PALEONTOLOGY OF THE LOWER CAMBRIAN ARCHAEOCYATHA-BEARING FORTEAU FORMATION IN SOUTHERN LABRADOR

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OF

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SOUTHERN LABRADOR

BY

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1967

Submitted in partial fulfillment of the

requirements for the degree of

MASTER OF SCIENCE

MEMORIAL UNIVERSITY OF NEWFOUNDLAND, 1967

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ABSTRACT

A fossil assemblage, characterised by reef-forming archaeocyathids and calcareous algae, of Lower Cambrian age is present in the carbonate and shale members in the Forteau formation of the Labrador Series, exposed along the southern coast of Labrador.

Nineteen species of archaeocyathids are described and assigned to eight genera. New taxa comprise one new genus (Sigmosyringocyathus) and four species. Seven archaeocyathid species are reported for the first time from Labrador Cambrian strata. The present study suggests re-establishing Genus Exocyathus which was eliminated by V.J. Okulitch in 1946; and the elimination of Genus Claruscyathus Vologdin, 1932.

Fossil calcareous algae comprise seven species and are assigned to four genera. Four new species including a dasyclad alga, Seletonella forteauensis nov. sp., are reported.

Other fossils including trilobites, brachiopods, and cephalopods, present in the Forteau formation are also described.

CHAPTER I

INTRODUCTION

LOCATION AND AREA

The regional setting of the thesis area is in southern Labrador along the northern coast of the Strait of Belle Isle. The area covers a surface extent of approximately 200 square miles, and lies between North Latitude $51^{\circ}23'$ and $51^{\circ}38'$, and West Longitude $56^{\circ}42'$ and $57^{\circ}15'$ (Plate 1).

PREVIOUS WORK

Although the area to be discussed has been well-known for its archaeocyathid fossils, for over a hundred years very few geologists have visited it.

The first geologist to visit the area was O. M. Lieber in 1860. One year later, in 1861, James Richardson of the Geological Survey of Canada made an extensive study of the Cambrian geology in the area and collected archaeocyathid fossils; unfortunately most of his archaeocyathid fossils were lost when the ship on which they were being transported to Montreal sank. The results of Richardson's work were presented by E. Billings in 1862 and W. Logan in 1863. In 1872 T. C. Weston was sent by Sir William Logan to the northern coast of the Strait of Belle Isle to collect additional Lower Cambrian fossils, and his collection arrived safely in Montreal.

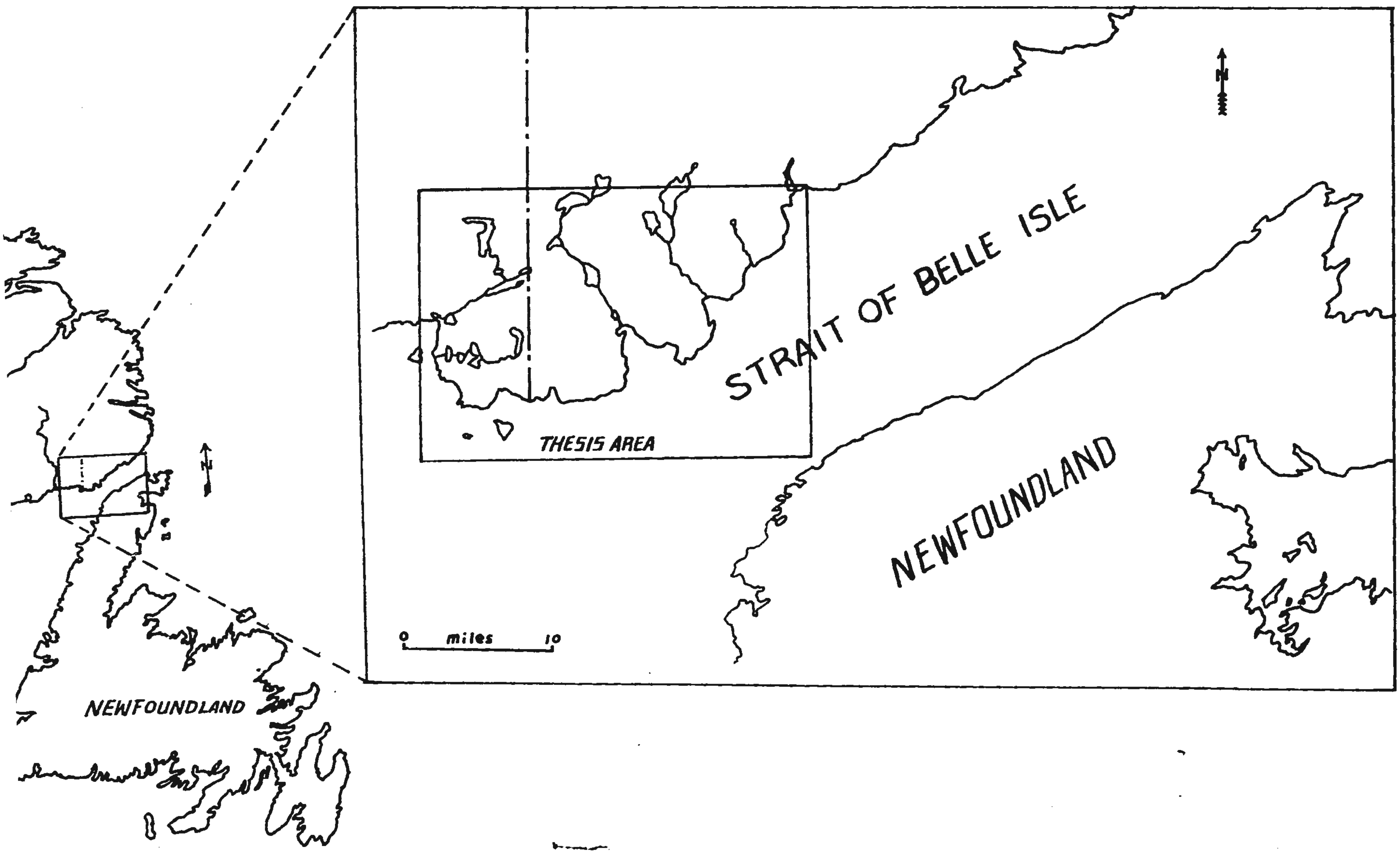


Plate 1. Index Map of Thesis Area

In 1891, A.S. Packard published his work on the geography of the Labrador coast, which includes some geological observations. R.A. Daly visited this part of the coast in 1900, and made some general observations on its geology.

C. Schuchert and W.H. Twenhofel in 1910, and C.O. Dunbar and T.S. Lovering in 1920 studied the stratigraphy of the southern coast of Labrador and proposed the name Labrador Series for the Cambrian sedimentary sequence found in the area. Schuchert and Dunbar in Stratigraphy of Western Newfoundland, Memoir 1, published in 1934 by the Geological Society of America, subdivided the Labrador Series into two formations: a lower Bradore Formation comprising sandstones, and an upper Forteau Formation made up of limestones and shale. Although in this publication only a brief description was given of the Labrador Series in the area, this Memoir has been most helpful to the present writer's work both in the field as well as in the laboratory.

Since the publication of Schuchert's and Dunbar's book in 1934, little new work has been done on this portion of the northern coast of the Strait of Belle Isle. In 1951, A.M. Christie mapped and studied the geology of the southern coast of Labrador from Forteau Bay to Cape Porcupine. However his report of the Lower Cambrian Labrador Series contained no new information but rather repeated Schuchert's and Dunbar's observations.

ACKNOWLEDGEMENTS

The writer wishes to express his sincere gratitude to all who assisted him in any way during the preparation of this thesis. He is especially indebted to Dr. R.D. Hughes of Memorial University of Newfoundland, under whose supervision this thesis was written and who collected a suite of archaeocyathid fossils from Labrador during the summer of 1965. Through the examination of this collection the writer was able to acquaint himself with fossils of this phylum before he carried out his field work in the summer of 1966. The writer is also indebted to Dr. W.D. Brueckner, Professor of Geology, Memorial University of Newfoundland, who offered helpful suggestions and kind encouragement. The writer is grateful for financial assistance provided by Memorial University of Newfoundland through a University Fellowship for the period October 1965 to April 1966 and by The Geological Survey of Canada which awarded Dr. R. Hughes Research Grant 20-65 used to support the writer's researches from May 1966 to July 1967. Without these financial aids this work would have been impossible.

CHAPTER II

PHYSIOGRAPHY

Physiography of the thesis area is largely controlled by the lithology of the bedrock of the area. Underlying the whole area is a stable "granite" mass which forms the extreme south-eastern exposed margin of the Canadian Shield. This stable "granite" mass belongs to the Precambrian Grenville Series which in this area is mostly granite, granitic gneiss, and gneiss, and shows a very gentle relief with the elevations of its undulating surface ranging from near sea-level to slightly over five hundred feet in height. Overlying the Precambrian crystalline basement is a series of Lower Cambrian sedimentary rocks, termed the Labrador Series. These sedimentary beds are mostly horizontal except locally where strata dip gently southward towards the Strait of Belle Isle. This seaward inclination where present is very slight with dip angles ranging up to only five degrees, but further inland even this low inclination is no longer retained and the dip angle is so low as to be unmeasurable.

The mapped area as a whole is smooth to gently rolling as contrasted with the rugged granitic topography found further inland and beyond the eastern and western ends of the area. Along the coast line at Point Amour and Forteau Point the headlands rise out of the sea in gentle slopes and continue to heights of about six hundred feet above sea-level. The remainder of the coast line at Capstan Island, from L'anse au Diable to L'anse au Loup, and from L'anse au Clair to Blanc Sablon is guarded on the seaward side by bold cliffs of Bradore quartzitic sandstone three to four hundred feet in height. Inland from the coast line the area rises to nearly eight hundred feet in height, with the exception of a small hill at the heads of L'anse au Loup and L'anse au Diable Valleys which rises to an altitude of 1,117 feet.

The area is transected by several southeastward flowing rivers into four blocks of different sizes. These rivers, from the east to the west, are: L'anse au Diable River, L'anse au Loup River, Forteau River, and Blanc Sablon River; and are fed with rain and melt water running down the slopes of the rugged hills north of the mapped area. These rivers empty into either coves or bays where they reach the Strait of Belle Isle. Bays or coves considered to be of stream erosion origin include L'anse au Diable Bay, L'anse au Loup Bay, Forteau Bay, and Blanc Sablon Bay. Short, smaller streams whose headwaters do not reach the "granite" inland area empty into the Strait of Belle Isle at L'anse Amour Bay, and L'anse au Clair Bay. River valleys of L'anse au Diable River, L'anse au Loup River, Forteau River, and Blanc Sablon River are relatively wide, U-shaped, and underlain by the same crystalline basement which is exposed in the rolling hills also found in the valleys. Although the valleys are wide, the channels of these rivers are narrow and deep probably as a result of the lithologic control of topography in the mapped area. Lakes and rapids are distributed along these rivers and in valleys, and are believed to be topographic features resulting from the irregularity of the erosional surface of the granitic basement. Tributaries that flow down the steep sides of the U-shaped valley are seen to join the main streams at right angles. These tributaries are short and many are intermittent.

On hills throughout the area terraces and cliffs, from twenty to thirty feet in height, have been formed through differential erosion of the Forteau Formation. Terraces were formed both at places where the hard resistant Bradore sandstone was overlain by less resistant Forteau Formation beds and where shale and limestone interbeds of the Middle Member overlie the more resistant archaeocyathid reef limestones of the Lower Member of the Forteau Formation. These terraces were first observed by Twenhofel and Schuchert and were interpreted as elevated marine terraces. Later, in 1920, Dunbar pointed out that these terraces were formed through differential erosion in unequally resistant flatlying strata. The present writer agrees with the latter interpretation. Cliffs were formed in the same way as the terraces through differential erosion. The resistant archaeocyathid reefs of the Forteau Formation are cliff-forming.

The only evidence observed of glacial activity in the mapped area is huge erratics of Bradore sandstone and Precambrian granitic rocks seen resting on top of Forteau formation on some of the hills.

STRUCTURE

The mapped area shows no evidence of tectonic disturbance; however several epeirogenic movements in Post-Cambrian time raised the area above sea-level exposing the Paleozoic sequence to subaerial agents of erosion.

CHAPTER III

STRATIGRAPHY

GENERAL STATEMENT

Sedimentary rocks of Lower Cambrian age are present throughout most of the mapped area. This Lower Cambrian sedimentary sequence, named the Labrador Series by Schuchert and Dunbar (1934), has been divided into two formations: a lower Bradore Formation which contains very coarse sandstone with local feldspathic conglomeratic quartzite beds that weather to a reddish colour; and an upper Forteau Formation which is composed of archaeocyathid reefs, dolomites, alternations of limestone and shale, and fossiliferous oölitic limestones.

I. PRECAMBRIAN: Precambrian rocks belonging to the Grenville Series are exposed along the coast from West St. Modeste to Bradore Bay, except at the headlands at Point Amour and Forteau Point where the tops of the Precambrian basement complex are below sea-level and not seen. The Precambrian is chiefly a pinkish granite and granitic gneiss. At Capstan Island and L'anse au Diable the gneissic structure of this rock is very conspicuous and belts of dark coloured pyroxene and/or amphibole gneiss are present. At Bradore Bay the Precambrian complex exhibits well-developed schistose structure, and sillimanite needles are found in this schistose rock.

II. BRADORE FORMATION: The Bradore Formation rests horizontally but nonconformably on the underlying Precambrian granite. At the base of this formation is a thin conglomerate. Thickness of this basal conglomerate varies from one to four inches, which is also the size range of the pebbles that make up this conglomerate. This size relationship seems to indicate that the pebbles originally covered the weathered surface of the Precambrian landmass as a thin pebble sheet. After Cambrian submergence of the Precambrian landmass this thin sheet of pebbles was buried by Bradore clastic sediments. The basal conglomerate is made up of pebbles of granite and quartzite with minor accessory constituents including magnetite and micas, all firmly held together by a siliceous cement. The basal conglomerate is not everywhere readily observed in the mapped area,

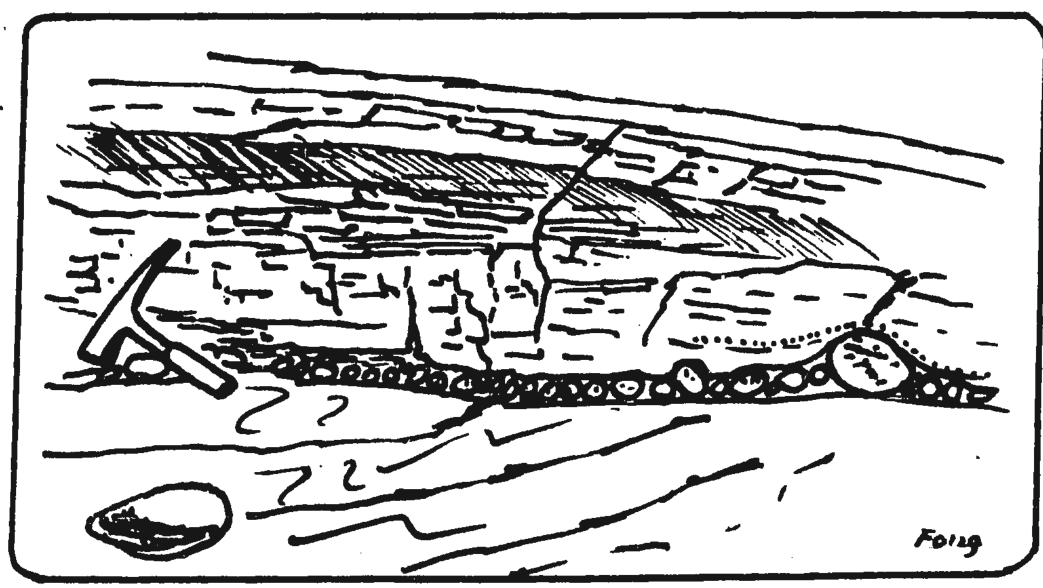


Figure 1. Basal conglomerate at the contact between Bradore Formation and Precambrian basement complex.

despite the fact that blocks of it commonly are found in the field. The only outcrop located by the writer was found at Blanc Sablon, where the contact of the Bradore Formation with the Precambrian basement coincides with sea-level. Overlying the thin basal conglomerate is a coarse quartzitic sandstone which is cross-bedded. This quartzitic sandstone is very rich in fresh feldspar and granite fragments derived from the Precambrian basement. These feldspar fragments are so abundant that they give the rock a spotted pinkish appearance. This quartzitic sandstone persists vertically throughout the Bradore Formation and is distributed horizontally across the mapped area. Towards the upper part of the formation the quartzitic sandstone decreases in feldspar content, which finally results in a clean quartzite facies that occupies the uppermost part of the Bradore Formation.

Microscopic study shows that the sandstone of the Bradore Formation was made up of poorly sorted, angular, mostly quartz and feldspar, sand grains. Grain size of this sediment ranges from 125 microns to 5mm in diameter. In places the coarse grains are very abundant and the rock may be regarded as a conglomeratic sandstone. Throughout the whole formation the sandstone is free of argillaceous material and the interstices are filled only with fine quartz and feldspar grains in addition to siliceous cement. In certain layers of the formation the unsorted sand grains are so closely packed that the grains appear to be interlocked.

Thicknesses of beds in the Bradore Formation vary from one-eighth of an inch to three feet. Cross bedding is common throughout the Bradore Formation. The only evidence of organic activity is long tube-like "worm burrows" known as Skolithos linealis (Plate 4, Figs. 1,2), which occur at various horizons of the formation.

The top of the Bradore Formation is marked by a thin bed of conglomerate.

III. FORTEAU FORMATION: The Forteau Formation rests conformably on the Bradore Formation. The boundary between Bradore and Forteau Formations is placed at the first appearance of a dolomite bed which is found immediately above the thin bed of conglomerate that marks the top of Bradore Formation. In the mapped area the Forteau Formation can be subdivided into three members: a lower dolomitic member which locally may or may not include archaeocyathid reefs; a middle member composed of alternations of shale and limestone beds; and an upper member of oölitic limestone with a higher level archaeocyathid reef at the top.

A. Lower Member: The lower dolomite member is mainly a greyish-red dolomite which exhibits numerous vertical "worm burrows". These trace fossils, burrowed in the carbonate mud by some unknown organism, are hour-glass shaped with two extremities measuring up to 30mm in diameter, and a narrow "neck" with a maximum diameter of about 10mm. These burrows were filled with a greyish-brown primary sediment that was recrystallized into secondary euhedral rhombic dolomite crystals locked in a reddish-brown ferruginous matrix. Most of the rock is composed of clear dolomite crystals. The fossil content in this rock varies quantitatively in different localities, and usually the fossil fragments are so minute as to be only observed under a microscope. Glauconite flakes and the calcareous alga Solenopora taylorensis nov. sp. are the chief minor constituents of this rock.

The dolomite bed usually is platy and in places is crumpled.

(i) Lower-Level Archaeocyathid Reefs: Archaeocyathid reef bodies in the Lower Member of the Forteau Formation conveniently may be termed the Lower-Level Archaeocyathid Reefs for the purpose of distinguishing them from reefs that occupy a higher horizon in the Forteau Formation. These reefs border the mapped area along the coast from West St. Modeste to Long Point coinciding with the curved rim of the sedimentary mass. They rest on the dolomite beds that comprise the base of the Forteau Formation. Thicknesses of the Lower-Level Archaeocyathid Reefs are variable, but in general they thin landward, and further inland disappear with the basal dolomite beds being overlain directly by the Middle Member of the Forteau Formation. Reef bodies at Fox Cove, Point Amour, Forteau Point and Long Point are conspicuously thick, and the reefoid structure is well developed in these localities. Thicknesses of reefs from these localities measure:

Locality:	Fox Cove	Point Amour	Forteau Point	Long Point
Thickness:	45 ft.	25+ ft.	52 ft.	30 ft.
Elevation of base of reef above sea-level	0 ft.	base below sea-level	30 ft.	140 ft.

These reefs are red in colour, composed of archaeocyathid colonies, <u>Salterella</u> limestone lenses, fossiliferous clastic limestone, thinly laminated red shale, and "pockets" of microcrystalline limestone. Shales or clastic limestones that cap a reef body usually dip quaquaversally away from the centre of the reef in angles that range up to as steep as forty degrees. In places high reefoid forms reaching heights of 30 feet are seen to be composed of several small reef bodies resting one on top of another, but separated by thin beds of shale or clastic limestone. Single large reef bodies with a height of 30 feet are also present.

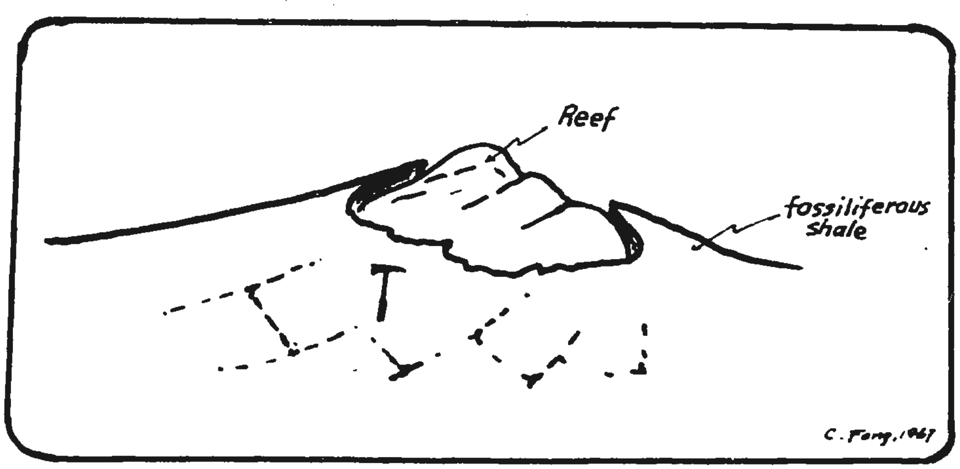


Figure 2. Sketch of a knoll-shaped reef body capped by quaquaversally dipping shale bed.

B. Middle Member: The middle member of the Forteau Formation comprises alternations of fossiliferous clastic limestone and shale. The Middle Member directly overlies archaeocyathid reefs of the Lower Member at places where these reefs are present; alternatively the Middle Member overlies the dolomite beds where archaeocyathid reefs are absent.

The shale in this member is greenish-grey in colour and contains abundant trilobite exoskeletons, brachiopod and cephalopod shells. In the shale there are numerous thin layers of concentric-ringed structures, seemingly of algal origin but not positively identified. The limestone beds are composed of dark grey fossiliferous clastic limestone containing trilobite exoskeletons, brachiopod and cephalopod shells. Glauconite grains and minute fragments of archaeocyathid cups are present as minor constituents. The rock contains low amounts of silt but is free of argillaceous material, and the limestone is clean in appearance.

The total thickness of the Middle Member varies between 40 and 50 ft. and it thins seaward.

C. Upper Member: The uppermost part of the Forteau Formation is chiefly composed of beds of oölitic limestone, fossiliferous clastic limestone, and a platy archaeocyathid reef which by its form resembles a shelf margin reef complex. This platy reef will be referred to as the Higher-Level Archaeocyathid Reef in this thesis.

The oölitic limestone beds in the Upper Member include several limestone layers showing various microfacies: oölitic limestone; oölitic algal limestone; oölitic Girvanella limestone; oölitic Girvanella-Salterella limestone; and microcrystalline limestone. Vertically these microfacies may occur in repeated successions with little apparent arrangement or order. Laterally they change abruptly and are difficult to trace.

Microscopic study of thin sections of the oölitic limestones reveals that the oölites are embedded in a matrix of clear microcrystalline calcite. Diameters of oölites range from 0.2mm to 1.0mm, although at Taylor's Gulch oölites with diameters up to 2.0mm are found in a Salterella-bearing limestone, but these do not occur as an important constituent of the rock. The oölites show both concentric and radiating internal structures. Some oölites are dolomitized and in these well-crystallized euhedral dolomite crystals obscure the internal structure.

(i) Higher-Level Archaeocyathid Reefs: The Higher-Level Archaeocyathid Reefs appear to have developed as a shelf margin reef complex. They are now mostly concealed under a soil cover and vegetation. The reefs usually are grey in colour, although red-coloured reef bodies frequently occur adjoining the grey-coloured ones. The reef limestone in the Higher-Level Reefs contains a higher amount of mud than the Lower-Level Reefs, and the argillaceous fraction ranges up to twenty-five per cent of the total weight of the rock. Despite the higher mud content the higher archaeocyathids apparently developed into a larger size than those in the Lower-Level Reefs, and pycnoidocyathids measuring up to 80mm at their widest cup diameter are quite common. One of the largest pycnoidocyathid specimens collected measures 200mm across.

The Higher-Level Archaeocyathid Reefs were always found to be capped by beds of a platy clastic limestone made up of fragmented archaeocyathid skeletons and other associated fossils. In the thesis area this clastic limestone marks the top of Forteau Formation.

Plate 3

Figure 1. Thin beds of cross-bedded coarse sandstone in the Bradore formation. Head of Forteau Valley, Forteau, Labrador.

Figure 2. Calcitic veins and red coloured concentric bands exposed on an erosional surface at the base of Bradore formation. Forteau, Labrador.

FIG. 1

FIG. 2

Plate 4

Figure 1. Thick platy sandstone and thin-bedded sandstone at the upper part of the Bradore formation. Long tubes of *Skolithos* are seen, many penetrating the bedding planes. English Point, Forteau Bay, Labrador.

Figure 2. Upper openings of numerous densely packed *Skolithos lineal*is on the bedding plane of a sandstone block belonging to the Bradore formation. Forteau, Labrador.

FIG. 1

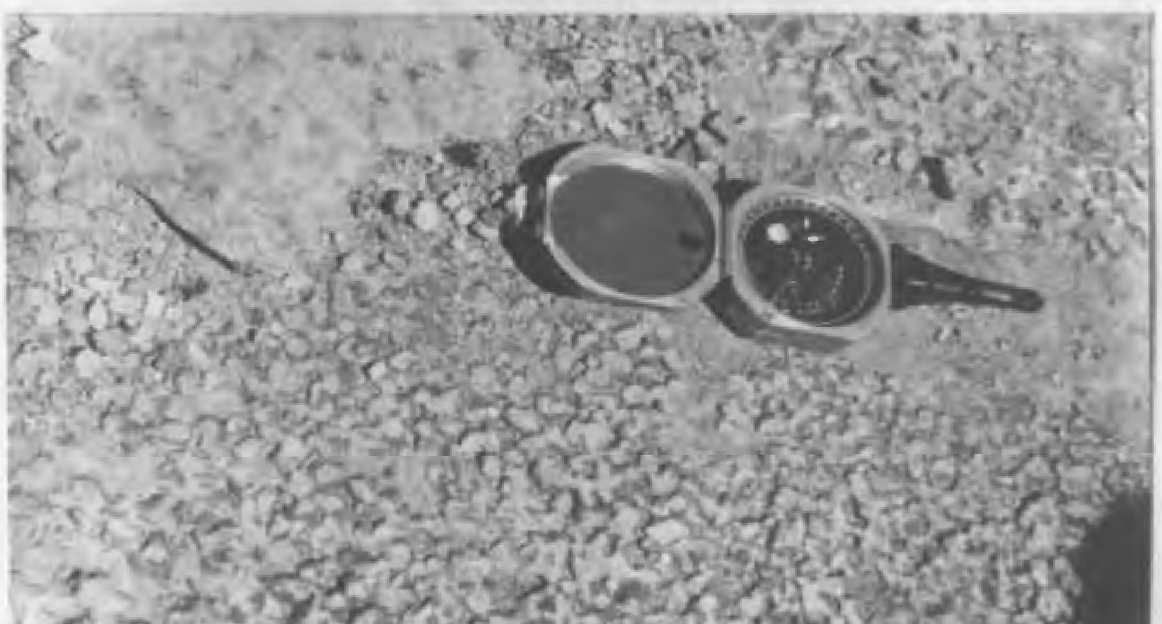


FIG. 2

Plate 5

Figure 1. Cross-bedded coarse sandstone at the base of Bradore formation. Forteau, Labrador.

Figure 2. Thick-bedded sandstone interbedded with thin beds of sandstone in the Bradore formation. English Point, Forteau Bay, Labrador.

FIG. 1

FIG. 2

Plate 6

Figure 1. The boundary between the Bradore and Forteau formations can be seen along the top of the thick bed of quartzite. Blanc Sablon, Quebec.

Figure 2. Lower part of the Lower-Level Archaeocyathid Reefs, showing red shale and angular breccia of the Lower Member dolomite beds. Blanc Sablon, Quebec.

FIG. 1

FIG. 2

Plate 7

Figure 1. Platy dolomite beds exposed at English Point, Forteau Bay, Labrador.

Figure 2. Alternations of shale and limestone of the Middle Member of Forteau formation. Taylor's Gulch, Labrador.

FIG. 1

FIG. 2

Plate 8

Figure 1. Well developed reefoid form with platy clastic limestone in the Lower-Level Archaeocyathid Reefs. Point Amour Light House, Labrador.

Figure 2. Archaeocyathid reefs on platy dolomite beds, Lower Member, Forteau formation. Point Amour Light House, Labrador.


FIG. 1


FIG. 2

Plate 9

Figure 1. Lower-Level Archaeocyathid Reefs exposed close to the shoreline. Point Amour Light House, Labrador.

Figure 2. Lower-Level Archaeocyathid Reefs capped by platy clastic limestone. Point Amour Light House, Labrador.

FIG. 1

FIG. 2

Plate 10

Figure 1. Cliff formed of the Higher-Level Archaeocyathid Reefs. L'anse Amour, Labrador.

Figure 2. Cliff formed of the Higher-Level Archaeocyathid Reefs. L'anse Amour, Labrador.

FIG. 1

FIG. 2

Plate 11

Figure 1. Higher-Level Archaeocyathid Reefs exposed at a low cliff. East of L'anse au Clair, Labrador.

Figure 2. Higher-Level Archaeocyathid Reefs. East of L'anse au Clair, Labrador.

FIG. 1

FIG. 2

CHAPTER IV

PALEONTOLOGY

The Forteau formation is a fossil-rich rock unit. Invertebrate fossils collected from this formation belong to the following phyla:

PHYLUM ARCHAEOCYATHA ------------	19 species
PHYLUM BRACHIOPODA --------------	3 species
PHYLUM MOLLUSCA -----------------	3 species
PHYLUM ARTHROPODA ---------------	2 species

Plant fossils, all of which are calcareous algae, also are present throughout the whole formation. They belong to:

DIVISION RHODOPHYTA -------------	2 species
DIVISION CHLOROPHYTA ------------	1 species
DIVISION SCHIZOMYCOPHYTA --------	5 species

In the present writer's work most attention was directed to Phylum Archaeocyatha and the algal divisions.

The archaeocyathid fauna of the thesis area generally is quite well-known to paleontologists. The first actual discovery of this fossil group was made in 1845 by Captain H.W. Bayfield, who thought that he found a species of the fossil coral *Cyathophyllum*.

Billings (1861) was the first paleontologist to describe and use the term Archaeocyathus when he described a specimen collected by Richardson from L'anse au Loup. In 1886, Walcott described archaeocyathid fossils under the heading "Sponges".

Archaeocyathid collections from the thesis area were thoroughly studied and described by V.J. Okulitch in 1943. In his North American Pleospongia, Special Paper No. 48, published by The Geological Society of America, Okulitch listed 14 species, considered them to belong to phylum Porifera, and proposed the Class Pleospongia to include these fossils. Okulitch's list of species of Labrador archaeocyathids include:

Archaeocyathus atlanticus Billings

Cambrocyathus profundus (Billings)

C. loupensis Okulitch

C. amourensis Okulitch

C. orthoconicus Okulitch

C. dissepimentalis Okulitch

Ajacicyathus profundomimus Okulitch

Protopharetra dunbari Okulitch

P. sp.

Metethmophyllum labradorensis Okulitch

Archaeosycon billingsi (Walcott)

A. vesiculosum Okulitch

Exocyathus canadensis Okulitch

E. regularis Okulitch

The Genus Cambrocyathus was later altered to Pycnoidocyathus (Okulitch, 1950).

A list of archaeocyathids collected and identified by the present writer is given in Table 1.

Localities at which archaeocyathid fossils were collected are illustrated in Plate 62. The distribution of collected fossil species from these localities is tabulated in Plate 63.

Several species previously reported by Okulitch from the thesis area were not collected by me and include:

Pycnoidocyathus (Cambrocyathus) orthoconicus (Okulitch)

P. dissepimentalis (Okulitch)

Protopharetra dunbari Okulitch

Metethmophyllum labradorensis Okulitch

Exocyathus regularis Okulitch

Archaeosycon vesiculosum Okulitch

Seven species from the list of the present writer's archaeocyathid fossil collections are reported for the first time from Labrador Cambrian strata:

Ajacicyathus nevadensis (Okulitch)

A. undulatus Okulitch

A. argentus (Okulitch)

Pycnoidocyathus columbianus (Okulitch)

P. sp.

Syringocyathus canadensis Okulitch

S. sp.

Four new species are proposed for archaeocyathid fossils of the Labrador Archaeocyathid Fauna, these are:

Ajacicyathus richardsoni nov. sp.

Archaeocyathus irregularis nov. sp.

Archaeocyathus patelliformis nov. sp.

Sigmosyringocyathus cylindricus nov. sp.

One new genus, *Sigmosyringocyathus*, represented by the new species *S. cylindricus*, the holotype, is also proposed from this fauna.

Systematic descriptions of archaeocyathid fossils are mainly based on morphometric and structural features of the solid cups as observed either in freed cups or in oriented thin sections.

Two numerical relationships, one the relationship between the width of the intervallum and the width of the central cavity (intervallum coefficient); and the second relating the number of parieties to the diameter of the cup in millimeters (parietal coefficient), were considered to be of taxonomic significance and were proposed originally for use by A.G. Vologdin. Okulitch questioned the validity of the intervallum coefficient, and the present writer concludes that this intervallum coefficient is of no taxonomic significance. The width of the intervallum of most archaeocyathids remains constant throughout the whole cup of an individual archaeocyathid as rightly stated by Vologdin and found to be true by students of this fossil phylum, thus the intervallum coefficient, obtained by dividing the diameter of the central cavity by the width of the intervallum, would be variable in individuals because the width of the central cavity increases as the cup leads upward. However, the parietal coefficient obtained by dividing the number of parieties in the intervallum by the diameter of the corresponding cross section of the cup in millimeters is valid and of taxonomic importance. From the study of serial sections prepared from cups of Pycnoidocyathus amourensis and P. profundus the writer found that the number of parieties increases proportionally with the increase of cup diameter, and the parietal coefficient is quite constant in the same species.

Dimensional measurements stating the diameter of the cup, height of cup, width of intervallum, width of central cavity, number of parieties, and parietal coefficient are given in systematic descriptions of archaeocyathid fossils.

Table 1. List of Archaeocyatha Present in the Thesis Area

PHYLUM ARCHAEOCYATHA

CLASS ARCHAEOCYATHEA

ORDER AJACICYATHIDA

Family Ajacicyathidae

Ajacicyathus nevadensis (Okulitch)

A. profundomimus Okulitch

A. undulatus Okulitch

A. argentus (Okulitch)

A. richardsoni nov. sp.

Order METACYATHIDA

Family Archaeocyathidae

Archaeocyathus atlanticus Billings

A. irregularis nov. sp.

A. patelliformis nov. sp.

Protopharetra sp.

Family Pycnoidocyathidae

Pycnoidocyathus amourensis (Okulitch)

P. profundus (Okulitch)

P. loupensis (Okulitch)

P. columbianus (Okulitch)

P. sp.

Family Metacoscinidae

Archaeosycon billingsi (Walcott) Taylor

Order SYRINGOCNEMIDA

Family Syringocnematidae

Syringo-cyathus canadensis Okulitch

Syringocyathus sp.

Sigmosyringocyathus cylindricus gen. nov.,
nov. sp.

Family Ajacicyathidae Bedford and Bedford, 1939

Ajacicyathus nevadensis (Okulitch), 1943

(Plate 12, Figs. 1,2; Plate 37, Fig. 1)

Specimens of Ajacicyathus nevadensis were collected from Lower-Level Archaeocyathid Reefs at Point Amour, L'anse Amour and Forteau.

Microscopic studies were made both of a naturaly-weathered surfaces showing etched cross sections and of thin sections prepared from limestone blocks from the Lower-Level Archaeocyathid Reefs containing this fossil species.

GENERAL SHAPE: The general shape of this species was not observed, because no isolated specimens free from their limestone matrix were available for examination.

OUTER WALL: The outer wall, as observed in thin section, is simple. Thickness of wall is 0.06mm and fine pores with a diameter of 0.0875mm perforate it. Two to four pores occur in each interseptal area.

INTERVALLUM: The intervallum contains simple, straight parieties which are perforated by pores with diameters as large as 0.33mm. The number of parieties is 27 where the cup is 9mm across, giving a parietal coefficient of 3.0. Thickness of a single pariety is 0.2mm.

INNER WALL: The inner wall is simple and perforated by pores 0.1mm in size; two pores occur in each interseptal area.

No.	040101	040102	040103	090101	050101
Locality	Point Amour			Taylor's Gulch	L'anse Amour
Diameter	9 mm	8 mm	8 mm	5 mm	8 mm
Diameter of Central Cavity	4 mm	3 mm	3 mm	2 mm	3.5mm
Width of Intervallum	2.5mm	2.5mm	2.5mm	1.5mm	2.8mm
Number of Parieties	27	23	25	18	27
Parietal Coefficience	3	3	3	3.6	3.3

Table-2 Dimensional Measurements of

Ajacicyathus nevadensis

Ajacicyathus undulatus Okulitch, 1948

(Plate 14, Fig. 2; Plate 38, Fig. 1)

This species is a very large archaeocyathid and fragments of it are found distributed in both the Lower and Higher-Level Archaeocyathid Reefs. Three comparatively complete specimens were collected, one from Forteau, one from L'anse au Clair, and one from Taylor's Gulch. Localities from which specimens of this species were collected are listed in Table-3 which also gives the dimensional measurements of these specimens.

