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DEPARTMENT OF MINES AND TECHNICAL SURVEYS

BULLETIN 78

THE SILURIAN FAUNA OF THE SANDPILE GROUP OF NORTHERN BRITISH COLUMBIA

B. S. Norford

Price, $2.50

1962

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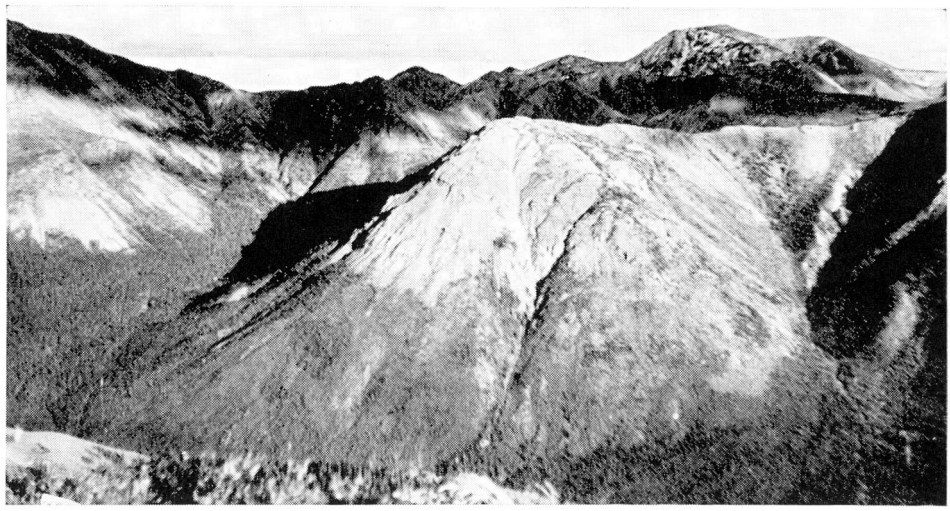
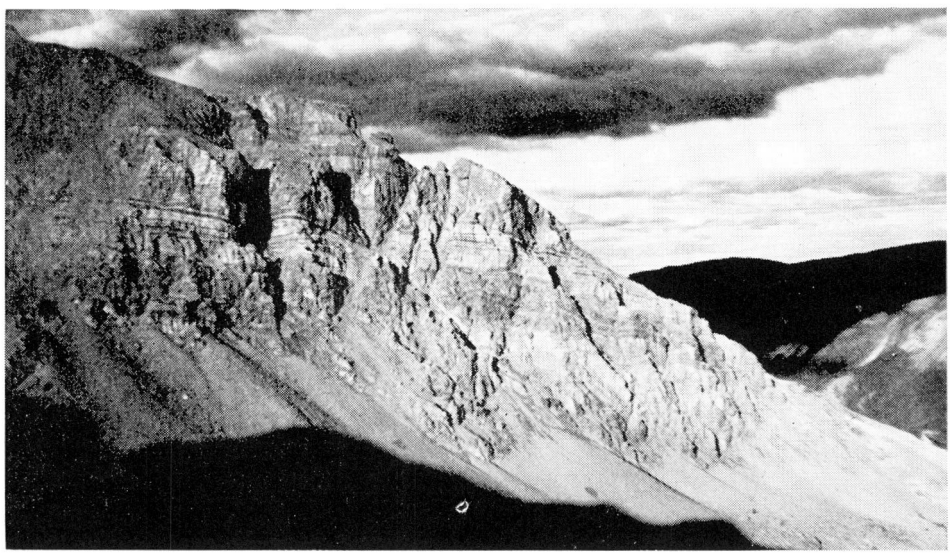


Mountains formed by rocks of the Sandpile Group. The view is taken looking southeastwards across Sandpile Creek. Local relief is about 3,000 feet; the section described on page 5 was measured on the face of the central mountain.

Cliff-outcrop of rocks of the Sandpile Group, near the head of Sandpile Creek; about 1,000 feet of strata exposed.



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PREFACE

This report provides one of the first detailed descriptions of a Lower Palæozoic fauna from northwest Canada when geological investigation is still largely concerned with primary exploration. The fauna permits rocks of the Sandpile Group to be correlated with Silurian units in other parts of North America. Silurian rocks are widespread in parts of northwest Canada and this report will provide a reference horizon for their comparison.

J. M. HARRISON,
Director, Geological Survey of Canada

OTTAWA, October 27, 1960

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THE SILURIAN FAUNA OF THE SANDPILE GROUP OF NORTHERN BRITISH COLUMBIA

Abstract

The Sandpile Group outcrops in the Cassiar Mountains, west of the Rocky Mountain Trench. Beds in the upper part of the group contain a large silicified fauna. Forty-two species are described and represent twenty-nine coral, brachiopod, and crinoid genera. Five new species are proposed: *Halysites occidens, Halysites sandpilensis, Fletcheria major, Fletcheria deadwoodensis,* and *Atrypa gabrielsi.* The fauna is thought to be of middle Clinton (late Early or early Middle Silurian) age.

Résumé

Le groupe Sandpile affleure dans les monts Cassiar, situés à l'ouest du Sillon des Rocheuses. Les couches de sa partie supérieure contiennent de nombreux fossiles silicifiés. L'auteur en décrit 42 espèces, appartenant à 29 genres de coraux, brachiopodes et crinoïdes. Cinq nouvelles espèces sont proposées: *Halysites occidens, Halysites sandpilensis, Fletcheria major, Fletcheria deadwoodensis* et *Atrypa gabrielsi.* Cette faune daterait du Clinton moyen (fin du Silurien inférieur ou début du Silurien moyen).

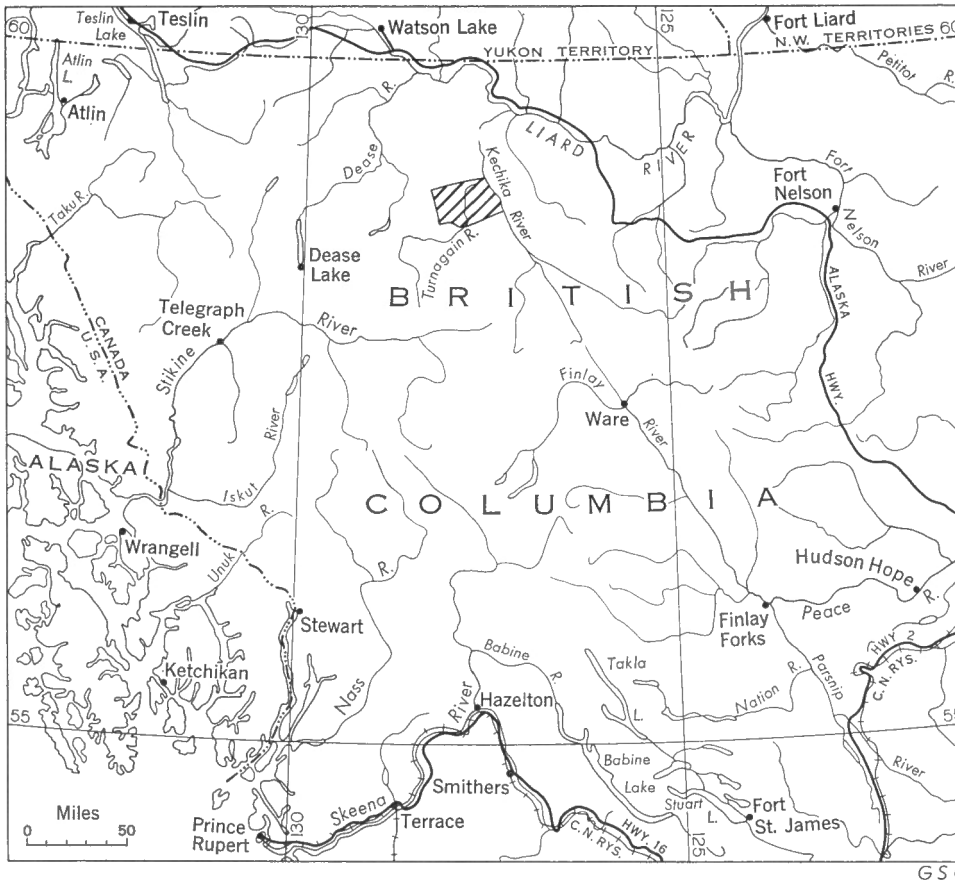

Figure 1. *Index map*

INTRODUCTION

Location

The fauna of the Sandpile Group is described from rocks outcropping near Sandpile Creek, a tributary of Turnagain River whose water eventually drains into Mackenzie River by means of Kechika and Liard Rivers. The headwaters of Sandpile Creek lie near latitude 59°02′N and longitude 128°12′W (Fig. 1), and are located within the Cassiar Mountains of the Interior system of the Canadian Cordillera (Bostock, 1948).

Access to the region is by pack-trails from Lower Post on the Alaska Highway at mile-post 620, and also from the abandoned McDame Post on Liard River. The latter post is connected by a rough road to the gravel road that connects Cassiar to the Alaska Highway. Several lakes allow servicing by aircraft based at Watson Lake, Yukon Territory, and some reaches of Turnagain River provide potential landing places under favourable water conditions.

Geological Setting

The major structural features of northern British Columbia trend northwest-southeast. The Cassiar batholith forms the backbone of the Cassiar Mountains and its time of emplacement is thought to be Mesozoic. Two great belts of strata outcrop northeast of the batholith and west of the Rocky Mountain Trench. The Sylvester Group forms the belt adjacent to the batholith and consists of a vast thickness of sedimentary and volcanic rocks, and their metamorphic equivalents. The Sylvester may be late Devonian and early Mississippian (Gabrielse, *in press*). The second belt of strata dips below that of the Sylvester and consists of an assemblage of Palæozoic carbonate units and Precambrian rocks.

The lower Turnagain region lies within the latter belt. The structural pattern is complex but may be concisely described as that of several anticlinoria trending northwest-southeast, complicated by longitudinal and transverse faults. Precambrian, Cambrian, Ordovician, Silurian, Devonian, and Mississippian sedimentary rocks outcrop (Norford, 1959).

Previous Investigations

The first geological investigations in the region were conducted in 1940 by the British Columbia Department of Mines (Hedley and Holland, 1941). These took the form of a reconnaissance survey of the district drained by Turnagain River and

the upper reaches of Kechika River. The rocks outcropping along the lower reaches of Turnagain River were divided into four gross lithological units, none of which was considered sufficiently investigated to be named or dated.

Since then Gabrielse (1954, and *in press*) has mapped the McDame map-area (bounded by latitudes 59°N and 60°N, and by longitudes 128°W and 130°W), and in 1956 a field party briefly visited the region immediately to the south (Geol. Surv., Canada, 1957).

Acknowledgments

This report arose from a study of the Palæozoic rocks outcropping in the vicinity of the lower reaches of Turnagain River; the necessary field work occupied the summers of 1957 and 1958. A dissertation based on this study was submitted to Yale University in partial fulfilment of the requirements for the degree of Doctor of Philosophy.

The author gratefully acknowledges the assistance of Professor C. O. Dunbar of Yale University who guided the study and critically read most of the manuscript; Dr. Hubert Gabrielse who gave valuable advice on the problems of the field relations and in planning the field work; and Dr. T. E. Bolton who discussed the Silurian fauna. Messrs. J. G. Burns, W. D. Groves, B. T. Furneaux, and R. M. Williams gave competent assistance in the field.

STRATIGRAPHY

The term Sandpile Group (Fig. 2) has been applied to resistant carbonates and associated sandstones and siltstones that outcrop in a belt trending northwest across McDame map-area (Gabrielse, 1954, and *in press*). Some of the component rock-units have restricted lateral development and only the upper two units outcrop near Sandpile Creek itself. There the rocks lie disconformably on different members of the Kechika Group, and the overlying beds of the McDame Group rest on an erosion surface cut deeply into Sandpile strata.

A standard section for the rocks of the Sandpile Group exposed near Sandpile Creek is described on page 5, but greater thicknesses of the uppermost unit are developed nearby. The present report does not discuss the graptolitic siltstones and the subjacent carbonate units of the group, but deals only with the fauna of the younger strata.

Contacts

The resistant Sandpile rocks form the high ground of the mountains surrounding Sandpile Creek. On the 6,266-foot mountain east of the stream, two outcrops suggest an unconformable relationship between the McDame Group and the Sandpile Group, but the structural discordance is almost negligible. Comparison of the two sections (located half a mile apart) reveals the removal by erosion of a minimum of 60 feet of Sandpile strata from one before deposition of rocks of the McDame Group. Indications of erosion are present at the base of the lowest McDame beds at both localities, and at one a thin basal conglomerate is developed with roundstones of chert, apparently derived from the immediately subjacent chert nodule bearing Sandpile dolostones.

At exposures of the contact of the Sandpile with the underlying Kechika Group, the bedding in the two sets of rocks appears parallel. No signs of erosion were seen at the contact but an abrupt lithologic change was always discernible. Different Kechika rock-types are present beneath the basal Sandpile beds at various localities in the lower Turnagain River region. This could be the result of facies changes within the Kechika Group, or of erosion before deposition of the basal Sandpile strata.

Beds near the top of the Kechika Group have been dated as Middle Ordovician at several localities, and within the area considered there is no evidence for an age older than middle Clinton for the Sandpile strata, but the lower part of the group is virtually barren of fossils. The suggestion of a hiatus between the two groups allows pre-Sandpile erosion to explain the different rock-types below the Sandpile Group, and requires a disconformity between the two groups.

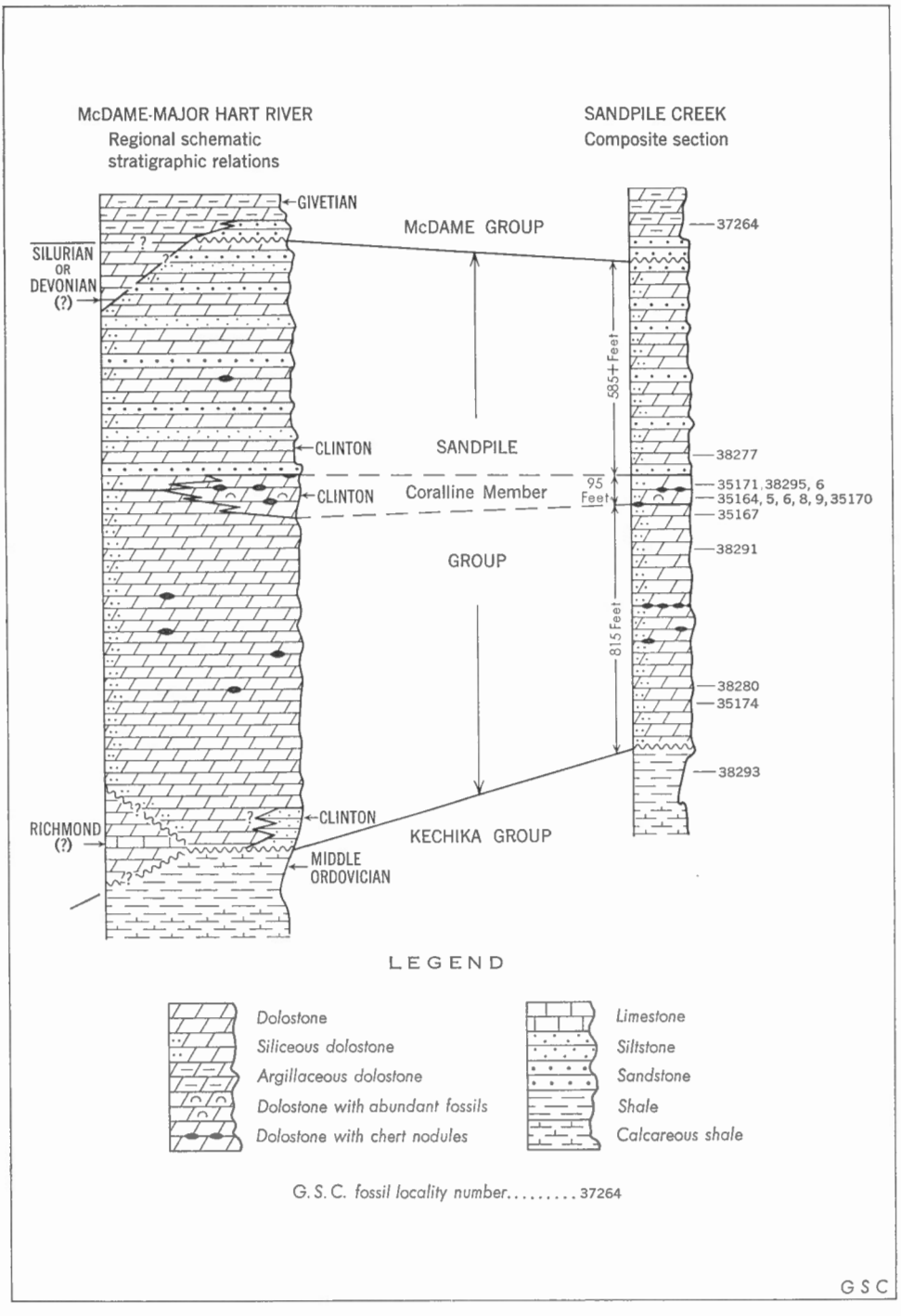

Figure 2. ***Stratigraphic relations of the Sandpile Group.***

Section of Sandpile Group measured on northeast face and upper surface of mountain one mile southeast of the lower lake on Sandpile Creek

