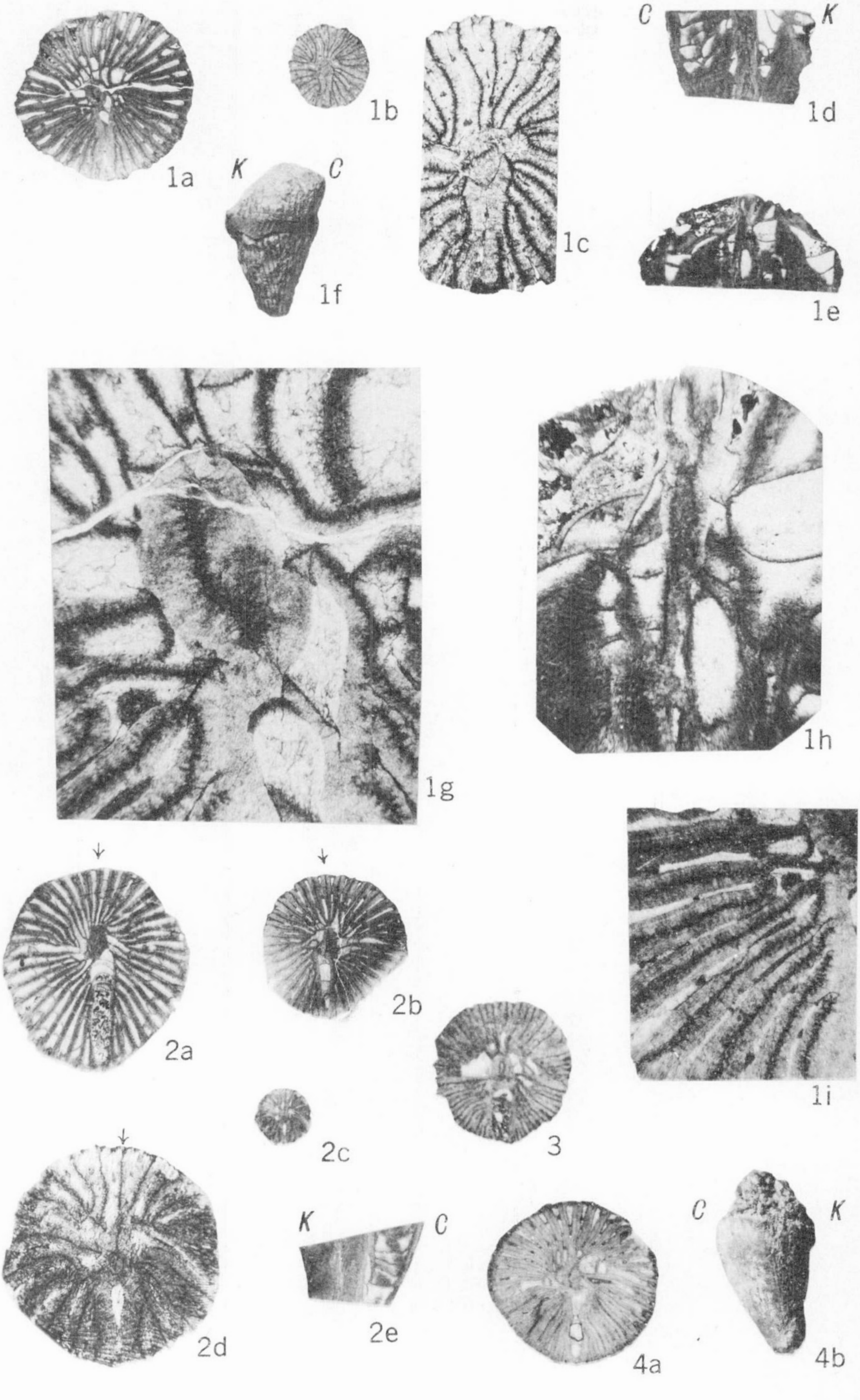
Figures 1-4. *Ekvasophyllum enclinotabulatum* n. sp. Locality 82, Prophet formation, Member B, Halfway River region. Middle? Mississippian. (Page 81.)