No.	04-0301	05-0301	07-0301	09-0301
Locality	Pt.Amour	L'anse Amour	Taylor's Gulch	Forteau
Stratigraphic Elevation	Lower-Level Archaeocyathid Reefs		High.-Lev. Arch. Rfs.	Low.-Lev. Arch. Rfs.
Diameter	not available	not available	70mm	180mm
Width of Intervallum	3mm	3mm	4mm	4mm
Diameter of Central Cavity	-	-	60mm	172mm
Number of Parieties	-	-	220	650
Parietal Coefficient	-	-	3.1	3.6

Table-3 Dimensional Measurements of

Ajacicyathus undulatus

GENERAL SHAPE: Large conoflabellar form resembling a distorted bowl.

Outer wall is transversely annulated with crests of annulations 15-12mm apart. Greatest diameter of cup is 180mm as reconstructed from the specimen collected from Forteau. Number of parieties in the intervallum is approximately 650 which gives a parietal coefficient of 3.6. The intervallum width varies from 3.0mm to 4.0mm.

OUTER WALL: The outer wall is simple and perforated by fine pores. Four pores occur in each intersept.

INTERVALLUM: The intervallum contains numerous straight, regularly arranged parieties. Distances between parieties range from 0.9mm to 1.3mm apart. All parieties are perforated by large pores arranged in regular quincunx. These pores have a maximum diameter of 0.7mm and decrease in size downward towards the lower end of the cup. The combined pore area of the parieties is larger than the total area of the solid skeletal part, and this gives them a network appearance.

INNER WALL: The inner wall is simple and slightly thicker than the outer wall. Pores slightly larger than those of the outer wall perforate the inner wall.

<u>Ajacicyathus argentus</u> (Okulitch), 1943

(Plate 15, Figs. 1, 2)

GENERAL SHAPE: The general shape of this specimen may be described as of an acute conical cup (see text fig. 3) which is bilaterally symmetrical instead of being radially symmetrical as are most archaeocyathids.

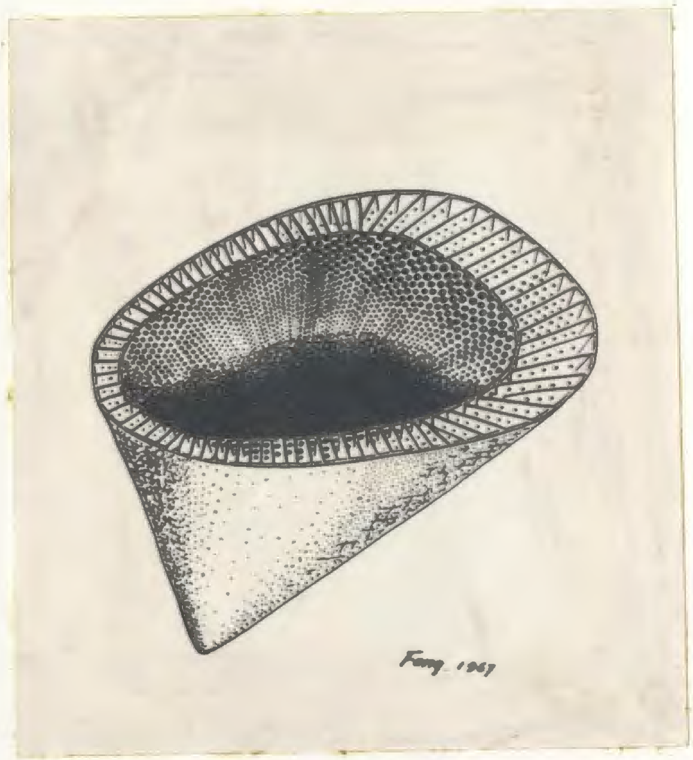


Fig. 3 - Reconstruction of a cup of A. argentus.

This bilateral symmetry is probably the result of different growth rates of opposing sides of the cup. During the process of cup building, one side of the cup apparently grew faster and extended farther away from the vertical axis of the cup and the intervallum on this side is wide, while the opposite side of the cup grew slowly and the corresponding intervallum is narrower. This difference in growth rates produces the short stout tusk shape characteristic of this species. Numbers of parieties in the intervallum are 112 for a specimen with a diameter of 32mm; 67 for a specimen with a diameter of 20mm; and 56 for a specimen with a diameter of 15mm; the parietal coefficients are 3.6, 3.5 and 3.7 giving an average parietal coefficient of 3.6.

OUTER WALL: The outer wall is simple, thin and perforated by fine pores.

INTERVALLUM: The width of the intervallum is not uniform in any selected whole cross section of the cup; one side of it is narrow and the opposing one is wider. Straight, thin parieties fill the intervallum. The parieties are narrowly spaced and the distance between two successive parieties measures 1mm. Arrangement of parieties for most part of the intervallum is in a regular radiating pattern. At the two places on the circumferance where the intervallum begins to widen parieties grew in an oblique angle from the inner wall towards the outer wall, and often two parieties occur with the inner-wall-ends connected (see Fig. 3). In the portion of the cup where the intervallum is widest the parieties resume the radiating arrangement again normal to both walls. All parieties are perforated by medium-sized pores. The pattern of the pore arrangement was not observed. Skeletal elements other than parieties are absent in the intervallum. In the intervallum of some specimens the calcareous alga Solenopora belemnos nov. sp. is seen to occupy the intervallum space.

INNER WALL: Inner wall thin and perforated by large pores. The diameter of these pores is 0.25mm. The pores are arranged in quincunx, one row of pores occur as stirrup pores, and one row of pores occur in an intersept. The combined pore area is slightly larger than the solid area giving the inner wall a network appearance.

CENTRAL CAVITY: Some fine spine-like skeletal elements can be seen projecting into the central cavity from the inner wall, but this feature is not readily observed in every specimen.

DISCUSSION: This is the first report of Ajacicyathus argentus from the Labrador Archaeocyathid Fauna. Specimens collected by the writer resemble Okulitch's holotype 9325 from Nevada, but differ in having a slightly higher parietal coefficient. The difference, 3.6 for specimens from Labrador in contrast to 2.8 for the holotype from Nevada, is judged to be of no critical importance in the systematic position of the specimen.

No:	05-0401	05-0403	04-0401
Locality	L'anse Amour	L'anse Amour	Point Amour
Stratigraphic Elevation	Low.-L. A. Reef	Low.-L. A. Reef	Low.-L. A. Reef
Diameter	32-40mm	20-35mm	15-18mm
Width of Intervallum	4-10mm	3-10mm	2-4 mm
Diameter of Central Cavity	16-26mm	13-22mm	11-12mm
Number of Parieties	112	67	56
Parietal Coefficient	3.6	3.3	3.7

Table-4 Dimensional Measurements

Ajacicyathus profundomimus Okulitch, 1943

(Plate 13, Figs. 1,2; Plate 14, Fig. 1;
Plate 37, Fig. 2; Plate 38, Fig. 2)

Specimens of this species were collected from both the Lower- and Higher-Level Archaeocyathid Reefs. Localities at which specimens were collected are: Point Amour Light House, L'anse Amour, Taylor's Gulch, Forteau, and Blanc Sablon. Exocyathid tissue is found both attached to the outer wall of this species, and housed in the intervallum of individuals of this species. Such exocyathid tissue structure sometimes gives the intervallum of this species a non-typical intervallum structure, with dissepiments and synapticulae very much resembling the intervallum structure of archaeocyathids belonging to Genus Pycnoidocyathus. (Plate 13, Figs. 1, 2).

GENERAL SHAPE: The general appearance of this species resembles a deep conical cup transversely annulated exteriorly. The spacing of annulations ranges from 6mm to 20mm apart. The maximum cup diameter, measured from the largest specimen collected from L'anse Amour and labelled MUAF 05-0201, is 90mm. The number of parieties in the intervallum of this specimen is 380 which, when divided by the diameter of the cup, gives a parietal coefficient of 4.2.

OUTER WALL: The outer wall is thin, simple and perforated by fine pores. The pore pattern of the outer wall is unknown.

INTERVALLUM: The intervallum is rather narrow, being close to 3mm for most specimens. It contains numerous thin straight parieties which are narrowly spaced. Parieties are each perforated by 4 to 6 pores. No other skeletal elements occur in the intervallum.

INNER WALL: The inner wall is perforated by large pores with diameters of 0.3mm. Two rows of pores occur in each intersept area. The combined pore area of the inner wall is larger than that of the solid skeletal area.

CENTRAL CAVITY: The central cavity is deep and no skeletal structure is present in it.

No:	04-0201	04-0202	04-0209	05-0202	05-0203
Locality	Point Amour			L'anse Amour	
Stratigraphic Elevation	Lower-Level Archaeocyathid Reefs				
Diameter	50mm	20mm	65mm	90mm	50mm
Height	-	-	60mm	75mm	60mm
Width of Intervallum	3mm	4mm	4mm	3mm	3mm
Diameter of Central Cavity	44mm	12mm	57mm	84mm	44mm
Number of Parieties	162	62	200	380	200
Parietal Coefficient	3.2	3.1	3.0	4.2	4.0

Table-5 Dimensional Measurements of

Ajacicyathus profundomimus

Ajacicyathus richardsoni nov. sp.

(Plate 39, Figs. 1,2; Plate 40, Fig. 1)

GENERAL SHAPE: The general shape of the holotype of this new species has the appearance of a shallow bilaterally symmetrical cup. Horizontal cross sections of the upper portion of the cup have the shape of a cardioid curve with a notch at one side. The outer wall is strongly transversely annulated with a spacing of 5.0mm between crests of annulations. The lower portion of the cup does not lead straight downward as in most archaeocyathids, but instead curves and bends towards the notched side of the cardioid. (Fig. 4)

OUTER WALL: The outer wall is simple, thin and perforated by fine pores. Pore pattern not observed.

INTERVALLUM: The intervallum contains numerous thin straight parieties which are perforated by a few pores of medium size. The combined pore area is much less than the area of solid skeletal elements. The width of the intervallum is 4.0mm for the holotype.

Fig. 4 - Reconstruction of A. richardsoni nov. sp.

The number of parieties in the intervallum of the holotype is 140 which, divided by the holotype's average diameter of 35.0mm, gives a parietal coefficient of 4.0. The parieties are closely spaced with a distance between two adjacent parieties of 0.625mm. No skeletal elements other than the parieties are present in the intervallum.

INNER WALL: The inner wall is thin and perforated by large pores giving it a net-like appearance. The combined pore area is greater than the area of the solid skeleton.

CENTRAL CAVITY: The central cavity is simple and no skeletal elements are present in it.

DISCUSSION: The simplicity of the skeletal elements, and the regularly arranged radiating parieties in the intervallum doubtlessly refer these specimens to Genus Ajacicyathus. The new species differs from other ajacicyathids first in having the lower portion of its cup curved; and secondly in its bilaterally symmetrical cardioid-shaped cross section.

The trivial name is proposed to honour Mr. James Richardson who was the first geologist to collect archaeocyathid fossils in the thesis area, and whose original collection was lost at sea.

MATERIAL: The holotype of the new species, which is labelled MUAF 11-0501, was collected from the Higher-Level Archaeocyathid Reefs at Locality 11, east of L'anse au Clair. Paratypes collected from Taylor's Gulch and L'anse au Clair are labelled MUAF 11-0502, 07-0501 and 07-0502.

No:	11-0501	11-0502	07-0501	07-0502
Locality	E. of L'anse au Clair		Taylor's Gulch	
Stratigraphic Elevation	Higher-Level Archaeocyathid Reefs			
Diameter	35mm	46mm	35mm	60mm
Height	42mm	15mm	60mm	40mm
Width of Intervallum	4mm	4mm	3mm	3mm
Diameter of Central Cavity	36mm	38mm	29mm	54mm
Number of Parieties	140	190	150	-
Parietal Coefficient	4.0	4.1	4.3	-

Table-6 Dimensional measurements of

Ajacicyathus richardsoni nov. sp.

Family ARCHAEOCYATHIDAE Taylor, 1910

Archaeocyathus atlanticus Billings

(Plate 16, Figs. 1, 2)

This species, although it was one of the earliest discovered archaeocyathids, is not common in the thesis area. It is represented in my collection by three specimens only.

GENERAL SHAPE: The cup is cylindrical in shape, tapering gently, and sometimes surrounded externally by exocyathid structures or other archaeocyathids. In one case the species *Sigmosyringocyathus cylindricus* nov. sp. was found attached to the outer wall of a specimen collected from Forteau.

OUTER WALL: The outer wall is thin and simple, and perforated by numerous fine pores; arrangement of the pore pattern was not observed as the outer walls of all three specimens were badly eroded. In places the outer wall is thickened by secondary deposition of microcryptocrystalline calcite on the original outer wall.

INTERVALLUM: The intervallum is wide and contains many curving taeniae and rods. All skeletal elements are considerably thickened.

INNER WALL: The inner wall is thicker than the outer wall. It is perforated by large pores. Secondary thickening of the inner wall tends to give the central cavity an irregular outline. No skeletal elements of any kind are observed in the central cavity.

No:	04-0501	05-0501	09-0501
Locality	Point Amour	L'anse Amour	Forteau
Stratigraphic Elevation	Lower-Level Archaeocyathid Reefs		
Diameter	10mm	15mm	22mm
Width of Intervallum	4mm	5mm	8mm
Central Cavity	2mm	5mm	6mm

Table-7 Dimensional measurements of

Archaeocyathus atlanticus

Archaeocyathus irregularis nov. sp.

(Plate 17, Figs. 1, 2)

This new species is the most common archaeocyathid in the thesis area. It is found both in the Higher- and Lower-Level Archaeocyathid Reefs in every locality. A small colony of this "creeping" archaeocyathid intergrown with colonies of the calcareous alga Girvanella sp. was found in the Higher-Level Archaeocyathid Reefs in Taylor's Gulch. At one locality, situated two miles to the west of Forteau, an eight inches thick bed of archaeocyathid limestone composed entirely of the new species was found to be isolated between two beds of oolitic Girvanella-Salterella limestone. This thin lens of archaeocyathid limestone is the only archaeocyathid bed found interbedded with algal limestone in the thesis area. In limestone blocks containing A. irregularis specimens of it rest in concordance with the surface irregularity of the substratum which was commonly a soft calcareous ooze.

GENERAL SHAPE: The term "cup" is not adequate for describing this species, since it does not maintain a general cup-shaped skeletal structure. The skeleton which is made up of an outer wall, an intervallum containing numerous taeniae, and an inner wall is spread in a horizontal direction along the surface of the substratum on which the living archaeocyathid grew as a thin sheet. These sheets are usually crumpled in appearance and very irregular in shape as seen in random section. The length measured across the surface of a crumpled sheet of the new species sometimes may be quite long, and in the holotype MUAF 01-0701, collected from Bouger's Hill at L'anse au Diable, it measures 200mm.

OUTER WALL: The outer wall is simple and perforated by pores with openings as large as 1mm. Irregular secondary deposition of micro-cryptocrystalline calcite on the outer wall increased its thickness, consequently it is very uneven. The arrangement of pore pattern was not observed.

INTERVALLUM: The width of the intervallum is uneven and varies between 1mm and 3mm. Numerous thin, curving taeniae fill the intervallum and are the only skeletal elements in it.

INNER WALL: The inner wall is perforated by numerous large pores. The combined pore area is far greater than the area of solid structure and this gives the inner wall a net-like appearance.

CENTRAL CAVITY: Traces of prismatic porous skeletal elements are present in the central cavity of the holotype. (Plate 17, Fig. 1.) Archaeocyathids with central cavities filled with prismatic skeletal elements were reported by V. D. Fonin in 1960 from Cambrian strata of Tuva, Khakassiya, Mongolia. Based on the presence of this type of prismatic structure in the central cavity of the archaeocyathids collected from the abovementioned regions Fonin established a new Family. His new Family, Prismocyathidae Fonin, contains one genus, Prismocyathus Fonin gen. nov., which in turn contains two new species. A. G. Vologdin concluded that the prismatic structure should be considered as unique supporting skeletal elements of an internal "organ" which is postulated to have existed in the central cavity of these animals. The present writer agrees with Vologdin's hypothesis that these prismatic skeletal elements provided supporting structures for the internal "organ" because in the central cavities of the holotype and paratypes from Labrador the writer observed tissue-like material surrounding the prismatic skeletal structure. However, the writer does not agree with Fonin that this prismatic structure is of sysmatic importance because in the central cavities of a few archaeocyathids belonging to other genera these prismatic skeletal elements are also present. The writer believes that prismatic structures were common feature in the central cavities of many archaeocyathids but seldom preserved in fossil form. In the thesis area preservation of soft tissue is not an unusual phenomenon and the preservation of this prismatic structure appears to be more common in Labrador than in other archaeocyathid localities of the world.

DISCUSSION: The diagnostic presence of numerous curving taeniae in the intervallum places this new species in the Genus Archaeocyathus. The crumpled sheet-like appearance of the "cups" distinguishes the new species from other archaeocyathids belonging to the same genus. The skeletal structure of the new species, especially the thickened outer wall, the taeniae-filled intervallum, and the porous net-like inner wall, fits Fonin's new Family and new Genus in every aspect, but since the presence of prismatic structure is not considered by the present writer to be of systematic importance he prefers to include this new species in the Genus Archaeocyathus.

MATERIAL: Holotype, MUAF 01-0701, collected from the Lower-Level Archaeocyathid Reefs on Bouger's Hill at L'anse au Diable; paratypes MUAF 09-0701, 01-0702, 09-0702.

Archaeocyathus patelliformis nov. sp.

(Plate 18, Figs. 1, 2)

Specimens representing this new species are distributed throughout the thesis area both in the Higher-Level and Lower-Level Archaeocyathid Reefs. Six specimens were collected from Fox Cove, Point Amour, Forteau, and L'anse au Clair.

GENERAL SHAPE: This new species usually shows an open saucer-shaped form. In the holotype, MUAF 04-0801, the shallow saucer-shaped cup more or less maintains a circular cross section, but in many paratypes the cup, although still saucer-shaped, is irregular and a cross section through the upper half of it does not show a circular outline. The outer wall of the cup is gently annulated transversely. Regular spacing of annulation rings was seen only in the holotype (MUAF 04-0801) from the Higher-Level Archaeocyathid Reefs at Point Amour. Diameter of the cup ranges from 35mm to 70mm. Depth of cup varies from 10mm to 20mm.

OUTER WALL: The outer wall is smooth in appearance except for large pore openings that penetrate it. The thickness of the outer wall is uneven as a result of secondary deposition of calcium carbonate on the original outer wall which was consequently irregularly thickened. Large pores with openings ranging from 0.6mm to 1.2mm are arranged in opposite rows with a distance between them of 2mm. The solid skeletal area is far greater than the combined pore area.

INTERVALLUM: The intervallum contains abundant taeniae which serve to connect the outer and inner walls. The width of the intervallum is variable and ranges from 0.8mm to 3.0mm.

INNER WALL: The inner wall is highly porous and has the appearance of a network made up of fused thin rods.

CENTRAL CAVITY: The central cavity is shallow and free of skeletal elements.

DISCUSSION: This new species like Archaeocyathus irregularis nov. sp. is included in the Genus Archaeocyathus because of the numerous taeniae in the intervallum. It differs from A. irregularis in having a more definite cup-shaped form and from other species of Archaeocyathus in having a shallow saucer-shaped cup.

MATERIAL: Holotype 04-0801; paratypes MUAF 03-0801, 03-0802, 09-0801, 09-0802, 09-0803, 09-0805 and 11-0801.

Protopharetra sp

(Plate 19, Figs. 1, 2)

GENERAL DESCRIPTION: Archaeocyathids belonging to this genus are mostly minute in size. Their cups consist of a distinct outer wall, an indistinct intervallum, which is filled with parieties (?) and/or dissepiments, and an inner wall which is indistinct or lacking, which results in either a poorly defined central cavity or no central cavity at all.

DISCUSSION: This genus is of dubious validity. Okulitch in 1954 stated that it is quite probable that the majority of described Protopharetra are young stages of Archaeocyathus and related Metacyathida. In the Labrador fauna only minute cross sections of their cups are observed and the writer failed in attempting by serial sectioning to trace any complete cup that would be indicative of the validity of the genus. He believes that Okulitch's statement explains the situation.

Family PYCNOIDOCYATHIDAE Okulitch, 1950

Pycnoidocyathus amourensis (Okulitch), 1943

(Plate 20, Figs. 1,2; Plate 21, Figs. 1,2; Plate 41, Figs. 1,2)

This species is very common in the thesis area both in the Higher-Level and the Lower-Level Archaeocyathid Reefs. Despite its common occurrence complete specimens are seldom found perhaps because the long slender tubular form of the cups made them susceptible to fragmentation under the impress of Cambrian wave action.

GENERAL SHAPE: The general appearance of an individual of this species may be described as a long tubular cylindrical cup with an expanded upper end and resembling a small funnel with a long tube. The upper expanded end of the cup is so similar to the cup of P. profundus that sometimes it is difficult to distinguish the two apart, especially when the lower slender portion of the cup of P. amourensis is broken away. Total lengths of the species are seldom recorded, but one specimen collected from English Point has a length of slightly over 150mm although the upper end is broken off. The average diameter of the expanded end of this species is around 40mm while the diameter measured across the tubular cup is between 10mm and 20mm.

OUTER WALL: The outer wall is relatively thick, measuring around 0.5mm. Fine pores perforate the outer wall. The pattern of pore arrangement is a regular quincunx.

INTERVALLUM: The intervallum is wide and varies between 3mm and 7mm. The intervallum contains straight parieties which vary in number from 96 for a diameter of 3.5mm to 34 for a diameter of 10mm, giving a parietal coefficient of 3.5. Connecting the parieties are numerous synapticulae and dissepiments. Soft tissue is commonly preserved in the intervallum.

INNER WALL: The inner wall is thick and often complicated by synapticulae and dissepiments. It is perforated by fine pores, but pore patterns have not been observed in the present collection.

CENTRAL CAVITY: The central cavity is narrow and often filled with vesicular skeletal elements.

Pycnoidocyathus profundus (Billings), 1861

(Plate 22, Figs. 1,2; Plate 23, Figs. 1,2;
Plate 40, Fig. 2; Plate 42, Figs. 1, 2)

The species Pycnoidocyathus profundus (Billings) is among one of the most common Archaeocyatha found in the thesis area both in the Higher-Level and Lower-Level Archaeocyathid Reefs. It is usually free of exocyathid tissue, and does not show any tendency to live in small colonies. Occurrences of calcareous algae symbiotic with this species are recorded in two cases: in one case an algal form of Collenia structure is attached both on the inner and outer walls of the specimen labelled MUAF 07-1002. (Plate 22, Fig. 1.) In the other case a very large specimen, labelled MUAF 07-1006 and collected from Taylor's Gulch, is surrounded on the outer wall by a calcareous alga with numerous fine Girvanella-type algal tubes (Plate 23, Fig. 1). In both cases close association of calcareous algae does not seem to have caused any pathologic harm to the archaeocyathid. In the aforementioned examples the soft tissue of the archaeocyathids were preserved indicating that the algae attached themselves to the archaeocyathids while the latter were still alive.

GENERAL SHAPE: In general, the shape of this species is a deep conical cup composed of two walls. The taper of the conical cup is rather gentle, and in the specimen labelled MUAF 07-1004 collected from Taylor's Gulch, the diameter of the cup decreases from 60mm to 46mm in a distance of 40mm. Maximum measured diameters of cups range from 35mm to 120mm, but most commonly are around 45mm. The number of parieties in the intervallum is 230 where the diameter is 60mm, and 180 where the diameter is 46mm, which give a parietal coefficient of 3.8 (Table-8).

No:	07-1001	07-1004	07-1005	11-1001
Locality		Taylor's Gulch		E.of L'anse au Clair
Stratigraphic Elevation		Higher-Level Archaeocyathid Reefs		
Diameter	35mm	60mm	45mm	50mm
Width of Intervallum	3mm	4mm	3mm	3mm
Diameter of Central Cavity	29mm	52mm	39mm	44mm
Number of Parieties	170	230	180	200
Parietal Coefficient	4.8	3.8	4.0	4.0

Table-8 Dimensional measurements of *Pycnoidocyathus profundus*

OUTER WALL: The outer wall is transversely annulated. Annulation is rather strong and the spacing of crests of annulation varies between 5mm and 15mm. The outer wall is simple, thin, and perforated by numerous fine pores. These fine pores are arranged in straight rown along the narrow intersepts.

INTERVALLUM: The intervallum contains numerous parieties which connect the outer and inner walls. These parieties are mostly straight, but some are curving and may be somewhat irregular. The parieties are narrowly spaced and the distance between two adjacent parieties is 0.75mm. Short bars of synapticulae are present connecting parieties. Thin curving dissepiments fill the intervallum area. Parieties are perforated, but the pore pattern was not observed.

INNER WALL: The inner wall is thin and sometimes complicated by synapticulae and dissepiments. It is perforated by fine pores which appear to be larger than those of the outer wall.

CENTRAL CAVITY: The central cavity is deep, no skeletal structure is present in the central cavity.

Pycnoidocyathus loupensis (Okulitch), 1940

(Plate 43, Fig. 1; Plate 44, Fig. 1)

GENERAL SHAPE: Large archaeocyathid with a wide, open, saucer-shaped cup. The general appearance of cups is irregular. The sizes of cups vary from 70mm to 200mm as measured across the largest diameter.

OUTER WALL: The outer wall is slightly transversely annulated but annulations are not regularly spaced. In most of the specimens collected by the writer from the thesis area the outer wall has been eroded away. In the specimen labelled MUAF 03-1201, collected from Fox Cove, a small portion of the outer wall was found free of matrix, and the outer wall was seen to be simple, thin, and perforated by pores of medium size.

INTERVALLUM: The intervallum is narrow and its width varies from 2mm to 5mm. It contains numerous thin, straight parieties which are spaced 0.7mm to 0.625mm apart. The number of parieties in the intervallum varies from nearly 300 for a specimen having a diameter of 70mm to about 1,000 for a specimen having a diameter of 200mm, and the parietal coefficient is 4.5. Very fine, thin, and arched dissepiments occupy the intervallum. Synapticulae are few in number.

INNER WALL: The inner wall is thin, simple, and perforated by pores of medium size. The pore pattern was not observed.

No:	03-1201	03-1202	04-1201	07-1201
Locality	Fox Cove		Point Amour	Taylor's Gulch
Diameter	70mm	84mm	200mm	90mm
Width of Intervallum	2mm	4mm	5mm	2mm
Diameter of Central Cavity	66mm	76mm	190mm	86mm

Distance between Parieties	10/18mm	10/14mm	10/16mm	10/16mm
Depth of cup	30mm	34mm	60mm	35mm
Number of Parieties	285	340	1,000	-
Parietal Coefficience	4.0	4.2	5.0	-

Table-9 Dimensional measurements of

Pycnoidocyathus loupensis

Pycnoidocyathus columbianus (Okulitch), 1943

(Plate 24, Figs. 1, 2)

GENERAL SHAPE: The general shape of this species is an acute conical cup. In the specimen marked MUAF 02-1301, collected from a hill top 1,100 feet in height in L'anse au Loup Valley, the diameter of the cup decreases from 42mm to 35mm within a distance of 20mm. The outer wall is slightly annulated. The intervallum is wide and the width varies between 7mm and 12mm. The number of parieties varies between 90 and 143, giving a parietal coefficient of 2.6-3.0, but mostly it is close to 3.0 (Table-10).

No:	02-1301A	02-1301B	09-1301	09-1302	11-1301
Locality	L'anse au Loup		Forteau		L'anse au Clair
Stratigraphic Elevation	Higher-Level Archaeocyathid Reefs				
Diameter	37mm	35mm	50mm	35mm	40mm
Width of Intervallum	8mm	8mm	12mm	7mm	7mm
Diameter of Central Cavity	21mm	19mm	26mm	21mm	26mm
Number of Parieties	114	105	143	90	124
Parietal Coefficient	3	3	2.8	2.6	3

Table-10 Dimensional measurements of

Pycnoidocyathus columbianus

OUTER WALL: The outer wall is thick, perforated by medium-sized pores, and about three rows of pores occur in each intersept. The pore pattern was not observed. In one specimen from Forteau, marked MUAF 09-1301, the outer cup is surrounded by exocyathid tissue.

INTERVALLUM: The intervallum is wide, and contains straight radiating parieties which vary in number from 90 to 143. These straight parieties are perforated by pores. Numerous dissepiments connect the parieties in the intervallum. Synapticulae are very few in number and only occur close to the inner wall. Soft tissue is preserved in the intervallum.

INNER WALL: The inner wall is complicated by dissepiments and synapticulae which occur in greater concentration towards the inner wall. Pores perforate the inner wall, but the pore pattern is not observable.

CENTRAL CAVITY: The central cavity is simple. In most specimens it is filled with fossil debris of various kinds, and in the case of the central cavity of the specimen collected from L'anse au Loup öolites are the main cup-filling material.

<u>Pycnoidocyathus</u> sp.

(Plate 44, Fig.2)

GENERAL SHAPE: The general appearance of the cup of specimen MUAF 03-1401 is similar to a vase or flattened fusiform club. The middle portion of the cup is expanded and has the largest diameter whereas the lower and upper ends of the cup are narrower. A cross section through the cup does not show a circular ring as in most archaeocyathids but instead an elliptical outline.

OUTER WALL: The outer wall is longitudinally grooved with the grooves marking the position of the parieties. Transversely the outer wall is strongly annulated with annulations spaced 10mm apart. Most of the outer wall is eroded away. Neither pores nor a pore pattern could be observed.

INTERVALLUM: The intervallum is filled with straight parieties which are connected by numerous synapticulae and curving dissepiments. The width of the intervallum is variable and measures from 3 to 4mm. The number of parieties in the intervallum is 170 at the section where the cup has a diameter of 40mm, and therefore the parietal coefficient is 4.25. The parieties are perforated by pores but the pore pattern was not observed.

INNER WALL: The inner wall is thin and in places complicated by synapticulae. It is perforated by pores of an unknown pore pattern.

CENTRAL CAVITY: The central cavity is simple and no skeletal elements are to be seen.

DISCUSSION: The general form of this species distinguishes it from other pycnoidocyathids. However because there is not enough material for the valid establishment of a new species the writer in this thesis refers to it as an independent species of the genus Pycnoidocyathus.

LOCALITY: One complete specimen and the cast of second of this species were collected from Fox Cove.

Family Syringocnematidae Taylor, 1910

Genus Sigmosyringocyathus gen. nov.

(Plate 32, Figs. 1-6)

DERIVATION OF NAME: Greek, sigmo-- S-shaped; syringo-- pipe.

TYPE SPECIES: Sigmosyringocyathus cylindricus sp. nov.

DIAGNOSIS: Double-walled; outer wall simple, perforated by numerous fine pores. Intervallum filled by elongated hexagonal loculi oriented obliquely to the long axis of the cup. The loculi grew upward and outward from the inner to the outer wall, making an angle of 25^{o} with the vertical axis of the cup.

The complex inner wall is the most diagnostic feature of the new genus and distinguishes it from other genera belonging to Family Syringocnematidae. The inner wall is made up of numerous narrow sigmoidal annulate shelves which surround the central cavity one on top of the other. These shelves are unconnected, and canals separate successive shelves.

Sigmosyringocyathus cylindricus sp. nov.

DIAGNOSIS: Small archaeocyathid of cylindrical shape, slightly tapering. Diameters of holotype and paratypes range from 4.25mm to an extreme of 9.25mm, but for most specimens the diameter is around 5-6mm. Lengths of the holotype and two paratypes are 15mm, 20mm, and 23mm, but the actual length is suspected to be longer than 30mm (Table 11).

No part of the proximal end can be referred to as spitz. The proximal expanded end contains simple pariety-like loculi. Outer wall is thick and perforated by numerous fine pores. The intervallum contains hexagonal loculi, which are directed upward and outward from the inner wall towards the outer wall, making an angle of approximately 25° with the inner wall. Skeletal elements making up the loculi have a thickness of 0.1mm. Diameters of loculi measure 0.25mm. In cross sections of specimens, the loculi project from the inner wall and have the appearance of simple parieties. In the holotype, thirty-two parietal elements were counted which, when divided by its diameter of 5.5mm, gives a parietal coefficient of 5.8.

The diagnostic complex inner wall is made up of numerous annulate shelves, which in cross section are sigmoidal in shape. The height of a sigmoid shelf is about 0.2mm, and in the holotype thirty annulate sigmoidal shelves were counted in a space of 5.0mm along the inner wall in longitudinal section. The sigmoid shelves are set one on top of the other; a canal joining the loculi in the intervallum and the central cavity is formed between two successive shelves set a short distance apart. The annulate sigmoid shelves are held in position by loculi which are directed outward and upward from the point of connection. In sections cut perpendicular to the axis of the cup the annulate sigmoid shelf has the appearance of a solid ring lining the central cavity. In oblique and longitudinal sections the sigmoidal form of the annulate rings that make up the inner wall usually is well exhibited.

Dissepiment-like skeletal elements are present in the central cavity. These dissepiment-like elements appear either as thin solid lines or broken lines, and may extend into the intervallum.

DISCUSSION: The presence of loculi in the intervallum is a diagnostic feature of archaeocyathids belonging to the Family Syringocnematidae. The upward and outward oriented loculi which make an angle of 25-30 degrees with the axis of the cup are characteristic of the intervallum structure of Syringocyathus aspectabilis Vologdin found in the Siberian Platform as well as of S. canadensis Okulitch from northern British Columbia and S. inyoensis Okulitch from California, but the presence of a complex annulate inner wall in Sigmosyringocyathus distinguishes it from them. No archaeocyathids belonging to Family Syringocnematidae are known to have built an annulate inner wall, and on this basis the proposal of a new genus is considered necessary for systematic classification.

HORIZON AND LOCALITY: This new species is found to be common in the Lower-level Archaeocyathid Reefs in the lower part of Forteau formation. Specimens were collected by the writer from Point Amour, L'anse Amour, Forteau, and Blanc Sablon.

No:	04-1801	04-1802	04-1803a	04-1803b	04-1803c	04-1804	04-1805	09-1801a	09-1801b	09-1802a	09-1802b	09-1803	14-1801	14-1802	14-1803
Locality	POINT AMOUR							FORTEAU					BLANC SABLON		
Length	15													20	
Largest Diameter	4.50	5.50	8.00	6.00	9.25	5.00	5.75	5.20	5.00	8.00	5.75	4.25	5.25	6.5	6.75
Width of Intervallum	1.10	1.25	2.50	1.75	2.75	1.25	1.50	1.60	1.40	2.00	1.50	1.25	1.25	1.50	2.25
Diameter of Central Cavity	1.80	2.50	3.00	2.50	3.75	2.50	2.75	2.00	2.20	4.00	2.75	1.50	2.75	3.00	2.25
Diameter of Loculi	0.15	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Number of Parieties	-	32	44	32	47	-	38	29	23	45	34	23	29	-	29
Parietal Coefficience	-	5.8	5.5	5.3	5.0	-	7	5.5	4.6	5.5	5.9	5.4	7.4	-	4.4

Table-11 Dimensional Measurements of <u>Sigmosyringocyathus cylindricus</u> nov. sp.

(in millimeters)

MATERIAL: Holotype, MUAF 04-1801, cross section; MUAF 04-1802, longitudinal section. Paratypes, MUAF 04-1803, 04-1804, 04-1805, 09-1801, 09-1802, 09-1803, 14-1801, 14-1802, and 14-1803. All material is deposited with the Geology Department, Memorial University of Newfoundland.

Syringocyathus canadensis Okulitch, 1955

(Plate 25, Figs. 1,2; Plate 26, Figs. 1,2; Plate 27, Figs. 1,2; Plate 28, Fig. 1; Plate 45, Figs. 1,2)

This species is one of the common archaeocyathids found in the Labrador Cambrian area. It occurs both in the Lower-Level and the Higher-Level Archaeocyathid Reefs. Its habit of living in small colonies resulted in small localized facies composed entirely of this species in the major reef bodies. This species shows evidence of budding reproduction. Daughter archaeocyathids produced by budding frequently were found attached to mother archaeocyathids.

Despite its common occurrence in the area under discussion, this is the first report of this species from Labrador.

GENERAL SHAPE: The general shape of this species is a long, narrow, acutely conical cup. The length of the cup is slightly over 110mm for the longest specimen which was collected from a locality to the east of L'anse au Clair. The upper diameter of the cup ranges from 15mm to 26mm (Table-12).

No:	04-2001	04-2002	05-2001	06-2001	08-2002	08-2003	11-2001	11-2004	11-2005
Locality	Point Amour		L'anse Amour	Crow Head	Buckle's Point		L'anse au Clair		
Stratigraphic Elevation	Lower-Level Archaeo. Reefs				Higher-Level Archaeocyathid Reefs				
Largest Diameter	14mm	9mm	15mm	16mm	15mm	17mm	22mm	26mm	20mm
Length	-	-	-	-	80mm	-	-	-	110mm
Width of Intervallum	5mm	3mm	5mm	6mm	5mm	6mm	9mm	9mm	8mm
Diameter of Central Cavity	4mm	3mm	5mm	4mm	5mm	5mm	4mm	8mm	4mm

Table-12 Dimensional Measurements of Syringocyathus canadensis

OUTER WALL: The outer wall is simple, thin, and perforated by fine pores. It is gently transversely annulated, with crests of annulations spaced 10mm apart.