Unit		Thickness (feet) Unit	Cumulative
	Faulted contact against about 160 feet of beds similar to those below the fault, beyond these a major fault zone separating them from the Kechika Group and containing wedges of black, fetid dolostones of the McDame Group.		
	Sandpile Group		
1	Dolostones, mostly siliceous, light grey and dark grey, very finely to medium crystalline, weathering brownish grey and buff, in beds 1-5 feet thick; most beds with a small content of quartz sand with the grains commonly concentrated into laminae and weathering in relief; with interbedded light grey, medium-grained, quartz-sandstone beds (dolomitic and siliceous cement), weathering buff-grey, grey, and white-grey, with variable content of quartz sand; these quartzose beds amount to 25% of the section near the top of the unit; unfossiliferous; a 20-foot dyke occurs 60 feet from the base	585	585
2	Dolostones, dark grey-black, finely crystalline, weathering brown-grey, in beds mostly 2-8 feet thick, some beds slightly siliceous, chert nodules present (amounting to less than 5% of beds); abundantly fossiliferous in lower 25 feet (GSC loc. 35168) with silicified rugose and tabulate corals, very rare brachiopods; some beds with a profusion of a single species [e.g. a 6-inch *Coenites rectilineatus* (Simpson) bed], but most with a mixture of many species; fossils rare in the upper 70 feet	95	680
3	Dolostones, some siliceous, blue-grey, finely and medium crystalline, weathering brown-grey and light brown-grey, in beds 2-10 feet thick, some beds with a small content of quartz sand that weathers in relief and is commonly concentrated into laminae, some of which may be graded, rare beds in the upper part appear laminated on weathered surfaces; with one 2-foot chert bed (occurring at about 175 feet above base of unit and consisting of 90% nodular chert and 10% dolostone matrix), discontinuous laterally, otherwise chert nodules absent; with very rare silicified crinoid columnals and tabulate corals; no collections	536	1,216
4	Dolostones, dull, dark blue-grey, finely crystalline, weathering dark brownish grey, in beds 1-8 feet thick, some beds slightly siliceous; with rare layers of chert nodules in the upper 50 feet (dark blue-black, pebble and cobble-sized nodules); with some beds (in the lower part of the unit) mottled on weathered surfaces; with very rare silicified crinoid columnals, rugose and tabulate corals, brachiopods; no collections	100	1,316
5	Dolostones, grey, medium crystalline, weathering buff-grey, in beds 5-10 feet thick, some beds with quartz sand; unfossiliferous	110	1,426
6	Dolostones, dark blue-grey, finely crystalline, weathering grey-brown and brown-grey, in beds 8 inches to 4 feet thick, some beds slightly siliceous, others in the upper part showing vague lamination on weathered surfaces; with very rare crinoid columnals, brachiopods, and tabulate corals; no collections	235	1,661
	Disconformable contact with no signs of erosion or structural discordance.		
	Kechika Group		
	Black shaly argillites, with graptolite fragments (GSC loc. 38293) some 80 feet below the contact.		
	Total thickness of Sandpile Group		1,661

Lithology

Sandstone beds form a prominent part of the uppermost unit of the section shown on page 5, and this unit is somewhat thicker on neighbouring ridges. The quartz grains in these sandstones are fine silt to fine sand in size. The sandstones have dolomitic cement but all gradations exist between a dolostone with scattered quartz grains and a quartzite with siliceous cement. The grains are well rounded, almost all extinguish sharply, a few contain numerous minute inclusions, others bear zircon and rutile, but many have no inclusions. A very few sand grains are rock fragments composed of several interlocking quartz crystals. Most grains show irregular, corroded boundaries against the carbonate cement, with crystals projecting into the quartz grains. Some sand lenses are locally cemented by quartz in optical continuity with the sand grains so that only faint dirt lines reveal their original rounded outlines.

The dolostones are mostly grey or dark grey, finely or medium crystalline, and weather brownish grey. Bedding is well developed. Fine silt-sized quartz grains may be scattered throughout the rock or locally concentrated into thin, discontinuous laminae. The quartz content of a typical dolostone is about 5 per cent. Blue-black, lenticular chert nodules are present in some parts of the stratigraphic section, being characteristic of the coralline member, and may amount to 5 or 10 per cent of the containing rocks. The nodules are arranged in discontinuous layers that parallel the bedding.

Fossils are extremely rare except at the stratigraphic position indicated in Figure 2, and this sequence of fossiliferous beds with plentiful layers of chert nodules can be traced as a map-unit over the neighbouring mountains but is absent beyond Major Hart River. It is overlain by interbedded sandstones and dolostones and for convenience may be termed the coralline member of the Sandpile Group. Most of the fossil collections were made from this member, but of the others, two (GSC locs. 35174 and 38280) were obtained from within 200 feet of the base of the group, and another (GSC loc. 38277) was derived from sandstones 40 feet above the coralline member. These collections are poor but all three are of Silurian age. Correlation has been based on the fauna of the coralline member but is supported by evidence from the other collections.

The populations vary within the belt of abundant fossils, both from bed to bed at a locality, and from locality to locality. Each collection was derived from a group of beds at a locality, not from a single stratum. Halysitid corals are commonly the most profuse part of the fauna, but locally *Heliolites* or *Favosites* are just as numerous. Brachiopods nowhere form more than a nominal part of the association. Biohermal structures are absent and the local variations in the faunal associations are thought to indicate minor differences in living conditions on the sea-floor.

Many of the fossils are delicately silicified and this may indicate that such silicification antedated dolomitization of the host rock. Other fossils are massively silicified, resembling associated chert nodules, and emplacement of the chert and silicification of the fossils were probably broadly contemporaneous. A basal conglomerate of the McDame Group contains chert pebbles derived from Sandpile strata and indicates formation of the chert in pre-McDame time (i.e. pre-Middle Devonian).

Cross-lamination and oscillation ripple-marks occur locally in the sandy beds of the Sandpile Group. Detrital quartz grains are rare in lower beds of the group but become very common in the upper strata. The carbonate material shows no trace of the original particles of sediment; silt or sand grains may have disappeared during recrystallization but initially the rock may have been fine grained.

The fauna of corals, brachiopods, and crinoids suggests water of moderate depth. One brachiopod is preserved with gaping valves, another retains a frilly ornament. Encrusting corals still cling to the shells of their hosts, and disarticulated arm-fans from one crinoid lie together in finely crystalline matrix. The histograms for *Atrypa gabrielsi* (Fig. 3) reveal that, locally at least, size-sorting was inoperative. All these facts suggest that the animals are preserved where they died, without transport from their living environment. Such a fauna, living on the sea-floor without benefit of biohermal structures, would have little tolerance for sand-sized material and the calcium carbonate was probably deposited in fine grains. Beds that contain a considerable amount of quartz silt or sand are barren of fossils except for one locality (GSC loc. 38277) where a poorly preserved halysitid coral [probably *Catenipora simplex* (Lambe)] indicates a Silurian age.

The Silurian beds of the Sandpile Group may have been deposited in an epeiric sea of moderate or shallow depth, into which detrital quartz was from time to time introduced. Shallowing conditions are suggested in the upper part of the unit, with a greater supply of quartz sand and the local formation of oscillation ripples and cross-laminated beds. The source area of the well-rounded quartz grains is not known, but the shape of these grains suggests that they may have passed through more than one cycle of sedimentation, and their structure indicates that most were originally derived from plutonic igneous rocks. Quartzites of late Precambrian and Early Cambrian age outcrop within the map-area, but the shape of their quartz grains is no longer preserved, due to recrystallization.

Fauna and Correlation

Table I shows the distribution of species within the Sandpile Group. In addition the following were identified:

crinoid columnals	at almost every fossil locality
unidentified rugose corals	at many localities
small gastropods, of several genera	GSC locs. 35168, 38280, and 38296
Astraeospongia sp.	GSC loc. 35166
Pisocrinus? sp.	GSC locs. 38277 and 38296
Cimitaria? sp.	GSC loc. 35170 (identified by Mr. A. L. McAlester)
Favosites sp. 1	GSC loc. 35164
Planalveolites sp.	GSC loc. 35170
halysitid coral, probably *Catenipora simplex* (Lambe)	GSC loc. 38277
Receptaculites sp.	GSC locs. 35165 and 38296

Carbonate rocks of supposed Niagaran age have been reported from many regions of northwest Canada and are discussed below. The available faunal information is commonly restricted to faunal lists included in reports of areal geology.

Table I

Distribution of Fossils in Collections from Sandpile Group

(Geological Survey of Canada localities)

	35164	35165	35166	35167	35168	35169	35170	35171	35174	38278	38279	38280	38290	38291	38295	38296
Dinobolus cf. *D. conradi* (Hall)		x														
Hesperorthis cf. *H. laurentia* (Billings)			x				x									
Hesperorthis sp.			x													
Isorthis sp.			x				x									x
Pentamerus sp.			x		x	x		x		x					x	x
?*Clorinda* sp.	x		?			x						x				
Atrypa parva Hume			x	x												
Atrypa gabrielsi n. sp.			x				x									
Glassia variabilis Whiteaves	?		x		x	x										
Dicaelosia cf. *D. biloba* (Linnaeus)							x									
Cyrtia sp.									x							
Howellella pauciplicata Waite						x	x									
Leptelloidea sp.			x													
Petalocrinus mirabilis Weller and Davidson		x					x									
Heliolites cf. *H. megastoma* (M'Coy)	x	x			x		x									
Favosites cf. *F. brownsportensis* Amsden	x	x	x		x	x	x	x		x			x	x		x
Favosites discoideus (Roemer)	x	x	x			x	x	x					x		x	

Favosites favosus (Goldfuss)						x	x						x		
Thamnopora sp.			x			x	x	x		x				x	
?*Striatopora* cf. *S. gwenensis* Amsden		x				x	x								
Coenites laminatus (Hall)	x	x			x		x						x		
Coenites rectilineatus (Simpson)					x		x	x							
Halysites nitida Lambe				x	x	x									
Halysites occidens n. sp.		x			x	x	x		x				x		
Halysites sandpilensis n. sp.	x				x		x		x						
Catenipora simplex (Lambe)		x	x		x	x								x	
Cystihalysites magnitubus (Buehler)	x		x		x		x	x	x						
Cystihalysites sp. 1	x	x	x		x								x		
Cystihalysites sp. 2	x	x			x		x								
Auloporella cf. *A. typa* Grubbs			x		?		x								
Romingeria niagarensis (Rominger)		x	x				x								
Romingeria cf. *R. vannula* Davis	x	x					x								
Syringopora verticillata Goldfuss	x	x			x		?								
Syringopora sp.							x								
Asthenophyllum cf. *A. occidentale* (Whiteaves)			x			x	x								
?*Entelophyllum* sp.					x										
Ptychophyllum sp.	x		x		x				x				x	x	
Fletcheria deadwoodensis n. sp.	x				x		x								
Fletcheria major n. sp.		x			x	x	x	x	x				x	x	
"Cyathophyllum" aff. *"C" pennanti* Billings		x		x	x		x							x	
Cystiphyllum cf. *C. tubiforme* Poulsen	x			x			x								
Cystiphyllum sp. 1					x				x						

Most fossils were identified only to genus, and many of the specific names that were applied may have been loosely used. Such names as *Favosites niagarensis, Halysites catenularia,* and *Atrypa reticularis* appear time and time again, but in the light of recent investigations, many of these specific identifications may be almost meaningless.

The lack of published palæontological descriptions makes local correlation difficult. Farther afield, the relatively well-documented faunas of the eastern United States are from strata exposed some 2,500 miles from Sandpile Creek. Over such distances considerable differences may be expected in contemporaneous faunas composed of benthonic animals, such as corals and brachiopods.

The Sandpile Group contains a large fauna, and the investigations have allowed the description of forty-two species that belong to twenty-nine genera. Additional fragmentary material suggests that future collecting may amplify this figure to sixty or seventy species.

Only a dozen species can be precisely identified with previously established species and correlation at the specific level is therefore somewhat unsatisfactory. Correlation by means of genera can only give a broad indication of the age of the fauna.

Bolton (1957) discussed the faunas of the Silurian strata of southern Ontario. Only three of the Sandpile species are represented in his faunal lists, but sixteen of the genera are included. Of these, the brachiopod genera provide some valuable information: *Eospirifer, Howellella,* and *Atrypas* of the *reticularis* group are not found in formations older than the middle part of the Clinton Group.

The Brownsport fauna of Tennessee has some resemblance to that of the Sandpile Group, but again the similarity is at the generic level. Amsden (1949, p. 36) thought the Brownsport Formation to be of Niagaran age, but considered its time of deposition to be unrepresented by rocks in the Ontario-New York succession. The age of the Brownsport is probably post-Clinton, pre-Albemarle.

In the southern Rocky Mountains of Canada, the Brisco Formation has been differentiated on faunal grounds from the underlying Ordovician (Richmond) Beaverfoot Formation. The two form a single map-unit of dolomitic limestones, about 1,880 feet thick (Evans, 1932, p. 141). Silurian fossils found in the upper 1,200 feet suggest a Niagaran age for that part of the unit. Corals and brachiopods are the common fossils and *Glassia variabilis* has been reported (Henderson, 1954, p. 75). Local shale lenses within the Brisco Formation contain graptolites that suggest a Clinton correlation, and Leech (1958, p. 15) stated that the graptolite fauna was of latest Early or earliest Middle Silurian age.

Severson (1950) listed a coral and brachiopod fauna from the *"Halysites"* beds near Sunwapta Pass, Alberta, and thought it Silurian rather than Ordovician. The faunal list contains only generic identifications and allows little decision of the age. Subsequent collections suggest an Ordovician correlation.

South of the International Border, Niagaran fossils have been collected from the Laketown Dolomite of Idaho and Utah (Ross, 1934; Nolan, 1935; Berdan and Duncan, 1955; Waite, 1956; Bick, 1958). Several species of the Halysitidae are represented, including *Cystihalysites magnitubus* (the most common halysitid coral

in the Sandpile fauna) and Waite reported the presence of other members of the fauna (*Coenites* aff. *rectilineatus,* and *Howellella pauciplicata*). The graptolite fauna of the underlying Trail Creek Formation indicates a Clinton horizon, and thus the Laketown is thought to be of Clinton, Brownsport, or Albemarle age.

Lower Niagaran, upper Niagaran, and Upper Silurian rocks have been reported from Alaska (Kirk, 1929; Mertie, 1937; Swartz *and others,* 1942; Kirk and Amsden, 1952). The lower Niagaran faunas are graptolitic. The upper Niagaran rocks contain faunas that were thought to show affinities to that of the Guelph Formation (late Albemarle) of Eastern Canada. A faunal list for the Tolovana Limestone of east-central Alaska shows nine genera of corals and brachiopods but allows only an inconclusive comparison with the Sandpile fauna.

In northern British Columbia, Gabrielse (*in press*) mapped outcrops of the Sandpile Group near Dease River, and assigned some Upper Ordovician (Richmond) strata to the unit. A late Llandovery or early Wenlock age was suggested for graptolitic siltstones that underlie Sandpile dolostones a few miles east of McDame Post. Near mile-post 700 on the Alaska Highway in Yukon Territory, Poole (1955) reported siltstones, quartzites, and dolostones that may perhaps be equivalent to parts of the Sandpile Group. An Early Silurian age has been suggested for these rocks. Farther north, Raasch, Norford, and Wilson (1959) report the presence of the *Aulacopleura socialis* fauna at Prongs Creek, Yukon Territory. *Glassia variabilis* and *Atrypa* cf. *A. gabrielsi* are associated with this fauna and graptolites indicate a correlation with the early Gala-Tarannon (late Early Silurian) of the standard European sequence. Laudon and Chronic (1957) reported about 1,200 feet of limestone and dolomitic limestone from Muncho Lake district of northern British Columbia, and gave a Niagaran faunal list that indicates generic similarity to that of the Sandpile Group. They suggested a correlation with the Ronning Group of the Northwest Territories. Fossiliferous Silurian dolostones and limestones widespread in the Mackenzie River region (Laudon, 1950; Kingston, 1951; Hume, 1954) have been habitually referred to the Ronning Group. The unit is 950-1,415 feet thick and includes the Franklin Mountain and Mount Kindle Formations. Available faunal lists show typical Niagaran corals, but do not permit detailed correlation.