1*a*-*i*. Holotype—G.S.C. No. 10636. *a*-*b*, transverse sections, middle and early ephebic stages. *c*, enlargement of *b* to show structure of axial column. *d*, longitudinal section, ephebic stage, along cardinal-counter plane. *e*, longitudinal section, late ephebic stage, at right angle to cardinal-counter plane. *f*, exterior view of water-worn corallite, x1. *g*, enlargement of *a* to show structure of axial column, x16. *h*, enlargement of *e* to show longitudinal structure of axial column; note vertical plates within column in late ephebic stage, x16. *i*, enlargement of *a* to show septal structure, x8.

2*a*-*e*. Paratype—G.S.C. No. 10637. *a*-*c*, transverse sections, late and middle ephebic and early neanic stages. *d*, enlargement of *c* to show nature of axial column, x8. *e*, longitudinal section, early ephebic stage; note continuation of tabulae with fibrous layers of axial column.

3. Paratype—G.S.C. No. 10638. Transverse section, middle ephebic stage; note open space at centre of axial column and tendency of septa to withdraw from axis.

4*a*-*b*. Paratype—G.S.C. No. 10639. *a*, transverse section, middle ephebic stage. *b*, exterior view of water-worn corallite, x1.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C K
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K C
1f
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1e
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1h
2a
2b
3
1i
2c
2d
K C
2e
4a
C K
4b

Plate XXVIII

(All figures twice natural size unless otherwise stated)

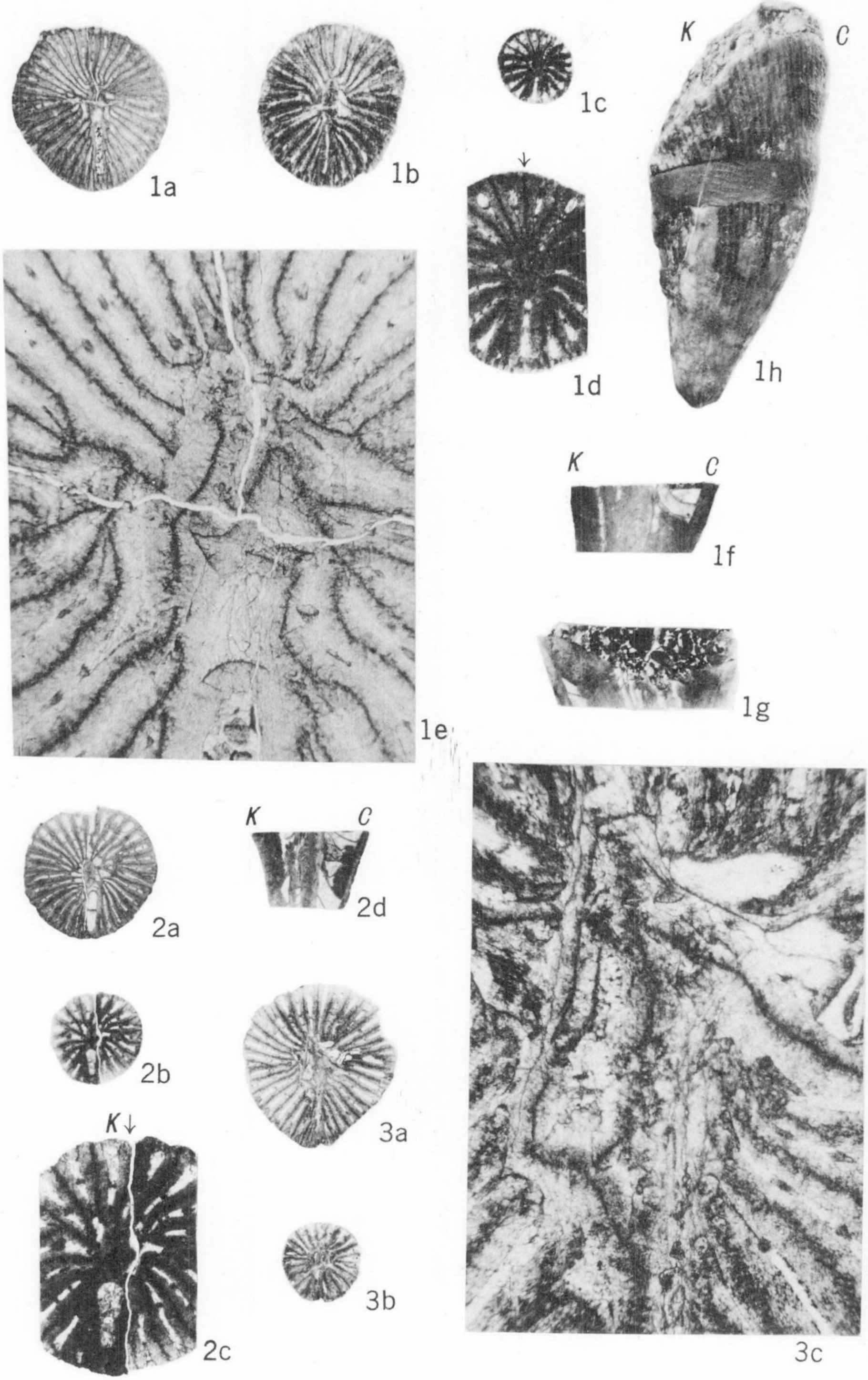
Figures 1-2. *Ekvasophyllum enclinotabulatum* n. sp. Locality 82, Prophet formation, Member B, Halfway River region. Middle Mississippian. (Page 81.)