INTERVALLUM: The intervallum is wide, occupies one-third of the diameter, and is about 6mm in width in most specimens. The width of the intervallum is maintained nearly constantly throughout the whole conical cup, consequently in the lower portion of the cup the intervallum relatively is so wide that the central cavity becomes indistinct. The intervallum contains many elongated polygonal loculi which have the appearance of rounded tubes as a result of secondary thickening of the loculi wall. These polygonal loculi lead upward and outward from the axis of the cup. The angle between the upward and outward directed loculi and the inner wall varies from 25 to 30 degrees. Secondary thickening of skeletal elements in the intervallum is commonly observed. Well-preserved soft tissue adjacent to and immediately surrounding these thickened skeletal elements provides evidence that thickening of skeletal elements resulted from increased secretion of calcium carbonate on the primary skeleton by the organism while it was still a living and growing form.

INNER WALL: The inner wall is thick and rather irregular. Large pores with diameters as large as 0.5mm to 0.8mm penetrate the inner wall and join the loculi in the intervallum and the central cavity.

At some places a thin layer of solid skeletal element can be seen to line the central cavity; this also may be the result of further deposition of calcium carbonate around the central cavity.

CENTRAL CAVITY: The central cavity is simple but has an irregular outline in the upper portion of the cup. In the lower portion of the cup the central cavity narrows and has a tendency to become indistinct. Dissepiment-like skeletal elements cross the narrow central cavity in the lower portion of the cup. It is quite possible that sections across the lower portion of the cups of this species have been mistaken for specimens of Genus Protopharetra at times by some students of this phylum.

Syringocyathus sp.

(Plate 28, Fig. 2)

This species is represented by a cross section cut through a single specimen marked MUAF 14-1901 collected from Locality 14 at Blanc Sablon. Dimensional measurements obtained from this cross section are as follows:

Diameter	Width of Intervallum	Central Cavity
10mm	3.0mm	4.0mm

OUTER WALL: Outer wall is thin, simple, continuous and perforated by fine pores.

INTERVALLUM: The intervallum contains large loculi. The detailed structure of the loculi could not be observed in the limited material available for study. Large pores penetrate the loculi in the intervallum.

INNER WALL: The inner wall is simple. It appears to be composed of the inner ends of loculi. Large pores perforate the inner wall and connect the central cavity with the loculi.

DISCUSSION: This species differs from the two other syringocnematids found in the thesis area by having larger loculi perforated by large pores, and by the simplicity of its inner wall.

Family METACOSCINIDAE Bedford and Bedford, 1936

Archaeosycon billingsi (Walcott), Taylor, 1910

(Plate 29, Figs. 1,2; Plate 30, Figs. 1,2; Plate 31, Figs. 1,2)

GENERAL SHAPE: The general shape of this species is a cylindrical tube with a very slight taper. In the specimen labelled MUAF 04-1501, the diameter of the cylindrical tube changes from 10mm to 8mm in a distance of 25mm, a rate of tapering almost the same as that of Walcott's holotype (U.S. Nat. Museum, No. 15305) which was later redescribed by Okulitch (1943). Okulitch's remeasurement of the rate of taper of Walcott's holotype gave a decrease from 16mm to 14mm in a distance of 30mm. In another specimen collected from

Labrador by Dr. R.D. Hughes and labelled MUAF 04-1503 there is no tapering of the tube and in a distance of 20mm its diameter, which measures 10mm across, remains unchanged.

OUTER WALL: The outer wall is transversely annulated, but spacing of the annulations is irregular. The thickness of the outer wall is 0.1mm as measured under a microscope. Pores are seen to have perforated the outer wall but are not distinctly observable.

INTERVALLUM: The intervallum is filled with up-arched tabulae. The number of tabulae ranges from 12 to 15 in a distance of 10mm in longitudinal section. These tabulae project from the inner wall outward into the intervallum in the form of horizontal bars. A short distance away from the central cavity and from the inner wall these horizontal bars unite and are woven into a porous network of skeletal elements which form the up-arched tabulae. The combined pore area of one of these tabulae is far greater than the area of its solid skeletal element. Pores of the net-like tabulae are polygonal in shape and their sizes are variable. Successive horizontal tabulae are fastened in position and supported by vertical skeletal elements. One noteworthy feature found in the intervallum of this archaeocyathid species is the secondary thickening of skeletal elements. In the lower portion of the cylindrical tube the skeletons were greatly thickened by the deposition of thin layers of microcryptocrystalline calcite on the primary skeleton, which also is composed of similar microcryptocrystalline calcite. Thin transparent suture lines dividing the two layers of primary and secondary skeletons outline the original shape of the primary skeletons. Usually in the lower portion of the tube the thickening of skeletal elements is so complete that pores of the porous tabulae are sealed off and solid non-porous up-arched tabulae are present. The secondary thickening of skeletal elements is judged not to be a result of sedimentary diagenetic calcification of the skeleton, but rather it is thought to have been deposited by the archaeocyathid during its lifetime. Evidence supporting this idea is the observation that the thickened part of the skeleton are made up of microcryptocrystalline calcite which easily can be distinguished from microcrystalline calcite or coarse transparent sparite. These two latter forms of calcium carbonate minerals are the result of diagenetic alteration. Thickening of skeletal elements proceeded from the lower portion of the tube into the upper portion in a vertical direction. In the horizontal direction, thickening of tabulae started from the inner wall and proceeded towards the outer wall. Accordingly, very often the lower portion of the tube is filled with solid blocks of skeletal elements while the tabulae in the upper portion of the tube are thin and porous. The living tissue of archaeocyathids, in addition to depositing secondary microcrystalline calcite which thickened the skeletal elements, also built numerous thin vesicular dissepiments in the lower part of the tube. Where the lower parts are not occupied by solid skeletal elements, they are filled with thin curving dissepiments which are totally lacking in the intervallum in the upper portion of the tube. Two complete longitudinal sections demonstrate that the spitz of this species is of Archaeophretra type.

INNER WALL: The inner wall is very thin and sometimes obscured by secondary thickening. It is perforated by fine pores of unknown pattern.

CENTRAL CAVITY: The central cavity is wide and usually has the same width as the intervallum. Ends of horizontal bars, which fused and united forming porous tabulae, project a short distance into the central cavity. In those places where these bars are thickened they give the central cavity an irregular outline. No skeletal elements were seen in the central cavity.

DISCUSSION: The genus Archaeosycon was founded by Taylor in 1910. It was based on Archaeocyathus billingsi Walcott which Taylor regarded as a member of the Coscinocyathidae. In 1943, Okulitch included this genus in Family Metacoscinidae on the basis of the presence of abundant taeniae and irregular skeletal structures which fill the intervallum, but he regarded this assignment to be tentative for lack of knowledge about the character of the spitz of Archaeosycon (Okulitch, 1943). Present work by the writer on Labrador material, including two complete longitudinal sections collected from Forteau and Point Amour, provides strong support for Okulitch's classification. The writer's present collection and research also show that there are some problems to be clarified concerning another genus, *Claruscyathus*, which was founded by Vologdin in 1932, and placed in the same family. Definition of the genus *Claruscyathus* can be given best by quoting Okulitch's description of it as it appears in the *Treatise on Invertebrate Paleontology*, Part E, Archaeocyatha and Porifera: "General structure like that of *Archaeocyathus* but has upwardly convex tabulae". This brief statement does not afford a very clear distinction between the genera *Archaeosycon* and *Claruscyathus*, and the writer finds it difficult to tell one from the other.

In one of the specimens collected by the writer from Point Amour and labelled MUAF 04-1701 the cylindrical cup is complete down to the spitz. A longitudinal section of the specimen (Plate 31, Fig. 1) shows that the upper portion of the cylindrical cup exhibits every structural feature characteristic of *Archaeosycon*. However, in the lower portion of the cylindrical cup most of the skeletal elements are thickened, and vesicular tissue fills the intervallum. It is unfortunate that Walcott's holotype did not show the skeletal structure of the lower portion of the cup because examination of the complicated lower portion of the cup alone will certainly lead one to believe that there are some systematic differences between the two genera. The present writer believes that during its earlier stages *Archaeosycon* species built a simple cylindrical cup in the intervallum of which porous up-arched tabulae and vertical skeletal structures were the main elements. The central cavity of this stage is simple. During the later stage of the organism's life excessive amounts of micro-cryptocrystalline calcite were added to the skeletal elements, which consequently were thickened. Another skeletal structure related to the aging of the archaeocyathid is the dissepiment in the intervallum. Deposition of thin curving dissepiments began in the lower portion of the cup and proceeded upwards during the later stage of the archaeocyathid's life. The result is that the simple upper portion of the cup usually differs from the complicated lower portion of the cup in appearance by a lack of vesicular tissue and in the presence of thinner skeletal elements.

The present writer believes that the specimens on which Vologdin founded the new genus Claruscyathus is in fact the lower portion of an Archaeosycon species with a complicated intervallum structure. Because the name Archaeosycon bears priority over the younger term Claruscyathus the latter should be abandoned.

Sub-class EXOCYATHA Okulitch, 1943

Order CROMMYOCYATHINA Bedford

Family EXOCYATHIDAE Bedford

Genus Exocyathus Bedford

Irregular masses of archaeocyathid vesicular structures, some in the form of concentric growths, and others comprising either exotheca-like or root-like tissue, observed surrounding or attached to other archaeocyathid individuals have been studied by many students of this phylum. Various explanations for these archaeocyathid structures, which are recorded from Cambrian strata of Australia, Sardinia, and North America, have been proposed. They are developed best in Labrador, South Australia, and in some Siberian localities (Okulitch, 1946).

Professor J.G. Bornemann (1866) was the first paleontologist to recognize and study this type of archaeocyathid structure. His research led him to the conclusion that it was related to reproduction. Taylor (1910), after examination of this structure, stated his belief that it was either an anchoring root or an exothecal structure. In 1937, R. Bedford and J. Bedford studied several types of this structure, considered them to be of systemic significance, and referred them to genera and species. They recognized two types: one they named Exocyathus, and the other Metaldetimorpha.

The Labrador Archaeocyathid Fauna was first described by Okulitch in 1943. He recognized two different types of this structure on the basis of which he proposed two new species: Exocyathus canadensis and E. regularis. Although Okulitch described these two "species" he was hesitant in classifying them as valid and independent generic form, and he stated that these "species" might actually be pathologic outgrowths of the enclosed archaeocyathids (Okulitch, pp. 48, 83, 84, 1943). Three years later, in 1946, he decided that these structures were not independent organisms but rather "exothecal lamellae" of the archaeocyathids enclosed by them. Consequently, he abandoned his earlier classification (Okulitch, 1943) of Exocyatha, given below:

Phylum ARCHAEOCYATHA

(Class PLEOSPONGIA)

Sub-class EXOCYATHA

Order CROMMYACYATHINA Bedford

Family EXOCYATHIDAE Bedford

Genus Exocyathus Bedford

Genus Ajacia Bedford

Genus Metaldetimorpha Bedford

Family VESICULOIDAE Vologdin

Genus Labyrinthomorpha Vologdin

Family MATHEWCYATHIDAE Okulitch

Genus Mathewcyathus Okulitch

Replacing this eliminated Sub-class, Okulitch proposed four descriptive terms for four distinct types of "exothecal lamellae", these terms were:

(i) Exocyathomorphous Exothecal Lamellae: "..... the most regular and solidly built exothecal structures. ..... The lamellae form concentric encrustations or more or less irregular protuberances attached to central cups of Ajacicyathina and Metacyathina. ..... Essentially, exocyathomorphous lamellae repeat and resemble the intervallum structure of the parent organism. In cross-sections this gives a pattern of complete or incomplete concentric lamellae, with more or less definite walls, and a well-developed system of parieties (septa), taeniae, and dissepiments extending from wall to wall." (Okulitch, op cit., p. 82)

(ii) Metaldetimorphous Exothecal Lamellae: "This type of lamellae is a modification of the preceeding, showing considerably less regularity of structure. The structure is still most commonly in the form of a concentric lamella tightly attached to the outer wall of the parent organism, but the transverse parieties or septa are lacking, being replaced by abundant taeniae and dissepiments, resulting in vesicular or semi-vesicular tissue. .....

"It is thus apparent that, in general, exocyathomorphous tissue resembles somewhat the intervallum structure of Cambrocyathidae and in some cases even Ajacicyathidae, while metaldetimorphouse tissue resembles more that of Archaeocyathidae (Spirocyathidae). Identification is sometimes made difficult because of intermediate types." (Okulitch, op cit., pp. 82, 83)

(iii) Labyrinthomorphous Exothecal Lamellae: "The labyrinthomorphous lamellae consist of irregular vesicular tissue. They seldom, if ever, form complete concentric rings around the parent organism, but rather form shapeless excrescences attached by their broad base to the outer wall of the central cup and gradually tapering off distally." (Okulitch, op cit., p. 83)

(iv) Tersiamorphous Exothecal Lamellae: "The tersiamorphous lamellae are long, ribbon-like structures, consisting of greatly elongated, filament-like taeniae, strengthened by vesicles. They form root-like excrescences on other pleosponges. ..... Because of their length, tersiamorphous lamellae are easily broken off and buried in the substratum as seemingly independent structures." (Okulitch, op cit., p. 83)

The present writer, after study of the Labrador fauna, believes that he has fossil material indicating that these structures are the skeletal elements of organisms of independent generic form, and next he will discuss evidence in support of the Bedfords' classification of these structures as independent genera and species.

In the Lower-Level Archaeocyathid Reefs of the thesis area, cups of archaeocyathids belonging to Genus Ajacicyathus frequently show confusing structures of pycnoidocyathid-type occupying part of the intervallum. These structures usually differ from the rest of the cup in having numerous dissepiments and in having well-preserved soft tissue. In the portion of the cup occupied by the dissepiment-bearing structures the intervallum is filled with clear, transparent, coarse crystalline calcite, however, the rest of the intervallum and the cup is void of such crystalline calcite and instead filled with a reddish coloured sediment. (Plate 33, Fig. 1)

In the Lower-Level Archaeocyathid Reefs at Point Amour a large cup of Ajacicyathus profundomimus was collected which was filled with red calcareous sediment. The simple radiating parieties in the intervallum of the specimen were well preserved, a mass of vesicular tissue made up of white calcite encrusted the lower end of the cup including the spitz and extended into the intervallum which, consequently, showed a cup structure completely different from that of an ajacicyathid. (Plate 34, Fig. 1)

These two striking phenomena are difficult to explain in terms of morphologic structure of the fossil, if it is to be considered a single individual. Okulitch's theory of "exothecal lamellae" will not explain these phenomena. It is evident that the cup housing the vesicular tissue had been left behind by a dead archaeocyathid and became evacuated, and this archaeocyathid certainly was not likely to have built the vesicular tissue in the intervallum. The present writer tends to think that "exothecal lamellae" if produced by an archaeocyathid should be identical with that of the parent organism, a point of view also stated by Okulitch (1946).

The writer believes that these structures were built by an archaeocyathid other than the one that built the evacuated basal cup. The former archaeocyathid, presumably of independent generic and specific rank, probably had either a free swimming or planktonic larval stage, during which the larva swam or drifted about until it encountered an adequate substratum on which to settle prior to development into an adult archaeocyathid. Abandoned empty cups of ajacicyathids appear to have served this purpose well. A drifting or free swimming larva of another archaeocyathid settled on an ajacicyathid cup and, using the skeletal elements of it as a supporting framework, was able to build the vesicular tissue typical of an exocyathid. Although an exocyathid was capable of building its own vesicular tissue, it seems to the writer that it may not have been able to build a complete cup, and in order to survive had to encrust itself around a foreign solid object as a means of support. If such was the case, it is only reasonable to assume that abandoned cups of other archaeocyathids, since they provided nearly the only available solid substratum in a reef, were well adapted to serve as basal supports.

Encrusting of vesicular archaeocyathid tissue on cups of other archaeocyathids occurs not only in the case of abandoned evacuated cups but also to cups still occupied by living archaeocyathids. Well-preserved soft tissue in the intervallum of the encrusted archaeocyathid as well as in encrusting vesicular tissue is obvious evidence of such a relationship. When an encrusting archaeocyathid settled on a host archaeocyathid, it did not settle in the intervallum but instead attached itself to the outer wall of the encrusted archaeocyathid forming a concentric layer of vesicular tissue which surrounded the encrusted cup almost completely. In most cases these layers grew out from one side of the attached cup leaving the opposite side of the cup open, and the whole mass of concentric tissue formed an omega-shaped layer. One may speculate that an encrusting layer on the outer wall of an archaeocyathid might harm the encrusted archaeocyathid, and the relationship between the encrusted and the encrusting archaeocyathids indeed may seem on cursory examination to resemble parasitism. Under this condition presumably the water currents, which passed through the tissue of encrusted archaeocyathid and brought a food supply, would be partially cut off, and the encrusted archaeocyathid consequently reacted by receding its soft living tissue towards the centre of the cup in order to leave a free space between the soft tissue and the cup so as to be able to maintain the water circulation system. This phenomenon is illustrated by several thin sections showing an encrusted archaeocyathid in which the soft tissue has receded to the opposite unencrusted side of the cup (Plate 35, Fig. 1). This relationship although not observed by Okulitch, was rightly surmised by him (Okulitch, op cit, p. 81).

The Bedfords referred to exocyathids as being parasitic in habit, but this would only cover the case when an exocyathid encrusted on the outer wall of another living archaeocyathid. On the other hand there are many examples in the writer's collection in which incrustation occurred in the empty abandoned cups and intervallum spaces of dead archaeocyathids. The definition of parasitism would not cover this latter case, and therefore the present writer favours the use of the word "encrusting" for the relationship found between exocyathids and the housing cups.

Okulitch stated that the "microscopic structure of the tissue appears to be identical with that of the parent organism." (Okulitch, op cit, p. 81) The structural framework of encrusting layers of archaeocyathid consisted of an outer wall which is perforated by pores, and pariety-like vertical skeletal elements that are arranged normal to the "outer wall" and joining these "parieties" are numerous curved dissepiments. In the species <u>Exocyathus canadensis</u> the skeletal structure very much resembles that of the intervallum structure of Pycnoidocyathus amourensis and it is quite difficult to distinguish the two apart. However, Exocyathus canadensis has been seen to encrust archaeocyathids belonging to the genus Archaeocyathus also. One could speculate that two species belonging to the same genus might produce almost identical "exothecal outgrowths" but it does not seem very likely that species belonging to two different genera would produce identical skeletal structures (Plate 36, Fig. 2). The present writer considers this phenomenon of identical encrusting structures on species belonging to different genera as further evidence pointing to the existence of either a free-swimming or free-drifting larval stage, or both. Settling of larvae on the cups of archaeocyathids belonging to different genera consequently might result in the development of identical vesicular tissue around cups of archaeocyathids belonging to different genera or species.

The position of these encrusting masses on the encrusted archaeocyathid cups also provide additional evidence confirming the writer's point of view. On cups of archaeocyathids overgrown by the vesicular tissue of encrusting exocyathids the vesicular mass may "cling" to the lower end of a cup and reach down to the substratum (Plate 34, Figs. 1,2), it may be housed in any portion of the intervallum of an abandoned cup (Plate 33, Figs. 1,2), but most commonly it surrounds the outer wall of an encrusted cup. The first and the third features may not be negative proofs to Okulitch's "exothecal lamellae" theory, but the second feature could only be built by a free-swimming or drifting larva which settled on the intervallum of the cup.

Based on the evidence discussed above the writer concludes that the organism that built the masses of vesicular tissue was an archaeocyathid with independent generic rank. This archaeocyathid, Genus *Exocyathus* Bedford, was capable of building a mass of vesicular tissue which maintained a difinite framework consisting of concentric layers of porous elements.

Exocyathus canadensis Okulitch, 1943

(Plate 35, Figs. 1,2; Plate 36, Figs. 1,2)

Encrusting archaeocyathid that had either a free-swimming or drifting larval stage, settled on a solid substratum -- in most cases either the abandoned cups of dead archaeocyathids or cups of living archaeocyathids -- and built either masses or concentric layers of skeletal elements which more or less maintained a definite structural framework. These masses and concentric layers of vesicular skeletal elements consist of a porous wall normal to which are numerous, regularly-arranged, vertical, porous parieties, which are usually short and thick. Numerous thin, curved dissepiments connect the parieties and trend parallel to the wall.

This species is distributed in both the Higher-Level and Lower-Level Archaeocyathid Reefs throughout the mapped area.

Phylum Brachiopoda Dumeril, 1806

Class Inarticulata Huxley, 1869

Order Obolellida Rowell, 1965

Superfamily Obolellacea Walcott & Schuchert, 1908

Family Obolellidae

Walcott & Schuchert, 1908

Obolella chromatica Billings

(Plate 46, Figs. 1,2)

Shell thick, calcareous, suboval in outline. Valves biconvex, curvature of anterior end stronger than posterior end, anterior margin broadly rounded. Growth lines are concentric and strongly ridged, spacing of growth lines is regular. Pedicle opening is situated slightly anterior to beak on the pedicle valve. Character of pseudointerarea not observed.

Order Orthida Schuchert & Cooper, 1932

Suborder Orthidina Schuchert & Cooper, 1932

Superfamily Billingsellacea Schuchert, 1893

Family Nisusiidae Walcott & Schuchert, 1908

Nisusia oriens Walcott

(Plate 47, Fig. 1)

Shell subquadrate, costellate, with faintly developed medium sulcus, growth lines not very distinct; hinge line rather long, only slightly shorter than the width of the valve. Interarea and pseudodeltidium not observed.

Class Uncertain

Order Kutorginida Kuhn, 1949

Superfamily Kutorginacea Schuchert, 1893

Family Kutorginidae

Schuchert, 1893

Kutorgina cingulata (Billings)

(Plate 47, Fig. 2)

Shell calcareous, suboval in outline. Valves concavoconvex, with anterior margin broadly rounded. Ventral valve strongly convex with faint concentric growth lines and a well developed sulcus. The brachial valve is convex at the umbo and becomes concave anteriorly. Beak and notothyrium not observed.

PHYLUM MOLLUSCA

Class CEPHALOPODA Cuvier, 1707

Sub-class uncertain

Order Volborthellida Kobayashi, 1937

Family Salterellidae Poulsen, 1932

Salterella rugosa Billings

(Plate 48, Fig. 1)

Small, slender, conical conchs with strongly conical, closely spaced septa. Lengths of the straight conical tubes range from 10mm to 15mm; maximum diameter of living chamber 3mm; maximum diameter of the central tube (which resembles the siphuncle of cephalopods) 0.4mm.

This small conical fossil is distributed widely in the Forteau formation both horizontally and vertically. It first appears at the base of the Forteau formation and is persistent throughout it. It forms small lenses of limestone in the Lower-level Archaeocyathid Reefs of the Lower Member of Forteau formation. In the Middle Member it is a component of the fossiliferous limestone beds which alternate with greenish-grey fossiliferous shale beds. In the Upper Member it is the chief component of the oölitic algal limestone beds and forms lenses in the Higher-level Archaeocyathid Reefs. Outcrops bearing this fossils are distributed from L'anse au Diable to L'anse au Clair.

Salterella sp.

(Plate 48, Fig. 2)

Small, slender, orthoconic conchs. Conical septa are widely spaced with a distance between successive cones of 2.4mm, and only three or four conical septa may be present in an adult conch the total length of which is 13mm. Diameter of the average living chamber is 1.3mm. No central tube present in conch. Cross section of conch is circular.

This species may be compared to *Salterella billingsi* Safford which is Middle Ordovician in age.

Salterella sp. occurs in a clastic limestone which overlies an archaeocyathid reef of the Lower Member of the Forteau formation at Forteau. This fossil locality was in a roadcut located 200 feet west of the village of Forteau, but now may have been obscured by road construction during the summer of 1966.

Class CALYPTOPTOMATIDA Fisher, 1962

Order HYOLITHIDA Mathew, 1899

Suborder HYOLITHINA Mathew, 1899

Family HYOLITHIDAE Nicholson, 1872

Hyolithes billingsi Walcott

(Plate 49, Figs. 1,2)

Bilaterally symmetrical, pyridal shells, cross sections of shells subtriangular, lengths of shells vary from 18mm to 35mm.

Dorsal side of shell rounded, ventral side flattened. Opercula not collected.

In the thesis area, this fossil is common in the fossiliferous Forteau formation, being found both in archaeocyathid reefs, and in muddy algal limestones of the Upper Member. A thin bed of limestones made up of this fossil and the calcareous alga Solenopora taylorensis is exposed near L'anse Amour.

Phylum ARTHROPODA

Subphylum TRILOBITAMORPHA

Class TRILOBITA Walch, 1771

Order REDLICHIIDA Richter, 1933

Suborder OLENELLINA Resser, 1938

Family OLENELLIDAE Vogdes, 1893

Subfamily OLENELLINAE Vogdes, 1893

Olenellus thompsoni (Hall)

(Plate 50, Figs. 1,2; Plate 51, Fig. 1)

Cephalon semicircular in shape, genal spine well developed, furrows very distinct. Glabella subcylindrical with rounded frontal lobe and 3 pairs of lateral furrows, glabella not reaching anterior border furrow. Eyes large.

Thorax composed of 14 segments with well-defined pleural furrows, pleural spines well developed, directed obliquely backward. Pygidium minute.

Order CORYNEXOCHIDA Kobayashi, 1935

Family DORYPYGIDAE Kobayashi, 1935

Bonnia sp.

(Plate 51, Fig. 2)

Small, strongly arched. Glabella expanding and reaching anterior furrow.

Pygidium large, and semicircular in shape.

PLANT FOSSILS

DIVISION RHODOPHYTA Papenfuss, 1946

(Red Algae)

Class RHODOPHYCEAE Ruprecht, 1901

Family SOLENOPORACEAE Pia, 1927

Genus Solenopora Dybowski, 1878

Solenopora belemnos nov. sp.

(Plate 52, Figs. 1,2; Plate 53, Figs. 1,2)

DESCRIPTION: Tissue composed of threads of large cells. Cell threads are spear-shaped, straight, loosely packed, and spread out in radiating fashion from their base. These spear-shaped cell threads are long and range from 0.25mm to 5.0mm. No cross partitions were observed in the cell threads. Cell widths range from 0.05mm to 0.15mm. Cross sections of cells are polygonal in shape.

Solenopora belemnos nov. sp. is directly associated with archaeocyathids in reef bodies in the Lower Member of the Forteau Formation and grew in physical niches in the densely populated archaeocyathid reefs, frequently attached to archaeocyathid cups. They also flourished in the central cavities and intervallum spaces of archaeocyathids (Plate 53, Fig. 2). The presence of soft tissue preserved in the intervallum of the archaeocyathid shown in the same Figure demonstrates that the alga grew in the intervallum of the archaeocyathid while the latter was still alive. It appears to the writer that the associated archaeocyathid at least tolerated the existence of the alga in its intervallum in this specimen and he believes that normal symbiotic relationships existed between archaeocyathids and algae. *Solenopora belemnos* nov. sp. was also found associated with *Seletonella forteauensis* nov. sp., a new species of dasyclad alga (Plate 53, Fig. 1).

HOLOTYPE: Holotype of the new species was selected in the thin section labelled MUCF 09-0101, which also contains many paratypes. The limestone block that contains the holotype was collected from the Lower-level Archaeocyathid Reefs exposed at Forteau, Forteau Bay, Labrador.

PARATYPES: Thin sections containing paratypes of the new species are labelled: MUCF 09-0101, 04-0101, 04-0311, 04-0312, 04-0314, MUAF 04-0204, 04-0208, 04-1501, 04-1701, 04-1707, 04-1801, 05-0201, 05-0401, 05-0403, 05-0601, 09-0805.

STRATIGRAPHIC POSITION AND LOCALITY: This species is restricted to the Lower-level Archaeocyathid Reefs. Localities from which this fossil was collected include: Locality 04, Point Amour Light House; Locality 05, L'anse Amour; Locality 09, Forteau.

Solenopora taylorensis nov. sp.

(Plate 54, Figs. 1,2)

DESCRIPTION: Minute nodular masses, the general appearance of which may be rounded, elongated, or irregular. These masses do not seem to have been attached either to the sea floor or to other solid objects. Sizes of nodular masses range from 400 microns to slightly over 2.0mm. Tissue composed of densely packed long cell threads. Walls of cell threads relatively thick, and vary between 3 microns and 10 microns. Cross sections of cell threads are polygonal in shape. Diameters of the polygonal cell threads range from 9 microns to 30 microns. Cell threads fan out radially from a centre and branch upward. Partitions of cell threads are thinner than the cell walls, and measure about one to two microns in thickness.

At Taylor's Gulch, where this algal species is exceptionally well preserved and where the nodular algal masses are filled with glauconite, large round chambers are common in many of the nodular masses (Plate 54, Fig. 2). These chambers are round objects with diameters ranging up to 190 microns. Usually several are present in each algal mass. Although the outline of such rounded objects is suggestive of the possible preservation of one type of reproductive organ termed conceptacle, the evidence for this conjecture is not conclusive. Furthermore, the presence of conceptacles earlier than the Pennsylvanian has never been recorded (Johnson, 1966).

DISCUSSION: Stratigraphically S. taylorensis is the longest ranging of the algal species found in the Forteau formation. It is present in the Forteau Formation in the basal dolomitic bed, in the Lower-level Archaeocyathid Reefs, and in the Middle and Upper Members. In Taylor's Gulch specimens of it are exceptionally well preserved and algae collected here exhibit the best form and finest structure detail. The trivial name of this new species is given for this geographic locality.

MATERIAL: The thin section containing the holotype of the new species was prepared from a limestone block collected from Locality 07 at Taylor's Gulch and labelled MUCF 07-0201. It also contains numerous paratypes.

DIVISION CHLOROPHYTA Papenfuss, 1946

Class CHLOROPHYCEAE Kützing, 1843

Order DASYCLADALES Pascher, 1931

Family DASYCLADACEAE Kützing, 1843

orth. mut. Stizenberger, 1860

Genus Seletonella Korde, 1950

Seletonella forteauensis nov. sp.

(Plate 55, Figs. 1,2; Plate 56, Figs. 1,2; Plate 57, Figs. 1,2)

DESCRIPTION: Thallus minute and non-ramified; exhibits one of two distinct forms, either an elongated fusiform or a hemispheroidal form. Both forms characteristically are attached to substrata including trilobite exoskeletons.

Measured dimensional data of the two forms are:

	Holotype	Fusiform	Hemispheroidal
Length	2,100 u	950 - 2,280 u	600 - 1,100 u
Width	-	300 - 400 u	520 - 890 u
Height (from base to top of branches)	500 u	330 - 560 u	370 - 940 u
Thickness of calcareous sheath	60 u	60 - 120 u	40 - 120 u
Height of branches	150 u	80 - 150 u	100 - 150 u
Diameter of branches	30-60 u	30 - 70 u	40 - 80 u

The branches are short club-like with a radiating astarisk-shaped central cavity. The branches are all equally spaced and arranged in an orderly pattern. The calcareous sheath is quite thick and is composed of fine crystalline calcite. This sheath is penetrated by openings which connect the central cavity of the main thallus and the branches.

DISCUSSION: The new species closely resembles Seletonella mira, which has been described by Korde from the Upper Cambrian strata in Siberia and Kazakstan. It differs from Seletonella mira in smaller size, non-ramifying form, orderly and equally spaced arrangement of the branches and in the characteristic radiating or astarisk-shaped cavities of the branches.

MATERIAL: Seletonella forteauensis has been found only in the Lower-level Archaeocyathid Reefs of the Forteau Formation. Reef limestone blocks containing this alga were collected from locations near Point Amour Light House and Forteau. The holotype of the new species is contained in the thin section marked MUCF 04-0304, which also contains many paratypes. Paratypes are also found in sections labelled MUCF 04-0301 to 04-0315.

DIVISION SCHIZOMYCOPHYTA

Class SCHIZOPHYCEAE or CHLOROPHYCEAE

"Section" POROSTROMATA Pia, 1927

Genus Girvanella

Nicholson and Etheridge, 1880

Girvanella incrustans (Bornemann)

(Plate 58, Figs. 1,2)

DESCRIPTION: Thallus consists of a mass of twisted fine tubes forming either a large circular or a slightly elliptical disk. The diameters of these disks vary between 30mm and 50mm and their thicknesses range from 10mm to 15mm. Megascopically the algal form is composed of layers of algal material aggregated around a nucleus. The nuclei, when observed under a microscope, are seen to be either exoskeletons of trilobites, brachiopod shells, cephalopod shells, or oölites.

The thallus of this species consists of layers of encrusting tubes centered about a nucleus. These tubes are very fine and twisted. In horizontal sections the tubes are seen to be loosely scattered in random directions on each layers. In vertical cross sections the layers of tubes can be seen to be closely packed together.

Diameters of tubes vary between 16 microns and 23 microns, with the majority close to 19 microns. Twenty measured thicknesses of tube walls gave a figure close to 3 microns but, because of recrystallization, the recognition and the measurement of tube walls was very difficult.

This species was found in the Upper Member of Forteau formation in the thesis area. Limestone beds containing it are usually oölitic and may, or may not, contain Salterella, a slender, conical cephalopod found in Lower Cambrian beds. The algal disks were arranged horizontally along the bedding planes.

Girvanella mexicana Johnson

(Plate 59, Figs. 1,2;
Plate 60, Figs. 1,2)

DESCRIPTION: Thallus consists of masses of twisted fine tubes forming small bean-shaped or irregular nodules. The size of these nodular algal masses ranges from 1mm to 6mm in diameter. The arrangement of tubes does not follow any definite pattern, and may be loosely scattered, closely packed, twisted into a circular network, or in encrusted layers. Sizes of the algal tubes range from 20 microns to 29 microns. Walls of tubes seem to be thin but are not readily measurable because of recrystallization of the calcitic material that make up the tube walls. Occasionally, dark dusty material is seen to line a wall giving it a thicker appearance.

Girvanella mexicana appears to be limited to the Upper Member of the Forteau formation in the thesis area. *Salterella*, a genus which is commonly associated with *G. incrustans*, is absent in those limestone beds which contain *G. mexicana*.

Girvanella cf. *Girvanella incrustans* (Bornemann)

(Plate 17, Fig. 2; Plate 23, Fig. 1)

DESCRIPTION: Thallus consists of twisted fine threads of algal tubes forming irregular masses. Unlike the other *Girvanella* species found in the thesis area, these masses do not form any definite algal form, but instead were found attached to the outer wall of an exceptionally large pycnoidocyathid cup and intergrown with the "creeping" archaeocyathid *Archaeocyathus irregularis* nov. sp. in the single specimen collected. The arrangement of the fine tubes is patternless. The algal tubes are densely packed and their diameters vary between 13 microns and 16 microns. The thickness of the tube wall could not be measured. Cross partitions appear to be absent in the tubes.

The lack of a definite form and the minute size of the fine tubes make this alga difficult to place in its specific systematic position, however, it seems nearer to *Girvanella incrustans* than to any other species and is tentatively compared to this species.

This algal specimen was collected from the Higher-level Archaeocyathid Reefs at Taylor's Gulch.

"Section" SPONGIOSTROMATA Pia, 1927

Genus *Collenia* Walcott, 1914

Collenia filosa nov. sp.

(Plate 61, Figs. 1,2)

DESCRIPTION: Digital forms connected at the base but branching upwards leaving many interdigital spaces. Diameters of digits range from 8mm to 60mm across. The digits are composed of dome-shaped up-arched layers, closely packed one on top of the other. The inter-digital spaces were filled with organic and inorganic material most commonly the alga *Solenopora taylorensis* nov. sp., and also clastic quartz grains, oölites, and fossil fragments. Shells of *Salterella rugosa* which are commonly found in the same beds with *Girvanella incrustans*, occasionally filled the digital spaces as well as in the interior of the algal masses. The rims of the algal forms ad-joining the interdigital spaces are marked by thin streaks of either brownish or dark-coloured material. Microscopic observations of the new species reveal that the digital algal forms are made up of layers of numerous twisting fine algal tubes identical with the tubes typical of algae belonging to Genus *Girvanella*. The writer found it very difficult to distinguish cell threads contained in specimens of the species when their external algal forms were not observable. The tubes are short and twisting and their diameters vary between 19 microns and 22 microns. The thickness of a tube wall measures 2 microns. No particular tube pattern was observed.

DISCUSSION: The "Section" SPONGIOSTROMATA was erected by Pia to include a large number of fossil forms built by algae which show little or no microstructure, but which develop colonies having constant shapes (Johnson, 1966). The Genus Collenia was described by Walcott (1914, p. 110) to be:

> "More or less irregular dome-shaped, turbinate or massive, laminated bodies that grew with the arched surface uppermost. The growth appears to have been by the addition of external layers of lamellae of varying thickness with interspaces that vary greatly even in the same specimen."

Rezak in 1957 added the following information to Walcott's definition:

> "Colonies begin as incrustations on a surface of the substratum and grow upward by addition of convex laminae. Gross form cylindrical or hemispheroidal." (Johnson, 1966, p. 49.)

From the above descriptions it is certain that the new species belongs to Genus Collenia. However, the presence of the fine twisting tubes removes this species, and perhaps the Genus Collenia to "Section" POROSTROMATA which originally was introduced by Pia to include all fossil algae which have microstructures consisting of masses or bundles of well-defined tubes but which are of unknown systematic position (Johnson, 1966, op. cit.). Further detailed study may clarify the confusing identity between Girvanella and the new species as well as the relationship between Girvanella and Collenia. Before this additional research has been carried out, the writer does not recommend the removal of the new species and the Genus Collenia to the possibly more valid position "Section" POROSTROMATA, and the problem of the systematic position of the Genus Collenia remains open.