Ruedemann (1938, pp. 115-116) reported a graptolite fauna from sandy shales exposed along South Nahanni River. The stratigraphic position of the beds is poorly known, but they may be equivalent to part of the Ronning Formation. The fauna was considered to be of Clinton age, probably correlating with those of the Brisco and Trail Creek Formations. All three of these faunas suggest a late Gala-Tarannon age (latest Early Silurian).

Silurian rocks are widely distributed in the Arctic regions of America (Poulsen, 1934, 1941, 1943; Teichert, 1937), and the Sandpile fauna shows some affinity to that of the Offley Island Formation of northwest Greenland. Fossils common to both faunas include *Howellella, Eospirifer* (or its relative *Cyrtia*), *Clorinda, Atrypas* of the *reticularis* group, *"Cystiphyllum" tubiforme,* and *Favosites* cf. *F. favosus;* but the Offley Island fauna lacks the abundance of halysitid corals that is found in the Sandpile. The Offley Island formation was dated as middle Clinton by Poulsen.

Savage and Van Tuyl (1919) described the Silurian rocks in the region south and west of Hudson Bay. Their faunal lists for the Ekwan River limestone and the Attawapiskat reef include *Pentamerus, Clorinda, Howellella, Atrypas* of the *reticularis* group, *Glassia variabilis,* and *Favosites favosus.* Savage (*in* Swartz, *and others,* 1942) considered these units to be of post-Clinton Niagaran age, but Stearn thought that they could be older (1956, p. 7).

At Lake Timiskaming an outlier of Palæozoic strata rests on rocks of the Canadian Shield with the Wabi and Thornloe Formations representing the Silurian (Hume, 1925). The Sandpile fauna shows little resemblance to that of the Wabi Formation but some similarity to that of the Thornloe Formation (Hume's Lockport Formation). *Atrypa parva, Glassia variabilis, Heliolites megastoma, Syringopora verticillata, Favosites favosus,* and many species of the Halysitidae are present, but Hume's fauna also contains twenty-five species of cephalopods, a group of animals virtually absent from the Sandpile Group. A similar fauna is present in the Cordell dolostone of northern Michigan (Ehlers and Kesling, 1957, p. 29). Stearn (1956, p. 7) and Bolton (1957, p. 44) have correlated the Thornloe with the Fossil Hill Formation of southern Ontario. Hume recognized the similarity of the two faunas but thought the Fossil Hill to be a Lockport correlate.

Very little similarity exists between the fauna of the Sandpile Group and those described by Stearn (1956) from the Interlake Group of southern Manitoba.

In conclusion, rocks of late Early and Middle Silurian age are widely distributed in Western Canada but no rigid correlation of the Sandpile fauna can be achieved. Some relation is indicated between the fauna and that of the Thornloe Formation, and a middle Clinton (late Early or early Middle Silurian) age is suggested for the fossiliferous beds of the Sandpile Group[1].

[1] Further collecting at GSC locality 35166 in 1961 resulted in the discovery of the coral *Palaeocyclus.* Hill (1959, p. 153) considers this genus an index fossil for rocks of Late Llandovery age, i.e., late Early Silurian.

PALÆONTOLOGY

The fossils from the Sandpile Group are almost without exception silicified. Although this state of preservation allows a more thorough investigation of the complete fauna and reduces the factor of selective collecting in the field, silicification of fossils has its attendant disadvantages.

The replacing silica may be fine grained and faithfully reproduce the skeletal elements, or it may be coarser and destroy fine detail. In corals, trabecular structures are commonly completely destroyed. The axial parts of large corallites tend to be poorly preserved. Corallite walls may be incompletely replaced and it is difficult to ascertain the thicknesses of the original walls. Silicification may be restricted to the fossil itself but may also include the matrix. If the latter, the internal structures of the fossil are revealed by dirt layers that are difficult to interpret and almost impossible to photograph. Corals with long septa are commonly preserved in this manner.

The Sandpile fauna is predominantly a coral fauna, with the tabulate corals more common than the rugose. Brachiopods are rather rare and many of the individuals in the collections were discovered in residues after etching with hydrochloric acid. Many of the brachiopod species are represented by small numbers of individuals, many of them juvenile, with too few adult specimens to allow either adequate identification with established species, or erection of new ones.

Throughout the descriptions the title Geological Survey of Canada has been abbreviated to GSC. All the specimens are in the collections of the Geological Survey of Canada, Ottawa.

Phylum *Brachiopoda*

Family TRIMERELLIDAE Davidson and King, 1874

Genus *Dinobolus* Hall, 1871

Dinobolus Hall, 1871, p. 4.

Type species. Obolus conradi Hall, 1868.

Dinobolus cf. *D. conradi* (Hall), 1868

Plate I, figures 1-10

(?) *Obolus conradi* Hall, 1868, pp. 368-369.
(?) *Dinobolus conradi* (Hall), Davidson and King, 1874, pp. 160-161.
(?) *Dinobolus conradi* (Hall), Hall and Clarke, 1892, pp. 38-39.

Description. Test biconvex, thick-shelled, with faint concentric growth lines near the margin.

Pedicle valve with a small beak. Pseudodeltidium low, broadly triangular, slightly convex, bounded laterally by two grooves, and with a well-developed anterior

slope curving into the cardinal socket at the hinge; without ornament preserved on the surface of the pseudodeltidium and without perforation or median groove (figs. 1 and 2). Hinge plate bearing a low, pedically directed undulation and supported by a well-developed cardinal buttress (fig. 3). Platform prominently vaulted with a biconvex brachial surface, vaults separated by a median partition. Cardinal buttress forming a double-chambered umbonal cavity; buttress tapered anteriorly, resting medianly on the platform. Muscle scars present on the platform and on the valve floor outside it.

Brachial valve with an inconspicuous beak. A thin, elevated, saucer-like, transverse plate located in front of the beak and fitting snugly into the cardinal socket of the pedicle valve (fig. 8). Two cardinal impressions on the hinge immediately in front of this plate, moulding the brachial surface of the pedicle valve's hinge plate. Platform vaulted, with a depression above the median partition, surface biconvex but less strongly so than the surface of the platform of the pedicle valve. Umbonal cavity with a deep subcardinal impression (the figured specimen shows a hole in the shell at the centre of this depression).

Distribution. Sandpile Group, GSC locality 35165.

Discussion. The paucity of the studied material (two incomplete valves belonging to a single individual) precludes a complete description and identification, but the individual agrees with *Dinobolus conradi* (Hall) as discussed by Hall and Clarke who allowed a great deal of variation within the species. The interesting hinge structures have been previously discussed (Norford, 1960). *D. conradi* has been reported from rocks of Niagaran age.

Family HESPERORTHIDAE Cooper, 1956

Genus *Hesperorthis* Schuchert and Cooper, 1931

Hesperorthis Schuchert and Cooper, 1931, p. 244; 1932, p. 85.

Type species. Orthis tricenaria Conrad, 1843.

Hesperorthis cf. *H. laurentia* (Billings), 1857

Plate II, figures 1-5, 9

(?) *Orthis laurentia* Billings, 1857, p. 297.

Material studied. One brachial valve and two nearly complete individuals, the valves of one of the latter were manually separated during preparation. All three shells are assumed to have belonged to mature individuals.

Description. Shell biconvex with the pedicle valve having much the greater depth. Outline broader than long, cardinal extremities abrupt, nearly orthogonal; position of greatest width at the hinge. Brachial valve with a faint, low sulcus.

Costae simple, straight and rounded, twenty-three in each valve. Pedicle valve gently convex with the greatest depth just in front of the small beak; interarea long, high (e.g. 20 mm by 4½ mm), plane or slightly concave, apsacline. Delthyrium open (in studied specimens), delthyrial cavity deep. Teeth probably large (broken in the studied specimen), dental plates receding; muscle field about as wide as it is long, bounded by a slightly raised rim, beyond which closely spaced, shallow pallial sinuses radiate (fig. 4).

Brachial valve slightly convex; interarea long, low (e.g. 20 mm by 1½ mm), anacline. Notothyrium wide, open; sockets of moderate size, cardinal process small, ridge-like, elevated to the rear at the edge of the notothyrial platform (figs. 5 and 9). Brachiophores large, blade-like; a low ridge extending forward from the base of the cardinal process to the mid-length, separating lightly impressed muscle scars (fig. 9).

Distribution. Sandpile Group, GSC localities 35166, 35170.

Discussion. The species shows some resemblance to *Hesperorthis davidsoni* (de Verneuil), but the latter is longer than it is broad, widest just in front of the hinge, and the beak of the pedicle valve is slightly incurved.

There is a slight difference between the Sandpile specimens and *H. laurentia* (Billings): the latter has a slightly incurved pedicle beak (but less incurved than that of *H. davidsoni).* This curvature is shown by specimens of *H. laurentia* in the Schuchert Collection in addition to Billings' description. *H. laurentia* occurs in the Ellis Bay Formation on Anticosti Island.

Hesperorthis sp.

Plate II, figures 6, 8, 10

Material studied. The species is represented by half a dozen pedicle valves and one small individual; all these shells may be immature.

Family SCHIZOPHORIIDAE Schuchert, 1929

Genus ***Isorthis*** Kozlowski, 1929

Type species. Dalmanella (Isorthis) szajnochai Kozlowski, 1929.

Isorthis Kozlowski, 1929, p. 75.

Isorthis sp.

Plate II, figures 7, 11-17, 22

Material studied. There are about a dozen free valves and complete individuals distributed among three collections.

Family PENTAMERIDAE M'Coy, 1844

Genus *Pentamerus* Sowerby, 1813

Pentamerus Sowerby, 1813, pp. 73*, 76*.
Pentamerus Sowerby, Alexander, 1948, p. 146.

Type species. Pentamerus laevis Sowerby, 1813.

Pentamerus sp.
Plate II, figures 18-21

Material studied. Incomplete pedicle valves are common in many of the collections, brachial valves are rarer and there is only the one mature specimen (figs. 19, 20) in which the valves are still in contact. The spondylia, and more especially the septa, are commonly broken and a typical specimen consists only of the posterior part of the pedicle valve (fig. 18). Thus although the species is one of the more abundant brachiopods in the Sandpile fauna, the material is insufficient for a specific identification.

Genus *Clorinda* Barrande, 1879

Clorinda Barrande, 1879, pl. 119.

Type species. Clorinda armata Barrande, 1879.

?*Clorinda* sp.
Plate III, figures 1-4

Material studied. The collections contain half a dozen pedicle valves and one small individual, there are no brachial valves or complete mature individuals. *Antirhynchonella* Oehlert is distinguished from *Clorinda* by characters of the interior of the brachial valve, so that the species from the Sandpile Group may belong to either of the two genera, but is somewhat similar to species of *Clorinda* described from north Greenland by Poulsen (1934 and 1943).

Family ATRYPIDAE Gill, 1871

Genus *Atrypa* Dalman, 1828

Atrypa Dalman, 1828, p. 102.
Atrypa Dalman, Alexander, 1949, p. 208.

Type species. Anomia reticularis Linnaeus, 1767.

Atrypa parva Hume, 1925
Plate III, figures 5-13

Atrypa reticularis var. *parva* Hume, 1925, p. 63.

Material studied. The species occurs in two collections with a total of four mature shells, three immature shells, and six free valves.

Description. Shell small, biconvex with the pedicle valve slightly deeper than the brachial; outline subcircular, cardinal extremities small and obtuse; hinge line about three quarters of the greatest width of the shell. Beaks minute, that of the pedicle valve incurved over the brachial valve. Low broad sulcus in the anterior commissure of the pedicle valve, this sulcus being absent in small shells, suggesting its initiation and progressive accentuation during late growth.

Ornament of strong, intercalating, coarse, rounded costellae that are visible on the interiors in addition to the exteriors of the valves, crossed by less conspicuous growth lamellae, the latter becoming somewhat stronger towards the margins of large individuals. At the anterior margin of the brachial valve of the individual shown in figure 5, 17 costellae occur in a space of 10 mm, and four growth lamellae in 5 mm. In some individuals, small tubular spines projecting in continuation with costellae at the sites of the growth lamellae.

Pedicle valve evenly convex, maximum depth of valve just behind the mid-length. Foramen open; teeth prominent, grooved, supported by small pedestals that have a cavity between them and the hinge, where they meet the floor of the valve (fig. 11). Small accessory sockets between teeth and hinge, above these cavities. Adductor muscle scars in a depression in front of the line of the teeth, separated from each other by a low elevation; large flabellate diductor scars, bounded anteriorly by a ridge (fig. 11).

Brachial valve almost circular, evenly convex, maximum depth of valve in front of the mid-length. Slight fold in the central commissure corresponding to the sulcus in the pedicle valve, posterior part of the valve bearing a small, sharp median sulcus that dies out rapidly away from the beak (fig. 5). Notothyrium small, open, notothyrial cavity deep, notothyrial platform resting on a wide median septum that dies out anteriorly before the mid-length (figs. 12, 13). Sockets deep, grooved, partly roofed on the anterior side by the outside part of the crural bases (fig. 13). No distinct denticles, parts of the hinge articulating with the accessory sockets of the pedicle valve. No cardinal process, crural bases of moderate size, T-shaped in section with the eave of the T being gently concave upward (fig. 13). Spiralia unknown, musculature indistinct (fig. 12).

Measurements. The table below lists measurements (in mm) of some individuals from locality 35166.

GSC No.	Length	Width	Thickness	Maximum Depth	
				Pedicle valve	Brachial valve
Individual 15789	14	14	8	5	4
Individual 15771	15	about 15	—	—	—
Brachial v. 15772	15+	16	—	—	—
Individual 15773	12	13½	6½	3½	3
Brachial v. 15774	10+	—	—	—	2
Individual 15786	8	7½	4	2½	2
Brachial v. 15787	7¾	7½	—	—	1½
Individual 15775	4½	4	1¾	1¼	½
Individual 15776	4¼	4	1½	1	½

Distribution. Sandpile Group, GSC localities 35166, 35167.

Discussion. The species closely resembles *Atrypa gabrielsi* in shape but the shell is slightly smaller and differs by its strong ornament of preponderant coarse costellae, and also by the greater development of the cavity in the pedestal supporting the tooth. *A. tennesseensis* Amsden has the brachial valve the more convex, and the costellae are somewhat coarser than those of *A. parva.* Previous to Alexander's (1949) redescription of *A. reticularis* (Linnaeus), *A. parva* might have been assigned to that species.

Hume (1925) described *A. reticularis* var. *A. parva* from the Thornloe Formation of Lake Timiskaming without designating type specimens. His description would embrace the Sandpile species but lacks illustrations and omits any discussion of the ornament. The collections of the Geological Survey of Canada contain specimens from the type area that were collected by Barlow in 1894 and were doubtless examined by Hume. These specimens are very similar in external appearance to those from the Sandpile Group, and the few internal moulds suggest similar internal characters. Norris is currently redescribing the species and will designate a lectotype.

Atrypa gabrielsi n. sp.

Plate IV, figures 1-13

Material studied. Although this species is present in only two of the collections, the total number of specimens approaches 150. Most of these are complete individuals but there are also many free valves, both brachial and pedicle.

Description. Shell biconvex, the pedicle valve slightly deeper than the brachial; outline subcircular in small shells but somewhat elliptical in adults; hinge line about five-eighths of the greatest width of the shell; cardinal extremities rounded. Beak of pedicle valve very small and closely incurved over that of the brachial valve but not in contact with the latter; anterior commissure with a broad shallow sulcus in the pedicle valve of adult individuals, straighter in small shells, indicating that a shallow fold and sulcus developed gradually during growth; fold and sulcus accentuated in the few exceptionally large shells.

Ornament reticulate, consisting of fine radial lirae crossed by concentric growth lines, both subdued, and in some shells scarcely detectable; spacing such that at 19 mm from the beak, eight lirae and eight growth lines occur in a space of 3 mm; growth lines commonly strong near the margins of adult shells.