1*a-h*. Paratype—G.S.C. No. 10640. *a-c*, transverse sections, late and middle ephebic and early neanic stages. *d*, enlargement of *c* to show early development of axial column, x8. *e*, enlargement of *a* to show structure of axial column; note irregular joining of lamellae column, x16. *f*, longitudinal section along cardinal-counter plane. *g*, longitudinal section through calyx at right angle to cardinal-counter plane. *h*, water-worn exterior.

2*a-d*. Paratype—G.S.C. No. 10641. *a-b*, transverse sections, middle and early ephebic stages. *c*, enlargement of *b* to show early structure of axial column. *d*, longitudinal section along cardinal-counter plane.

Figure 3. *Ekvasophyllum*? *harkeri* n. sp. Locality 82, Prophet formation, Member B, Halfway River region. Middle Mississippian. (Page 83.)

3*a-c*. Paratype—G.S.C. No. 10642. *a-b*, transverse sections, middle ephebic and late neanic stages. *c*, enlargement of *a* to show irregular, open, complex axial column, x16. (For longitudinal sections *see* Plate XXIX, fig. 2.)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1c
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K
C
1h
1e
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C
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1g
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C
2a
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2b
3a
K↓
3b
2c
3c

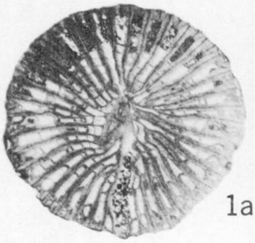
Plate XXIX

(All figures twice natural size unless otherwise stated)

Figures 1-2. *Ekvasophyllum*? *harkeri* n. sp. Locality 82, Prophet formation, Member B, Halfway River region. Middle Mississippian. (Page 83.)

1*a-h*. Holotype—G.S.C. No. 10643. *a-c*, transverse sections, ephebic stages. *d*, exterior view, x1. *e-f*, enlargements of *a* and *c* to show changes in structure of axial column, x16. *g*, longitudinal section through calyx at right angle to cardinal-counter plane. *h*, enlargement of *g* to show structure of axial column, x16.