MATERIAL: Two blocks containing algal forms were collected from a bed composed entirely of Collenia species at a locality four miles to the west of Forteau. The bed was 12 feet in length, 6 feet in width, and 1 foot in thickness. It crops out on the north side of the road between Forteau and L'anse au Clair. Unfortunately, the larger of the two blocks collected was lost overboard at the wharf during loading at L'anse au Loup. Thin sections were prepared for microscopic study from the smaller block measuring 8 inches long, 5 inches wide and 2 inches thick. The thin section labelled MUCF 09-0701 contains the holotype of the new species.

Collenia sp.

(Plate 22, Fig. 2)

DESCRIPTION: Small dome-shaped up-arched algal forms composed of thin layers of encrusting laminae which vary in colour from greenish-yellow to yellowish-brown. In the only specimen collected the base of the dome-shaped algal mass was attached to the inner wall of a specimen of the archaeocyathid species Pycnoidocyathus profundus. The algal form apparently grew from the inner wall towards the central cavity. In some places the inner wall of the attached archaeocyathid receded giving place to the attached alga, and in these portions of the intervallum the width between the two walls became narrower than normal. The top of the dome-shaped algal forms measure 10mm across. No microstructure could be observed, except for that of the included foreign material. A thin line of dark coloured material marks the outline of the algal form.

DISCUSSION: The general appearance of the algal form suggests that the alga should be referred to Genus Collenia, but the small size of the algal form and the limited material was insufficient for the writer to identify its specific position. This specimen is believed to be the first reported Collenia species attached to an archaeocyathid.

MATERIAL: Thin sections containing this alga were labelled MUAF 07-1002A and 1002B which also are the cross sections of the archaeocyathid Pycnoidocyathus profundus, collected from Taylor's Gulch, Labrador.

Plate 12 - Ajacicyathus nevadensis (Okulitch)

Figure		Page
1.	Ajacicyathus nevadensis (Okulitch) X4. MUAF 04-0101, Lower-Level Archaeocyathid Reefs, Point Amour Light House, Labrador.	43
2.	Ajacicyathus nevadensis (Okulitch) X4. MUAF 04-0102, Lower-Level Archaeocyathid Reefs, Point Amour Light House, Labrador.	43

FIG. 1

FIG. 2

Plate 13 - Ajacicyathus profundomimus Okulitch.

Figure		Page
1.	Ajacicyathus profundomimus Okulitch. X3. MUAF 04-0201, Lower-Level Archaeocyathid Reefs, Point Amour Light House, Labrador.	50
2.	Ajacicyathus profundomimus Okulitch. X2. MUAF 05-0201, Lower-Level Archaeocyathid Reefs, L'anse Amour, Labrador, showing three specimens that existed closely together. Exocyathid tissue may be seen attached to the outer walls as well as located in the intervallum.	50

FIG. 1

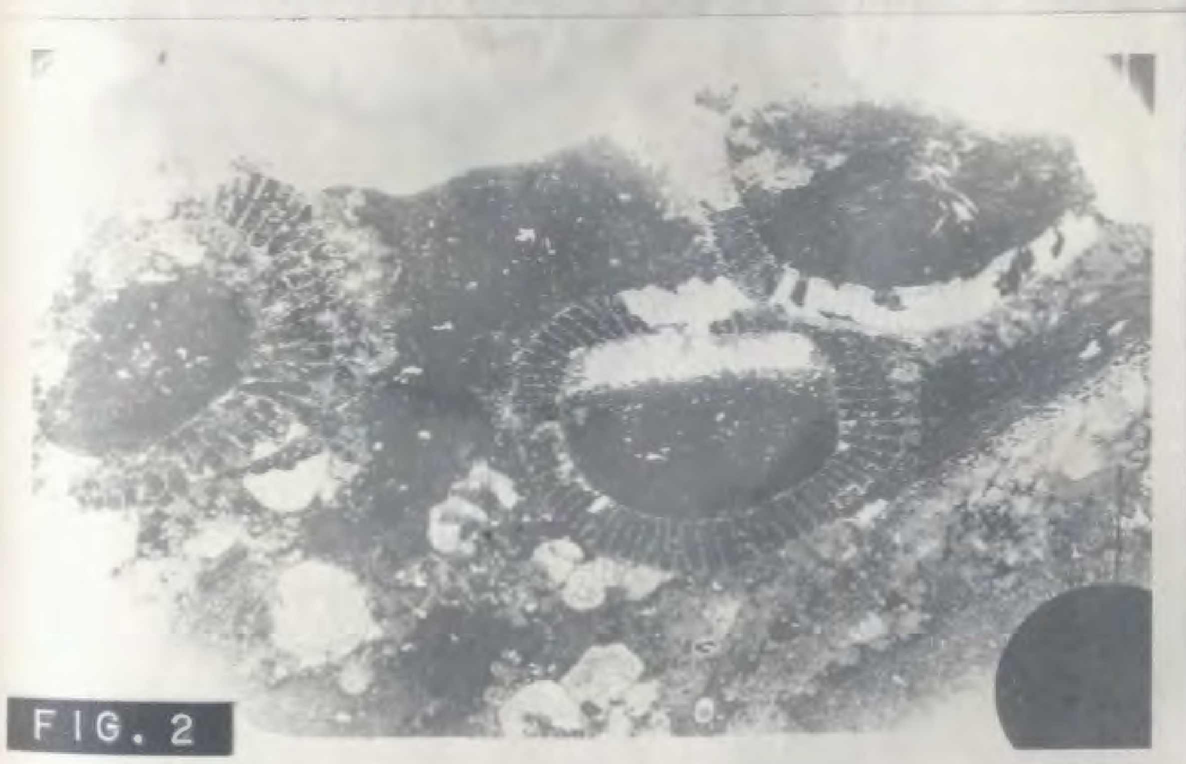


FIG. 2

Plate 14 - Ajacicyathus profundomimus Okulitch, and
Ajacicyathus undulatus Okulitch

Figure		Page
1.	Ajacicyathus profundomimus Okulitch X2. MUAF 09-0201, Lower-Level Archaeocyathid Reefs, Forteau, Labrador. Transverse section showing incomplete cups containing exocyathid tissue. Ajacicyathus nevadensis is present in the right hand side of the section.	50
2.	Ajacicyathus undulatus Okulitch X3. MUAF 06-0301, Higher-Level Archaeocyathid Reefs, Taylor's Gulch, Labrador.	44

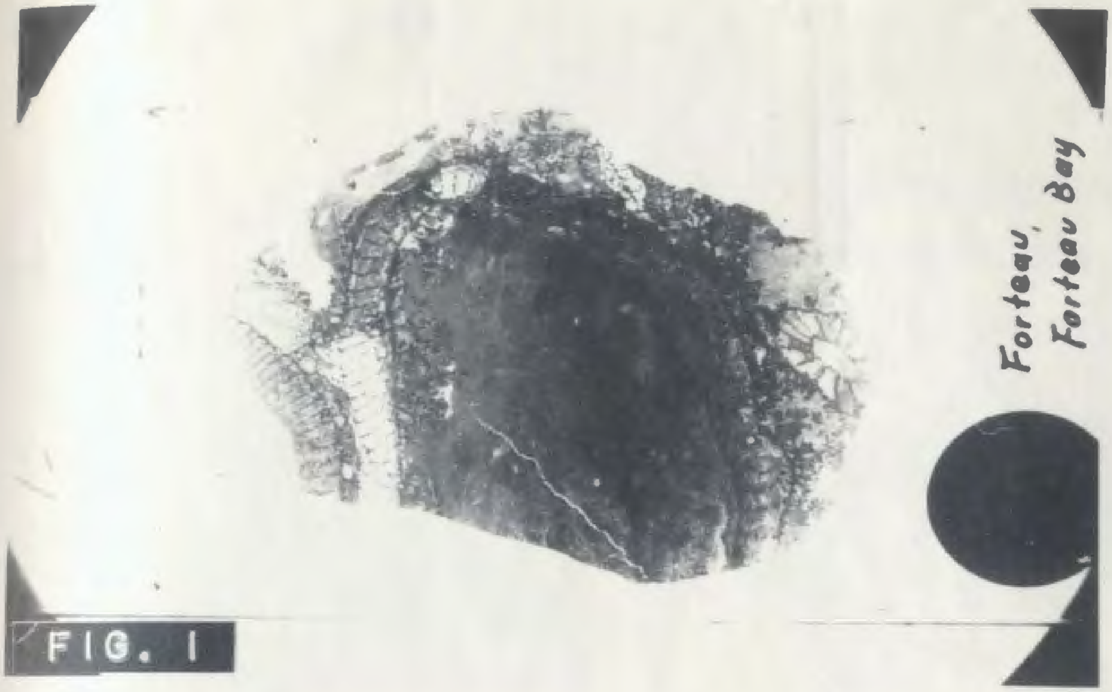


FIG. 1

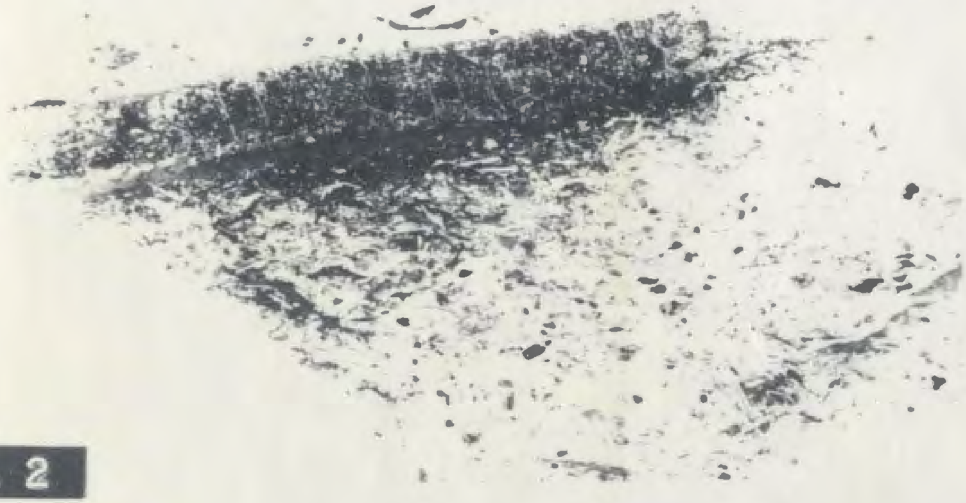


FIG. 2

Plate 15 - Ajacicyathus argentus (Okulitch)

Figure		Page
1.	Ajacicyathus argentus (Okulitch) X2.5. MUAF 05-0403, Lower-Level Archaeocyathid Reefs, L'anse Amour, Labrador, showing uneven thicknesses of the intervallum and the bilateral symmetry of the cup.	46
2.	Ajacicyathus argentus (Okulitch) X2. MUAF 05-0401, Lower-Level Archaeocyathid Reefs, L'anse Amour, Labrador.	46

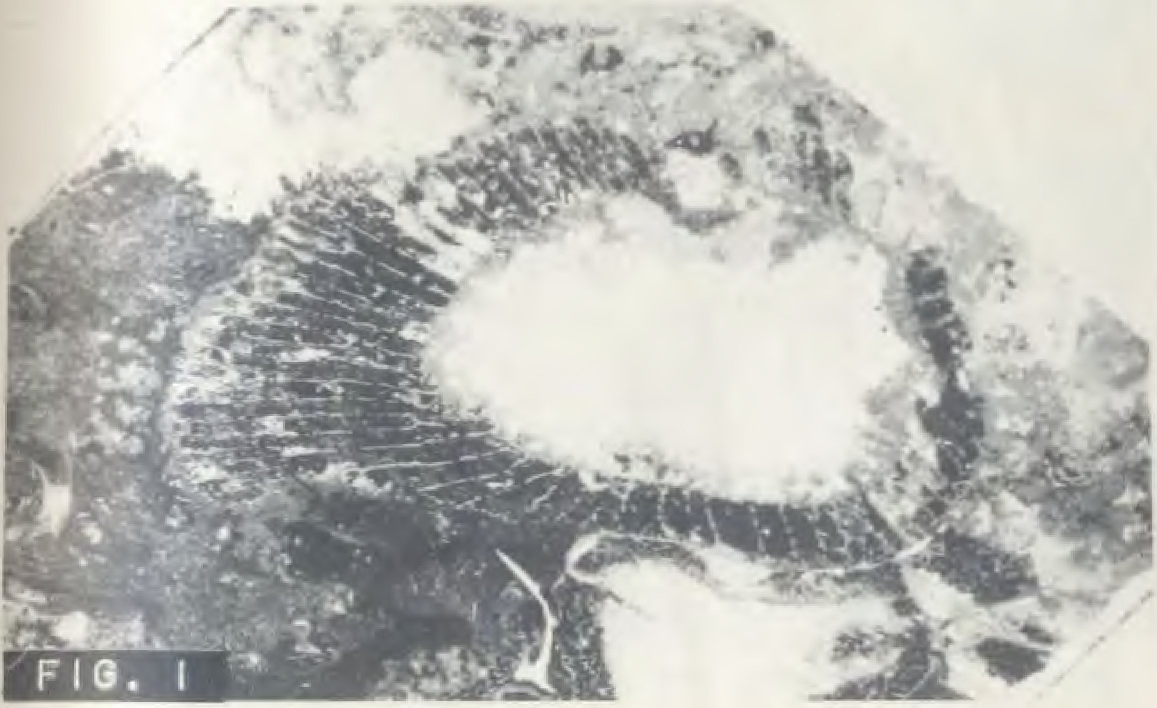


FIG. 1

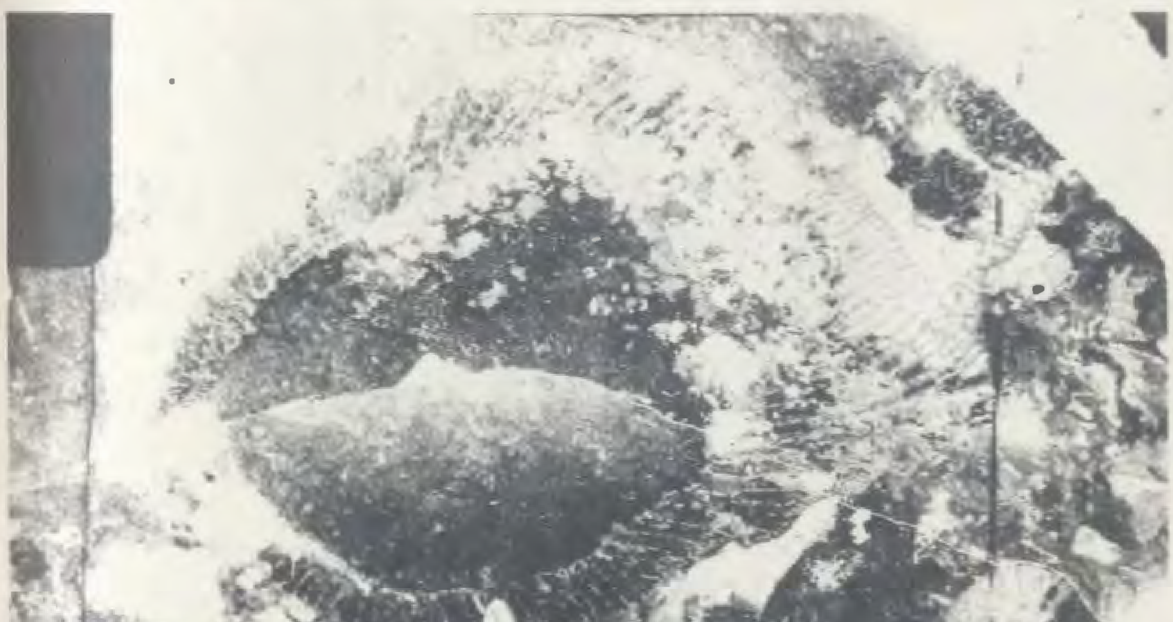


FIG. 2

Plate 16 - Archaeocyathus atlanticus Billings

Figure		Page
1.	Archaeocyathus atlanticus Billings X2. MUAF 09-0601, Lower-Level Archaeocyathid Reefs, Forteau, Labrador. Transverse section showing thickened skeletal elements. Soft tissue is preserved in the intervallum. Surrounding the specimen are several Sigmosyringocyathus cylindricus nov. sp., three are attached to the outer wall of the large centrally located specimen of the A. atlanticus.	55
2.	Archaeocyathus atlanticus Billings X3. MUAF 04-0601, Lower-Level Archaeocyathid Reefs, Point Amour Light House, Labrador. Transverse section showing narrow central cavity and wide intervallum. The specimen is completely surrounded by exocyathid tissue.	55

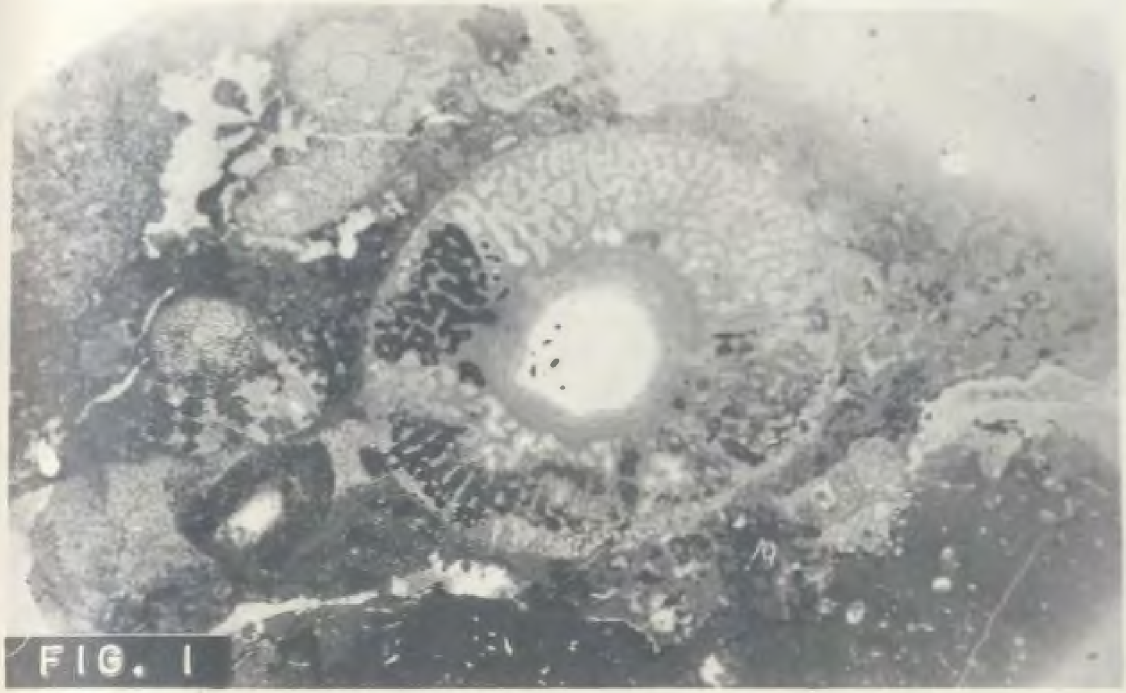


FIG. 1

FIG. 2

Plate 17 - *Archaeocyathus irregularis* nov. sp.

Figure		Page
1.	*Archaeocyathus irregularis* nov. sp.	56
	X1.5. MUAF 01-0701, Lower-Level Archaeocyathid Reefs, Capstan Island, Labrador. Random section of holotype, showing the long but irregularly extending "cup". Hexagonal prismatic supporting skeletal elements are seen at places marked "p" in the figure.	
2.	*Archaeocyathus irregularis* nov. sp.	56
	X1.6. MUAF 07-0701, Higher-Level Archaeocyathid Reefs, Taylor's Gulch, Labrador. Paratypes. In this random section several specimens may be seen extending very irregularly in twisted groups.	

FIG. 1

FIG. 2

Plate 18 - Archaeocyathus patelliformis nov. sp.

Figure		Page
1.	Archaeocyathus patelliformis nov. sp. X2. MUAF 09-0805, Forteau, Labrador. Paratype. Vertical section, showing the thickened outer wall. The intervallum is filled with taeniae.	60
2.	Archaeocyathus patelliformis nov. sp. X2. MUAF 09-0803, Lower-Level Archaeocyathid Reefs, Forteau, Labrador. Paratype.	60

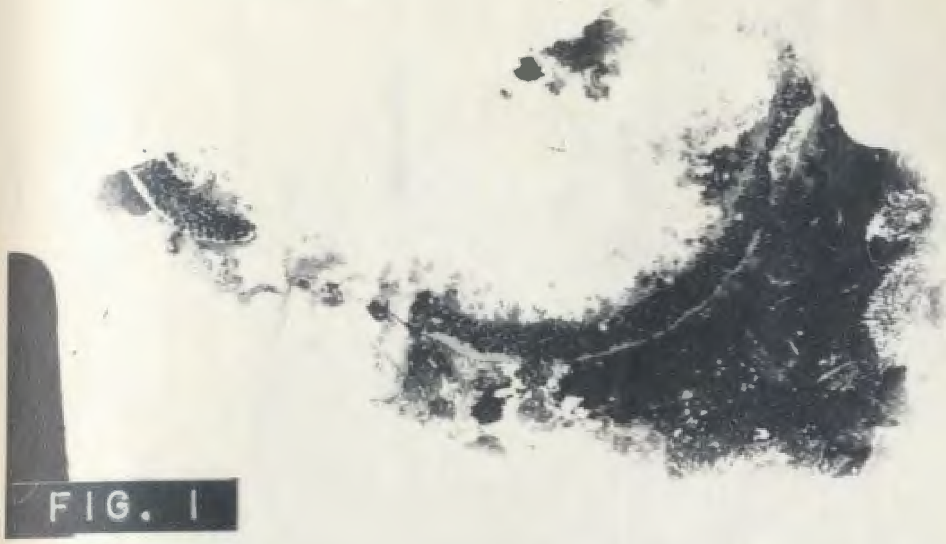


FIG. 1

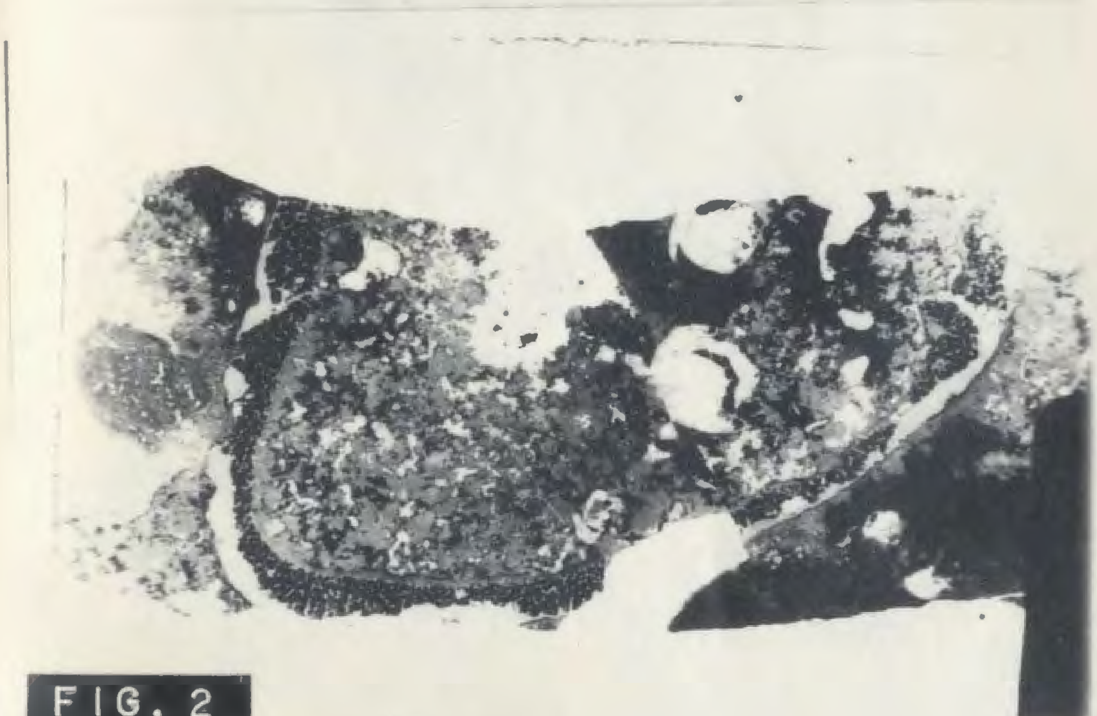


FIG. 2

Plate 19 - Protopharetra sp.

Figure		Page
1.	Protopharetra sp. X7. MUAF 04-0402, Lower-Level Archaeocyathid Reefs, Point Amour Light House. Cross section showing narrow central cavity, P. dunbari?	61
2.	Young stage of a pycnoidocyathid X7. MUAF 09-1803, Lower-Level Archaeocyathid Reefs, Forteau, Labrador.	61

FIG. 1

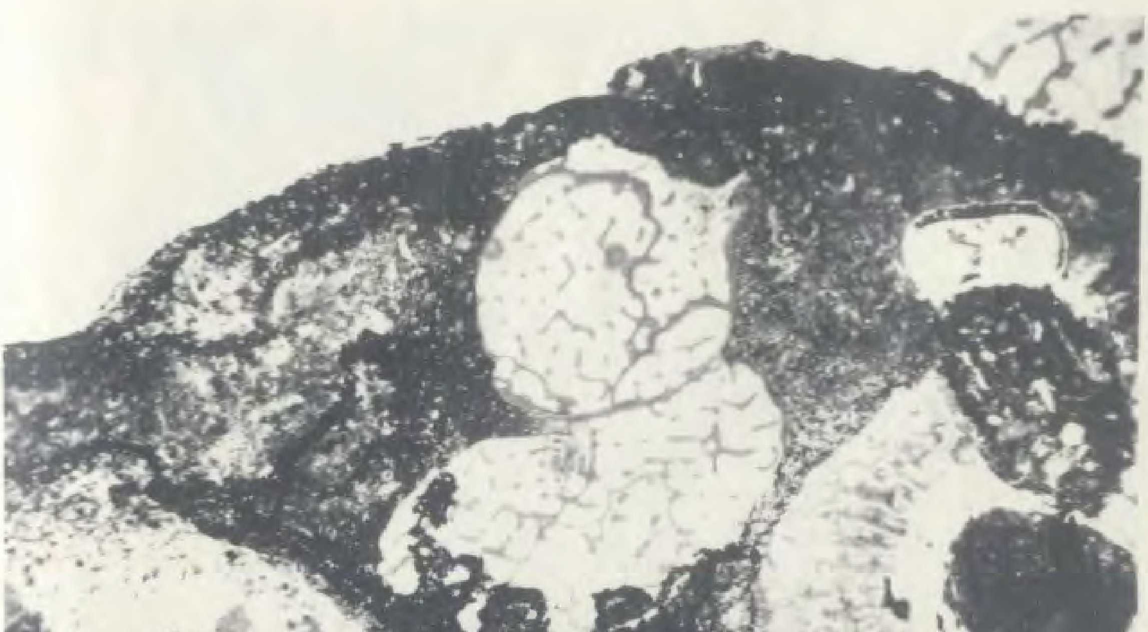


FIG. 2

Plate 20 - Pycnoidocyathus amourensis (Okulitch)

Figure		Page
1.	Pycnoidocyathus amourensis (Okulitch) X2. MUAF 09-0902, Lower-Level Archaeocyathid Reefs, Forteau, Labrador. Transverse section through the lower portion of the cup which shows a very narrow central cavity. Several layers of exocyathid tissue surround the outer cup.	62
2.	Pycnoidocyathus amourensis (Okulitch) X3. MUAF 04-0906, Lower-Level Archaeocyathid Reefs, Point Amour Light House, Labrador. The intervallum is filled with straight parieties which were perforated by many large pores, thin dissepiments are numerous.	62

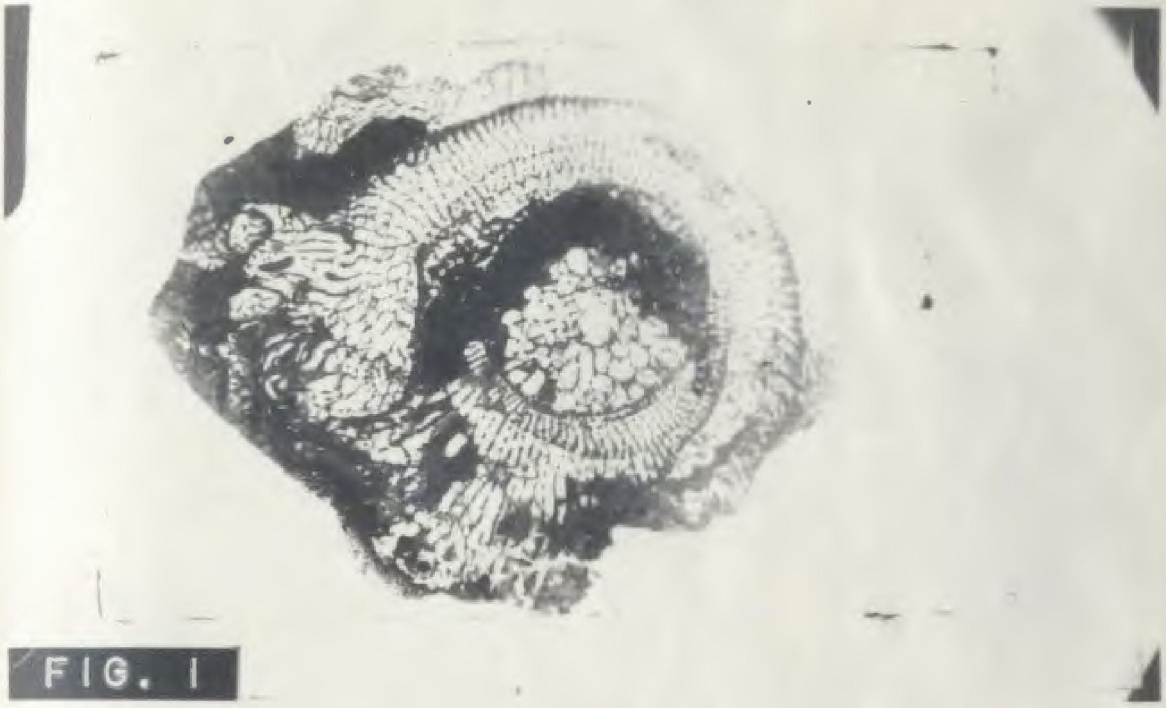


FIG. 1

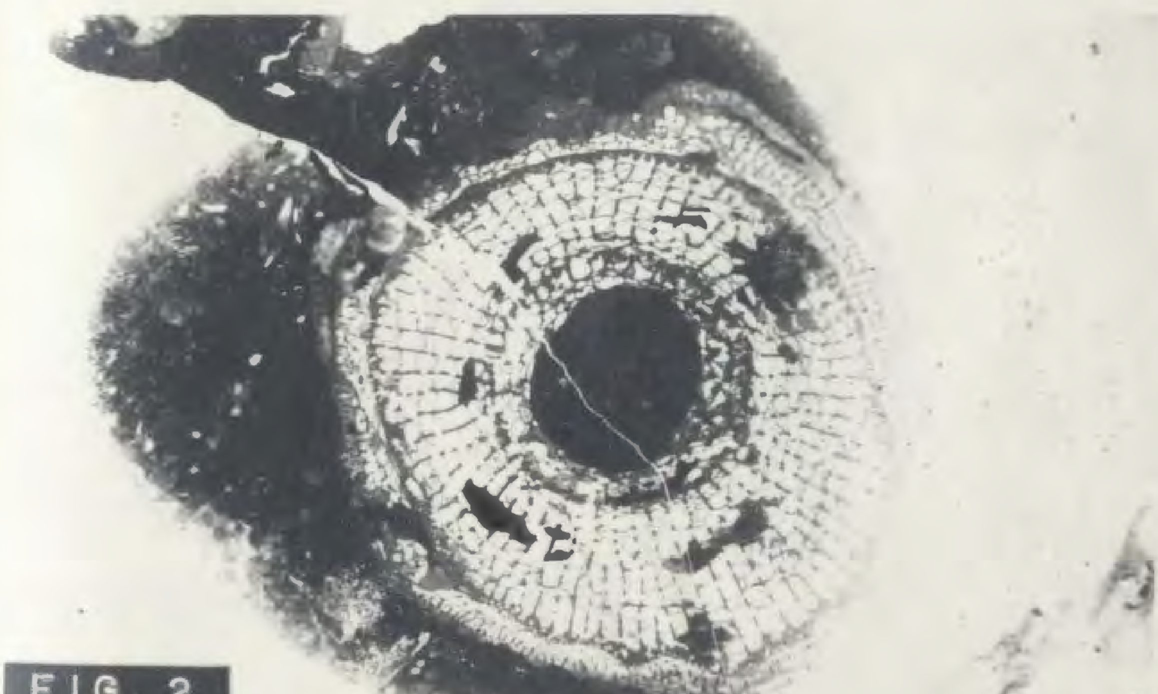


FIG. 2

Plate 21 - Pycnoidocyathus amourensis (Okulitch)

Figure		Page
1.	Pycnoidocyathus amourensis (Okulitch) X2. MUAF 09-0903, Lower-Level Archaeocyathid Reefs, Forteau, Labrador. Transverse section through the lower portion of a cup, showing the central cavity filled with irregular skeletal elements which are mostly curving parieties and dissepiments.	62
2.	Pycnoidocyathus amourensis (Okulitch) X2. MUAF 09-0904, Lower-Level Archaeocyathid Reefs, Forteau, Labrador.	62

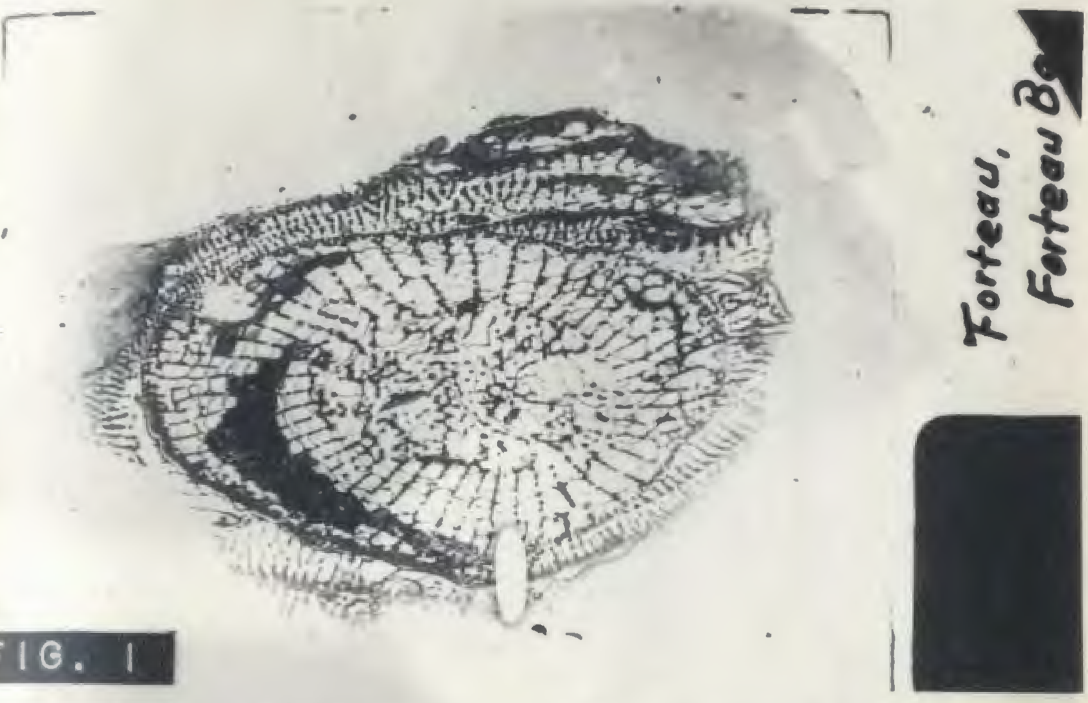


FIG. 1

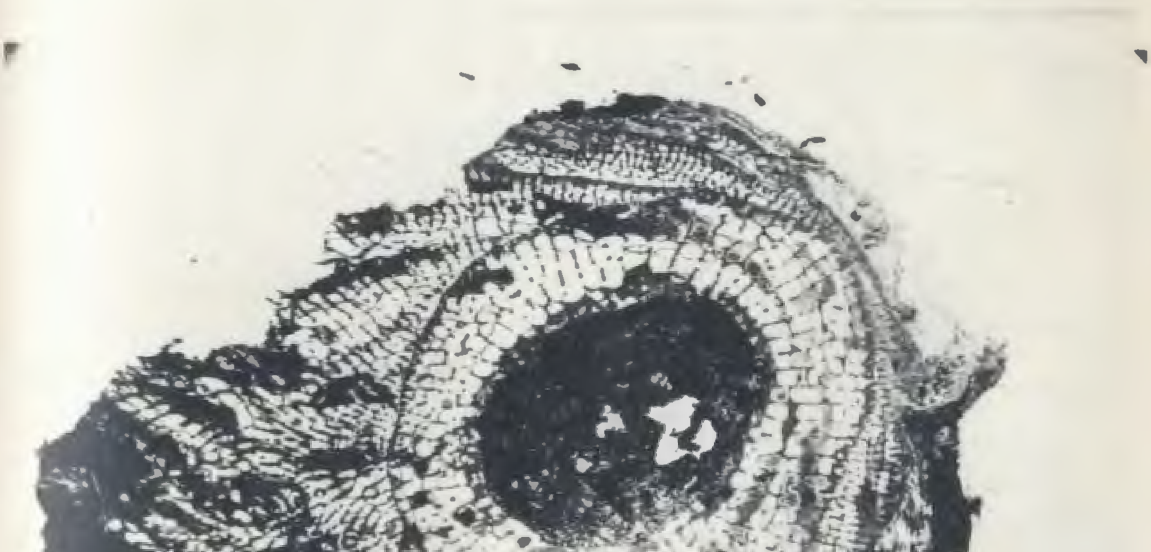


FIG. 2

Plate 22 - Pycnoidocyathus profundus (Okulitch)

Figure		Page
1.	Pycnoidocyathus profundus (Okulitch) X1.5. MUAF 07-1002, Higher-Level Archaeocyathid Reefs, Taylor's Gulch, Labrador, showing wide central cavity to the inner wall of which are attached several algal forms.	64
2.	Pycnoidocyathus profundus (Okulitch) X1.5. MUAF 03-1001, Higher-Level Archaeocyathid Reefs, Fox Cove, Labrador, showing narrow intervallum and wide central cavity.	64

FIG. 1

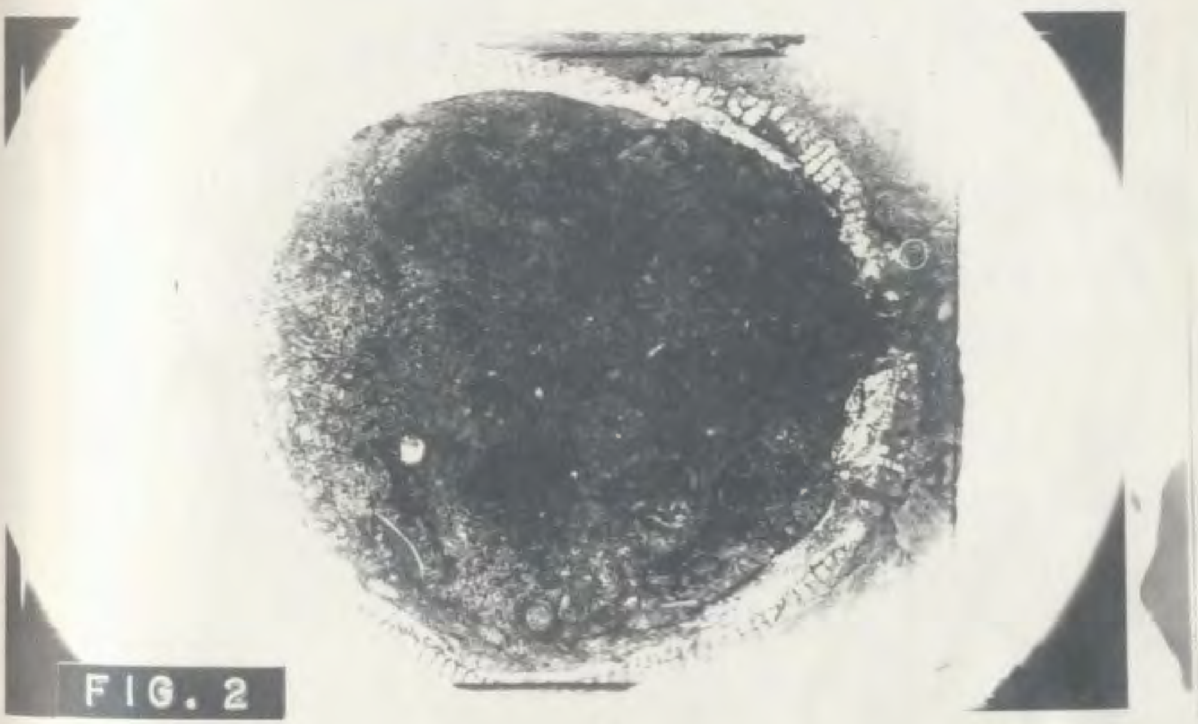


FIG. 2

Plate 23 - Pycnoidocyathus profundus (Okulitch)

Figure		Page
1.	Pycnoidocyathus profundus (Okulitch) X2. MUAF 07-1003, Higher-Level Archaeocyathid Reefs, Taylor's Gulch, Labrador. Part of a very large specimen. Calcareous algae of Genus Girvanella form small colonies attached to the outer wall.	64
2.	Pycnoidocyathus profundus (Okulitch) X2. MUAF 07-1001, Higher-Level Archaeocyathid Reefs, Taylor's Gulch, Labrador.	64

FIG. 1

FIG. 2

Plate 24 - Pycnoidocyathus columbianus (Okulitch)

Figure		Page
1.	Pycnoidocyathus columbianus (Okulitch)	68

X1.5. MUAF 02-1301, Higher-Level Archaeocyathid Reefs, from a hill top 1,117 ft. in elevation in the valley of L'anse au Loup, Labrador. The intervallum is wide, filled with straight parieties, and the central cavity is filled with oölites.