Pedicle valve evenly convex with maximum depth just behind the mid-length. Delthyrium small with minute marginal deltidial plates bordering an open foramen; teeth prominent (fig. 10) each bearing on its summit a pair of grooves delimiting three denticles, and separated from the adjacent shell margin by an accessory socket; each tooth supported by a pedestal, a small cavity is present at the base of the pedestal, between it and the adjacent side of the valve. Adductor muscle scars small and posterior to the broad and short diductor scars (fig. 7) that are bounded anteriorly by a slight rim.

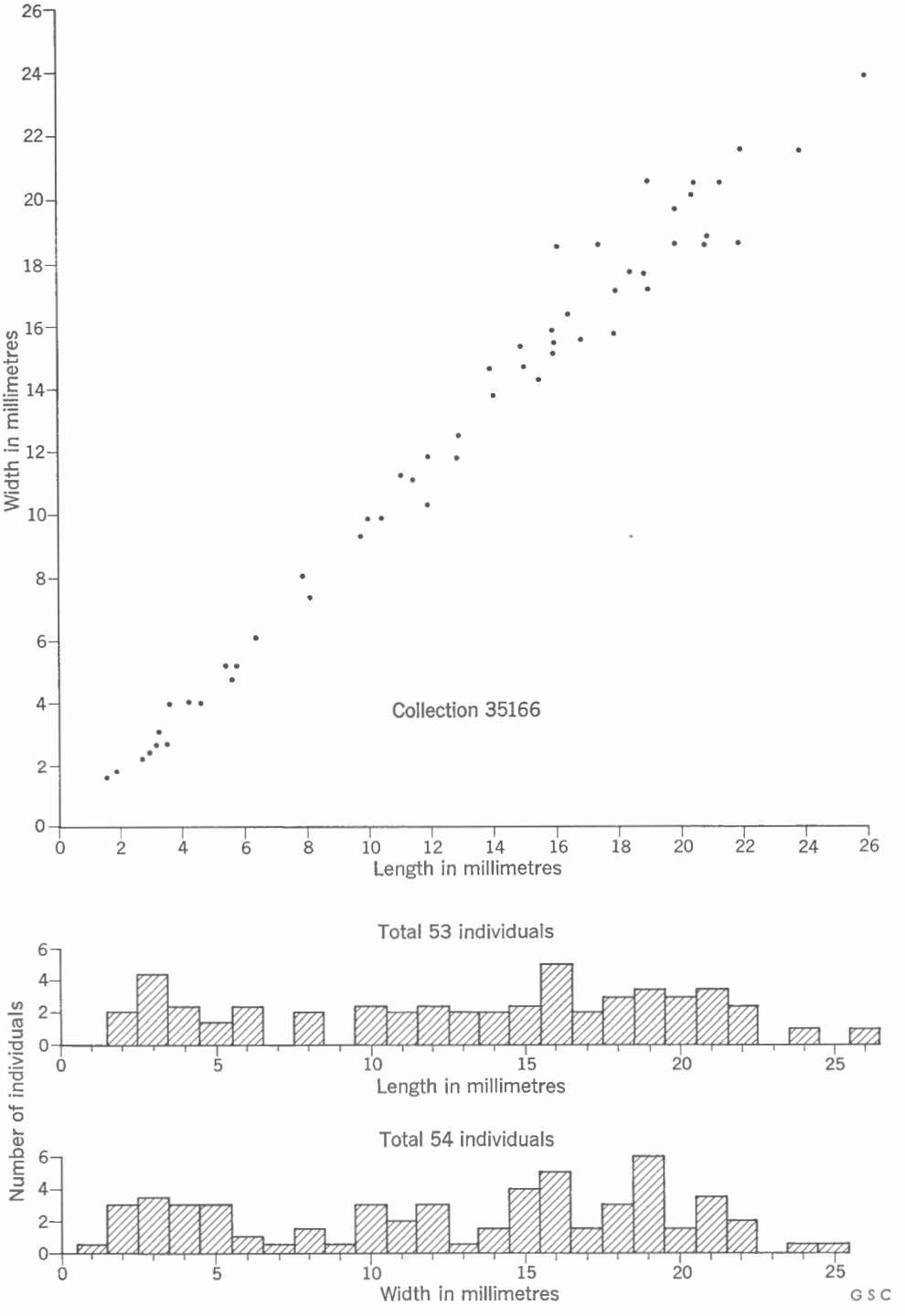

Figure 3. *Atrypa gabrielsi n. sp., growth curve, width to length, length and width histograms.*

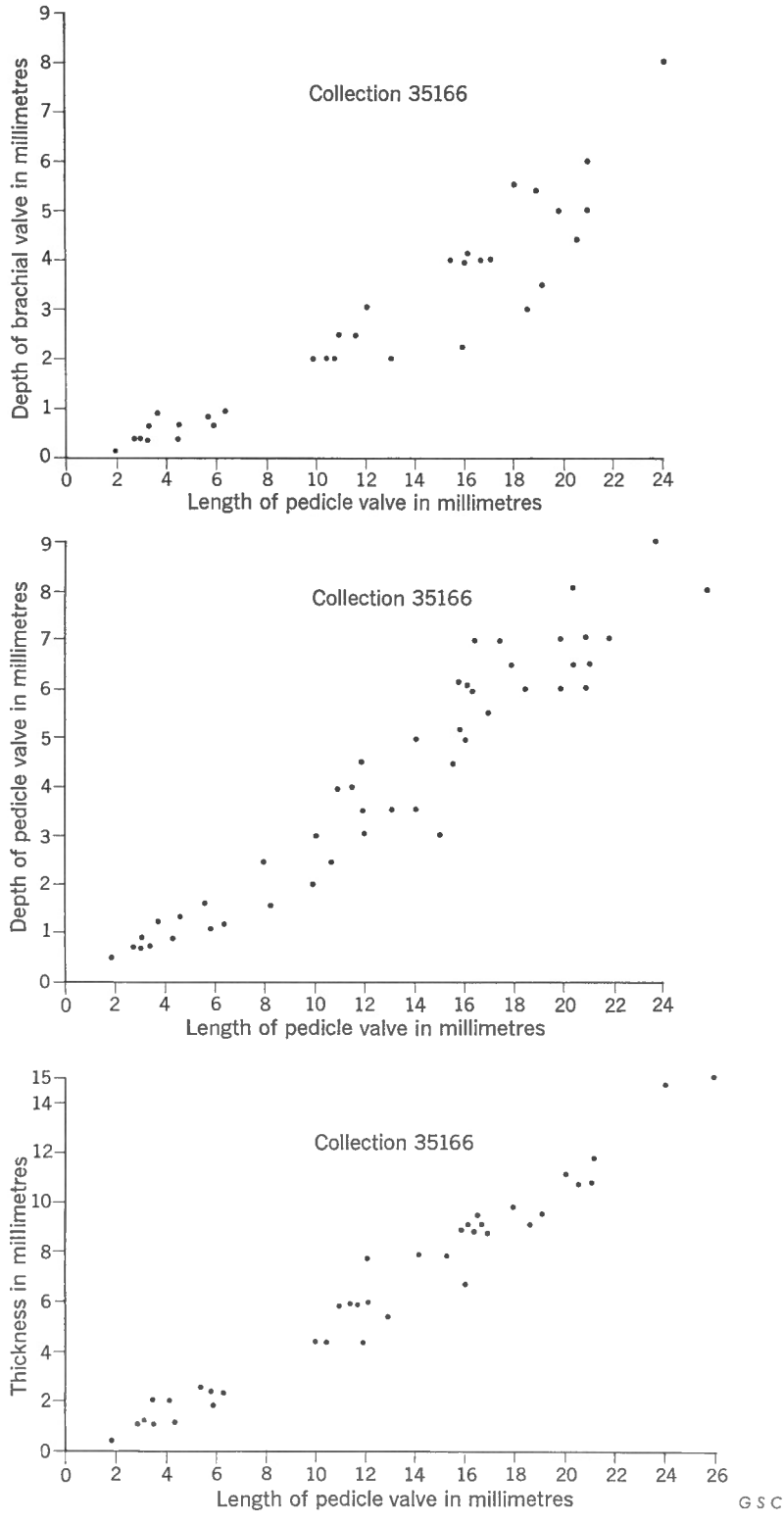

Figure 4. ***Atrypa gabrielsi n. sp., growth curves, depths of valves to length, and thickness to length.***

Brachial valve almost circular in outline (fig. 13), evenly convex with maximum depth in front of the mid-length; beak very small and inconspicuous. A shallow fold in the anterior commissure corresponding to the sulcus of the pedicle valve; a small, sharp, median sulcus in the posterior part of the brachial valve dies out rapidly away from the beak (figs. 1 and 11). Notothyrium small, open; notothyrial cavity deep, bounded anteriorly by a fat median septum that reduces forwards (fig. 8), the notothyrial platform rests on the posterior end of this septum. Sockets grooved (figs. 8, 13), no distinct denticles, parts of the hinge fit into the accessory sockets of the pedicle valve. No cardinal process, crural bases shown by figures 8 and 13, spiralia coil towards the floor of the brachial valve (fig. 12), the crura leave the crural bases at an abrupt angle. Musculature indistinct (fig. 13).

Measurements. Figures 3 and 4 indicate variations in the proportions of the shell. The table below lists the dimensions (in mm) of some individuals from locality 35166.

GSC No.	Length	Width	Thickness	Maximum Depth	
				Pedicle valve	Brachial valve
Holotype 14486	20	19	11½	6	5
Paratype (disintegrated)	26	24½	15½	8	—
Paratype (b.v.) 15797	17+	17½	—	—	4
Paratype (p.v.) 15853	18	17½	—	6½	—
Paratype 15777	16½	16½	9½	6	3½
Paratype 15803	16	15¾	7	5	2¼
Paratype 15778	11	11½	6	4	2½
Paratype (p.v.) 15802	8	8	—	2½	—

Holotype. GSC No. 14486, from GSC locality 35166.

Distribution. Sandpile Group, GSC localities 35166, 35170.
The species is named for Dr. H. Gabrielse.

Discussion. The species conforms to the generic diagnosis in Alexander's redescription of *Atrypa* Dalman, but also shows some resemblance to *Lissatrypa* Twenhofel, in that the valves are sub-equally convex and the ornament is subdued. *Lissatrypa* has a smooth exterior with faint concentric growth lines, radial ornament being typically absent. *A. gabrielsi* is larger than *A. parva* Hume and has a finer ornament.

Genus *Glassia* Davidson, 1881

Glassia Davidson, 1881, p. 11.
Glassia Davidson, 1882, pp. 38-39.
Glassia Davidson, Hall and Clarke, 1895, pp. 152-153.

Type species. Terebratula obovata Sowerby, 1813.

Glassia variabilis Whiteaves, 1905
Plate III, figures 14-18, 23-25

Glassia variabilis Whiteaves, 1905, pp. 42-43.
Glassia variabilis Whiteaves, 1906, pp. 252, 273, 274, 277.

Material studied. Several free valves and about a dozen complete individuals are present in the collections.

Description. Size and shape of the shell well shown by figures 14-18. Surface smooth except for traces of lirae that are discernible in places, near the front margin of a shell 9 mm long there are eight or nine in a space of 3 mm.

Pedicle valve deepest near the mid-length. Delthyrium open, apparently lacking deltidial plates. Teeth relatively large (commonly broken in the free pedicle valves, and retained in the deep sockets of the brachial valves, as in fig. 24), supported by outgrowths from below the hinge rather than by distinct dental plates. Muscle scars shown by figure 23.

Brachial valve, beak very small, commonly hidden by that of the pedicle valve. Notothyrium open, sockets large, deep, curved under the large crural bases (fig. 24); cardinal process lacking. Notothyrial cavity deep, resting on the rear end of a median septum that tapers to the mid-length of the valves, muscle scars narrow and elongate, lying close to this septum and obscurely defined. Crural bases large, swollen, anteriorly in contact; crura initially directed into the pedicle valve.

Measurements (in mm). Collections from GSC localities 35166 and 35169.

GSC No.	Length	Width	Thickness	Maximum Depth	
				Pedicle valve	Brachial valve
35166					
Individual 15792	8.9	9.7	5.7	3.3	2.4
Pedicle v. 15854	7.7	8.9	—	3.3	—
Pedicle v. 15793	7.4	9.3	—	3.5	—
Brachial v. 15794	6.4+	8.9	—	—	2.9
35169					
Individual 15855	8.1+	9.0	4.6	2.8	1.9
Individual 15856	6.5	7.7	4.0	2.3	1.7

Distribution. Sandpile Group, GSC localities 35166, 35168, 35169, 35164 (?).

Discussion. The species resembles *Glassia obovata,* the type species of the genus, but *G. obovata* bears faint concentric growth lamellae. Much of Davidson's (1881) description deals with the spiralia, which are not preserved in the Sandpile specimens. Hall and Clarke state that the genus has essentially smooth exteriors, but this is at variance with Davidson's description of the type species.

Whiteaves found the surface of *G. variabilis* to be apparently smooth, and although he described the spiralia, he did not discuss the dentition, musculature, or jugum. The Sandpile individuals agree with the illustrations and dimensions given

by Whiteaves and are very similar to his type specimens from Winisk River region. Many of his individuals from Fawn River region show a more intense fold and sulcus at the anterior margin of the shell, and thus Whiteaves, in his consideration of the species, allowed considerable tolerance in this character.

Glassia has been reported from Ordovician, Silurian and Devonian rocks; *G. variabilis* was described from Winisk River region and reported from Fawn River region, both of Keewatin, Manitoba; and a variety of the species was described from Ekwan River region of Manitoba. Savage and Van Tuyl (1919, pp. 356, 362) also found the species in the Silurian of the Hudson Bay region. Hume (1925, p. 39) reported the species from the Thornloe Formation of Lake Timiskaming; Henderson found it in the Brisco Formation (1954, p. 76).

Family Dicaelosiidae Roger, 1952

Genus *Dicaelosia* King, 1850

Dicaelosia King, 1850, pp. 106-107.

Type species. Anomia biloba Linnaeus, 1767.

Dicaelosia cf. *D. biloba* (Linnaeus), 1767

Plate III, figures 19-22

(?) *Anomia biloba* Linnaeus, 1767.

Material studied. The species is represented by a solitary individual and thus no valve interiors were available for study.

Description. Shell bilobed, broader than long, biconvex with the brachial valve almost planar; hinge straight, equal to two thirds of the greatest width, cardinal extremities moderately sharp, obtuse. Anterior margin emarginate.

Ornament of rounded costellae, increasing by intercalation, spacing about five in 1 mm at a point 3 mm from the beak. No growth lines.

Pedicle valve evenly convex, deepest near the mid-length; beak small, interarea triangular, high (e.g. 2.3 mm long by 1.1 mm high in the figured specimen), apsacline. Delthyrium large, triangular, open.

Brachial beak small, interarea triangular, anacline, low (e.g. 2.3 mm long by 0.5 mm high in the figured specimen).

Distribution. Sandpile Group, GSC locality 35170.

Discussion. The species differs from specimens of *Dicaelosia biloba* collected from Middle Silurian rocks in Gotland, Sweden, by having considerably larger interareas. Amsden (1951) described *D. oklahomensis* from the Henryhouse Formation of Oklahoma, and reported it from the Brownsport Formation of Tennessee; this species is longer and narrower than the Sandpile individual.

According to Hall and Clarke (1892), in North America *D. biloba* is restricted to rocks of Niagaran age.

Family SPIRIFERIDAE King, 1846

Genus *Cyrtia* Dalman, 1828

Cyrtia Dalman, 1828, p. 93, p. 97.

Type species. Anomites exporrectus Wahlenberg, 1821.

Cyrtia sp.

Plate III, figures 26-29

Material studied. The species is represented by two fragments, both the posterior parts of pedicle valves. One has a small part of the brachial valve adhering.

Genus *Howellella* Kozlowski, 1946

Howellella Kozlowski, 1946, p. 295 [pro *Crispella* Kozlowski, 1929 (non Gray, 1870)].

Type species. Terebratula crispa Hisinger, 1826.

Howellella pauciplicata Waite, 1956

Plate IV, figures 14-17

Howellella pauciplicata Waite, 1956, p. 17.

Material studied. The six available specimens comprise five free pedicle valves and a single complete individual. Thus knowledge of the brachial valve is restricted to its exterior.

Description. Size and shape of the complete shell shown by figures 14-16. A median plication present in the brachial valve, bordered by two pairs of faint, rounded plications, the latter being scarcely discernible in the rear half of the shell. Shell surface otherwise almost smooth (when coated with magnesium oxide very faint concentric growth lines are visible in places).

Interior of the pedicle valve bearing long dental plates that extend forward to the mid-length of the valve; without median septum; musculature ill-defined.