2*a-d*. Paratype—G.S.C. No. 10642. *a*, longitudinal section across weathered calyx at right angle to cardinal-counter plane. *b*, longitudinal section at right angle to cardinal-counter plane. *c*, water-worn exterior, x1. *d*, enlargement of *a* to show irregular structure of axial column; note vertical plates supporting column, x16. For transverse sections *see* Plate XXVIII, fig. 3.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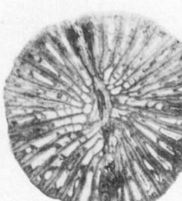
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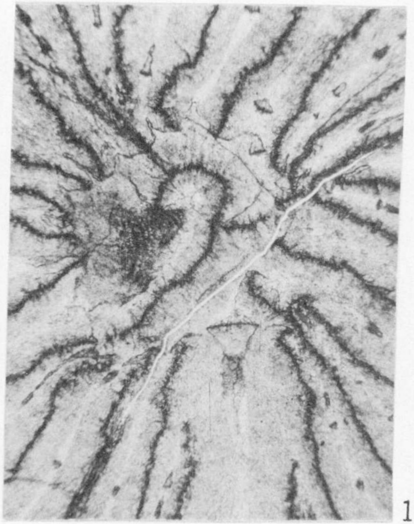
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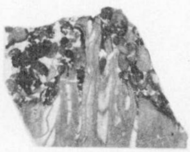
2a


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2c


2d

PLATE XXX

(All figures twice natural size unless otherwise stated)

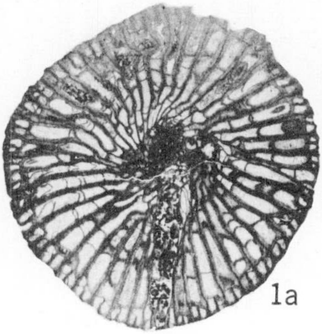
Figure 1. *Dibunophyllum*? sp. A. Locality 82, Prophet formation, Member B, Halfway River region. Middle Mississippian. (Page 85.)

1*a-e*. G.S.C. No. 10644. *a-d*, transverse sections, ephebic stages; note changes in development of axial column. *e*, enlargement of *b* to show structure of axial column; note well developed septal lamellae, x16.

Figure 2. *Dibunophyllum*? sp. B. Locality 28, Section 11, unit 4, Liard River region. Middle? Mississippian. (Page 86.)

2*a-f*. G.S.C. No. 10645. *a*, *d*, and *e*, transverse sections; *b-c*, transverse oiled surfaces, ephebic and late neanic stages; note change from simple to complex axial column. *f*, longitudinal section at right angle to cardinal-counter plane.

Figure 3. Hand specimen of crinoidal limestone. Locality 82, Prophet formation, Member B, Halfway River region, containing many water-worn solitary rugose corals, x1.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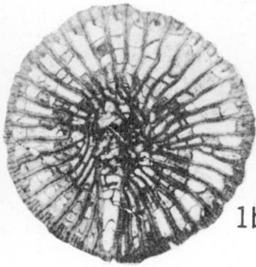
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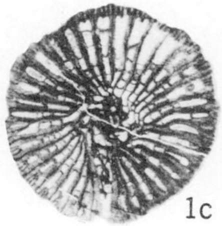
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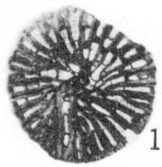
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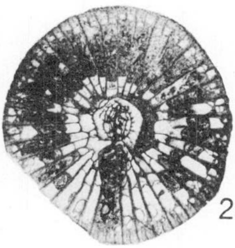
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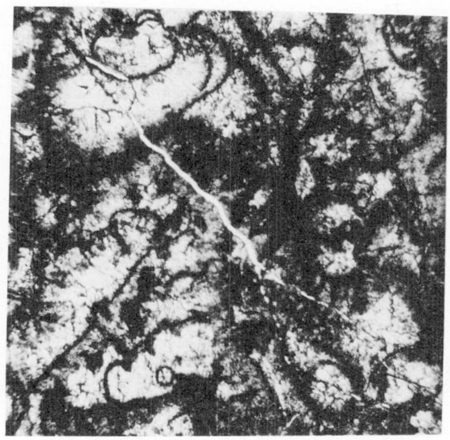
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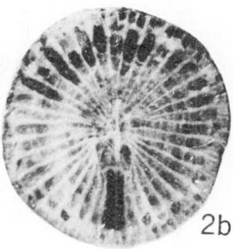
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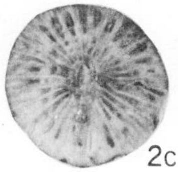
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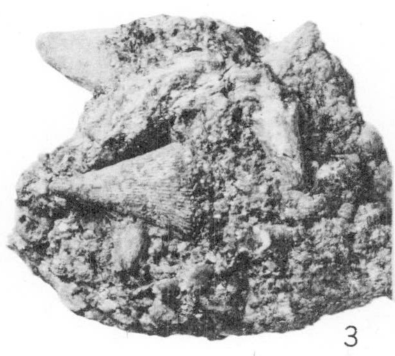
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PLATE XXXI