2.	Pycnoidocyathus columbianus (Okulitch)	68

X1.6. MUAF 09-1303, Lower-Level Archaeocyathid Reefs, Forteau, Labrador. The central cavity is filled with fossil fragments. Soft tissue is preserved at the lower right portion of the photograph.

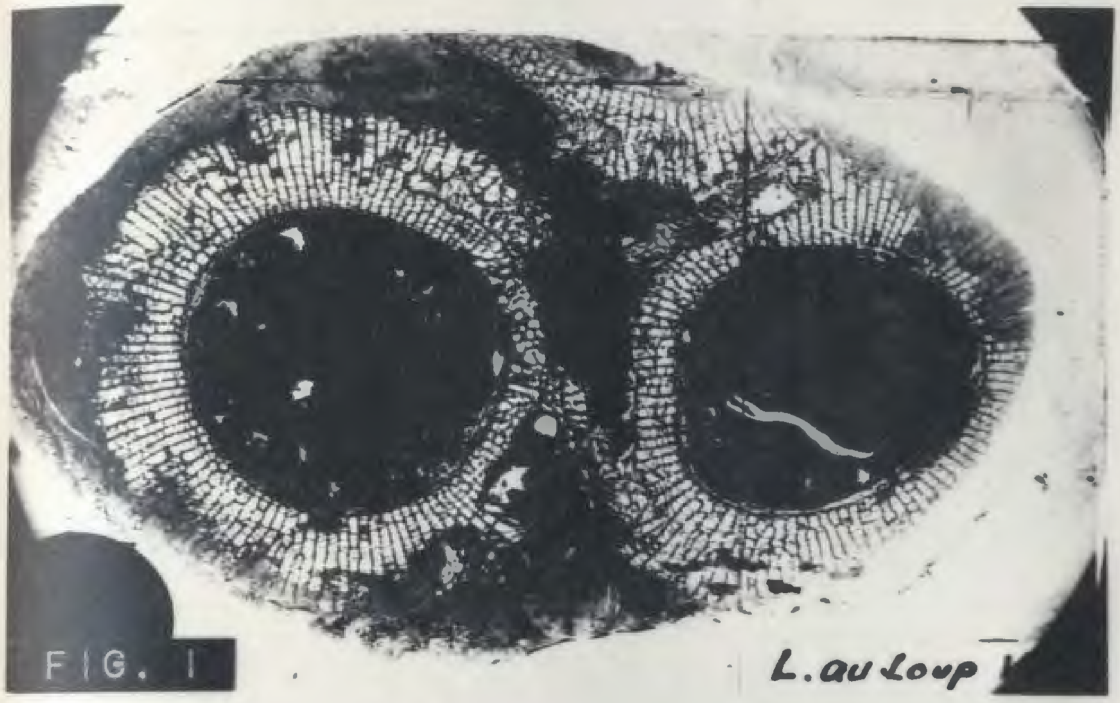


FIG. 1

L. au Loup

FIG. 2

Forteau, Fort

Plate 25 - Syringocyathus canadensis Okulitch

Figure		Page
1.	Syringocyathus canadensis Okulitch X2. MUAF 08-2002A, Lower-Level Archaeocyathid Reefs, Buckle's Point, Forteau Bay, Labrador. Transverse section showing the prismatic loculi in the intervallum. Thickening of skeletal elements occurs around the central cavity.	76
2.	Syringocyathus canadensis Okulitch X2. MUAF 11-2001, Higher-Level Archaeocyathid Reefs, E. of L'anse au Clair, Labrador. Longitudinal section through the upper portion of the cylindrical cup showing upward and outward directed loculi. Large pores are seen penetrating the inner wall. In the left half of the photograph annulation of the cup is shown.	76

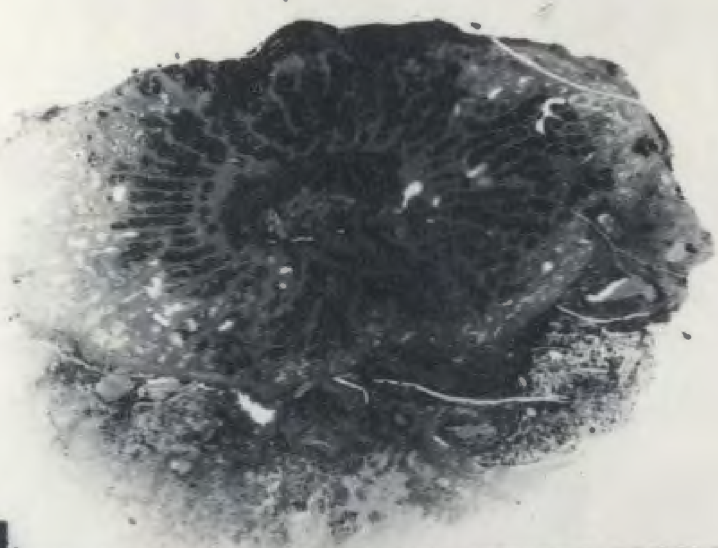


FIG. 1

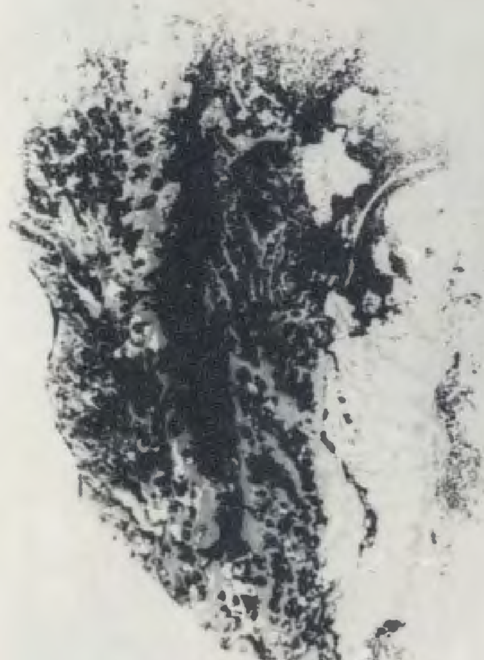


FIG. 2

Plate 26 - Syringocyathus canadensis Okulitch

Figure		Page
1.	Syringocyathus canadensis Okulitch X2.5. MUAF 05-2001, Lower-Level Archaeocyathid Reefs, L'anse Amour, Labrador. Oblique transverse section showing the loculi and thickened irregular inner wall.	76
2.	Syringocyathus canadensis Okulitch X2. MUAF 08-2001, Lower-Level Archaeocyathid Reefs, Buckle's Point, Forteau Bay, Labrador. Longitudinal section. Upper portion of the cup shows the upward and outward directed loculi. In the lower portion the skeletal elements are thickened, and large pores that penetrate the inner wall are present.	76

FIG. 1

FIG. 2

Plate 27 - Syringocyathus canadensis Okulitch

Figure		Page
1.	Syringocyathus canadensis Okulitch X3. MUAF 07-2001A, Higher-Level Archaeocyathid Reefs, Taylor's Gulch, Labrador. Transverse section through the lower portion of the cup of a small colony of S. canadensis. The skeletal elements were all thickened, and the central cavity is narrow and irregular in outline.	76
2.	Syringocyathus canadensis Okulitch X3. MUAF 07-2001B, Higher-Level Archaeocyathid Reefs, Taylor's Gulch, Labrador. Longitudinal section of 07-2001A, showing thickened skeletal elements and large pores on the inner wall. Soft tissue is seen in the intervallum.	76

FIG. 1

FIG. 2

Plate 28 - Syringocyathus canadensis Okulitch

Syringocyathus sp.

Figure		Page
1.	Syringocyathus canadensis Okulitch	76
	X2. MUAF 08-2003, Higher-Level Archaeocyathid Reefs, Buckle's Point, Forteau Bay, Labrador. Longitudinal sections of two specimens which branch from a single base.	
2.	Syringocyathus sp.	79
	X4.5. MUAF 14-1901, Lower-Level Archaeocyathid Reefs from the top of hill at rear of the ferry landing, Blanc Sablon, Labrador. Cross section showing the large polygonal tubulae.	

FIG. 1

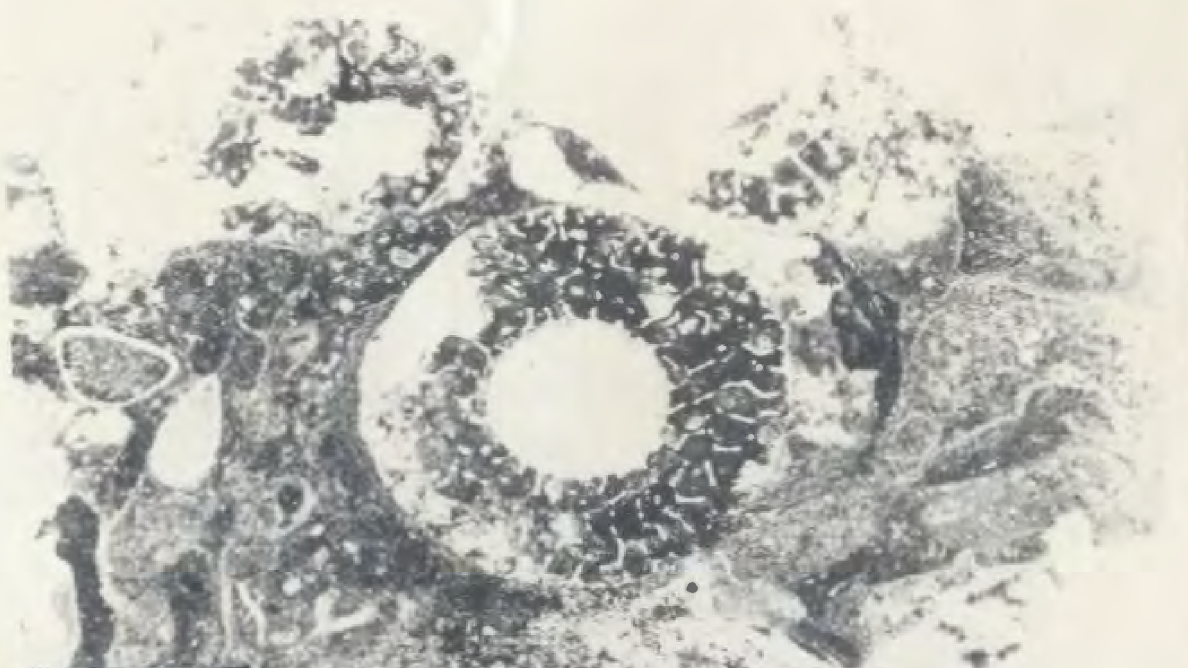


FIG. 2

Plate 29 - Archaeosycon billingsi (Walcott)

Figure		Page
1.	Archaeosycon billingsi (Walcott) X2. MUAF 04-1801, Lower-Level Archaeocyathid Reefs, Point Amour Light House, Labrador. Longitudinal section of a complete cup, showing the simpler upper portion of the cup and the complicated lower portion of the cup.	80
2.	Archaeosycon billingsi (Walcott) X2. MUAF 04-1703, Lower-Level Archaeocyathid Reefs, Point Amour Light House, Labrador. Cross section of the same specimen as seen above.	80

FIG. 1

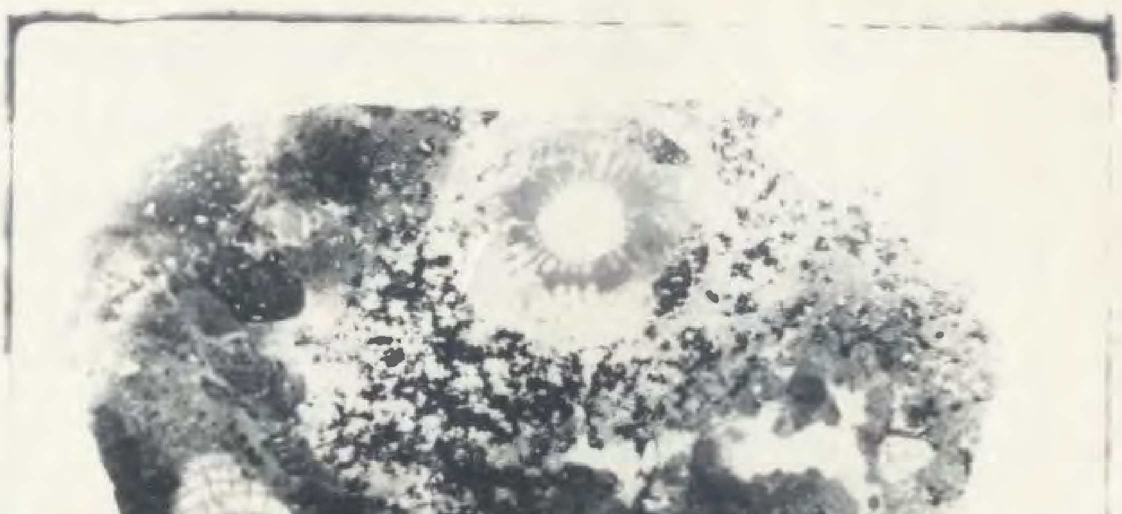


FIG. 2

Plate 30 - Archaeosycon billingsi (Walcott)

Figure		Page
1.	Archaeosycon billingsi (Walcott) X2. MUAF 09-1502, Lower-Level Archaeocyathid Reefs, Forteau, Labrador. Longitudinal section cutting through the upper portion of the cylindrical cup, showing the up-arching perforated tabulae and vertical rods that support the tabulae.	80
2.	Archaeosycon billingsi (Walcott) X2.5. MUAF 09-1501, Lower-Level Archaeocyathid Reefs, Forteau, Labrador. Cross section of specimen shown in the above figure. Thickening of skeletal elements occurs only around the central cavity. In the lower left portion of the cup the net-like porous tabula is also clearly seen.	80

FIG. 1

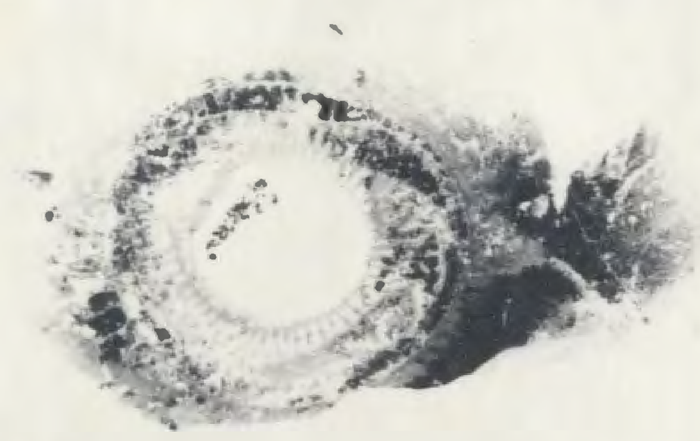


FIG. 2

Plate 31 - Archaeosycon billingsi (Walcott)

Figure		Page
1.	Archaeosycon billingsi (Walcott) X2. MUAF 04-1701, 04-1702, Lower-Level Archaeocyathid Reefs, Point Amour Light House, Labrador. Longitudinal section of a complete cup contained in two thin sections, showing the simple, unthickened upper portion of the cup, and the complicated lower portion of the cup due to thickening.	80
2.	Archaeosycon billingsi (Walcott) X2. Cross section of the same specimen.	80

FIG. 1

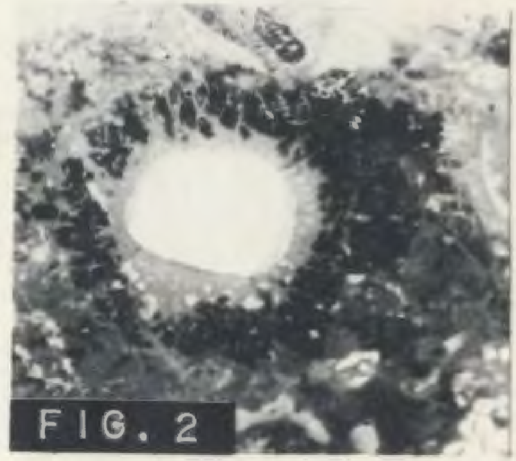


FIG. 2

Plate 32 - <u>Sigmosyringocyathus</u> <u>cylindricus</u> nov. sp.

Figure		Page
1.	Cross section of holotype, MUAF 04-1802, Point Amour. Due to recrystallization the fine structure is not clearly revealed.	72
2.	Longitudinal section of holotype, contained in thin section MUAF 04-1801. The upward and outward oriented loculi are clearly shown. The sigmoid-shaped cross sections of annulate shelves are seen lining the central cavity. At the lower portion of the central cavity two dissepiment-like skeletal elements are seen reaching across the central cavity.	72
3.	Section MUAF 14-1801, from Blanc Sablon, showing four specimens attached together. In the obliquely cut largest specimen the mesh-like appearance of the inner wall is shown.	72
4.	Section MUAF 04-1803, paratype, showing hexagonal loculi.	72
5.	Section MUAF 04-1803, from Point Amour, paratype, showing dissepiment-like skeletal elements in the central cavity. Note also the tendency of the loculi in the intervallum to form secondary cavities marked out in this photomicrograph as A and B.	72
6.	Section MUAF 09-1801, paratype from Forteau, showing the solid ring of the inner wall when cut perpendicular to the axis.	72

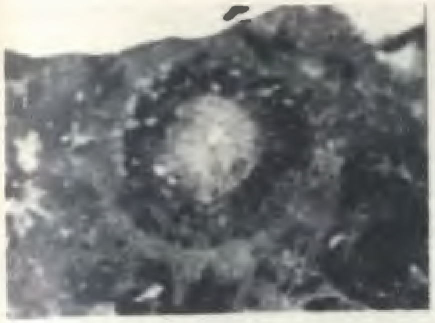


Fig. 1

Fig. 2

Fig. 3

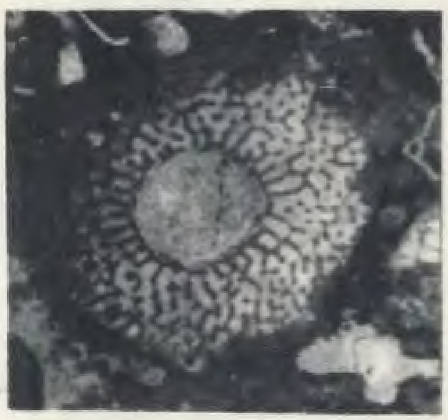


Fig. 4

Fig. 5

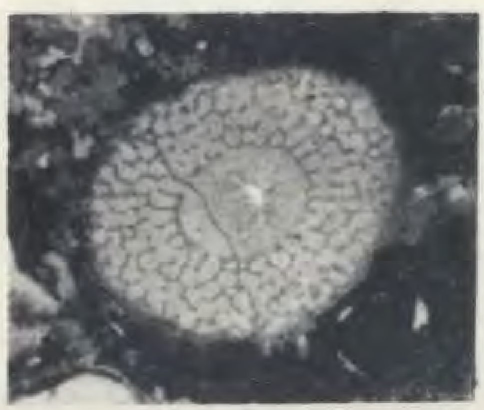


Fig 6

Plate 33 - Exocyathus canadensis Okulitch

Figure		Page
1.	Exocyathus canadensis Okulitch X5. MUAF 04-0207, 04-0208, Lower-Level Archaeocyathid Reefs, Point Amour Light House, Labrador. Serial sections of a cup of Ajacicyathus profundomimus housing an Exocyathus canadensis, soft tissue of the latter is well preserved.	86
2.	Reconstruction of cup of the ajacicyathid shown in Figure 1, with part of the outer wall peeled off to show the exocyathid structure.	86

FIG. 1

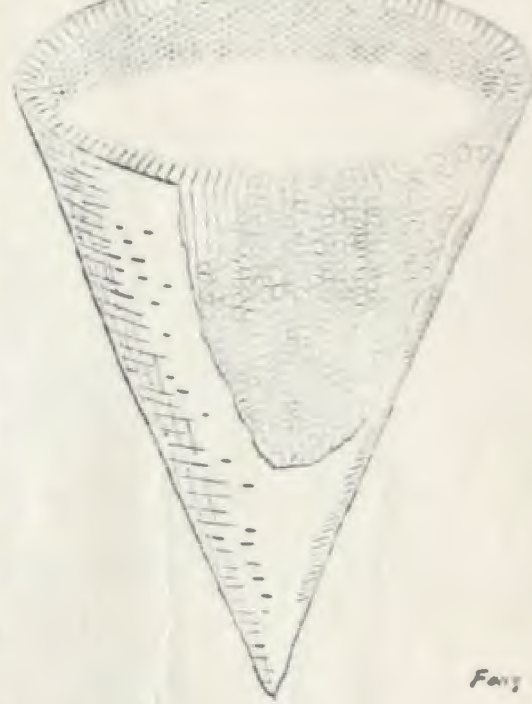


FIG. 2

Plate 34 - Exocyathus canadensis Okulitch

Figure		Page
1.	Polished section of a cup of Ajacicyathus profundomimus showing the lower portion of the cup encrusted with Exocyathus canadensis. Slightly smaller than actual size.	86
2.	Sketch of the same cup in Figure 1, showing detailed structure of Exocyathus canadensis.	86

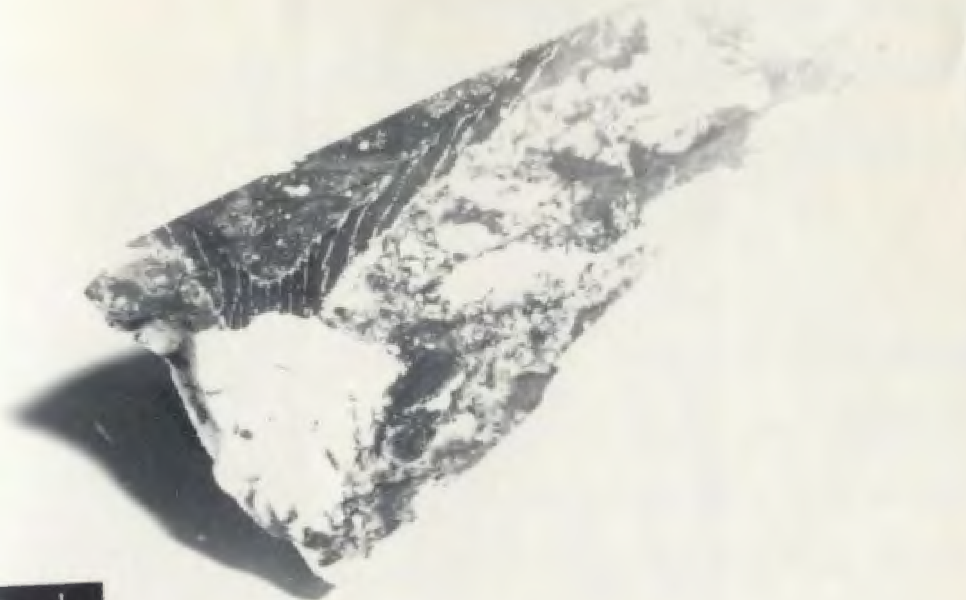


FIG. 1

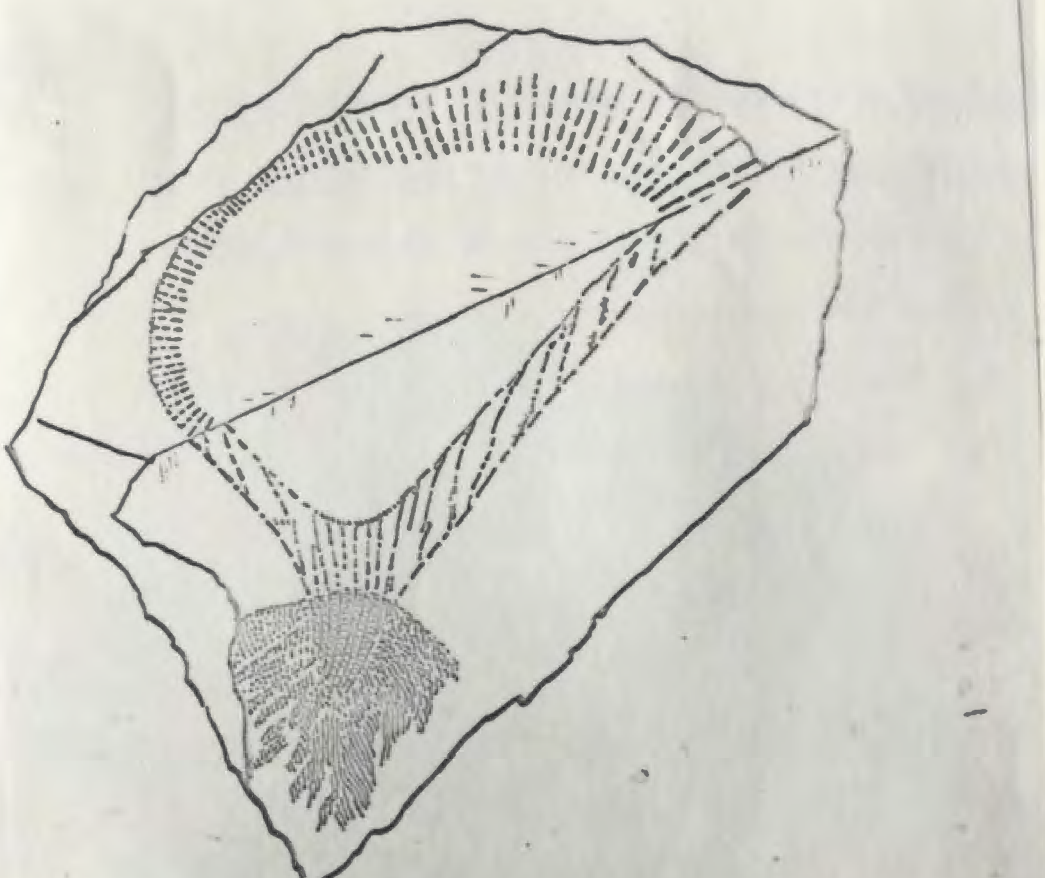


FIG. 2

Plate 35 - Exocyathus canadensis Okulitch,
Pycnoidocyathus amourensis (Okulitch),
Ajacicyathus profundomimus Okulitch, and
A. nevadensis (Okulitch)

Figure		Page
1.	Exocyathus canadensis encrusted on a cup of Pycnoidocyathus amourensis. X3. MUAF 04-0902, Lower-Level Archaeocyathid Reefs, Point Amour Light House, Labrador. The cup of the encrusted Pycnoidocyathus amourensis is seen receding its soft tissue to the other side of the cup where exocyathid tissue is absent.	86
2.	Exocyathus canadensis housed in cups of Ajacicyathus profundomimus and A. nevadensis. X3. MUAF 09-0201, Lower-Level Archaeocyathid Reefs, Forteau, Labrador. a. In this portion of the intervallum the exocyathids were housed in the intervallum. b. The exocyathid tissue had settled on the outer wall of the abandoned cup only. The cup of an Ajacicyathus nevadensis is also seen housing some exocyathid tissue.	86

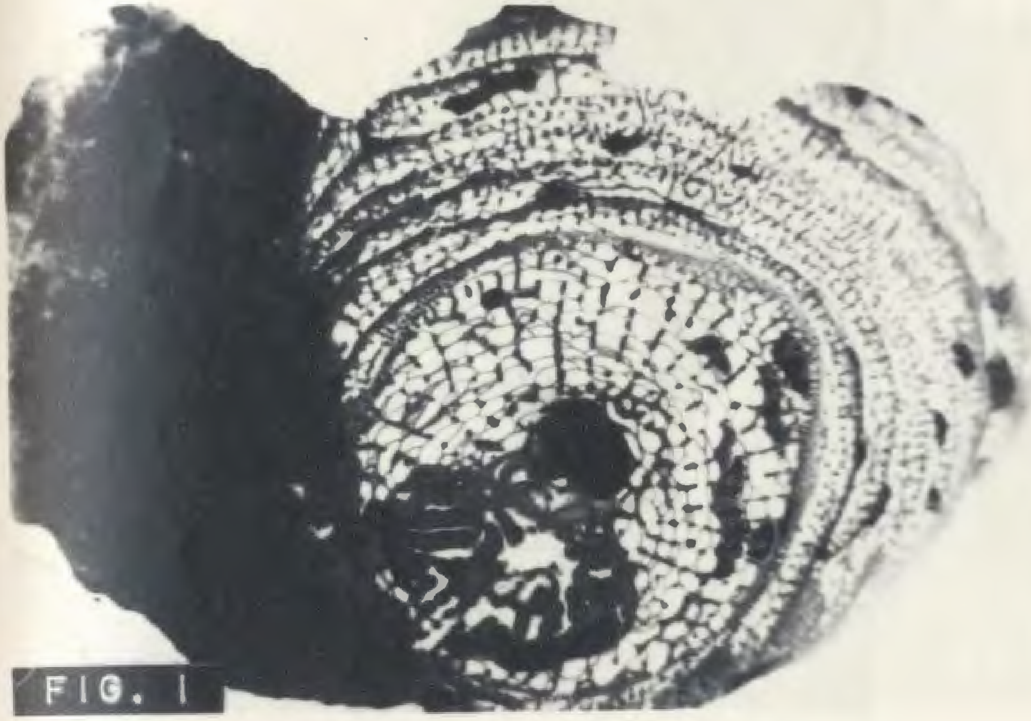


FIG. 1

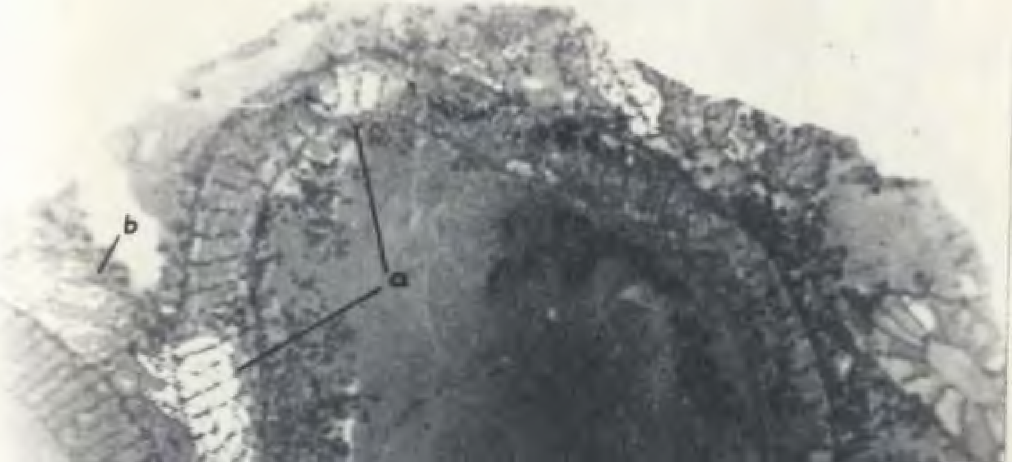


FIG. 2

Plate 36 - Exocyathus canadensis Okulitch,
Pycnoidocyathus amourensis (Okulitch), and
Archaeocyathus atlanticus Billings.

Figure		Page
1.	Exocyathus canadensis encrusting the cup of Pycnoidocyathus amourensis. X3. MUAF 04-0903. Lower-Level Archaeocyathid Reefs, Point Amour Light House, Labrador.	86
2.	Archaeocyathus atlanticus Billings encrusted by the vesicular tissue of Exocyathus canadensis. X3. MUAF 04-0601. Lower-Level Archaeocyathid Reefs, Point Amour Light House, Labrador.	86

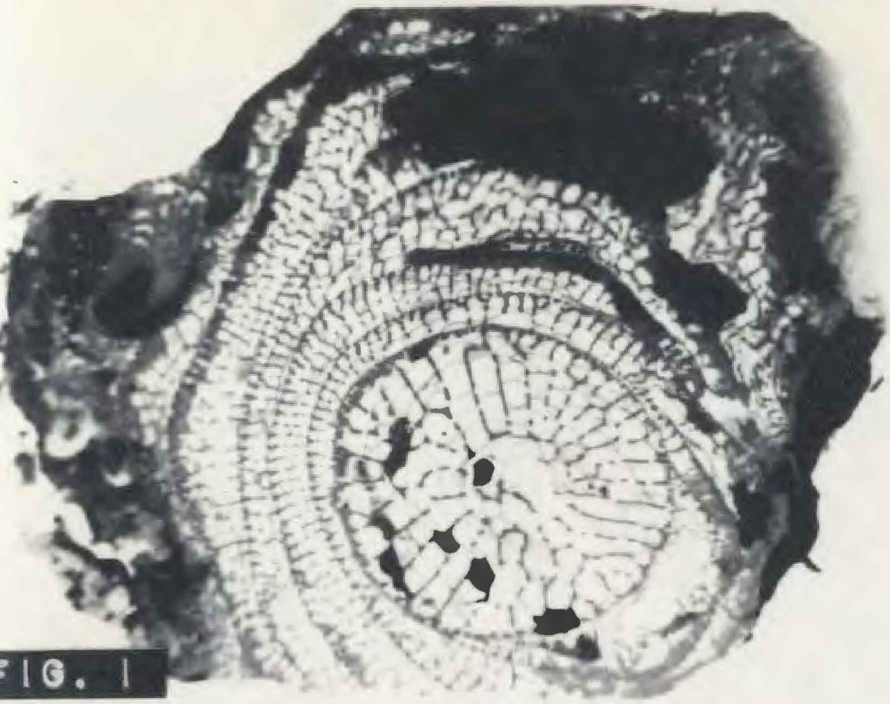


FIG. 1

FIG. 2

Plate 37 - Ajacicyathus nevadensis (Okulitch), and Ajacicyathus profundomimus Okulitch

Figure		Page
1.	(1) Ajacicyathus nevadensis (Okulitch)	43
	(2) Sigmosyringocyathus cylindricus nov. sp.	
	(3) Protopharetra sp.	
	(4) Pycnoidocyathus sp.	
	X2.7. MUAF 09-0102, Lower-Level Archaeocyathid Reefs, Forteau, Labrador. Natural etch figures.	
2.	Ajacicyathus profundomimus Okulitch	50
	X1. MUAF 04-0209, Lower-Level Archaeocyathid Reefs, Point Amour Light House, Labrador. Longitudinal section showing simple parieties. The lower portion of the cup is encrusted with exocyathid tissue.	