Distribution. Sandpile Group, GSC localities 35169, 35170.

Discussion. The species is very similar to *Howellella crispa* var. *H. simplex* (Hall), but all the plications in the latter extend to the beak region, whereas only the median one does in the Sandpile specimens. Hall states that the surface is marked as in *H. crispa* (Hisinger) which bears growth lines. *H. laeviplicatus* Kozlowski is another similar species and has a clear, though faint, ornament of growth lamellae. *H. henryhousensis* Amsden has more sharply defined plications, and a greater number of them.

Waite based *H. pauciplicata* on a population from the upper beds of the Laketown Dolomite of Utah, and considered the associated fauna to indicate a Late Silurian age.

Family LEPTELLINIDAE Ulrich and Cooper, 1936

Genus *Leptelloidea* Jones, 1928

Leptelloidea Jones, 1928, pp. 385-389, 392.

Type species. Plectambonites schmidt var. *leptelloides* Becker, 1921.

Leptelloidea sp.

Plate IV, figures 18-24

Material studied. The species is represented by seven free valves and one almost complete individual, the valves of the latter were manually separated during preparation.

Phylum *Echinodermata*

Family PETALOCRINIDAE Weller and Davidson, 1896

Genus *Petalocrinus* Weller and Davidson, 1896

Petalocrinus Weller and Davidson, 1896, pp. 167-170.

Type species. Petalocrinus mirabilis Weller and Davidson, 1896.

Petalocrinus mirabilis Weller and Davidson, 1896

Plate IV, figures 25-27

Petalocrinus mirabilis Weller and Davidson, 1896, pp. 167-170.

Material studied. The species is represented by two dozen discrete arm-fans, no other part of the skeleton is preserved.

Description. Shape of arm-fan shown by figures 26 and 27, angle of fan averaging 70 degrees, and varying 55 to 80 degrees for individual fans. The largest arm-fan from GSC locality 35170 measures 12½ mm long by 14½ mm wide, the largest one from locality 35165 measures 16 by 16 mm. Dorsal surface smooth, slightly concave; ventral surface bearing prominent erect ridges separating the ambulacral grooves (which birfurcate as in fig. 26), numbering sixteen at the margins of large arm-fans from locality 35170 and twenty-two or twenty-four for arm-fans from GSC locality 35165. Some slight variation in order of appearance of the later branches of the ambulacral grooves.

Distribution. Sandpile Group, GSC localities 35165, 35170.

Discussion. Collections from locality 35170 contain arm-fans of varying sizes, probably representing individual crinoids of differing stages of maturity. On the other hand, collections from locality 35165 contain only three arm-fans, all of large and

similar size, and, from their intimate association in the dolostone (fig. 25), thought to be parts of a single large crinoid. These arm-fans are larger than those in the former collection and corresponding to the greater size, the ambulacral grooves have a greater number of branches.

Springer (1926) considering the type material and additional specimens, limited the number of ambulacral grooves in his conception of *P. mirabilis* to a maximum of sixteen, and established a size limit of 14 mm long and 16 mm wide. The specimens from locality 35170 fit within this conception of the species.

Bather (1898) erected *P. visbycensis* for discrete arm-fans from Gotland, this species being very similar to *P. mirabilis* but having a larger average fan angle and greater size tolerance, thus including arm-fans with as many as twenty-two ambulacral grooves at their margins. The method of branching of the ambulacral grooves is almost identical in *P. mirabilis, P. visbycensis,* and the Sandpile specimens. The arm-fans from locality 35165 compare with those of *P. visbycensis* in size and thus also in the number of ambulacral grooves; their fan angles, although compatible with the variation within the species, are smaller than the average.

The differences between individual arm-fans within and between the two collections are clearly due only to differences in size of the crinoids that furnished them.

Weller and Davidson collected the type material from rocks of Niagaran age in Jones county, Iowa; Springer obtained his specimens from the Hopkinton Dolomite in the same county. Bather reported *P. visbycensis* from rocks situated about the Llandovery-Wenlock boundary in Gotland, which would be of a similar age to the Hopkinton Dolomite. The Hopkinton Dolomite correlates with the Clinton Group of southern Ontario.

Phylum *Coelenterata*

Family Heliolitidae Lindström, 1876

Genus *Heliolites* Dana, 1846

Heliolites Dana, 1846, pp. 541-542.

Type species. Astraea porosa Goldfuss, 1826.

Heliolites cf. *H. megastoma* (M'Coy), 1846

Plate V, figures 1-5

(?) *Porites megastoma* M'Coy, 1846, p. 62.
(?) *Heliolites megastoma* (M'Coy), Milne Edwards and Haime, 1854, pp. 251-252.

Description. Corallum commonly bun-shaped, largest dimension of a representative corallum about 5 cm. Tabularia 2.0-2.5 mm in diameter, separated by tubuli, polygonal in transverse section, about 0.25 mm in diameter. A tabularium being bounded by thirty to forty tubuli; no septal structures preserved. Tabulae

in tabularia flat, commonly complete, about four in 1 mm of longitudinal section, those in the tubuli also flat, more closely spaced, about seven in 1 mm. Spacing of the tabularia in transverse section variable but mostly less than their diameter.

Distribution. Sandpile Group, GSC localities 35164, 35165, 35168, 35170.

Discussion. The species shows considerable variation in the spacing of the tabularia, both in different coralla and in different parts of the same corallum (fig. 1). The transverse diameter of the tabularia is also a variable character. Milne Edwards and Haime state that in *H. megastoma,* the tabularia have similar dimensions within a corallum, but that the diameter varied from 1.4 to 2.7 mm in the coralla studied. *H. megastoma* is frequently found in faunal lists of Niagaran rocks in Europe and North America.

Family FAVOSITIDAE Dana, 1846

Genus *Favosites* Lamarck, 1816

Favosites Lamarck, 1816, p. 204.

Type species. Corallium gothlandicum Fougt, 1749.

Favosites cf. *F. brownsportensis* Amsden, 1949

Plate VI, figures 1-6

(?) *Favosites brownsportensis* Amsden, 1949, pp. 87-88.

Description. Corallum low, bun-shaped (largest observed corallum, incomplete, measuring 30 by 40 by 70 mm). Epitheca on lower surface, bearing fine growth lines (fig. 3). Corallites commonly six-sided, transverse diameter of large corallites 2½-3 mm. Mural pores circular, about 0.3 mm in diameter, with a distinct rim, commonly biserially arranged in the wall with the pores in the two rows positioned at similar levels, about six pores in 5 mm longitudinally. Septal spines (preserved in a few coralla) numerous in transverse section. Tabulae slightly convex up, three to five in 2 mm.

Distribution. Sandpile Group, GSC localities 35164, 35165, 35166, 35168, 35169, 35170, 35171, 38278, 38290, 38291, 39296.

Discussion. The species shows many characters in common with *Favosites gothlandicus* (Fougt). The types of this latter species were lost and Goldfuss selected four neotypes, two of which were later mislaid. Lecompte (1936) based a revised description on one of the two surviving neotypes, from which the Sandpile species differs by having larger and more closely set mural pores non-alternating in adjacent rows. *F. niagarensis* (Hall) has smaller corallites. *F. brownsportensis* Amsden has slightly larger corallites (averaging about 3 mm in diameter) and its corallum is typically large and plate-like. It is a common form in the Brownsport Formation of Tennessee.

Favosites discoideus (Roemer), 1860

Plate VII, figures 1-7

Calamopora forbesi var. *discoidea* Roemer, 1860, p. 19.
Favosites discoideus (Roemer), Amsden, 1949, p. 90.

Description. Small coralla, inversely conical with small basal parts for attachment, becoming somewhat more bun-shaped when larger. Epitheca present on lower side of corallum, bearing fine growth lines (fig. 4). Corallites commonly five or six-sided, large corallites measuring 1½-2 mm in transverse diameter (figs. 2 and 3 illustrate variation in size of the corallites). Mural pores slightly elongate upwards, rimless, about 0.3 mm in diameter, uniserial, sited in the central part of each wall (fig. 1), about 1 mm apart longitudinally. No septal structures preserved. Tabulae flat, complete, about 1 mm apart.

Distribution. Sandpile Group, GSC localities 35164, 35165, 35166, 35169, 35170, 35171, 38290, 38295.

Discussion. Favosites forbesi Edwards and Haime has corallites of a similar size, but a more massive corallum and biserial mural pores. *F. louisvillensis* Davis has a large plate-like corallum, somewhat smaller corallites, more closely spaced tabulae, and smaller mural pores.

The specimens of *F. discoideus* from the Brownsport Formation of Tennessee are very similar to those from the Sandpile Group, but the latter's corallites are slightly larger.

Favosites favosus (Goldfuss), 1829

Plate V, figures 6, 7, 11

Calamopora favosa Goldfuss, 1829, p. 77.

Description. Corallum low; corallites six and five-sided, 4-5 mm in transverse diameter. Mural pores circular, about 0.3 mm in diameter, commonly biserially arranged. Septal spines short, numerous in transverse sections (about forty in large corallites) spaced about 5 per mm longitudinally. Tabulae slightly convex up or flat, complete, about 1 mm apart.

Distribution. Sandpile Group, GSC localities 35169, 35170, 38295.

Discussion. The species is represented by fragments of coralla which do not allow a comprehensive description of their size and shape, but the corallum seems to be large. No furrows are present on the inner sides of the corallite wall, as described by Rominger (1876, p. 20), and by Shimer and Shrock (1944, p. 105). The latter authors cited the range of *F. favosus* as Upper Cataract to Niagara; Bolton (1957) reports it from the Fossil Hill Formation (Clinton Group) of southern Ontario; Hume (1925) found it in the Thornloe Formation of Lake Timiskaming; and Savage and Van Tuyl (1919) reported it from the Silurian of the Hudson Bay region.

Genus *Thamnopora* Steininger, 1833

Thamnopora Steininger, 1833, p. 337.

Type species. *Alveolites cervicornis* de Blainville, 1830.

Thamnopora sp.

Plate V, figures 8-10

Material studied. Most of the collections contain coralla but their state of preservation does not allow a thorough investigation of the species.

Genus *Striatopora* Hall, 1852

Striatopora Hall, 1852, p. 156.

Type species. *Striatopora flexuosa* Hall, 1852.

?*Striatopora* sp. cf. *S. gwenensis* Amsden, 1949

Plate VII, figures 8, 9

(?) *Striatopora gwenensis* Amsden, 1949, pp. 96-97.

Description. Corallum branching, stems somewhat oval in transverse section, the larger diameter 9-17 mm. Corallites arising in the axial part of the stem, bending outwards so that the calyxes open at about 90 degrees to the surface; rims of calyxes circular, about 1½ mm in diameter, calyxes spaced about 2 mm apart; wall thick at the surface of the stem, thinner within it. Mural pores abundant, four or five in the circumference of the corallite, suboval in shape with the larger (longitudinal) diameter 0.3-0.4 mm; about 1 mm apart longitudinally. Tabulae flat or gently concave up, sparsely distributed. No septal structures or striations about the calyxes observed.

Distribution. Sandpile Group, GSC localities 35165, 35169, 35170.

Discussion. The lack of, or non-preservation of, striations about the apertures of the corallites precludes the definite assignment of the species to the genus *Striatopora.* Excepting this character, the species is similar to *S. gwenensis* Amsden.

Genus *Coenites* Eichwald, 1829

Coenites Eichwald, 1829, p. 179.

Type species. *Coenites juniperinus* Eichwald, 1829.

Coenites laminatus (Hall), 1852

Plate VII, figures 10, 12

Limaria laminata Hall, 1852, p. 143.

Description. Corallum composed of thin undulose laminal expansions, positioned above one another, sheets commonly about 2 mm thick, with epitheca on the lower surface. Corallites growing parallel to the lower surface for two thirds of their length,

then upturning to reach the upper surface at an angle of about 45 degrees. Calyxes about 0.4 mm in transverse diameter, suboval with a projecting upper lip. Appearance of the calyxes when viewed from above dependent upon the degree of preservation of this lip; calyxes appear crescentic, oval, or subspherical.

No mural pores, septa, dentiform projections, or tabulae preserved.

Distribution. Sandpile Group, GSC localities 35164, 35165, 35168, 35170, 38295.

Discussion. One of Hall's illustrations of *Coenites laminatus* depicts a crescentic appearing calyx with a median notch in the upper lip (Hall, 1852, pl. 39, fig. 6c). This notch is not detectable in the Sandpile material, but preservation of the upper lip varies greatly within the collections, and the feature, if originally present, may possibly have been obscured by the silicification.

Bassler (1915, p. 255) reports *C. laminatus* from the Lockport Formation of New York, from the Louisville Limestone of Kentucky, and from Drummond Island on Lake Huron. Bolton (1957) reported the species from the Fossil Hill Formation of southern Ontario.

Coenites rectilineatus (Simpson), 1890

Plate VII, figures 11, 13, 14

Cladopora rectilineata Simpson 1890, pp. 459-460.

Description. Corallum composed of subparallel cylindrical stems, closely arranged, bifurcating at distinct intervals; stems commonly 2-2½ mm in diameter. Within the stem, corallites radiating from the axial region, bending away from it and regularly increasing in size towards the surface. Calyxes opening at about 65 degrees to the surface, rim of calyx circular, about 0.4 mm in transverse diameter, with a slight lip on the lower side; calyxes arranged in ten longitudinal rows and alternating in position in adjacent rows (fig. 11). Longitudinal spacing, about eleven calyxes in 10 mm within a single series (i.e. twenty-two calyxes in 10 mm for the stem as a whole). No septa, mural pores, or tabulae observed.

Distribution. Sandpile Group, GSC localities 35168, 35170, 35171.

Discussion. Coenites seriatus (Hall), *C. multiporus* (Hall), and *C. rectilineatus* (Simpson) are three similar species in which the coralla take the form of slender bifurcating branches. *C. seriatus* has smaller calyxes than the other two and Hall states that the calyxes are somewhat transversely elongate. The stem bears about fourteen calyxes in a circumference, in the other two species there are ten or fewer. These two species are very similar but Simpson, erecting *C. rectilineatus,* compared it to *C. multiporus* and stated that in the former species, the stems were smaller and straighter, and that the calyxes were much more regularly arranged in parallel longitudinal rows.

C. rectilineatus has been reported from the Keyser Group (latest Silurian) of Pennsylvania, Maryland, New Jersey, and New York; and also from southwest Ellesmere Island.

Family HALYSITIDAE Milne Edwards and Haime, 1850

Discussion. Hamada (1957b) revised the genera of the Halysitidae, using the lack or possession of septal spinules as a critical criterion. Septal spinules are discontinuous structures that will be revealed by some transverse sections of an autocorallite but not by others (Hamada, 1957a, p. 386), so that no single transverse section of a well-preserved corallum can be confidently considered to indicate that a species lacks such structures. The spinules are delicate and easily destroyed during recrystallization. Halysitid corals of Western Canada are very commonly silicified and rarely is there preservation of any septal structures that may have been initially present. Thus Hamada's generic differentiation unfortunately cannot be satisfactorily applied.

Genus *Halysites* Fischer von Waldheim, 1828

Alyssites Fischer von Waldheim, 1813, p. 387.
Halysites Fischer von Waldheim, 1828, p. 15 [nom. conserv. (ICAN. pend.) pro *Alyssites* Fischer von Waldheim 1813].
Halysites Fischer von Waldheim, Thomas and Smith, 1954, p. 766.

Type species. Tubipora catenularia Linnaeus, 1767.

Halysites nitida Lambe, 1899

Plate VIII, figures 1-3

Halysites catenularia var. *nitida* Lambe, 1899, pp. 71, 76, 77.
Halysites nitida Lambe, Buehler, 1955, p. 49.

Material studied. The species is represented by a large corallum in one collection, and by small fragments in the others.

Description. Corallum large (that from locality 35167 measures about 30 by 30 by 20 cm), divergence of ranks of corallites very small, resulting in deep, parallel-sided lacunae that present a labyrinthine pattern in transverse section (fig. 1). Ranks consisting of many or few corallites. Exterior of wall bearing growth lines, continuous from corallite to corallite.

Autocorallites elliptical in transverse section, about 1.2 by 1.7 mm in diameter, longest observed autocorallite about 60 mm long. No septal structures preserved in either type of corallite. Tabulae complete, flat or slightly concave up (fig. 3), twelve to seventeen in 5 mm.

Mesocorallites small, square in transverse section, about 0.5 mm in diameter. Tabulae complete, flat or slightly convex up, more closely spaced than those in the autocorallites, seventeen to twenty-two in 5 mm.