(All figures twice natural size unless otherwise stated)

Figure 1. Genus and species undetermined-A. Locality 28, Section 11, unit 4, Liard River region. Middle? Mississippian. (Page 87.)

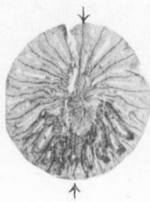
1*a-f*. G.S.C. No. 10646. *a-c*, transverse sections, ephebic stage. *d-e*, enlargements of *a* and *b* to show nature of columella and septal structure, x6. *f*, exterior view, x1.

Figure 2. Genus and species undetermined-B. Locality 370, Section 3A, unit 13, upper Banff formation, Kakwa-Jarvis Lakes area. (Page 87.)

2*a-b*. G.S.C. No. 10647. Transverse sections, late and early ephebic stages.

Figure 3. *Lithostrotion* cf. *whitneyi* Meek. Locality 284, Pine River area. Middle? Mississippian. G.S.C. No. 10648. Transverse section, showing frequent lateral budding. (Page 93.)

1a



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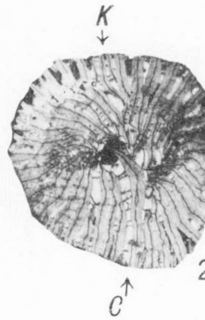

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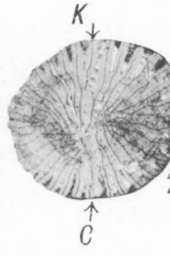

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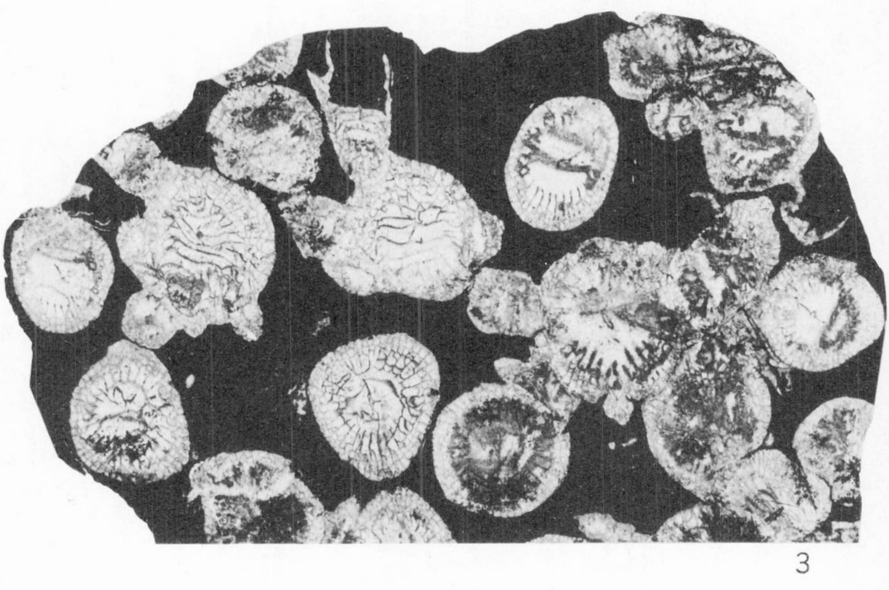


3

Plate XXXII

(All figures twice natural size unless otherwise stated)

Figures 1-3. *Lithostrotion* cf. *pauciradiale* (McCoy) and *Diphyphyllum* sp. B. Locality 89, Section 8, Prophet formation, Prophet-Muskwa area. Middle Mississippian. (Page 92.)