FIG. 1

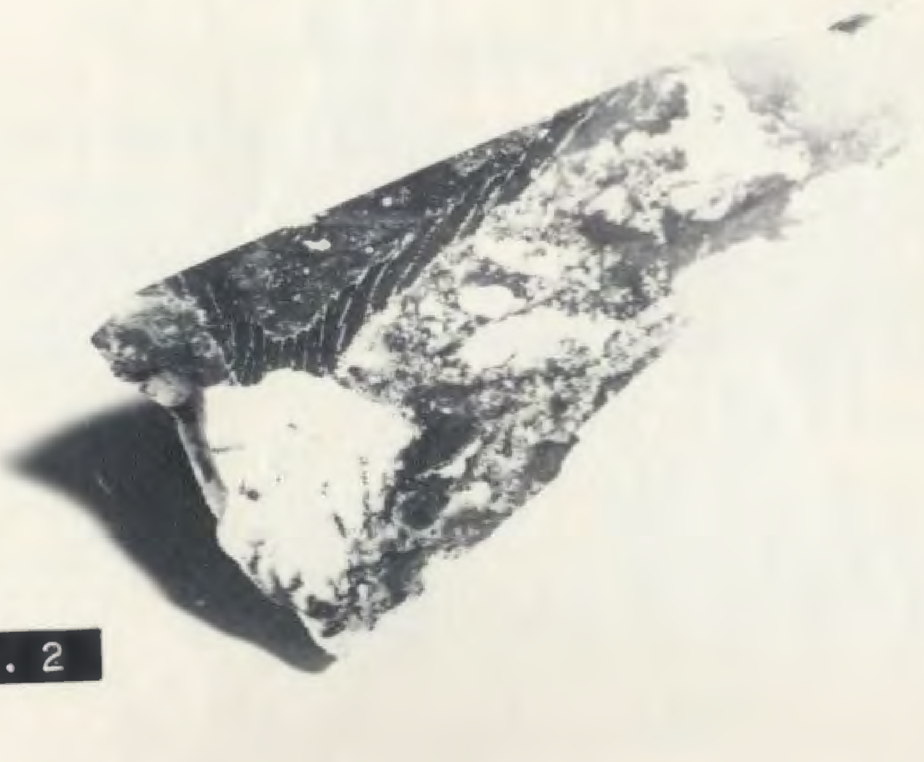


FIG. 2

Plate 38 - Ajacicyathus undulatus Okulitch

Figure		Page
1.	Ajacicyathus undulatus Okulitch X0.5. MUAF 11-0301, Higher-Level Archaeocyathid Reefs, east of L'anse au Clair, Labrador. Stereoscopically paired photographs of naturally weathered cup seen looking into the central cavity. The inner wall is weathered away and shows the intervallum structure.	44
2.	Ajacicyathus profundominus Okulitch X1. MUAF 04-0201, Higher-Level Archaeocyathid Reefs, Point Amour, Labrador. Stereoscopically paired photographs showing the central cavity. The intervallum contains numerous straight parieties.	50

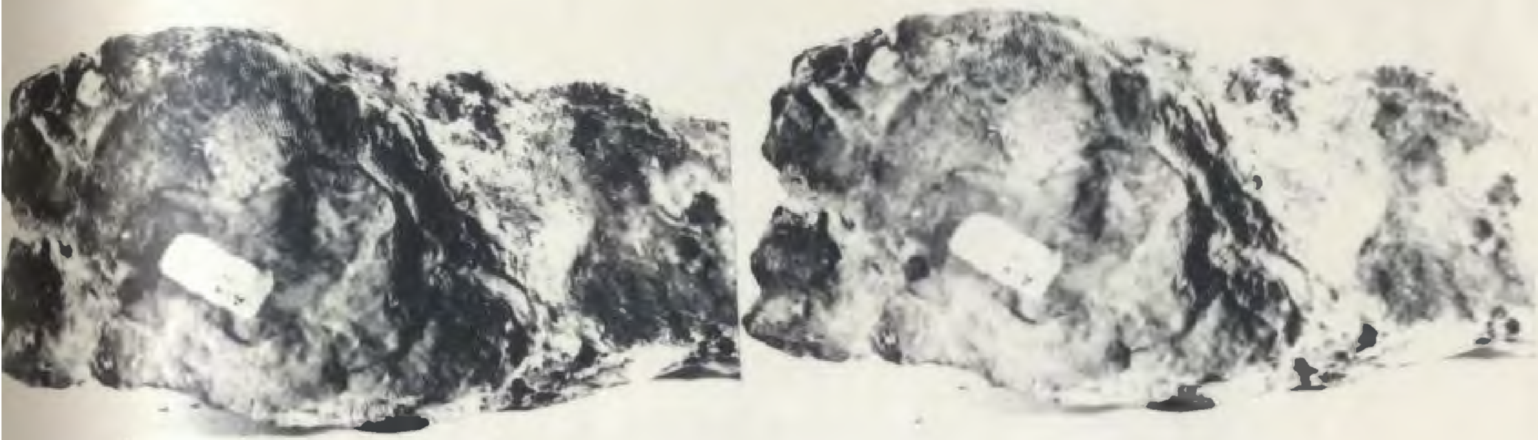


FIG. 1

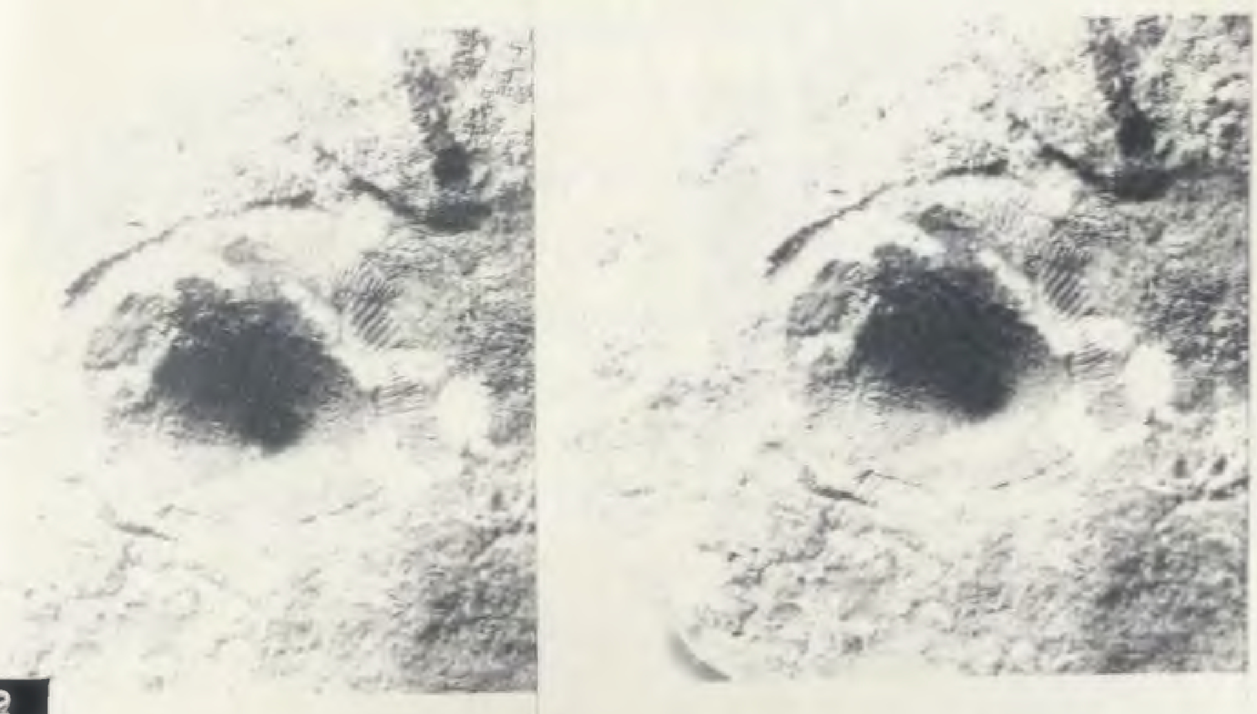


FIG. 2

Plate 39 - Ajacicyathus richardsoni nov. sp.

Figure		Page
1.	Ajacicyathus richardsoni nov. sp. X1. MUAF 11-0501, holotype, Higher-Level Archaeocyathid Reefs, east of L'anse au Clair, Labrador. Stereoscopically paired photographs of holotype showing the characteristic cup and annulations.	52
2.	Ajacicyathus richardsoni nov. sp. X1. MUAF 11-0502, paratype, Higher-Level Archaeocyathid Reefs, east of L'anse au Clair, Labrador. Stereoscopically paired photographs showing the intervallum structure where the outer wall is completely eroded away.	52

FIG. 1

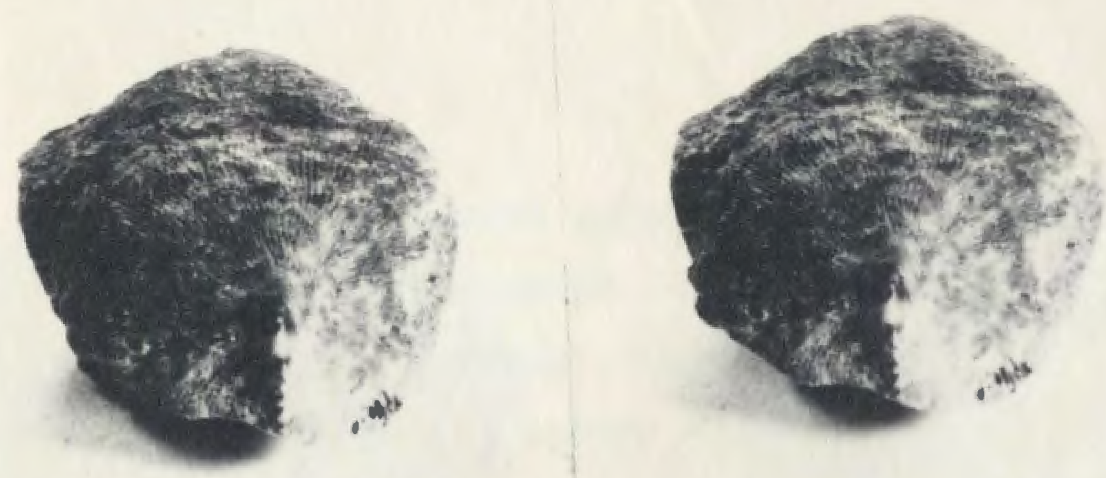


FIG. 2

Plate 40 - <u>Ajacicyathus</u> <u>richardsoni</u> nov. sp. and <u>Pycnoidocyathus</u> <u>profundus</u> (Okulitch)

Figure		Page
1.	<u>Ajacicyathus</u> <u>richardsoni</u> nov. sp. X1. MUAF 07-0501, Higher-Level Archaeocyathid Reefs, Taylor's Gulch, Labrador. Stereoscopically paired photographs of paratype, showing annulated outer wall and narrow curving lower portion of cup.	52
2.	<u>Pycnoidocyathus</u> <u>profundus</u> (Okulitch) X0.7. MUAF 07-1003, Higher-Level Archaeocyathid Reefs, Taylor's Gulch, Labrador. Stereoscopically paired photographs showing the strongly annulated outer wall.	64

FIG. 1

FIG. 2

Plate 41 - Pycnoidocyathus amourensis (Okulitch)

Figure		Page
1.	Pycnoidocyathus amourensis (Okulitch)	62
	X1. MUAF 10-0905, Lower-Level Archaeocyathid Reefs, Forteau Point, Labrador. Naturally weathered cross section with some skeletal elements of Archaeocyathus irregularis nov. sp. crossing the central cavity.	
2.	Pycnoidocyathus amourensis (Okulitch)	62
	X1. MUAF 07-0903, Higher-Level Archaeocyathid Reefs, Taylor's Gulch, Labrador. Complete cup with the outer wall weathered away showing the intervallum structure.	

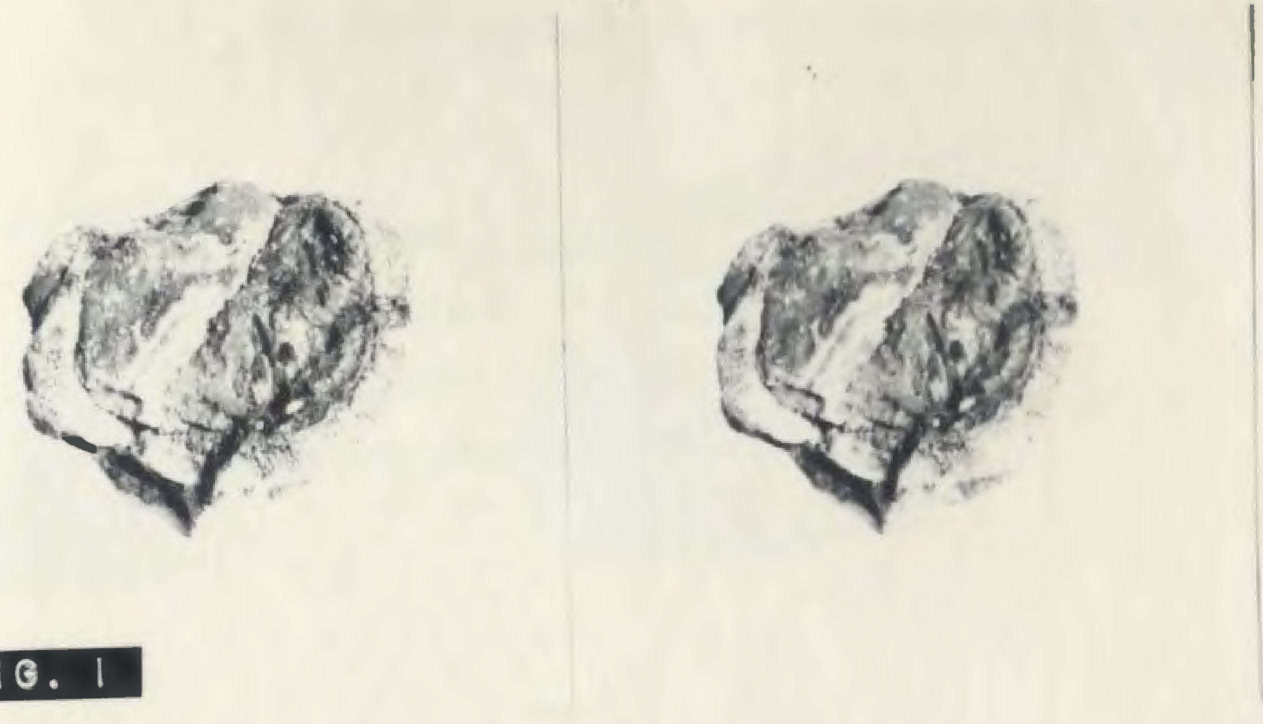


FIG. 1

FIG. 2

Plate 42 - Pycnoidocyathus profundus (Okulitch)

Figure		Page
1.	Pycnoidocyathus profundus (Okulitch) X0.7. MUAF 07-1004, Higher-Level Archaeocyathid Reefs, Taylor's Gulch, Labrador. Stereoscopically paired photographs showing the upper half of an incomplete cup.	64
2.	Pycnoidocyathus profundus (Okulitch) X0.7. MUAF 07-1005, Higher-Level Archaeocyathid Reefs, Taylor's Gulch, Labrador. Stereoscopically paired photographs showing the lower portion of a strongly annulated cup.	64

FIG. 1

FIG. 2

Plate 43 - <u>Pycnoidocyathus</u> <u>loupensis</u> (Okulitch) and <u>Pycnoidocyathus</u> <u>amourensis</u> (Okulitch)

Figure		Page
1.	<u>Pycnoidocyathus</u> <u>loupensis</u> (Okulitch) X0.8. MUAF 03-1201, Higher-Level Archaeocyathid Reefs, Fox Cove, Labrador. Stereoscopically paired photographs showing the shallow saucer-shaped cup and cross section of the lower portion of the cup.	66
2.	<u>Pycnoidocyathus</u> <u>amourensis</u> (Okulitch) X0.3. MUAF 04-0906, Lower-Level Archaeocyathid Reefs, Point Amour, Labrador. Stereoscopically paired photographs of a naturally weathered longitudinal section showing numerous parieties and dissepiments. Several layers of exocyathid tissue are seen enclosing the outer wall.	62

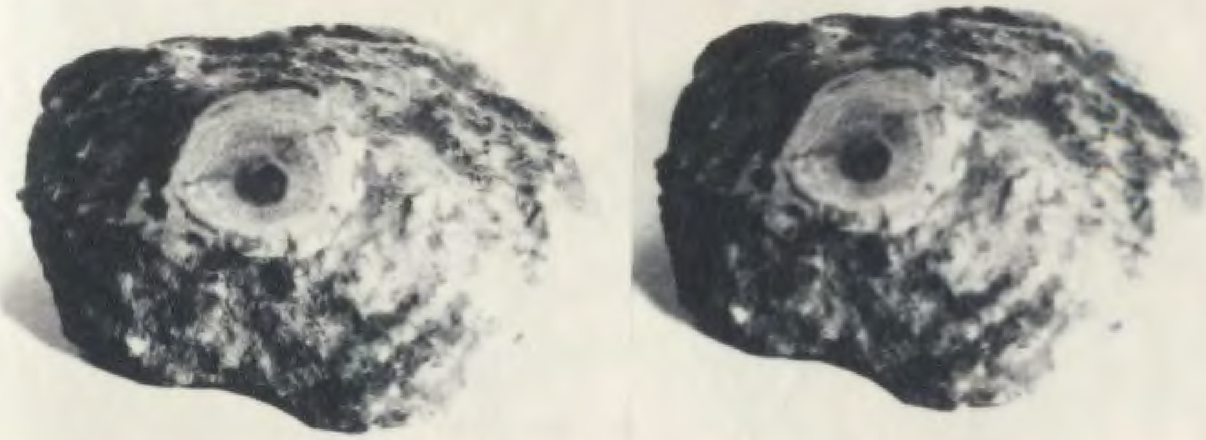


FIG. 1

FIG. 2

Plate 44 - *Pycnoidocyathus loupensis* (Okulitch)

Pycnoidocyathus sp.

Figure		Page
1.	*Pycnoidocyathus loupensis* (Okulitch) X0.4. MUAF 04-1201, Higher-Level Archaeocyathid Reefs, Point Amour, Labrador. Stereoscopically paired photographs showing the annulated outer wall.	66
2.	*Pycnoidocyathus* sp. X0.6. MUAF 03-1401, Higher-Level Archaeocyathid Reefs, Fox Cove, Labrador. Stereoscopically paired photographs showing the flattened fusiform cup and the strongly annulated outer wall.	70

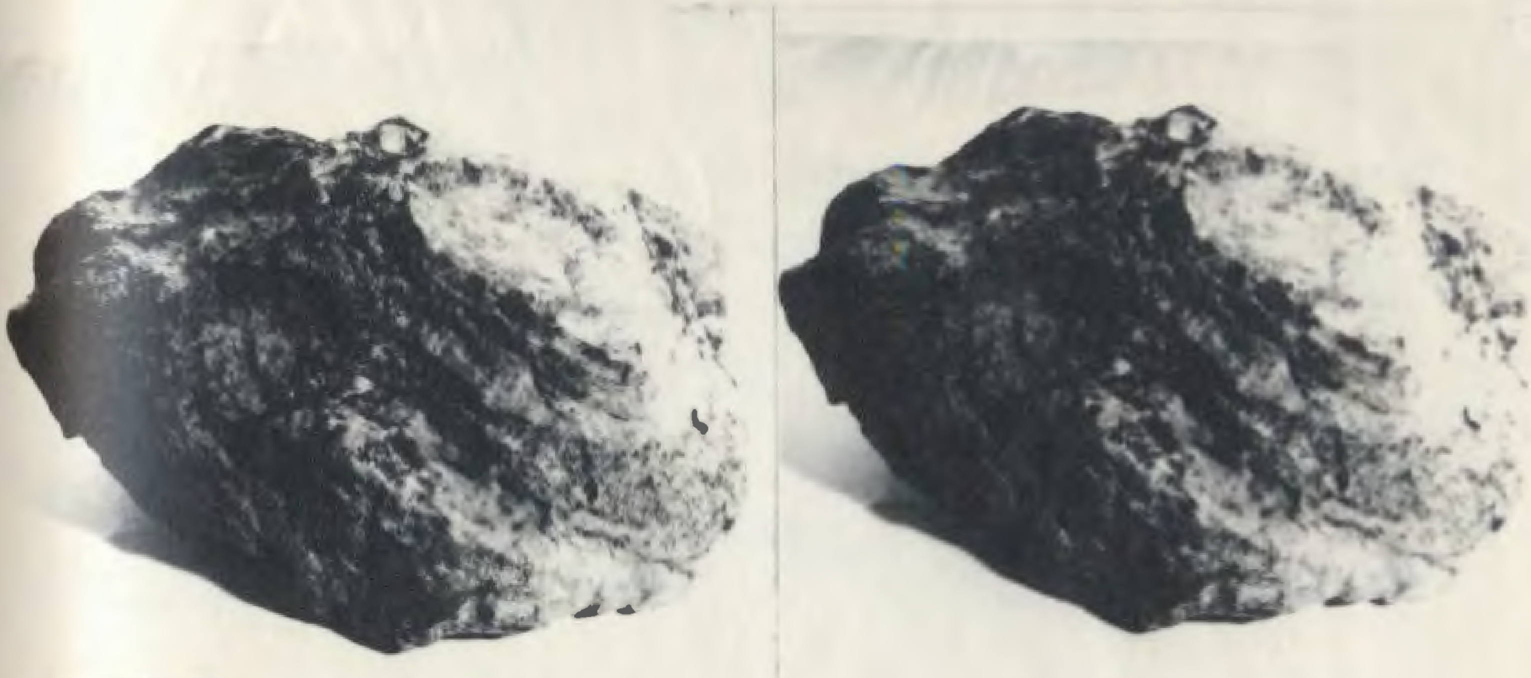


FIG. 1

FIG. 2

Plate 45 - Syringocyathus canadensis Okulitch

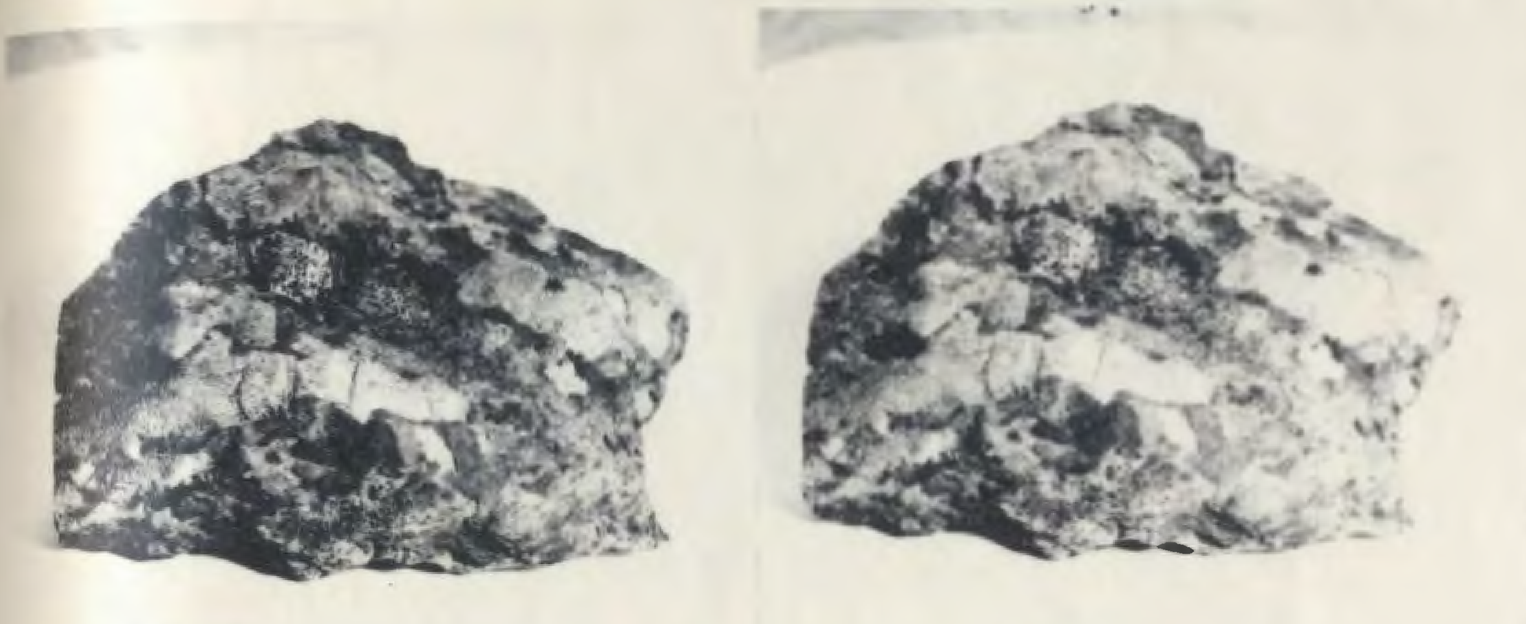


FIG. 1

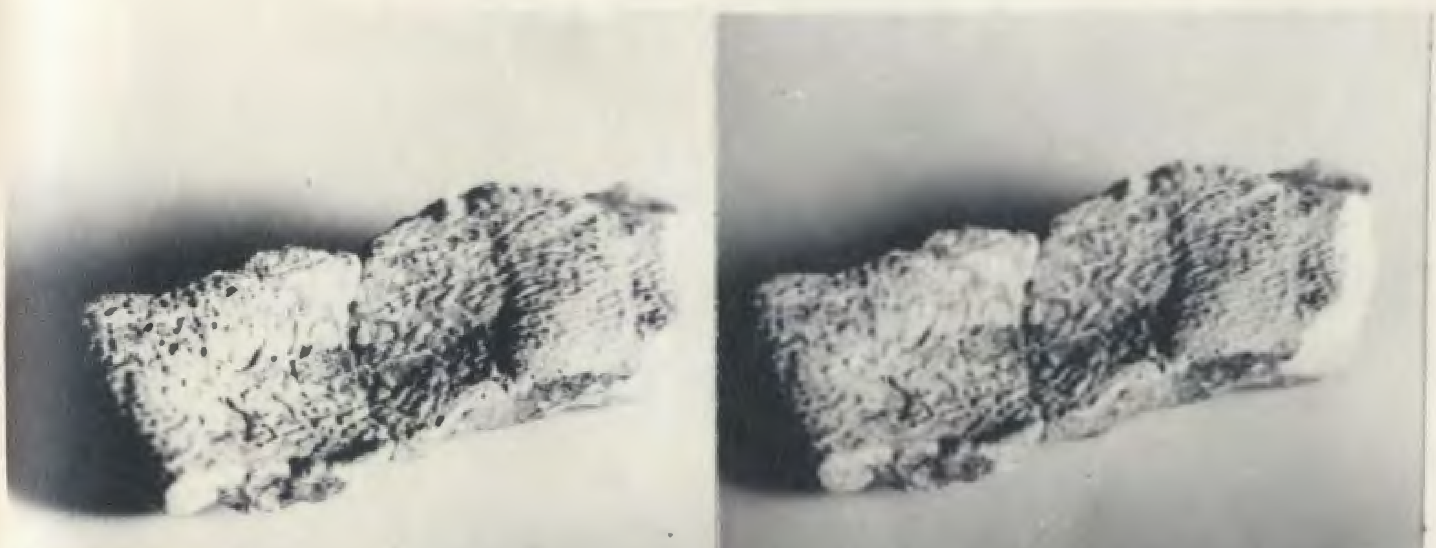


FIG. 2

Plate 46 - Obolella chromatica Billings

Figure		Page
1.	Obolella chromatica Billings X2.5. MUBF 11-0101, east of L'anse au Clair. Thick shell showing distinct growth lines.	96
2.	Same specimen showing lateral view.	96

FIG. 1

FIG. 2

Plate 47 - Nisusia oriens Walcott and
Kutorgina cingulata (Billings)

Figure		Page
1.	Nisusia oriens Walcott X2.5. MUBF 05-0301, L'anse Amour, Labrador.	96
2.	Kutorgina cingulata (Billings) X2.5. MUBF 07-0202, Taylor's Gulch, Labrador. Brachial valve showing growth lines.	97

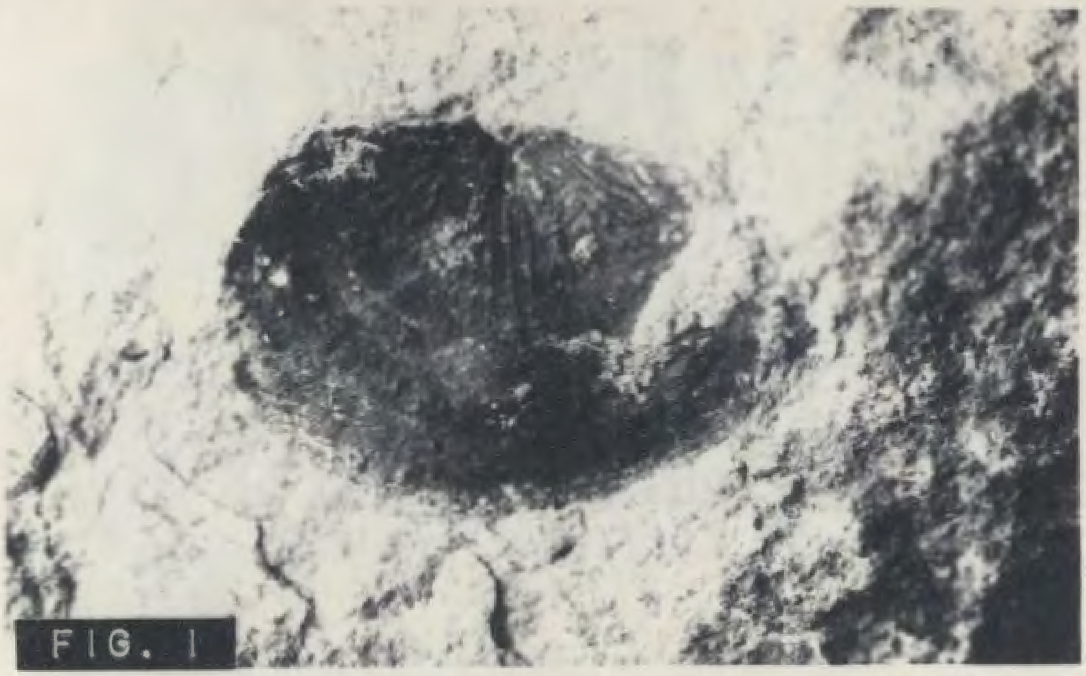


FIG. 1

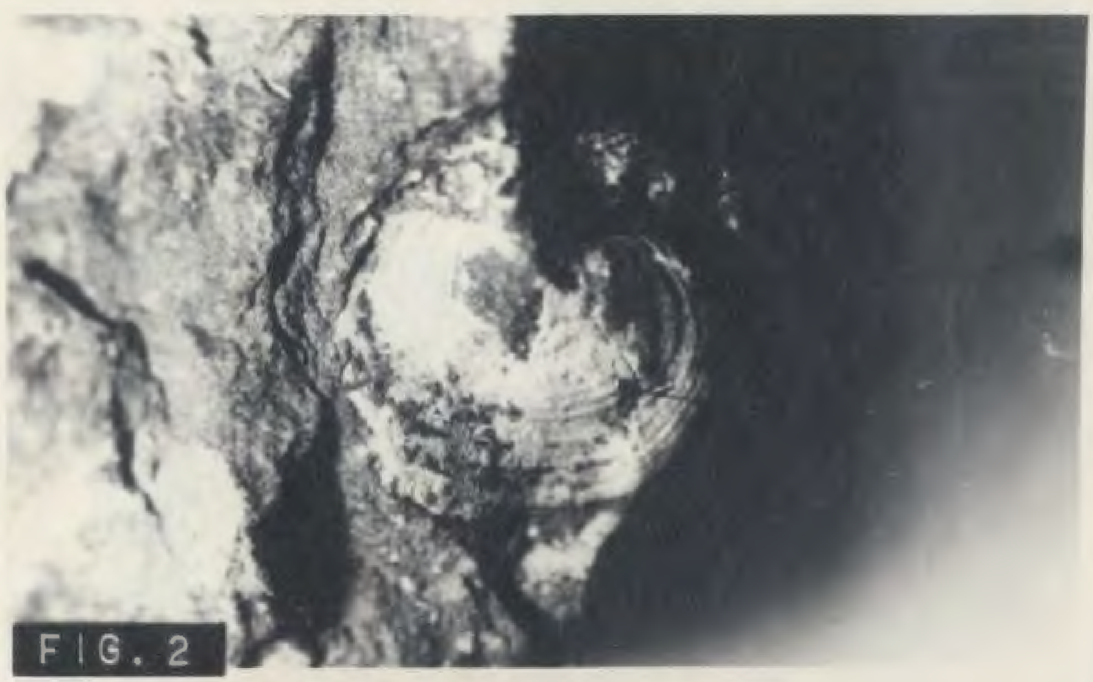


FIG. 2

Plate 48 - Salterella rugosa Billings and

Salterella sp.

Figure		Page
1.	Salterella rugosa Billings X12. MUSF 02-0101, Upper Member, Forteau formation, L'anse au Loup. Longitudinal section of a complete conch embedded in a matrix of öolitic limestone.	98
2.	Salterella sp. X12. MUSF 09-0201, Lower Member, Forteau formation, Forteau. Longitudinal section of the long, slender, straight conch, showing the widely spaced conical septa. The limestone that contains this fossil is an algal limestone.	99

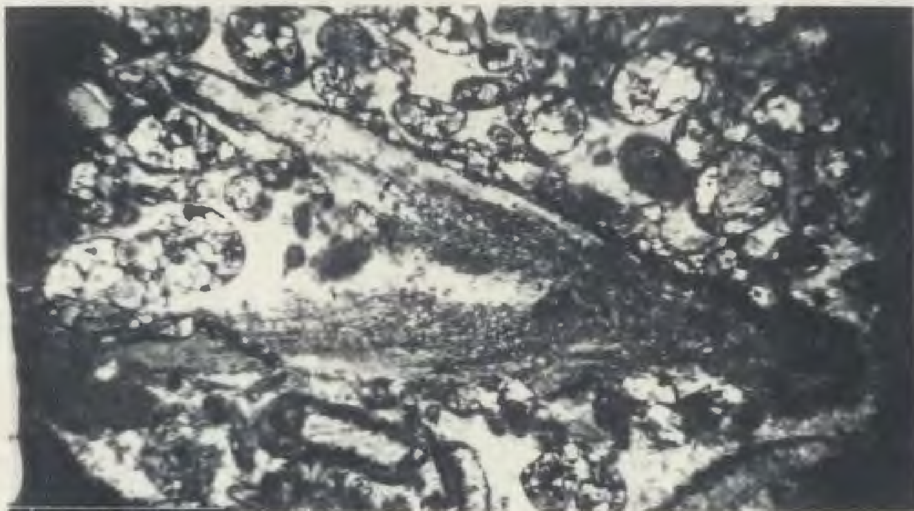


FIG. 1

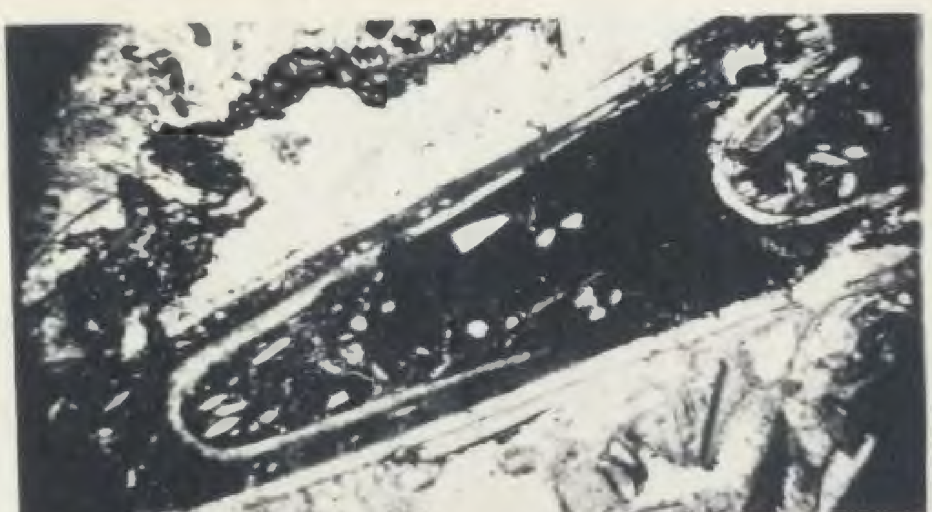


FIG. 2

Plate 49 - Hyolithes billingsi Walcott

Figure | Page

1. Hyolithes billingsi Walcott 99

X3. MUHF 11-0101, east of L'anse au Clair.