Calyxes of autocorallites considerably deeper than those of mesocorallites (fig. 3). Intermural increase is present but subordinate to peripheral.

Distribution. Sandpile Group, GSC localities 35167, 35168, 35169.

Discussion. The species was assigned to *Acanthohalysites* by Hamada (1957b, p. 425) presumably on the basis of the reports of septal structures in the publications

of Lambe and Buehler. No septal spinules were observed in the material from the Sandpile Group.

Buehler (1955) stated that *Halysites nitida* occurs in the La Vieille and Gascon Formations (Middle Silurian) of Quebec. The corallite dimensions cited by Lambe are slightly less than those for the Sandpile specimens. The latter dimensions are external measurements and Lambe did not state whether his measurements are internal or external. Lambe noted that the tabulae in the mesocorallites were vesicular in some of his specimens, although in most the tabulae were flat or slightly convex. No vesicular tabulae were observed in the Sandpile specimens.

Halysites occidens n. sp.

Plate IX, figures 1-5

Description. Corallum low and broad, dimensions of holotype, 80 by 70 by 18 mm; divergence of ranks of corallites most rapid at base of corallum, above which growth is almost vertical (fig. 4). Lacunae polygonal or elongate in transverse section, commonly bounded by four to seven ranks, tapering gradually downward, variable both within a corallum and from corallum to corallum (figs. 1 and 3). Exterior of wall showing growth lines, wall consisting of two layers, in transverse section outer layer about 0.07 mm thick, inner layer about 0.04 mm thick (these dimensions refer to the silicified wall, the original wall may not be fully preserved).

Autocorallites small, elliptical in transverse section, about 0.9 by 1.2 mm in diameter. No septal structures preserved in either type of corallite. Tabulae flat, habitually complete, closely spaced, seventeen to twenty in 5 mm.

Mesocorallites small, in transverse section square with slightly concave sides, about 0.5 mm in diameter. Tabulae flat, complete, slightly more closely spaced than in autocorallites, twenty to thirty in 5 mm.

Calyxes of autocorallites shallow, those of mesocorallites very shallow (fig. 3). Increase peripheral.

Holotype. GSC No. 14484 from GSC locality 35170.

Distribution. Sandpile Group, GSC locality 35170 contains four coralla, one of which was selected as the holotype. Other collections from GSC localities 35165, 35168, 35169, 38278, 38295.

Discussion. Halysites occidens has smaller autocorallites than *H. nitida* Lambe, and the latter species possesses longer narrower lacunae. *Cystihalysites encrustans* (Buehler) differs in the shape of the tabulae in the mesocorallites.

Halysites sandpilensis n. sp.

Plate VIII, figures 4-8

Description. Corallum low and broad, dimensions of holotype, 100 by 50 by 35 mm, ranks of corallites diverge at moderate angles (fig. 6). Lacunae small, polygonal or somewhat elongate in transverse section, commonly five or six-sided; ranks subparallel in longitudinal section, mostly with one to five autocorallites per rank.

Exterior of wall bearing growth lines; layering distinguishable in transverse sections of the silicified wall, thickness of outer layer about 0.03 mm, thickness of inner layer about 0.03 mm.

Autocorallites small, in transverse section elliptical with rounded ends, about 0.7 by 1.0 mm in diameter; longest autocorallites visible in the holotype about 12 mm long. No septal structures preserved in either type of corallite. Tabulae flat, complete, closely spaced, about four in 1 mm, closely crowded in places (fig. 8).

Mesocorallites small, almost square in transverse section, 0.3-0.4 mm in diameter. Tabulae flat or slightly convex up, complete, more closely spaced than those in the autocorallites, about five in 1 mm.

Peripheral increase far more common than intermural.

Holotype. GSC No. 14485 from GSC locality 35164.

Distribution. Sandpile Group, three coralla were collected from locality 35164, one of which was selected as the holotype. The species is also represented in collections from GSC localities 35168, 35170, 38278.

Discussion. Halysites sandpilensis resembles *H. occidens* but the differences between the two species appear to be of specific value. In *H. sandpilensis* both autocorallites and mesocorallites are considerably smaller, the tabulae are slightly more closely spaced, and the shape of the autocorallites in transverse section is more slender.

Genus *Catenipora* Lamarck, 1816

Catenipora Lamarck, 1816, p. 206.
Palaeohalysites Chern'shev, 1941a, pp. 36, 57.
Catenipora Lamarck, Buehler, 1955, pp. 21-22.

Type species. Catenipora escharoides Lamarck, 1816.

Catenipora simplex (Lambe), 1899

Plate X, figures 1-3

Halysites catenularia var. *simplex* Lambe, 1899, pp. 70, 71, 76, 77.
Catenipora simplex (Lambe), Buehler, 1955, pp. 47-48.

Description. Corallum irregular in shape, ranks of corallites subparallel and somewhat meandrine, commonly not closing to form lacunae (fig. 1), many autocorallites per rank. Lacunae elongate if closed, wedge-shaped in longitudinal section. Exterior of wall bearing strong growth lines that are continuous from corallite to corallite. Two layers perceptible in thin sections of the silicified wall, outer layer about 0.11 mm, inner about 0.05 mm thick.

Autocorallites large, elliptical in transverse section with straight ends at the contacts with the adjacent autocorallites in a rank (fig. 3); 2-2½ mm by about 3½ mm in diameter. Septal structures not preserved; tabulae flat or slightly concave up, complete, regularly spaced (fig. 2), seven to nine in 5 mm in longitudinal sections.

Mesocorallites absent. Intermural increase (figs. 2 and 3) more common than peripheral.

Distribution. Sandpile Group, GSC localities 35165, 35166, 35168, 35169, 38277, 38296.

Discussion. Catenipora simplex is one of the Silurian species of the genus. Lambe's original specimens were lost and Buehler selected as neotype for the species one of several specimens collected from the La Vieille Limestone (Niagaran) of Quebec.

The specimens from the Sandpile Group differ slightly from those described by Lambe. His description cited the spacing of the tabulae as six in 5 mm, and the dimensions of the autocorallites in transverse section as 2½ mm by 4 mm.

Genus *Cystihalysites* Chern'shev, 1941

Cystihalysites Chern'shev, 1941b, p. 70.
Cystihalysites Chern'shev, Hamada, 1957b, pp. 402-404.

Type species. Cystihalysites mirabilis Chern'shev, 1941.

Discussion. Due to his lack of Chern'shev's publication, Hamada (1957b) erred in his consideration of the genus, for he restricted *Cystihalysites* to those forms with incomplete tabulae in the mesocorallites. Chern'shev's diagnosis includes forms with strongly convex complete tabulae. Hamada thought the genus aseptate but septal spinules have been observed in species of *Cystihalysites* that conform to both his restricted conception and Chern'shev's original usage. These species are *Cystihalysites encrustans* (Buehler) and *Cystihalysites* sp. 1 (this paper).

Cystihalysites magnitubus (Buehler), 1955

Plate X, figures 4-8

Halysites magnitubus Buehler, 1955, p. 68.

Description. Specimens commonly showing long winding ranks of corallites rarely meeting to form elongate lacunae. Exterior of wall bearing a few coarse growth lines, layers present in the silicified wall, thickness of the inner layer about 0.05 mm, of the outer layer about 0.15 mm. No distinct wall between autocorallites and mesocorallites.

Autocorallites large, elliptical in transverse section, about 2.8 by 3.1 mm in diameter, but size somewhat variable from corallum to corallum. No septal structures preserved in either type of corallite. Tabulae complete, commonly flat, four to seven in 5 mm.

Mesocorallites of moderate size, irregularly biconcave in transverse section with the cross-rank diameter being the larger, about 2 by 1 mm in diameter. Tabulae convex up, centred longitudinal sections commonly showing one column of mostly complete tabulae (fig. 8 and see *Discussion*), seventeen to twenty-three in 5 mm.

Intermural increase and peripheral increase.

Distribution. Sandpile Group, GSC localities 35164, 35165, 35166, 35168, 35170, 35171, 38278.

Discussion. In the Sandpile species, adjacent corallites are not separated by a distinct wall, but the sides of the conical tabulae in the mesocorallites extend downwards to rest low down on the sides of lower tabulae, thus the mesocorallite is bounded by a series of nearly vertical parts of tabulae, against which lap the tabulae in the autocorallites (fig. 8). A normal wall is present on the exterior sides of the mesocorallites. The lateral parts of a tabula in a mesocorallite extend downwards below the levels of the apical parts of one or more other tabulae, giving a complex arrangement in transverse sections (figs. 5 and 6). The arrangement of tabulae may be roughly expressed as that of five columns of tabulae distributed within the mesocorallite as the symbols are arranged on a five playing card, with the traces of several tabulae in each column being visible in a transverse section (fig. 6). Longitudinal sections cut parallel to the rank of corallites will reveal just one column if accurately centred, and more than one if inaccurately centred (fig. 8). A longitudinal section cut through the mesocorallite orthogonal to the rank will commonly show two columns of tabulae (fig. 7).

The type material of *Cystihalysites brownsportensis* (Amsden) reveals a very similar arrangement of tabulae in the mesocorallites, and no wall is present between the mesocorallites and the autocorallites. Sections made by Buehler of *C. encrustans* (Buehler) and *C. infundibuliformis* (Buehler) also show the latter feature, as do sections of *Cystihalysites* sp. 1 and *Cystihalysites* sp. 2. The absence of this wall may be characteristic of many of the species of *Cystihalysites* but Chern'shev (1941b) describes such a wall in the type species, *C. mirabilis* Chern'shev.

The specimens from the Sandpile Group resemble *C. brownsportensis* in the shape of the corallites and the form and spacing of the tabulae in both types of corallites. The corallites are smaller in *C. brownsportensis,* and the mesocorallites are more nearly square in transverse sections. In the Sandpile species the mesocorallite shape was found to be dependent upon the size of the autocorallites, the along-rank diameter of the mesocorallite remaining fairly constant, but the across-rank diameter being larger in coralla with large autocorallites.

The Sandpile specimens more closely resemble *C. magnitubus* (Buehler) in the size and shape of the corallites. The spacing of the tabulae is similar, and from Buehler's illustrations the mesocorallite tabulae are cystose, incomplete, but vaguely concave up, thus differing from the convex up mesocorallite tabulae of the Sandpile species (figs. 7 and 8).[1]

C. magnitubus has been reported from the Laketown Dolomite of Idaho and the Hidden Valley Dolomite of California.

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[1] Dr. Helen Duncan of the United States Geological Survey has examined the types of *Halysites magnitubus* Buehler, and reports that the illustration of the longitudinal section (Buehler, 1955, Pl. 11, Fig. 3) was printed upside down. She examined topotype material in addition to cutting new surfaces in the holotype (personal communication, 1962).

Cystihalysites species 1

Plate XI, figures 1-3

Description. Coralla with irregular lacunae (fig. 1), ranks of corallites subparallel vertically, few or several autocorallites in a rank. Exterior of wall bearing coarse growth lines, no distinct wall between autocorallites and mesocorallites.

Autocorallites of moderate size, elliptical in transverse section, about 1.9 by 2.1 mm in diameter, with distinct septa (preserved in some corallites) (fig. 2). Tabulae complete, flat or slightly concave upwards, two or three in 1 mm.

Mesocorallites quadrangular in transverse section, about 0.9 by 1.0 mm, containing an irregular network of cystose tabulae, arranged in several discontinuous columns, spacing of tabulae about five to 1 mm longitudinally.

Peripheral increase dominant.

Distribution. Sandpile Group, GSC localities 35164, 35165, 35166, 35168, 38295.

Discussion. Cystihalysites sp. 1 is closely akin to *Cystihalysites* sp. 2, but differs in the size of the corallites. *Cystihalysites* sp. 1 resembles *C. mirabilis* Chern'shev, but the latter has rather larger autocorallites and possesses a wall separating the autocorallites from the mesocorallites. *C. magnitubus* (Buehler) and *C. brownsportensis* (Amsden) have larger autocorallites, *C. encrustans* (Buehler) has smaller lacunae, and *C. infundibuliformis* (Buehler) has differently shaped corallites and labyrinthine lacunae.

Cystihalysites species 2

Plate XI, figures 4-9

Description. This species is very similar to *Cystihalysites* species 1 in most of its characters, but differs by having smaller corallites. The autocorallites measure about 1.2 by 1.3 mm, and the mesocorallites about 0.6 by 0.9 mm in diameter in transverse sections. A section from a fragmentary corallum reveals cystose tabulae lining the autocorallites (fig. 6). This feature has not been found in other coralla, but was noted in *C. mirabilis* by Chern'shev. There, as in *Cystihalysites* sp. 2, some corallites showed this lining, others did not, so that this feature may be an inconstant character within the genus.

Distribution. Sandpile Group, GSC localities 35164, 35165, 35168, 35170, 38296.

Discussion. The size of the corallites in both *Cystihalysites* sp. 1 and *Cystihalysites* sp. 2 is somewhat variable, but the studied specimens form two distinct groups when this character is considered. Further material may reveal the two to be conspecific, but if so, the size tolerances of the corallites in this species are exceptional for the family.

Family AULOPORIDAE Milne Edwards and Haime, 1851

Genus *Auloporella* Grubbs, 1939

Auloporella Grubbs, 1939, p. 549.

Type species. Auloporella typa Grubbs, 1939.

Auloporella cf. *A. typa* Grubbs, 1939

Plate XII, figures 1-3

(?) *Auloporella typa* Grubbs, 1939, p. 549.

Material studied. The species is represented by fragments of coralla in the etched residues of two collections. Some of the fragments consist of two or three corallites.

Description. Corallites trumpet-shaped, straight for about two thirds of their length, then gradually upturning for the calyx to be directed at a high angle to the original growth direction. Wall thick, epitheca with faint growth constrictions, aperture circular. Small, blister-like dissepiments lining the inside of the wall; in places no dissepiments, in others a single one, in others an opposing pair within the corallite, elsewhere a short longitudinal series. Increase lateral, sometimes two or more new corallites originating from the mature corallite, but commonly just one, sited on the outside curve of the corallite at the beginning of its upturn, with the growth direction of the new corallite in the same plane as the earlier part of the old. (A typical corallite measures about 4.5 mm to the base of its new corallite, about 3 mm from there to the aperture, is 1 mm in diameter at its origin, about 1.6 mm at the base of the new corallite, and about 2.3 mm at the aperture). Septa and tabulae apparently lacking.

Distribution. Sandpile Group, GSC localities 35166, 35170.

Discussion. The species is very similar in its external characters to *Auloporella typa* Grubbs and if the latter's secondary chamber located below the aperture may be interpreted as a dissepiment, the two are doubtless conspecific. Grubbs reported just one chamber per corallite whereas the Sandpile specimens typically have more than one dissepiment.

A. typa was described from Niagaran dolostone exposed in a Chicago quarry, probably correlatable with the Racine Formation.

Romingeria Nicholson, 1879

Romingeria Nicholson, 1879, p. 114 [pro *Quenstedtia* Rominger, 1876, (non Morris and Lycett, 1854)].

Type species. Aulopora umbellifera Billings, 1859.

Romingeria niagarensis (Rominger), 1876

Plate XII, figures 4-6

Quenstedtia niagarensis Rominger, 1876, p. 71.

Material studied. Corallites are present in the etched residues of three collections.

Description. Size and shape of the corallum unknown. Corallites umbelliferous, cylindrical, about 2 mm in diameter; without stolons, commonly discrete except at positions of increase but in some specimens adjacent corallites remain in contact for some distance. Common wall (when corallites are in contact) bearing suboval mural pores, about 0.3 mm in diameter. Epitheca with fine growth lines; tabulae and septa lacking or not preserved. Increase lateral with four to eight new corallites forming a somewhat irregular umbellate whorl around the parent.

Distribution. Sandpile Group, GSC localities 35165, 35166, 35170.

Discussion. The species resembles a Devonian species, *Romingeria umbellifera* (Billings), in the size and shape of the corallites but the increase is less regular. *R. uva* Davis, is a similar form, as far as can be ascertained from Davis' illustrations. *R.* cf. *R. vannula* Davis has more slender corallites. *R. niagarensis* (Rominger) resembles the Sandpile specimens in corallite size and shape, but Rominger reported a rim to the mural pore; such a rim is not preserved in the studied material.

R. niagarensis was described from rocks of Niagaran age at Point Detour, Lake Huron, and has also been reported from Iowa.

Romingeria cf. *R. vannula* Davis, 1885

Plate XII, figures 7-9

(?) *Romingeria vannula* Davis, 1885, pl. 75, figs. 1-3, 5.