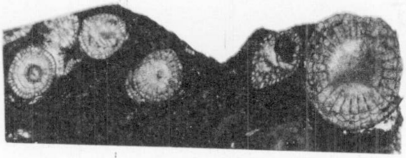
1-2. G.S.C. Nos. 10649, 10650. Transverse sections of different specimens with corallites of the two above listed species interwoven, the larger single corallites in each figure being *Diphyphyllum* sp. B.

3*a*-*c*. G.S.C. No. 10651. *a*-*b*, transverse sections of typical corallites, *a* at x4. *c*, longitudinal section of a single corallite, x4.

Figure 4. *Lithostrotion* [*Diphyphyllum*] sp. A. Locality 366, Rundle formation, Kakwa-Jarvis Lakes region. Middle Mississippian. (Page 98.)

4*a*-*d*. G.S.C. No. 10652. *a*, *b*, *d*, serial transverse sections with *a* the later; *c*, longitudinal section between *b* and *d*; all trace development of three corallites and show the discontinuous nature of columella.

Figure 5. *Lithostrotion* [*Diphyphyllum*] aff. *proliferum* (Thomson and Nicholson). Locality 38, Section 11, unit 5, Liard River region. Middle Mississippian. G.S.C. No. 10653. Transverse section, mature corallites. (Page 97.)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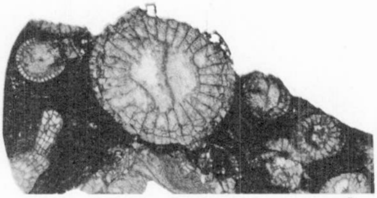
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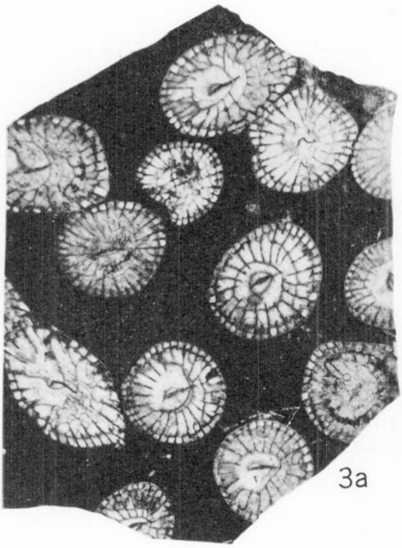
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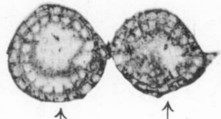
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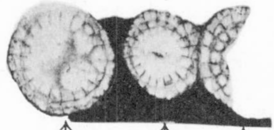
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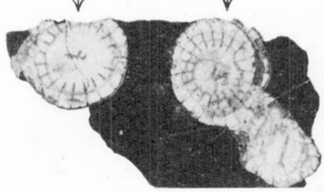
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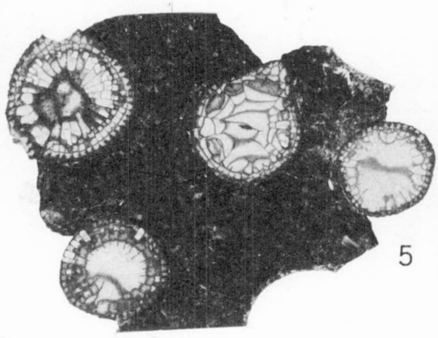
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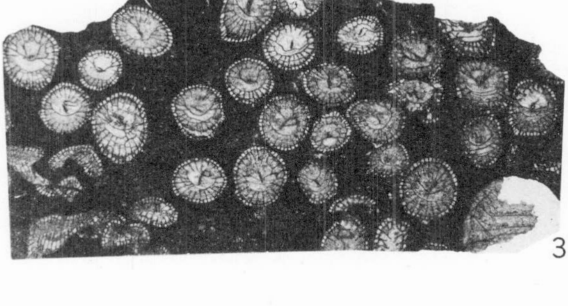
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PLATE XXXIII