Side view of a complete cone.

2. Photomicrograph of a Hyolithes limestone lens in the Lower-Level Archaeocyathid Reefs, showing the subtriangular cross sections of the fossil. 99

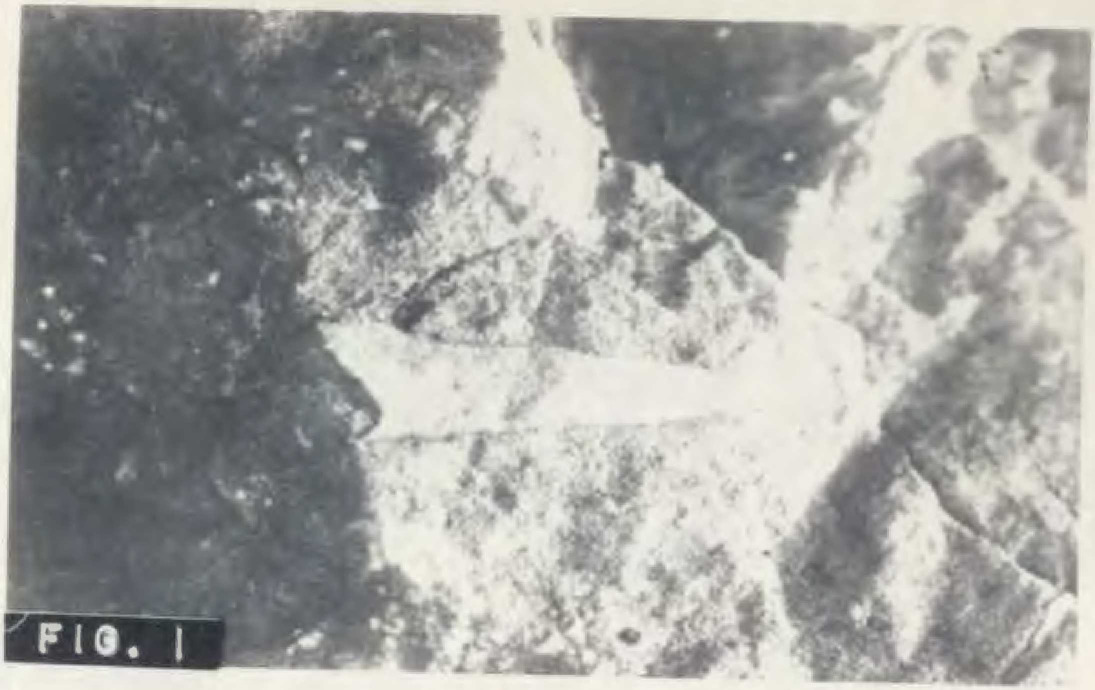


FIG. 1

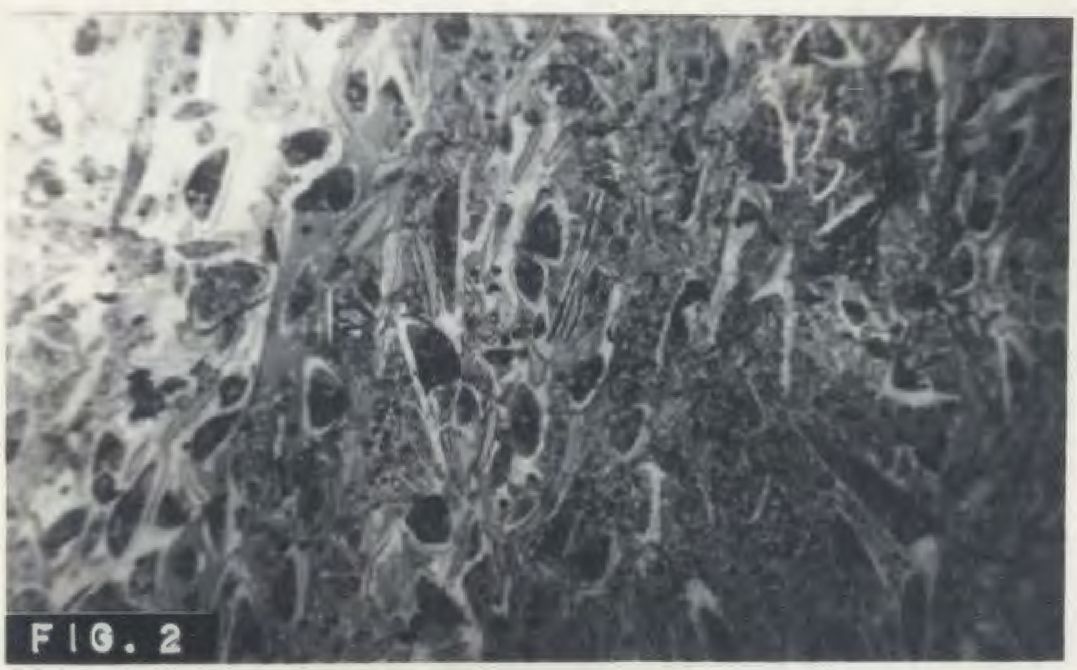


FIG. 2

Plate 50 - *Olenellus thompsoni* (Hall)

Figure		Page
1.	*Olenellus thompsoni* (Hall) X1.8. MUTF 06-0101, Crow Head, English Point, Labrador. An almost complete specimen showing a well preserved cephalon and thorax.	101
2.	*Olenellus thompsoni* (Hall) X1.25. MUTF 06-0102, Crow Head, English Point, Labrador. Photograph of a large cephalon.	101

FIG. 1

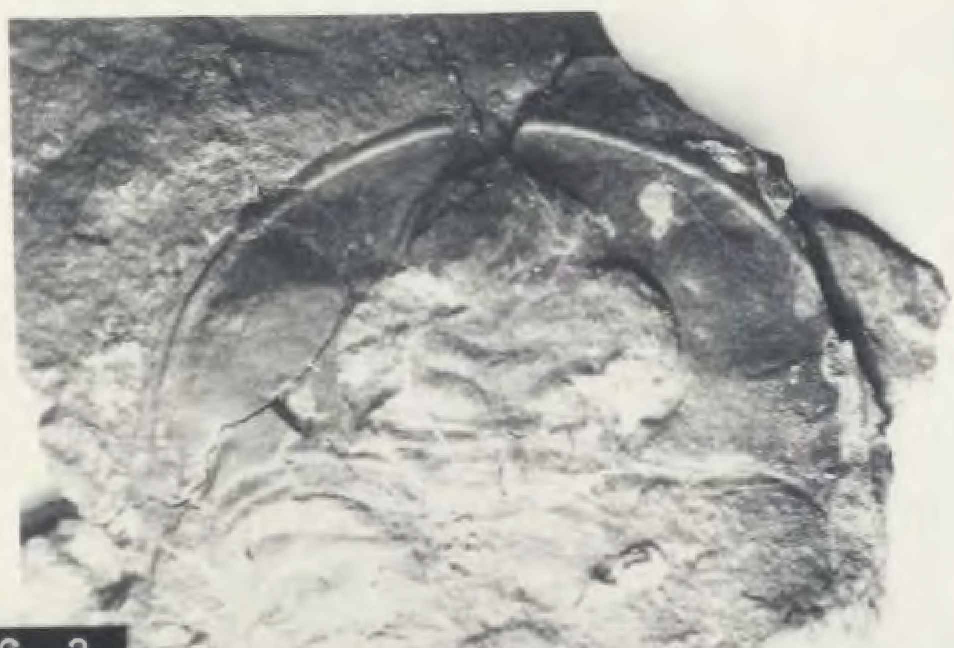


FIG. 2

Plate 51 - Olenellus thompsoni (Hall) and

Bonnia sp.

Figure		Page
1.	Olenellus thompsoni (Hall)	101
X1.5. MUTF 06-0103, Crow Head, English Point, Labrador. Specimen with well preserved thorax but crushed cephalon. The pleural spines are backwardly directed and with distinct pleural furrows.
2.	Bonnia sp.	101
X6. MUTF 05-0201, L'anse Amour, Labrador. Magnified photograph of a cephalon, showing texture on the cephalon.

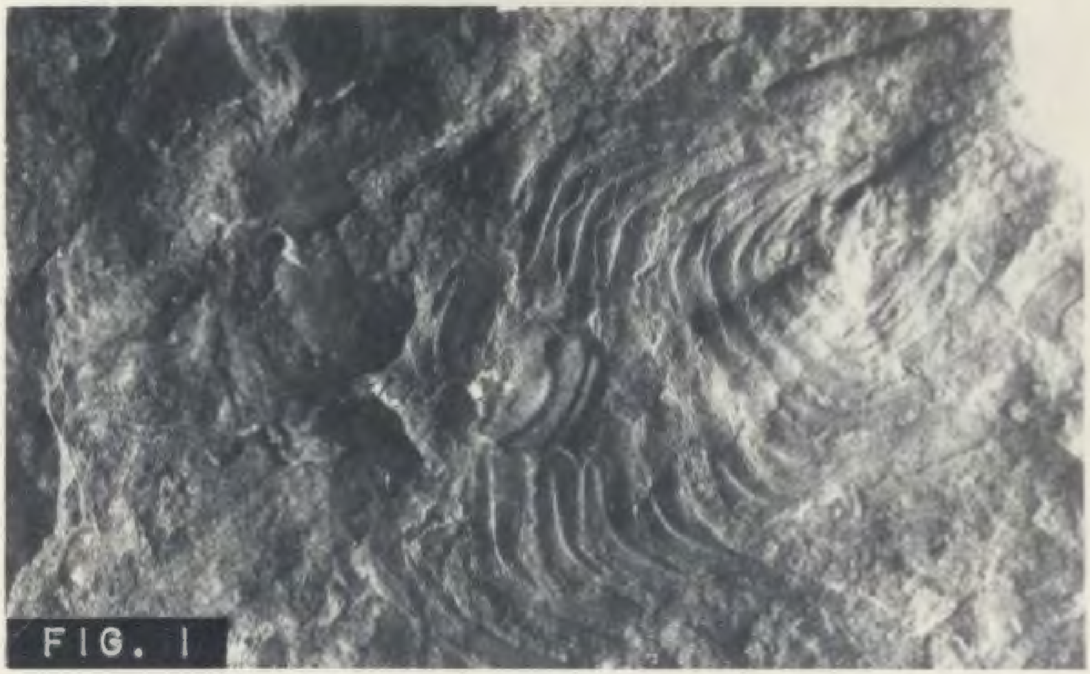


FIG. 1

FIG. 2

Plate 52 - Solenopora belemnos nov. sp.

Figure		Page
1.	Solenopora belemnos nov. sp. Holotype. X20. MUCF 09-0101, Lower-Level Archaeocyathid Reefs, Forteau, Labrador. Cell threads are straight lance-shaped. It is seen attached to an archaeocyathid, part of which is in the lower right of the photomicrograph.	102
2.	Solenopora belemnos nov. sp. Paratype. X20. MUCF 04-0101, Lower-Level Archaeocyathid Reefs, Point Amour, Labrador. The straight cell threads here are short.	102

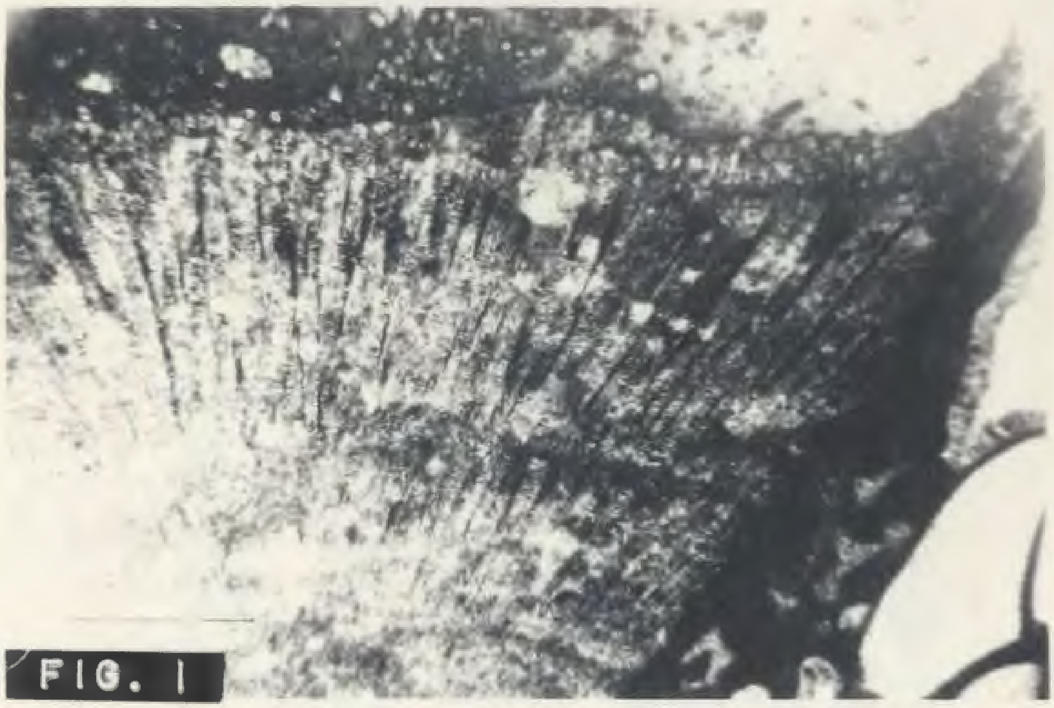


FIG. 1

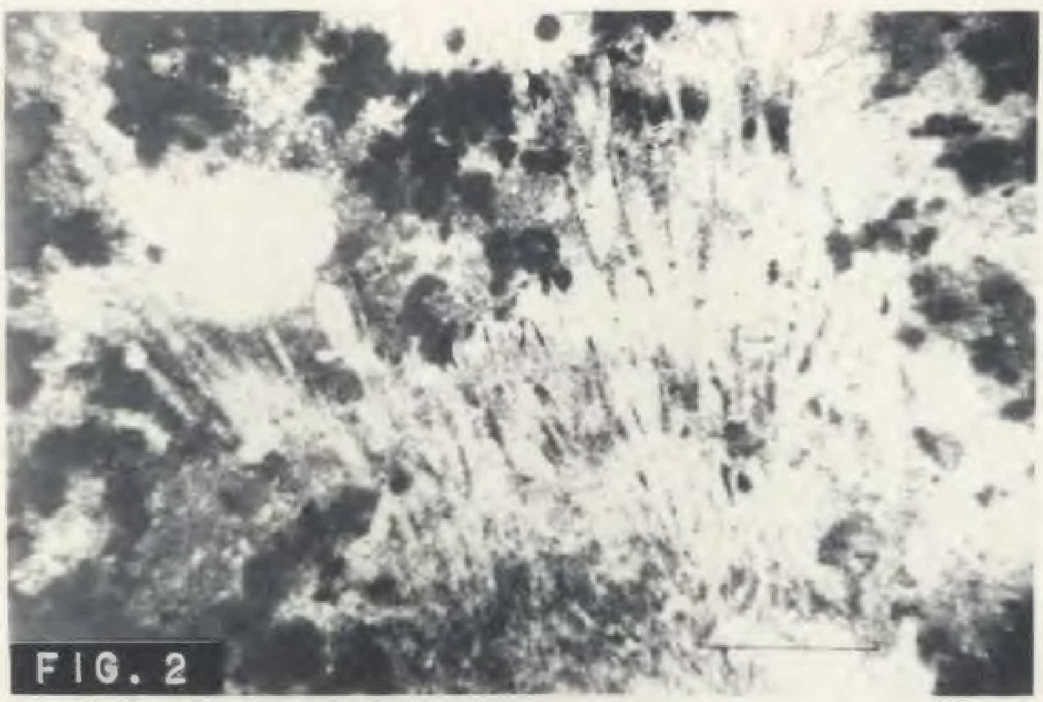


FIG. 2

Plate 53 - Solenopora belemnos nov. sp.

Figure		Page
1.	Solenopora belemnos nov. sp. X20. MUCF 04-0311, Lower-Level Archaeocyathid Reefs, Point Amour, Labrador. Long, straight, loosely packed, radiating, spear-shaped cell threads of Solenopora belemnos nov. sp. are seen attached on top of Seletonella forteauensis nov. sp.	102
2.	Solenopora belemnos nov. sp. X20. MUAF 05-0201, Lower-Level Archaeocyathid Reefs, L'anse Amour. Straight, radiating cell threads are seen in the intervallum of Ajacicyathus profundominus. In the centre of the photomicrograph cross sections of cell threads are shown.	102

FIG. 1

FIG. 2

Plate 54 - Solenopora taylorensis nov. sp.

Figure		Page
1.	Solenopora taylorensis nov. sp. X80. MUCF 07-0201, Upper Member, Forteau formation, Taylor's Gulch, Labrador. Holotype. The round nodular algal mass is embedded in a groundmass of clear sparite. Cross sections of cell threads and the thick cell walls are shown.	104
2.	Solenopora taylorensis nov. sp. X80. MUCF 07-0201, Upper Member, Forteau formation, Taylor's Gulch, Labrador. Paratype, showing several "conceptacles".	104

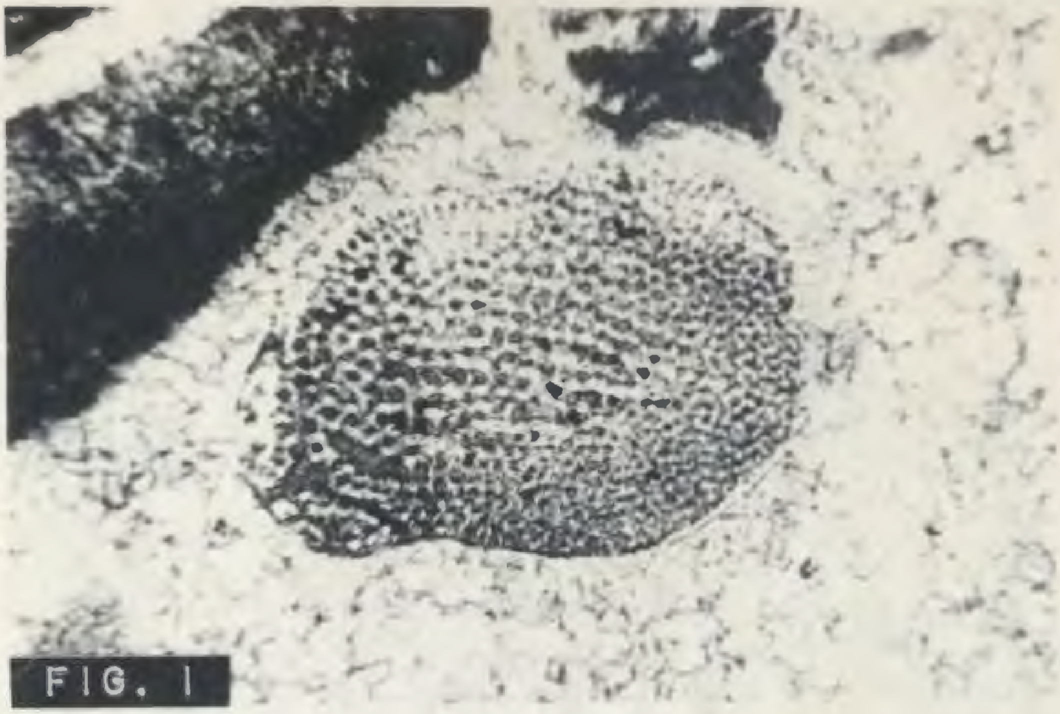


FIG. 1


FIG. 2

Plate 55 - Seletonella forteauensis nov. sp.

Figure		Page
1.	Seletonella forteauensis nov. sp. X50. MUCF 04-0305, Lower-Level Archaeocyathid Reefs, Point Amour Light House, Labrador. Holotype, vertical section cut parallel to the long axis of the fossil, showing the alga attached to a flat shell fragment.	106
2.	Seletonella forteauensis nov. sp. X50. MUCF 04-0305, Lower-Level Archaeocyathid Reefs, Point Amour Light House. Section grazing the surface of the sheath of a fusiform specimen. This top view shows the orderly arrangement of the branches and the characteristic radiating and astarisk central cavities in the cross section of the branches.	106

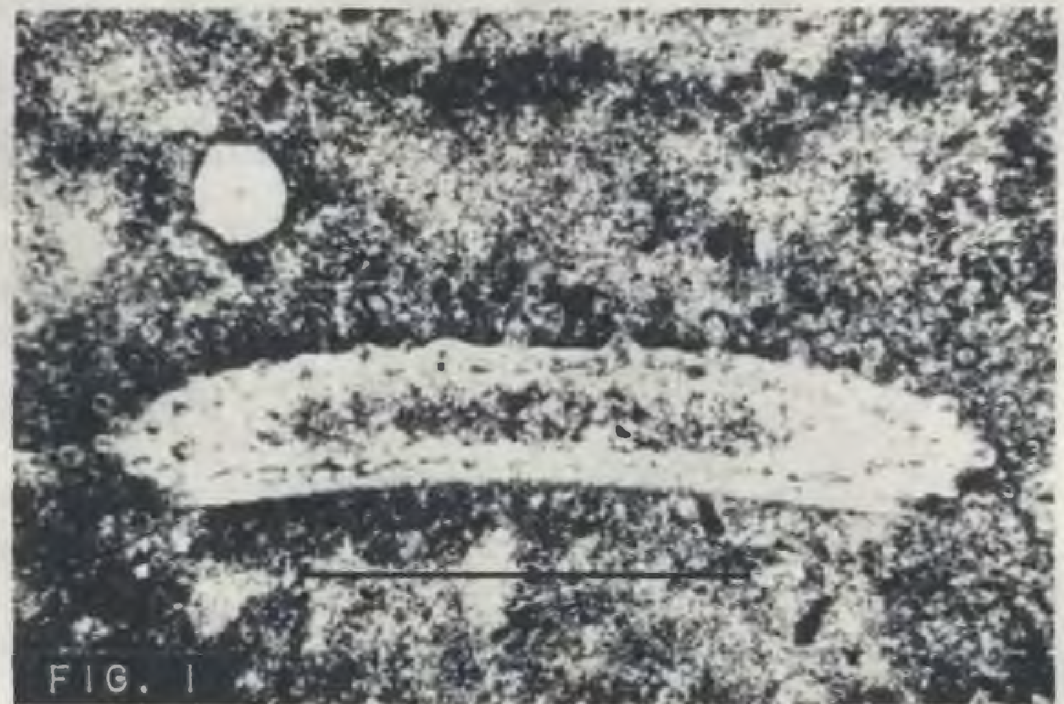


FIG. 1

FIG. 2

Plate 56 - Seletonella forteauensis nov. sp.

Figure		Page
1.	Seletonella forteauensis nov. sp. X50. MUCF 04-0309, Lower-Level Archaeocyathid Reefs, Point Amour Light House, Labrador. Vertical cross section perpendicular to the long axis of the fossil. The alga is attached to a shell fragment.	106
2.	Seletonella forteauensis nov. sp. X80. MUCF 04-0305, Lower-Level Archaeocyathid Reefs, Point Amour Light House, Labrador. Horizontal section of a paratype grazing the surface showing the hemispheroidal form.	106

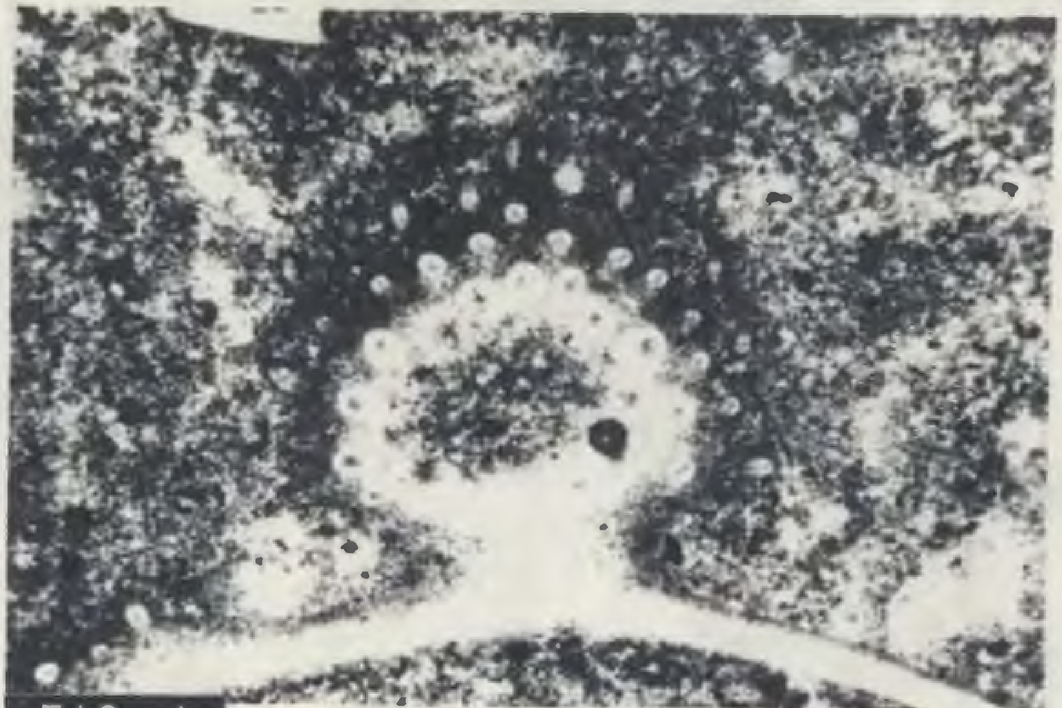


FIG. 1

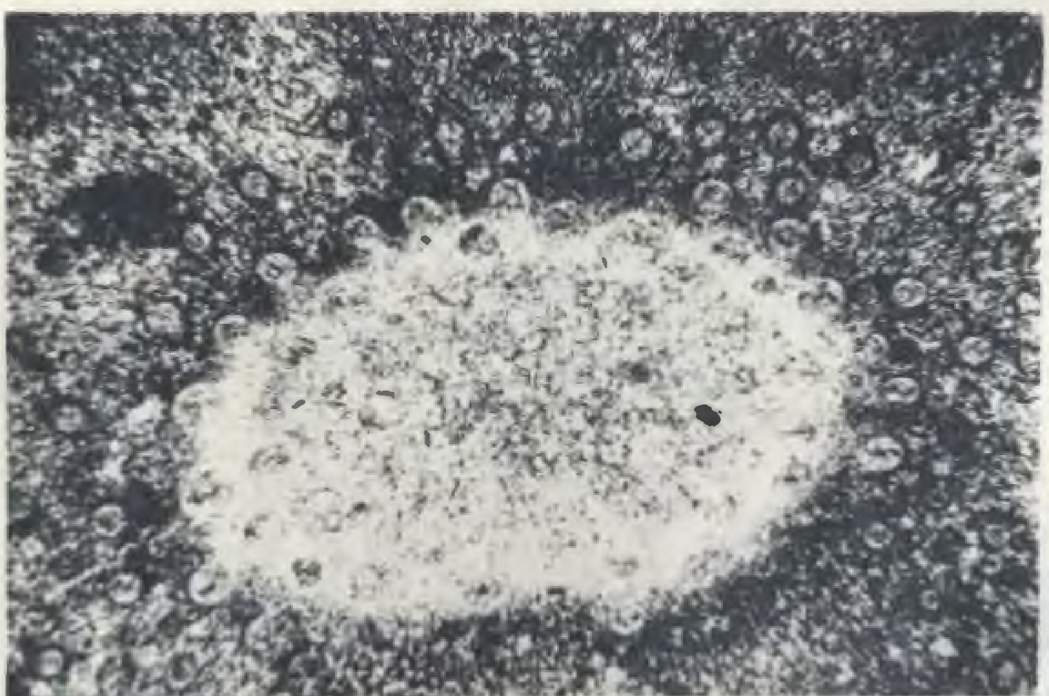


FIG. 2

Plate 57 - Seletonella forteauensis nov. sp.

Figure		Page
1.	Seletonella forteauensis nov. sp. X100. MUCF 04-0306, Lower-Level Archaeocyathid Reefs, Point Amour Light House, Labrador. Section through the exoskeleton of a trilobite on which the dasyclad alga settled.	106
2.	Seletonella forteauensis nov. sp. X20. MUCF 04-0313, Lower-Level Archaeocyathid Reefs, Point Amour Light House, Labrador. Three colonies of S. forteauensis on a fragment of exoskeleton of a trilobite; one on the central lobe, and the other two on the two lateral lobes.	106

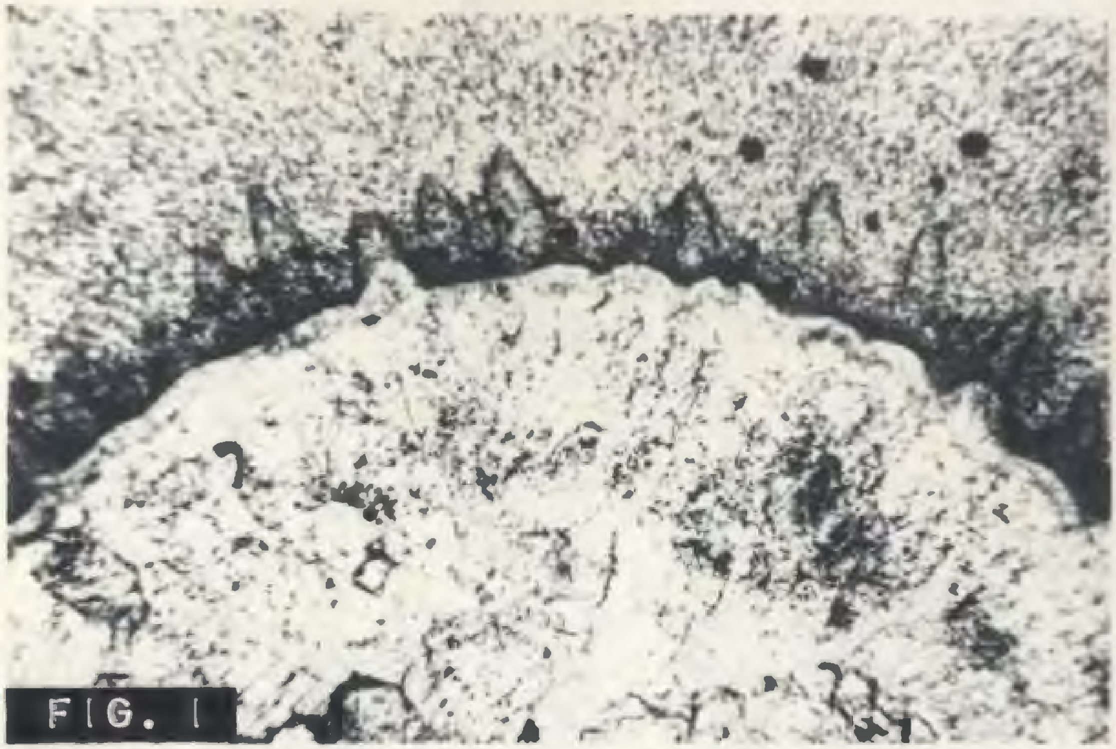


FIG. 1

FIG. 2

Plate 58 - Girvanella incrustans (Bornemann)

Figure		Page
1.	Girvanella incrustans (Bornemann) X100. MUCF 09-0401, Upper Member, Forteau formation, Forteau, Labrador. Section cut horizontally showing the loosely packed twisting fine tubes and numerous cross sections of such tubes.	108
2.	Girvanella incrustans (Bornemann) X100. MUCF 09-0402, Upper Member, Forteau formation, Forteau, Labrador. Vertical section cut perpendicular to the disc of the algal colony. Fewer cross sections of algal tubes are shown in section cut in this orientation than in horizontal sections.	108