Material studied. One corallum and fragments from the etched residues.

Description. Corallum bun-shaped with the corallites originating from a small basal area of attachment; composed of erect, subparallel, umbelliferous, cylindrical corallites (in the basal part of the corallum the growth pattern is less regular and the corallites are not erect); transverse stolons absent. Corallites about 1 mm in diameter, discrete except at positions of increase where some adjacent corallites may be in contact, the common wall bears suboval mural pores, about 0.3 mm in diameter. Epitheca with faint growth constrictions; tabulae sparse, complete, flat or slightly convex up, septa lacking or not preserved. Increase lateral, six to eight new corallites forming an umbellate whorl around the parent, adjacent corallites may increase at similar levels giving a layered aspect to the corallum (fig. 7); positions of increase in a corallite 5-10 mm apart longitudinally.

Distribution. Sandpile Group, GSC localities 35164, 35165, 35170.

Discussion. Romingeria umbellifera (Billings) and *R. niagarensis* (Rominger) are species with larger corallites (both about 2 mm in diameter) than *R. vannula. R. vannula* Davis and *R. uva* Davis were erected by illustrations without descriptions, the latter has larger corallites (1½-2 mm) than the Sandpile species, whereas the former resembles it in size and in shape of the corallites, and also (as well as the illustrations allow) in the growth pattern of the corallites.

The specimens of *R. vannula* figured by Davis, and on which the name is based, were collected from rocks of late Niagaran age near Louisville, Kentucky.

Genus *Syringopora* Goldfuss, 1826

Syringopora Goldfuss, 1826, p. 75.

Type species. *Syringopora ramulosa* Goldfuss, 1826.

Syringopora verticillata Goldfuss, 1826

Plate XIII, figures 1-4, 7

Syringopora verticillata Goldfuss, 1826, p. 76.
Syringopora verticillata Goldfuss, Rominger, 1876, p. 79.

Material studied. Several coralla and fragments.

Description. Corallum composed of erect, subparallel, cylindrical corallites, joined at irregular intervals by thin transverse stolons, commonly with several stolons present at the same level. Corallites 2-2½ mm in diameter; lacking septa, epitheca bearing fine growth lines. Tabulae deeply infundibuliform, forming a deep axial depression (containing sediment in fig. 4), mostly complete, closely spaced (e.g. about three in 1 mm). Increase lateral, mostly occurring at the base of the corallum, new corallites rapidly upturning to parallel the older corallites.

Distribution. Sandpile Group, GSC localities 35164, 35165, 35168, 35170 (?).

Discussion. *Syringopora dalmanii* Billings has corallites that are much closer together than those of *S. verticillata* Goldfuss. *S. bifurcata* Lonsdale is a similar species but has corallites that geniculate slightly, resulting in a non-parallel, somewhat zigzag, growth pattern.

The type material of *S. verticillata* was collected from rocks of Niagaran age on Drummond Island, Lake Huron, and Rominger collected his material from the same district.

Syringopora sp.

Plate XII, figures 10 and 11

Material studied. In one collection there are three incomplete coralla of this species that possess small corallites.

Family Metriophyllidae Hill, 1939

Genus *Asthenophyllum* Grubbs, 1939

Asthenophyllum Grubbs, 1939, pp. 546-547.

Type species. *Asthenophyllum orthoseptatum* Grubbs, 1939.

Asthenophyllum cf. *A. occidentale* (Whiteaves), 1906

Plate XIII, figures 5, 6

(?) *Petraia* (*pygmaea*? var.) *occidentalis* Whiteaves, 1906, pp. 291-292.
(?) *Asthenophyllum occidentale* (Whiteaves), Stearn, 1956, pp. 85-86.

Material studied. Half a dozen corallites are present in the etched residues, mostly attached to the skeletons of other fossils.

Description. Small, solitary, slightly curved trochoid corals; epitheca bearing low interseptal ridges, unpronounced growth undulations, and, proximally, small attachment talons. About nineteen major septa, with a somewhat radial pattern distally, initially in contact axially; higher in the corallite the ends of the major septa twist together and touch but commonly enclose a small irregular aulos. Short continuous minor septa alternating with the major (in one corallite the minor septa are inserted at 3 mm above the base); distally the major and minor septa are represented by low undulations of the corallite wall. Calyx very deep (one corallite length 10 mm, distal diameter 6 mm, has the floor of the calyx at 2½ mm); mode of increase unknown; lacking tabulae and dissepiments.

Distribution. Sandpile Group, GSC localities 35166, 35169, 35170.

Discussion. An adequate study of the system of septal insertion was not possible and thus a precise identification precluded. *Asthenophyllum orthoseptatum* Grubbs has the minor septa represented by rows of spines and the epitheca has no interseptal ridges preserved. *A. inwoodense* Stearn has a larger corallite, the major septa do not twist together or form an aulos, and the minor septa are denticulate at their free edges. *A. occidentale* (Whiteaves), as described by Stearn, is similar in size, shape, and major septa characters, but the minor septa are denticulate and below the calyx are present within a peripheral stereozone. Such a stereozone was not detected in the Sandpile specimens. *A. occidentale* was described from formations of the Clinton Group in southern Manitoba.

Family ARACHNOPHYLLIDAE Dybowski, 1873

Genus ***Entelophyllum*** Wedekind, 1927

Entelophyllum Wedekind, 1927, p. 22.

Type species. Madreporites articulatus Wahlenberg, 1821.

? *Entelophyllum* sp.

Plate XIV, figures 1-4

Material studied. A single incomplete corallum.

Genus *Ptychophyllum* Milne Edwards and Haime, 1850

Ptychophyllum Milne Edwards and Haime, 1850, p. lxix.
Ptychophyllum Milne Edwards and Haime, Smith, 1945, pp. 51-52.

Type species. *Ptychophyllum stokesi* Milne Edwards and Haime, 1850.

Ptychophyllum sp.

Plate XIV, figures 5-8

Material studied. The species is represented by many specimens, in most of which the state of silicification is such as to obscure the internal structures.

Family Stauriidae Milne Edwards and Haime, 1850

Genus *Fletcheria* Milne Edwards and Haime, 1851

Fletcheria Milne Edwards and Haime, 1851, pp. 156, 300.
Pycnostylus Whiteaves, 1884, pp. 2-3.

Type species. *Fletcheria tubifera* Milne Edwards and Haime, 1851.

Discussion. Duncan (1956, p. 228) considered *Fletcheria* and *Pycnostylus* as distinct genera, basing her opinion on Hill's (1940, p. 390) differentiation that restricted *Fletcheria* to forms in which the septa consist of rows of discrete spines [very similar to the septa in *Tryplasma* Lonsdale (Stumm, 1952, p. 842)], and used *Pycnostylus* for corals in which the septa are continuous lamellae. Later Hill (1956, p. 298) cited *Pycnostylus* as a junior synonym of *Fletcheria*.

Fletcheria deadwoodensis n. sp.

Plate XV, figures 1-4, 6-7, 9-11

Material studied. Corallites are common in the etched residues of some of the collections from the Sandpile Group.

Description. Corallum with dispersed, somewhat dendroid corallites, without transverse stolons. Corallites cylindrical, about 3 mm in diameter at maturity; epitheca bearing faint longitudinal grooves, very fine growth lines, and irregularly spaced growth constrictions. Tabulae flat or slightly concave up, complete, evenly spaced, about ½ mm apart; the only trace of septa are the longitudinal grooves. Calyx shallow (about 1 mm deep in fig. 2) increase axial, quadripartite.

Holotype. GSC No. 14488, from GSC locality 35168.

Distribution. Sandpile Group, GSC localities 35164, 35168, 35170.

Discussion. The species complies with the original generic description of *Fletcheria;* the only trace of septa is the faint longitudinal grooving of the epitheca.

F. tubifera Milne Edwards and Haime has slightly larger corallites (up to 5 mm in transverse diameter) that grow more closely together. *F. guelphensis* and *F. elegans* (Whiteaves) both have larger corallites (3-7 mm, and 13-17 mm in diameter).

Fletcheria major n. sp.

Plate XV, figures 5, 8, 12-14

Material studied. Isolated corallites are common in the etched residues of the collections, and a few rock fragments allow the relationships of the corallites within the corallum to be determined.

Description. Corallum fasciculate, consisting of an aggregate of subparallel cylindrical corallites, locally in contact above positions of increase; 4-11 mm in diameter. Epitheca bearing fine growth lines, unpronounced growth constrictions, and faint interseptal ridges (the last only visible in some individuals with well-preserved epithecae). Septa very short, subequal, about forty-eight in number, forming continuous ridges lining the inside of the wall. Tabulae flat, complete, spaced about 1 mm apart; no dissepiments. Increase axial, quadripartite, sited at corallite diameters of 7-11 mm.

Holotype. GSC No. 14489, from GSC locality 35170.

Distribution. Sandpile Group, GSC localities 35165, 35168, 35169, 35170, 35171, 38278, 38295, 38296.

Discussion. F. major is similar to *F. guelphensis* (Whiteaves) but the latter has smaller corallites (3-7 mm in diameter) and fewer septa (about thirty-two according to Lambe, 1900, p. 132). *F. elegans* (Whiteaves) has larger corallites (13-17 mm in diameter), *F. deadwoodensis* n. sp. has smaller corallites (about 3 mm in mature diameter).

Family ZAPHRENTIDAE Milne Edwards and Haime, 1850

Genus ***Cyathophyllum*** Goldfuss, 1826

Cyathophyllum Goldfuss, 1826, p.54.

Type species. Cyathophyllum dianthus Goldfuss, 1826.

"Cyathophyllum" aff. *"C." pennanti* Billings, 1862

Plate XVI, figures 1-4, 8

(?) *Cyathophyllum pennanti* Billings, 1862, p. 107.

Material studied. The species is present in several of the collections and abundant in one.

Description. Corallum fasciculate, consisting of erect, subparallel, ceratoid and cylindrical corallites, locally in contact, up to 12 mm in diameter at the rim of the calyx. Epitheca with fine growth lines, growth constrictions, faint interseptal ridges, and sparse small talons. About twenty-eight major septa extending to the axial region in the lower part of the corallite, gradually withdrawn during growth, and near the rim of

the calyx reaching less than one third of the distance to the axis. Minor septa alternating with the major septa and about half their length. Tabulae complete and incomplete, flat or slightly convex up, spaced about one half mm apart; dissepiments small, regular, four or five ranks within the dissepimentarium which is secreted in advance of the tabularium (fig. 8). Increase axial, commonly four offsets of uneven size. Calyx deep with a marginal platform (fig. 8).

Distribution. Sandpile Group, GSC localities 35165, 35167, 35168, 35170, 38296.

Discussion. *Cyathophyllum* is based on an unsectioned specimen and the species is assigned to the genus as it is used by Shimer and Shrock (1944, pp. 93-94) and by Amsden (1949, pp. 108-110). The Sandpile individuals resemble *C. articulatum* Wahlenberg and *C. pennanti* Billings, both with axial increase and about thirty major septa reaching nearly to the axis. The corallites of the latter species are of a similar size to those of the Sandpile species.

Family Cystiphyllidae Milne Edwards and Haime, 1850

Genus *Cystiphyllum* Lonsdale, 1839

Cystiphyllum Lonsdale, 1839, p. 691.
Cystiphyllum Lonsdale, Lang and Smith, 1927, p. 455.

Type species. *Cystiphyllum siluriense* Lonsdale, 1839.

Cystiphyllum cf. *C. tubiforme* Poulsen, 1941

Plate XIII, figures 8-11

(?) *Cystiphyllum tubiforme* Poulsen, 1941, p. 13.

Material studied. A small corallum in one collection and discrete corallites in this and other collections.

Description. Corallum consisting of an aggregate of cylindrical corallites, or simple; corallites up to 12 mm in diameter. Wall thin, epitheca bearing growth lines, growth constrictions, and traces of interseptal ridges. Septa numerous, represented by short spines projecting from the wall, and from dissepiment surfaces. Three or four ranks of globose dissepiments lining the wall and enclosing a small tabularium of undulatory tabulae, mostly complete (fig. 10). Dissepimentarium secreted in advance of the tabularium, resulting in an axial depression within the calyx. Increase axial, commonly quadripartite (fig. 11).

Distribution. Sandpile Group, GSC localities 35164, 35167, 35170.

Discussion. This small species conforms to the description of *Cystiphyllum tubiforme*. Poulsen thought his species to be simple, and observed no septal spines on the dissepiment surfaces. *C. tubiforme* was described from the Offley Island Formation (late Llandovery, middle Clinton) of northwest Greenland.

Cystiphyllum sp. 1

Plate XVI, figures 5-7

Material studied. The collections contain two fragmentary corallites.

Description. The illustrations reveal as much as is known of the size and shape of the corallite. Epitheca with numerous interseptal ridges, septa not preserved. Dissepiments globose, tabulae incomplete, inclined, blister-like, differentiated from the dissepiments only by their greater size, tabularium occupying slightly more than half of the corallite diameter.

Distribution. Sandpile Group, GSC localities 35168, 38278.

Discussion. The species clearly conforms to the generic description of *Cystiphyllum,* but the material available is inadequate to allow a more refined identification. *Cystiphyllum* sp. 1 is much larger than *C.* cf. *C. tubiforme* and has tabulae of different shape.

LIST OF FOSSIL LOCALITIES

GSC loc. No.	Position	Rock-unit
35164	58°59′N 128° 00′W 6,200 ft. ridge crest 3.3 ml. SE of 6,543-ft. cairn.	Sandpile, coralline member; from lower 40 ft.
35165	59°03½′N 128°12′W 5,550 ft. ridge crest 1.7 ml. NNW of north end of upper Sandpile Lake.	Sandpile, coralline member; from lower 15 ft.
35166	59°04′N 128°11′W 6,300 ft. just north of high point, 1.4 ml. NW of north end of lower Sandpile Lake.	Sandpile, coralline member; from lower 20 ft.
35167	58°48′N 127°57′W 5,800 ft. mountain top, 4½ ml. WNW of junction Dall and Turnagain Rivers.	Sandpile, from 3 ft. of beds about 1,000 ft. above base.
35168	59°02½′N 128°07½′W 4,800 ft. ridge face, 1½ ml. NE of north end of upper Sandpile Lake.	Sandpile, coralline member; from lower 15 ft.
35169	59°03½′N 128°10′W 5,400 ft. ridge crest, 1½ ml. north of upper Sandpile Lake.	Sandpile, coralline member; from upper 20 ft.
35170	59°03′N 128°11′W, 5,100 ft. ridge crest, 1.4 ml. NNW of north end of upper Sandpile Lake.	Sandpile, coralline member; from 15 ft. of beds.
35171	59°01′N 128°03′W 6,000 ft. ridge crest, 1 ml. ESE of 6,543-ft. cairn.	Sandpile, coralline member; from 2 ft. of beds.
35174	58°48′N 127°53′W 3,450 ft. creek 2 ml. NW of junction Dall and Turnagain Rivers.	Sandpile, from 1-ft. bed about 150 ft. above base.
37264	59°03′N 128°06′W 6,266 ft. peak of mountain with 6,266-ft. cairn.	McDame, from 15 ft. of beds, 75-90 ft. above base.
38277	59°03½′N 128°10′W 5,900 ft. ridge crest 1.6 ml. north of north end of upper Sandpile Lake.	Sandpile, from 1-ft. sandstone bed 80 ft. above coralline member.
38278	59°04′N 128°11′W 6,100 ft. mountain top 1.8 ml. north of north end of upper Sandpile Lake.	Sandpile, coralline member; from lower 10 ft.
38279	58°58′N 128°14′W 4,700 ft. ridge face 2 ml. north of Major Hart River.	Sandpile, from 20-ft. beds.
38280	59°01′N 128°22′W 4,800 ft. creek 2 ml. SW of south end of Deadwood Lake.	Sandpile, from 1-ft. bed about 300 ft. above base.
38290	58°49′N 127°57′W, 5,400 ft. ridge face 5 ml. NW of junction of Dall and Turnagain Rivers.	Sandpile from 3 ft. of beds some 500 ft. above base.
38291	58°48′N 127°56′W 5,000 ft. creek 4 ml. NW of junction of Dall and Turnagain Rivers.	Sandpile, from 5 ft. of beds some 700 ft. above base.
38293	59°02½′N 128°07½′W 4,300 ft. gulley 0.8 ml. east of south end of lower Sandpile Lake.	Kechika, from 3 ft. of beds 80 ft. below base of Sandpile.
38295	59°03′N 128°06′W, 5,500 ft. ridge crest 0.3 ml. west of 6,266-ft. cairn.	Sandpile, coralline member; from upper 5 ft. of beds.
38296	59°02½′N 128°06′W 5,000 ft. ridge crest 0.9 ml. south of 6,266-ft. cairn.	Sandpile, coralline member; from 20 ft. of beds 25-45 ft. below top of member.