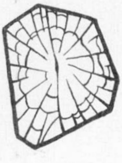
(All figures twice natural size unless otherwise stated)

Figure 1. *Lithostrotion* [*Lithostrotionella*] [*Thysanophyllum*] *mclareni* n. sp. Locality 85, near top of Prophet formation, Section 8, Prophet-Muskwa area. Middle Mississippian. (Page 95.)

1*a-g*. Holotype—G.S.C. No. 9666. *a-c*, enlarged drawings of typical corallites of the *Lithostrotion*, *Lithostrotionella* and *Thysanophyllum* types, x6, (*after* McLaren and Sutherland, 1949). *d-e*, transverse sections, x4. *f-g*, longitudinal sections of the *Lithostrotion* and *Thysanophyllum* type corallites, x4, (*after* McLaren and Sutherland).

Figure 2. *Lithostrotion* [*Diphyphyllum*] aff. *mutabile* Kelley. Locality 34, Liard River region. Mississippian. (Page 96.)

2*a-b*. G.S.C. Nos. 10654, 10655. Transverse sections.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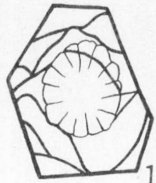
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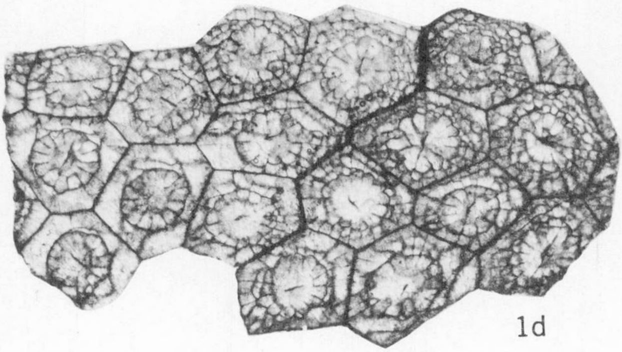
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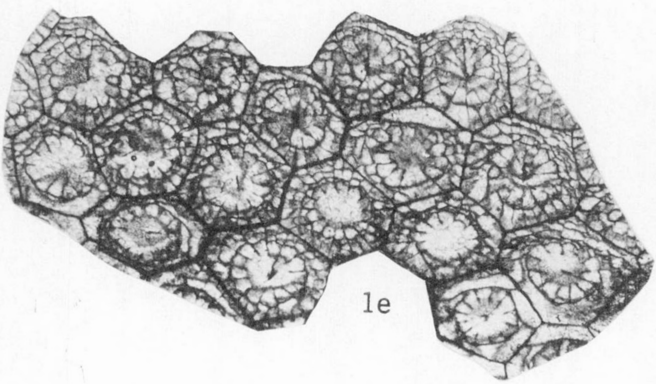
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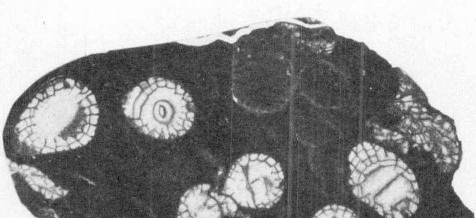
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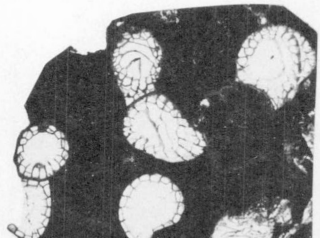
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INDEX

Numbers in **bold**-face type indicate pages where families, genera and species are described.