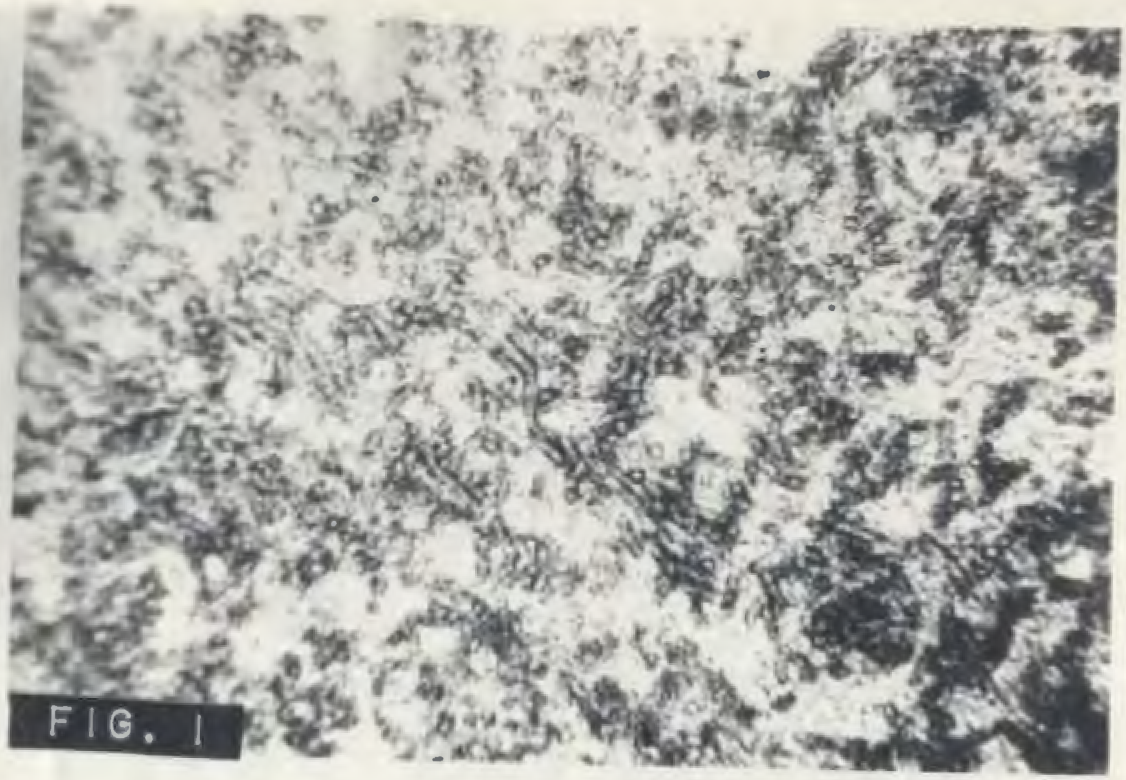


FIG. 1

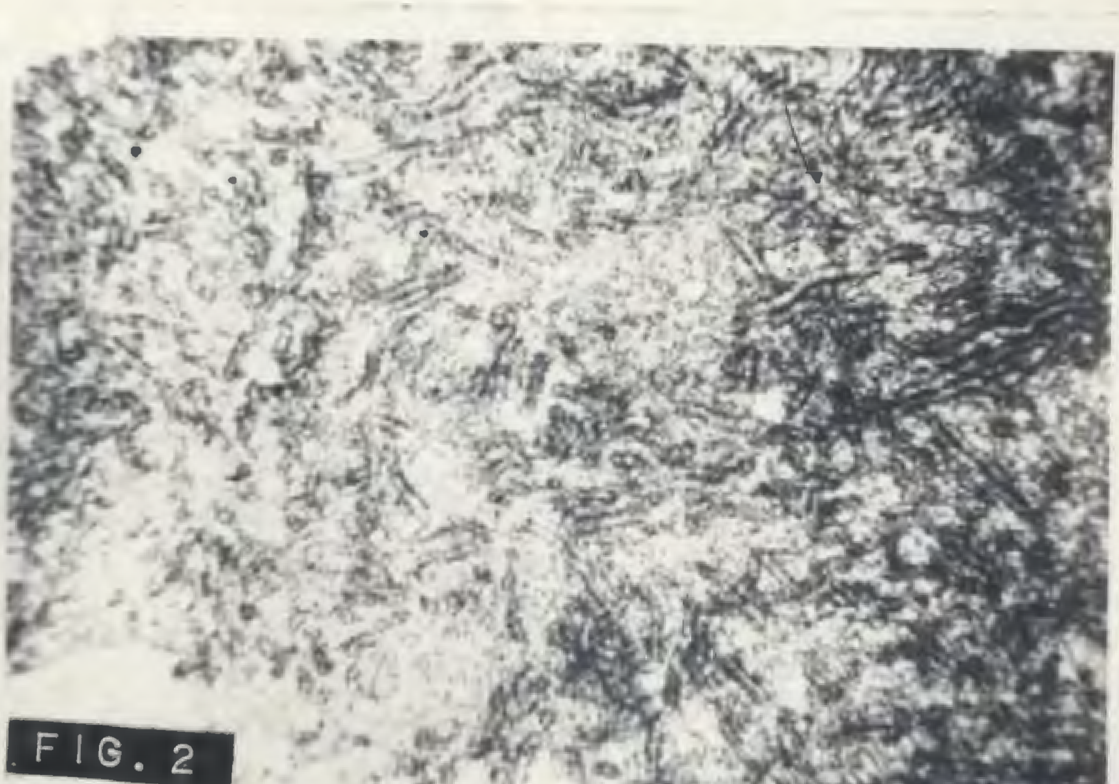


FIG. 2

Plate 59 - Girvanella mexicana Johnson

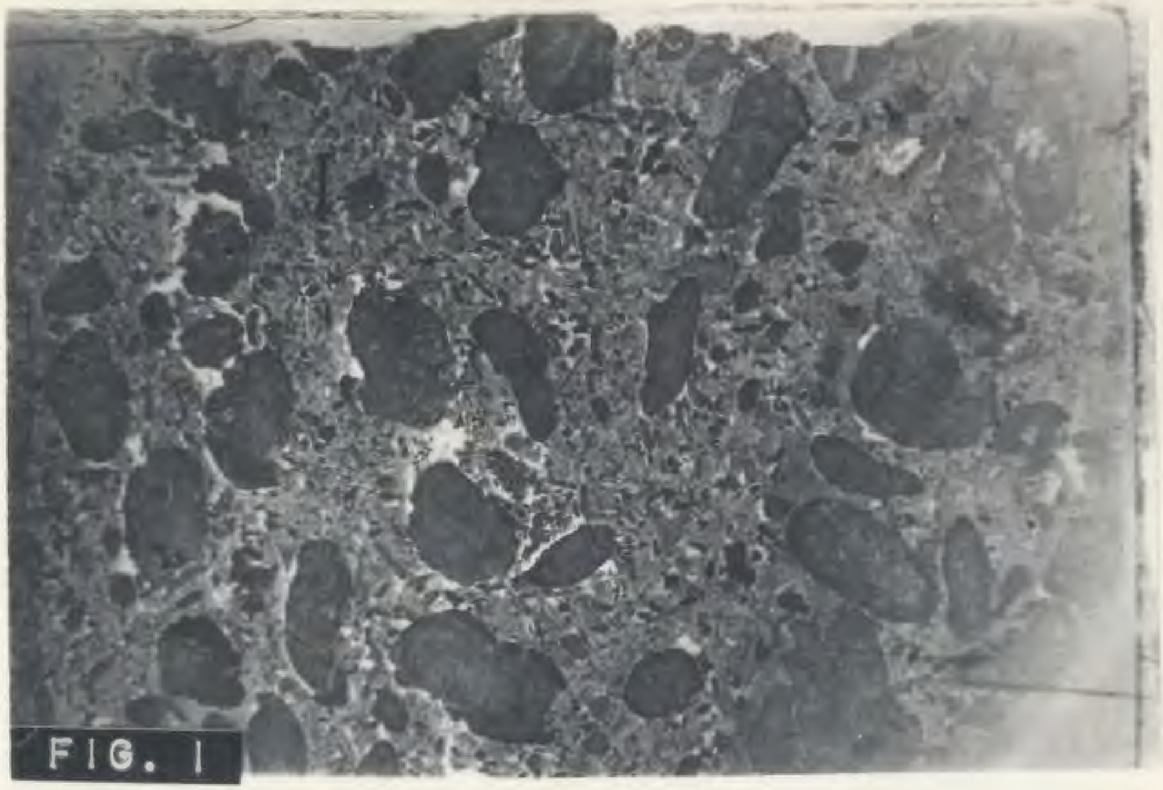


FIG. 1

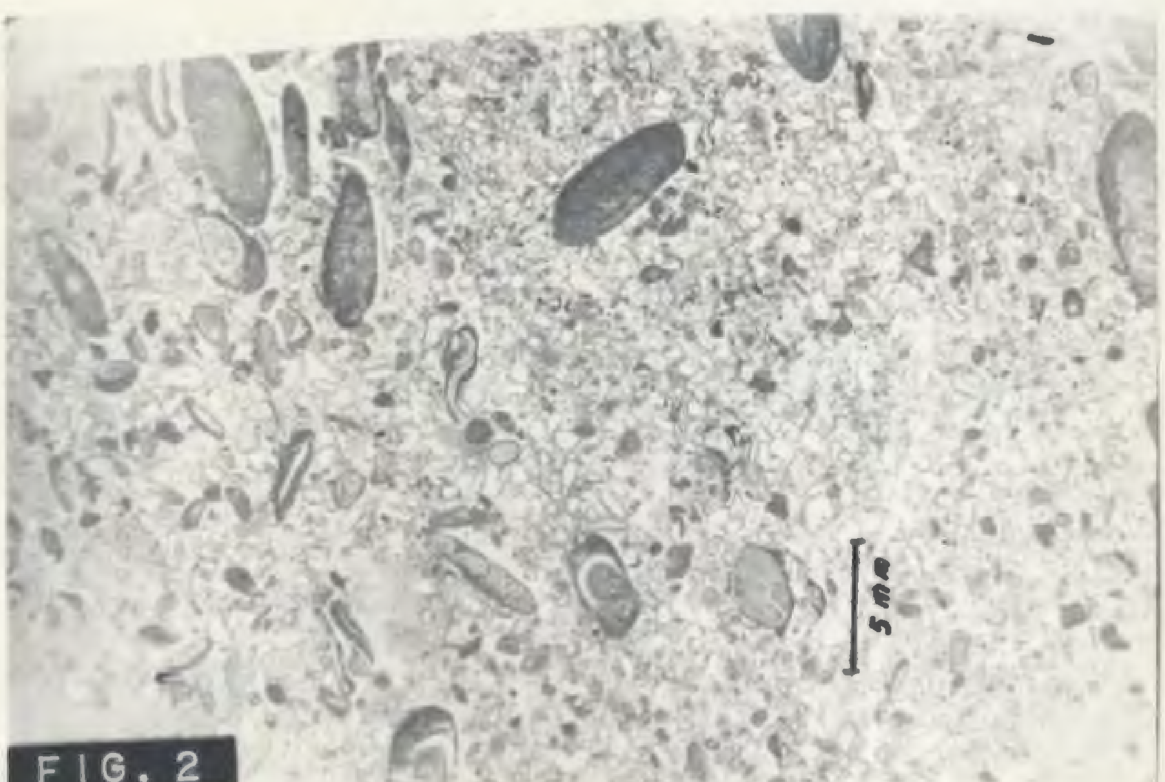


FIG. 2

Plate 60 - Girvanella mexicana Johnson

Figure		Page
1.	Girvanella mexicana Johnson X100. MUCF 06-0501, Upper Member, Forteau formation, Crow Head near English Point, Labrador. Fine algal tubes are loosely packed and randomly twisted.	109
2.	Girvanella mexicana Johnson X100. MUCF 06-0501, Upper Member, Forteau formation, Crow Head near English Point, Labrador. The algal tubes are long and densely packed together.	109

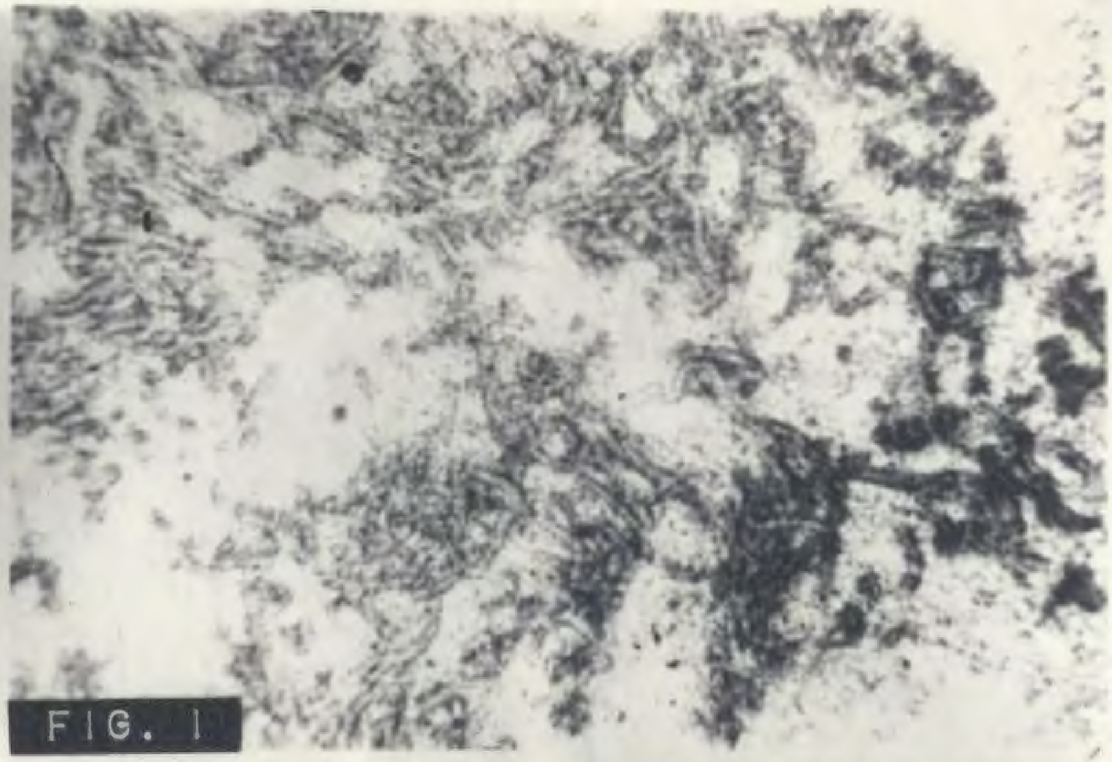


FIG. 1

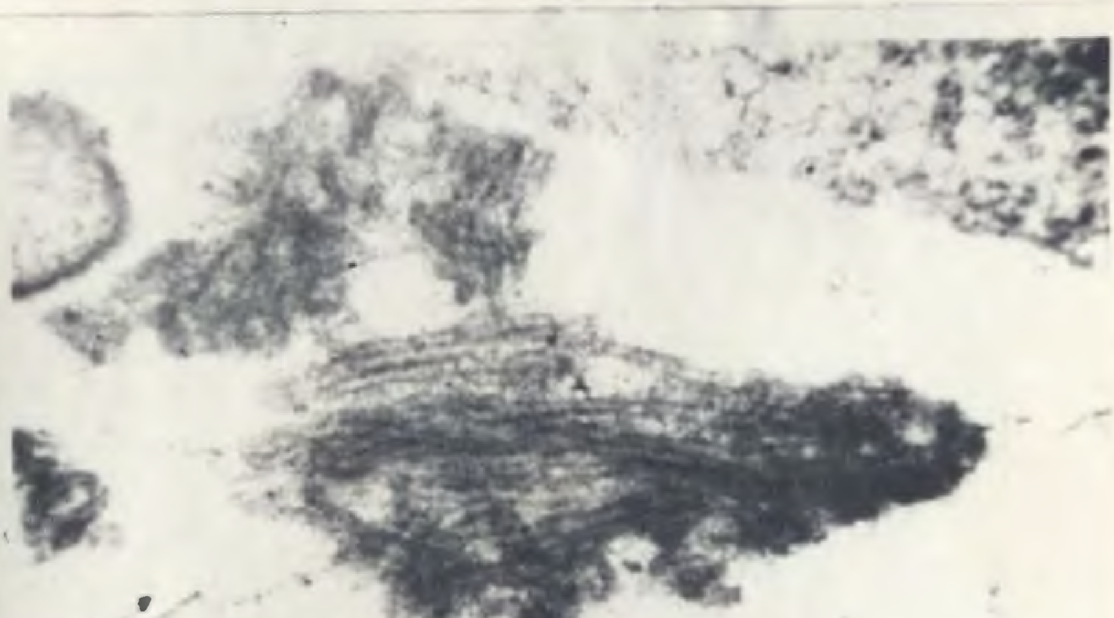


FIG. 2

Plate 61 - Collenia filosa nov. sp.

Figure		Page
1.	Collenia filosa nov. sp. X2.25. MUCF 09-0702, Upper Member, Forteau formation, Forteau, Labrador. Slightly enlarged photograph showing encrusting digital forms and inter-digital spaces filled with exotic material.	111
2.	Collenia filosa nov. sp. X100. MUCF 09-0701, holotype, Upper Member, Forteau formation, Forteau, Labrador. Photomicrograph showing twisting algal tubes.	111

FIG. 1

collevin x 2.85 Fnt

FIG. 2

APPENDIX

Description of Archaeocyathid Localities

Localities of outcrops in which archaeocyathid reefs are exposed are distributed along the northern coast of the Straits of Belle Isle where the Precambrian "granitic" basement is covered with Cambrian sedimentary rocks. Localities from which specimens of archaeocyathid fossils were collected and studied are numbered from the east to the west in the accompanying map (Plate 62). Brief descriptions of localities and the generalized lithology of exposed rocks are given below:

Locality 01: Archaeocyathid reef. This locality is situated at an elevation of 350 feet on the southern slope of Bouger Hill situated between West St. Modeste and Capstan Island. Quartzitic sedimentary rocks of the Bradore formation form bold cliffs on the southern seaward facing slope of Bouger Hill. The top of Bradore formation reaches a height of 340 feet. The dolomitic bed which comprises the base of the Forteau formation crops out at this height and resting on it is the archaeocyathid reef which is overlain by thin beds of grey calcareous shale.

Locality 02: On the hill top at an elevation of 1,117 feet at the heads of the L'anse au Loup and L'anse au Diable Valleys the Higher-Level Archaeocyathid Reefs crop out as small scattered blocks only.

Here the archaeocyathid fossils were well developed. At a lower level the Upper Member of the Forteau formation crops out and is a grey calcareous shale.

Locality 03: At Fox Cove, where Locality 03 is situated, both the Higher and Lower-Level Archaeocyathid Reefs were extensively exposed. This locality is considered to be the best place for collecting archaeocyathid fossils. Archaeocyathid fossils, weathered free from the matrix from both the Higher and Lower-Level Archaeocyathid Reefs, were scattered along the coast line but here one cannot be sure of their stratigraphic origin. The Lower-Level Archaeocyathid Reefs show well developed reefoid forms, which reach a height of 20 to 30 feet. The Higher-Level Archaeocyathid Reefs comprise part of a thick flat-lying platform reef complex.

Locality 04: This locality consists of extensive outcrops: one outcrop is immediately below the Point Amour Light House; and the other at Point Amour one mile south of the village of L'anse Amour. Below the light house the Lower-Level Reefs crop out extensively along the coast line; while the Higher-Level Reefs recede northward for a distance of 1,000 ft., and are mostly covered by vegetation. At Point Amour both the Higher and Lower-Level Reefs crop out: the Lower along the coast line with well developed reefoid forms, and the Higher occupying a higher altitude and forming cliffs accessible from the road. The Higher-Level Archaeocyathid Reefs are grey in colour both at the Point Amour Light House and Point Amour and contain a high amount of argillaceous material. The Lower-Level Archaeocyathid Reefs, on the contrary, are mostly red in colour and contain very little argillaceous material.

Locality 05: Specimens labelled 05 were collected from the northeastward trending valley located immediately north of L'anse Amour, and also from outcrops that were exposed by excavation along the road between English Point and L'anse au Loup. At these localities only the Lower-Level Archaeocyathid Reefs are present.

Locality 06: This locality is situated near English Point. Grey, muddy, reef limestone of the Higher-Level Archaeocyathid Reefs crop out along a low cliff.

Locality 07: Taylor's Gulch. Here at a height of 450 ft. the Higher-Level Archaeocyathid Reefs crop out in the form of low cliffs. The reef limestone is mainly grey in colour but locally some of the reef limestone is red in colour. The archaeocyathid fossils are well developed both in form and size.

Locality 08: Locality 08 is on a hill top to the west of Buckle's Point. The Higher-Level Archaeocyathid Reefs crop out and are overlain by clastic limestone beds composed of archaeocyathid and other fossil fragments. Both grey and red coloured reef facies are present.

Locality 09: Above the Village of Forteau two small reef bodies were exposed during road building. These reef bodies, the lower red in colour and the upper grey, rest on beds of dolomite which are slightly crumpled in appearance. Interbedded in these reef bodies are beds of calcareous grey shale rich in trilobite exoskeletons.

Locality 10: Fossil specimens from Locality 10 were collected from along the shore of the headland named Forteau Point. All the outcrops along this stretch of the coast line contain reefs belonging to the Lower-Level Archaeocyathid Reefs. Reefoid forms were well developed and attain heights ranging from 25 to 30 feet. The colour of the reef limestone is red.

Locality 11: Two miles to the northeast of L'anse au Clair the Higher-Level Archaeocyathid Reefs crop out as cliffs that fringe the northern shore of a small lake on the north side of the road from Forteau to L'anse au Clair. Reefs found here are mostly red in colour although grey-coloured reef facies are also present.

This locality is also one of the best collecting sites for archaeocyathids. Free weathered specimens are scattered along the foot of the cliffs on the slopes. The Lower-Level Archaeocyathid Reefs are also exposed in a series of small outcrops located in the bed of a small creek that leads out of the lake.

Locality 12: The road leading from L'anse au Clair to Blanc Sablon is situated on a terrace at an altitude of 350 feet. Archaeocyathid reefs of the Lower-Level Archaeocyathid Reefs crop out along the road and on the terrace. At this locality reef bodies stand out as small knolls of reddish reef limestone.

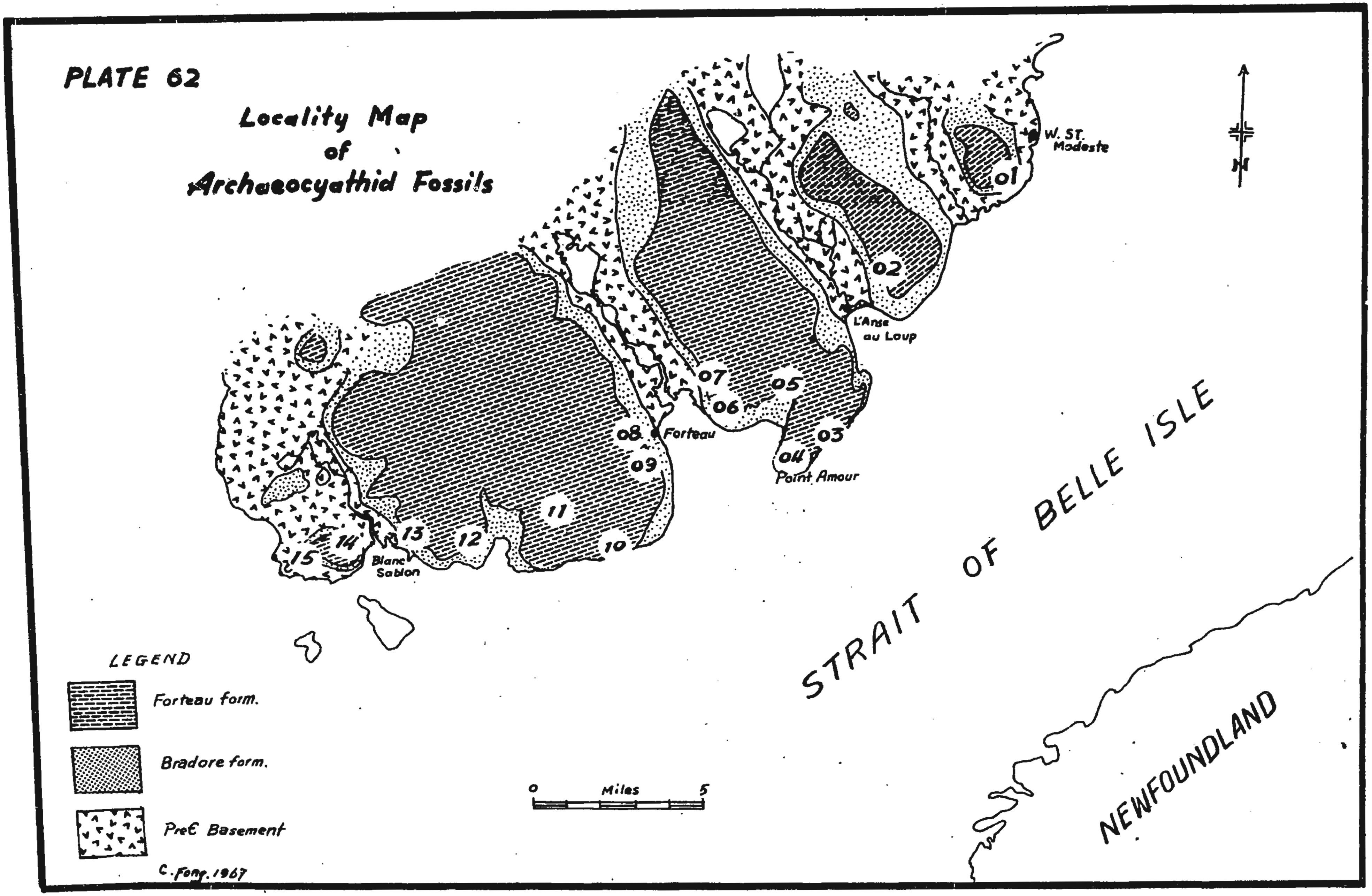
Locality 13: At Blanc Sablon outcrops of the Lower-Level Archaeocyathid Reefs are on strike with those seen at L'anse au Clair and occur here 350 feet above sea level. The reefs rest on the dolomite bed which is used to mark the base of Forteau formation. The colour of these reefs is mostly red, and the reefoid form is well developed.

Locality 14: This locality occurs at the top of the hill situated between Blanc Sablon and Long Point. The elevation of this locality is 300 feet. The Lower-Level Archaeocyathid Reefs cap the top and appear knoll-like when viewed from the road below the hill.

Locality 15: At Long Point, the Lower-Level Archaeocyathid Reefs stand out as knolls on the flat-lying Bradore formation as a result of differential erosion. Here the red-coloured reefs mark the western extremity of the archaeocyathid reefs found in the thesis area.

PLATE 62

Locality Map of Archaeocyathid Fossils



Lower-Level Archaeocyathid Reefs ↘ (lower-left of each cell) / ↖ Higher-Level Archaeocyathid Reefs (upper-right of each cell)

C : fossil collected from this locality ; N : not collected from this locality ; X : reef not exposed

Archaeocyatha fossil \ Locality	01: Bonger Hill	02: L'anse au Loup	03: Fox Cove	04: Point Amour	05: L'anse Amour	06: English Point	07: Taylor's Gulch	08: Buckles Point	09: Forteau	10: Forteau Point	11: E. of L'anse au Clair	12: W. of L'anse au Clair	13: Blanc Sablon	14: Blanc Sablon	15: Long Point
Ajacicyathus nevadensis	C / X	N / N	N / N	C / N	C / N	X / N	X / N	X / N	C / X	C / X	X / N	N / X	C / X	C / X	X / N
A. profundominimus	C / X	N / N	N / C	C / N	C / N	X / N	X / C	X / N	C / X	N / X	X / N	N / X	N / X	C / X	X / N
A. undulatus	C / X	N / N	N / C	C / N	C / N	X / C	X / C	X / N	C / X	N / X	X / C	N / X	N / X	C / X	X / N
A. argentus	N / X	N / N	N / N	N / N	C / N	X / N	X / N	X / N	N / X	N / X	X / N	N / X	N / X	N / X	X / N
A. richardsoni	N / X	N / N	N / N	N / C	C / N	X / N	X / C	X / N	C / X	N / X	X / C	N / X	N / X	N / X	X / N
Archaeocyathus atlanticus	N / X	N / N	N / N	C / N	C / N	X / N	X / N	X / N	C / X	N / X	X / N	N / X	N / X	N / X	X / N
A. irregularis	C / X	N / C	N / C	C / C	C / C	X / C	X / C	X / C	C / X	N / X	X / C	C / X	C / X	C / X	X / C
A. patelliformis	N / X	N / N	N / C	C / N	N / N	X / N	X / N	X / N	C / X	N / X	X / C	N / X	N / X	C / X	X / N
Protopharetra sp.	? / X	? / ?	? / ?	? / ?	? / ?	X / ?	X / ?	X / ?	? / X	? / X	X / ?	? / X	? / X	? / X	X / ?
Pycnoidocyathus amourensis	C / X	C / C	N / C	C / C	C / N	X / C	X / C	X / C	C / X	C / X	X / C	C / X	C / X	C / X	X / C
P. profundus	C / X	C / C	C / C	C / C	C / C	X / C	X / C	X / C	C / X	C / X	X / C	C / X	C / X	C / X	X / C
P. loupensis	N / X	N / N	C / C	C / N	C / N	X / N	X / C	X / N	N / X	N / X	X / C	N / X	N / X	N / X	X / N
P. columbianus	N / X	N / C	N / N	N / N	N / N	X / N	X / N	X / N	C / X	N / X	X / C	N / X	N / X	N / X	X / N
Pycnoidocyathus sp.	N / X	N / N	N / C	N / N	N / N	X / N	X / N	X / N	N / X	N / X	X / N	N / X	N / X	N / X	X / N
Archaeosycon billingsi (Walc.)	C / X	N / N	N / N	C / N	C / N	X / N	X / N	X / N	C / X	N / X	X / N	N / X	N / X	N / X	X / N
Syringocyathus canadensis	C / X	N / C	N / N	C / N	C / N	X / C	X / C	X / C	C / X	C / X	X / C	C / X	C / X	C / X	X / C
Syringocyathus sp.	N / X	N / N	N / N	N / N	N / N	X / N	X / N	X / N	N / X	N / X	X / N	N / X	N / X	C / X	X / N
Sigmosyringocyathus cylind.	C / X	N / N	N / N	C / N	C / N	X / N	X / N	X / N	C / X	N / X	X / N	C / X	C / X	C / X	X / N

Plate 63 - Distribution of Archaeocyathid fossils in Different Localities.

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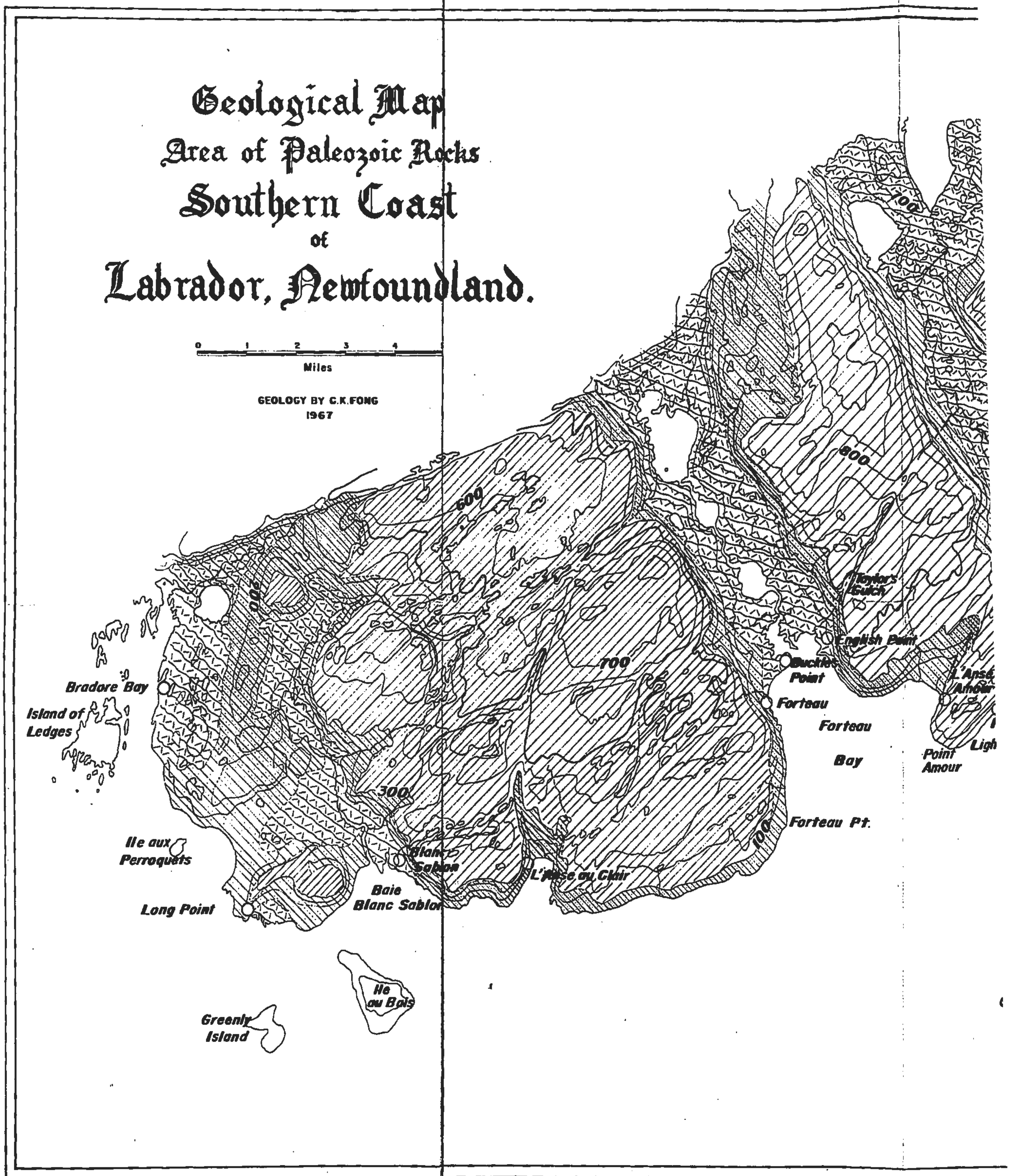
Geological Map
Area of Paleozoic Rocks
Southern Coast
of
Labrador, Newfoundland.
0 1 2 3 4
Miles
GEOLOGY BY C.K.FONG
1967
100
200
300
600
700
800
Bradore Bay
Island of Ledges
Ile aux Perroquets
Long Point
Blanc Sablon
Baie Blanc Sablon
L'Anse au Clair
Forteau Pt.
Forteau
Forteau Bay
Buckles Point
English Point
Taylors Gulch
L'Anse Amour
Point Amour
Ile au Bois
Greenly Island

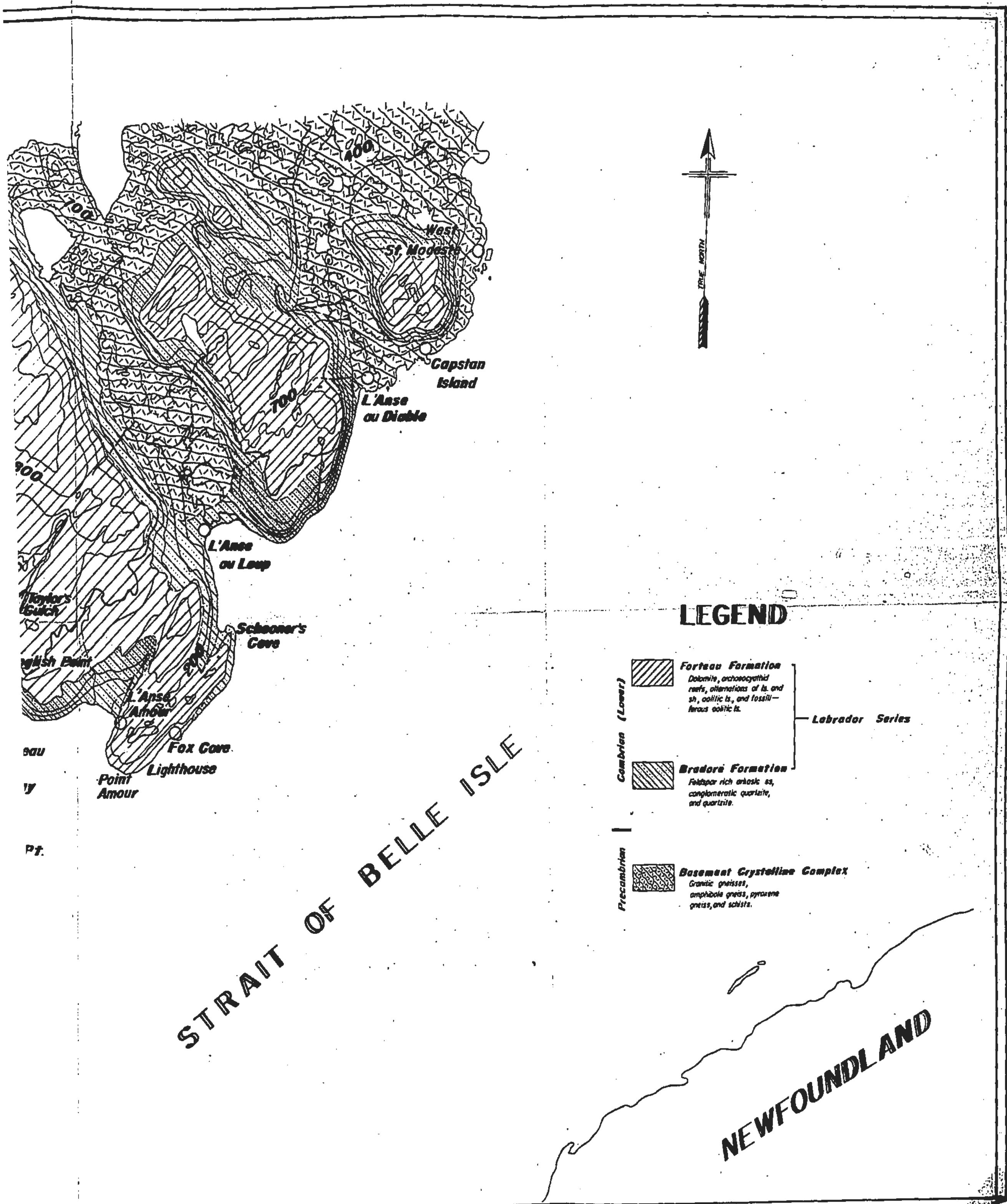
West St Modeste
Capstan Island
L'Anse au Diable
L'Anse au Loup
Schooner's Cove
English Point
L'Anse Amour
Fox Cove
Lighthouse
Point Amour
STRAIT OF BELLE ISLE
NEWFOUNDLAND
TRUE NORTH
LEGEND
Cambrian (Lower)
Forteau Formation
Dolomite, archaeocyathid reefs, alternations of ls. and sh, oolitic ls., and fossiliferous oolitic ls.
Bradore Formation
Feldspar rich arkosic ss, conglomeratic quartzite, and quartzite.
Labrador Series
Precambrian
Basement Crystalline Complex
Granitic gneisses, amphibole gneiss, pyroxene gneiss, and schists.

Plate 2

Column Sectio

Forteau Formatic

C.C.K. Fon

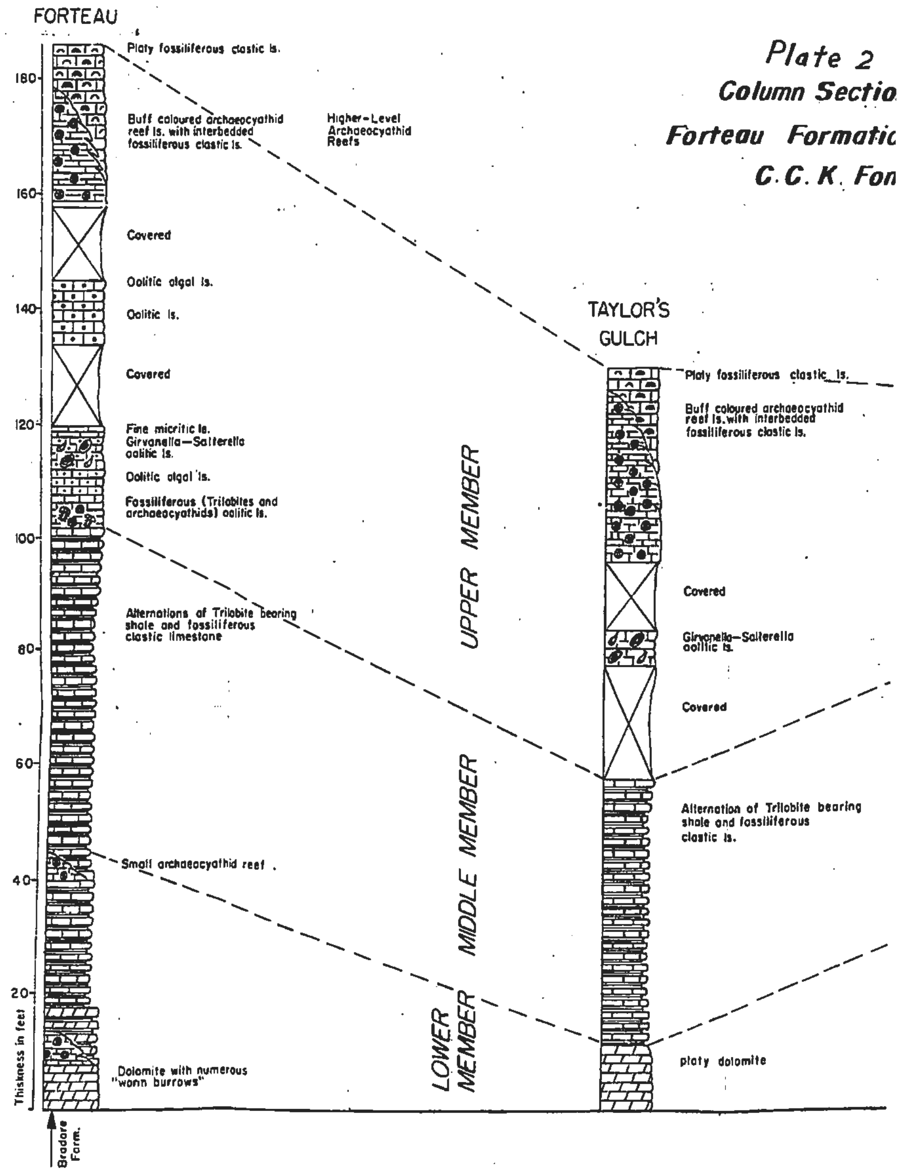

Plate 2
Column Sections of Forteau Formation 1967
C. C. K. Fong