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PLATES I to XVI

Plates I to XVI illustrate fossils from the Sandpile Group. Unless otherwise stated, all figures are natural sized, unretouched photographs. The locality and specimen numbers are those of the Geological Survey of Canada, Ottawa.

Plate I

Dinobolus cf. *D. conradi* (Hall) ..... page 13

Figures 1, 4. Internal views of the incomplete valves of the one individual (No. 14487 from locality 35165).

Figures 2, 3, 5, 6. Internal views of the same valves, tilted.

Figures 7, 8. Posterior views of the two valves.

Figures 9, 10. Reconstructions of the complete brachial and pedicle valves (outline and anterior parts adapted from Davidson and King, 1874, with slight modifications); scale x1¼.

a	groove	m	median partition
b	beak	o	subcardinal impression
c	cardinal buttress	p	platform
d	pseudodeltidium	s	cardinal socket
e	cardinal extremity	u	umbonal chamber
i	cardinal impression	v	platform vault
l	plate	t	position of trace of anterior part of crescent

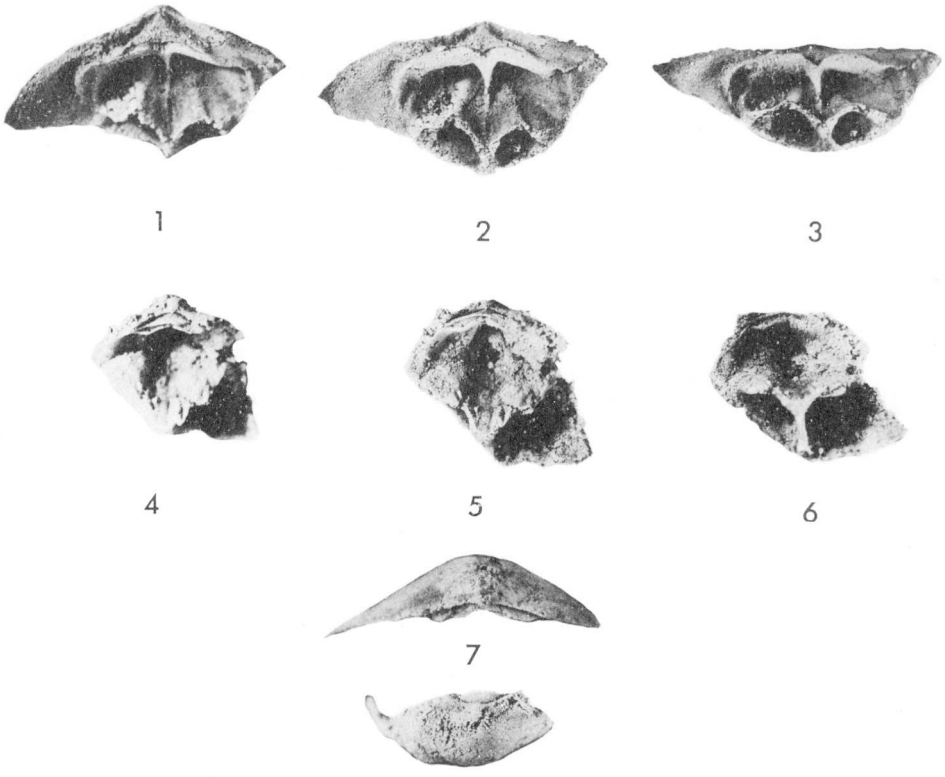
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PLATE II

Hesperorthis cf. *H. laurentia* (Billings) ..... page 14

Figures 1-3, 5. Brachial, pedicle, lateral, and posterior views of specimen No. 15727 from locality 35170. The rear end of the cardinal process is visible in fig. 5.

Figures 4, 9. Enlarged views (x2) of the pedicle and brachial valves (Nos. 15726 and 15725) of an individual from locality 35166. The valves are tilted to better reveal the cardinalia, and the cardinal extremities are broken.

Hesperorthis sp. ..... page 15

Figure 6. External view of pedicle valve No. 15728 from locality 35166.

Figures 8, 10. Enlarged views (x4) of the interior of the valve. In fig. 10 the valve is tilted and the dental plates are more clearly shown.

Isorthis sp. ..... page 15

Figure 7. Brachial view of specimen No. 15842 from locality 35170.

Figures 11-14. Enlarged lateral, pedicle, anterior, and posterior views (x2) of the specimen of fig. 7. Note the shallow sulcus (fig. 13), and the cardinal process (fig. 14).

Figures 15, 16. Enlarged views (x4) of the interiors of pedicle and brachial valves (Nos. 15779 and 15781) from locality 35166.

Figure 17. Enlarged view (x4) of the posterior part of a large brachial valve (No. 15780) from locality 35166; the valve is tilted.

Figure 22. Brachial view of another specimen (No. 15282) from locality 35166.

Pentamerus sp. ..... page 16

Figures 19, 20. Brachial and lateral views of incomplete individual No. 15783 whose valves are in contact; from locality 38296. The interior has been partly excavated so that the cusp of the spondylium is visible (fig. 20).

Figure 18. View of incomplete pedicle valve No. 15784, showing the nature of the spondylium and a remnant of the pseudodeltidium (in front of the beak); locality 38296.

Figure 21. Enlarged view (x2) of the posterior part of incomplete brachial valve No. 15785, showing the cruralium; locality 38296.

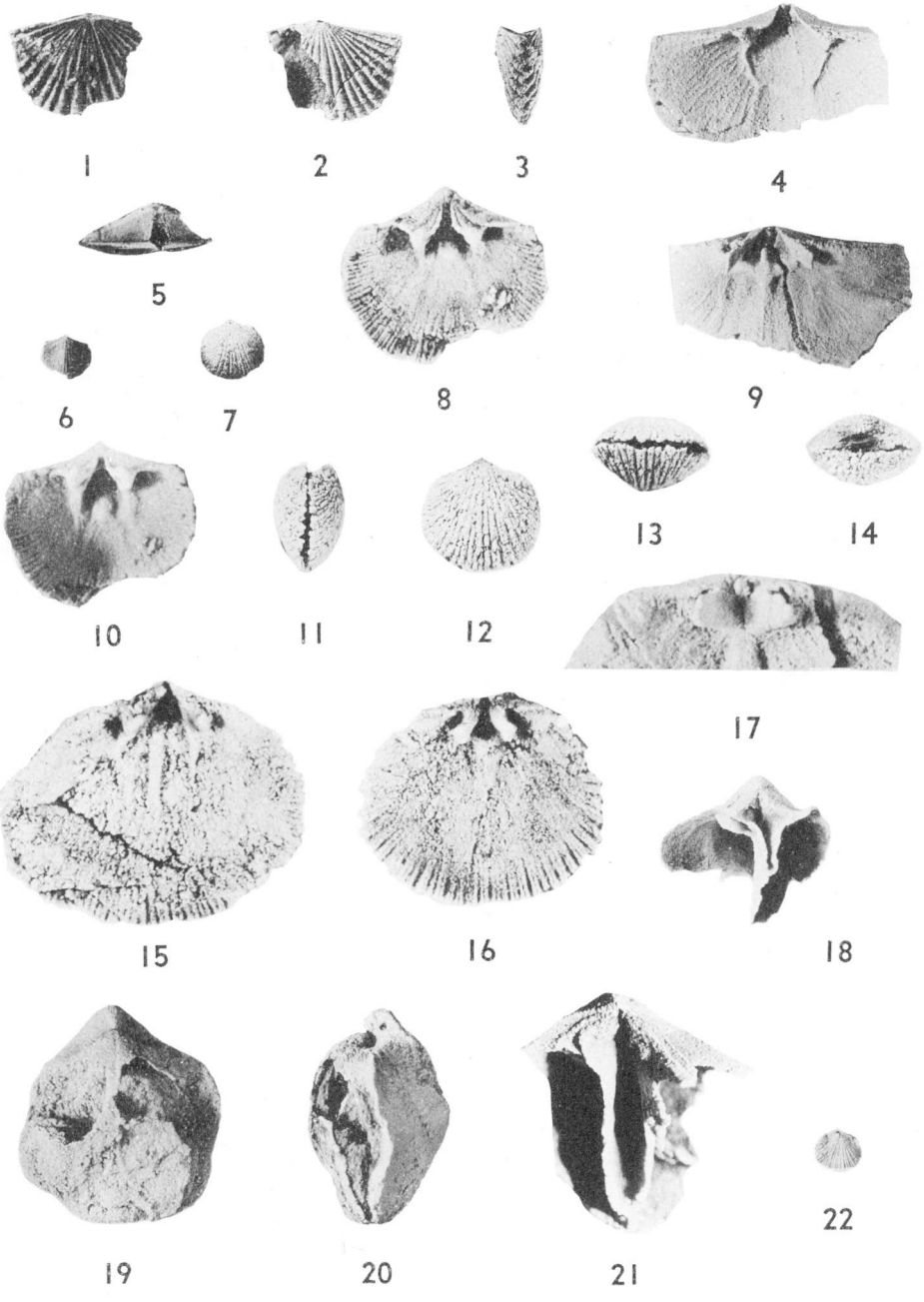
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Plate III

?Clorinda sp. ..... page 16

Figure 1. View of the interior of pedicle valve No. 15806 from locality 35169.

Figures 2, 4. Lateral and front views (x2) of another pedicle valve (No. 15805) from locality 35169.

Figure 3. Enlarged view (x2) of the valve shown by fig. 1; here tilted to better show the unsupported nature of the spondylium.

Atrypa parva Hume ..... page 16

Figures 5-9. Brachial, pedicle, lateral, anterior, and posterior views of individual No. 15789 from locality 35166.

Figure 10. Pedicle view of a smaller individual (No. 15786) from locality 35166.

Figures 11-13. Enlarged views (x4) of the interiors of a pedicle and two brachial valves from locality 35166 (Nos. 15791, 15787, 15790).

Glassia variabilis Whiteaves ..... page 22

Figures 14-18. Brachial, pedicle, lateral, anterior, and posterior views of specimen No. 15792 from locality 35166.

Figures 23, 25. Enlarged views (x4) of the interiors of pedicle and brachial valves from locality 35166 (Nos. 15793 and 15794).

Figure 24. Enlarged view (x8) of the posterior part of the brachial valve shown by fig. 25. The teeth (broken from the pedicle valve) are retained in the sockets.

Dicaelosia cf. *D. biloba* (Linnaeus) ..... page 23

Figures 19-22. Brachial, pedicle, posterior, and lateral views (x2), of individual No. 15788 from locality 35170.

Cyrtia sp. ..... page 24

Figures 26, 27. Views of an incomplete pedicle valve (No. 15796) from locality 35174. The swollen nature of parts of the dental plates is visible in fig. 27.

Figure 28. Enlarged posterior view (x2) of another fragmentary shell (No. 15795) from locality 35174.

Figure 29. Enlarged view (x2) of the exterior of the valve shown by fig. 26; illustrating the fine lirae.

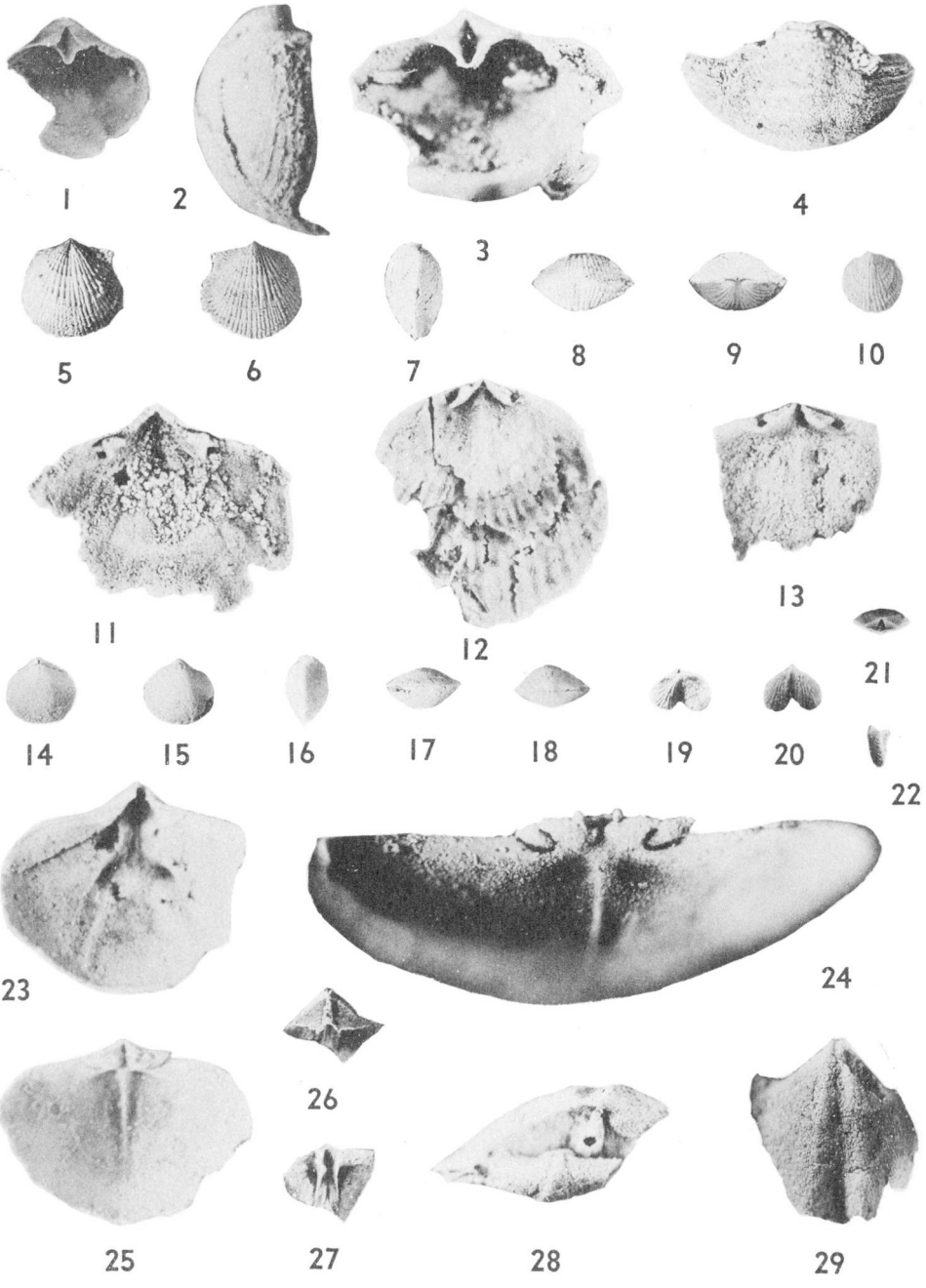
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PLATE IV

Atrypa gabrielsi n. sp. ..... page 18

Figures 1-5. Brachial, pedicle, lateral, anterior, and posterior views of the holotype (No. 14486) from locality 35166.

Figures 6, 7, 9. Enlarged views (figs. 6, 7, x2; fig. 9, x4) of the interiors of pedicle valves (paratypes Nos. 15801, 15804, 15802). Fig. 6 shows the valve of a mature individual, fig. 7 that of an older animal, fig. 9 that of a juvenile form; locality 35166.

Figure 8. Enlarged view (x4) of the posterior part of the interior of the brachial valve of an individual larger than that of fig. 13; paratype No. 15798 from locality 35166.

Figures 10, 11. Brachial views showing the ornament; paratypes Nos. 15803 and 15800 from locality 35166. Fig. 10 reveals the grooved teeth.

Figure 12. Pedicle view of an incomplete valve (paratype No. 15799) that has the spiralia preserved; locality 35166.

Figure 13. Enlarged view (x4) of the interior of the brachial valve of a mature individual; paratype No. 15797 from locality 35166.

Howellella pauciplicata Waite ..... page 24

Figures 14-16. Brachial, lateral, and posterior views of specimen No. 15807 from locality 35170.

Figure 17. Enlarged view (x2) of the interior of an incomplete pedicle valve (No. 15808) from locality 35170.

Leptelloidea sp. ..... page 25

Figure 18. External view of an incomplete pedicle valve (No. 15809) from locality 35166.

Figure 19. Diagram (x2) of the orientation of the lirae.

Figure 20. Interior view (x2) of pedicle valve No. 15812 from locality 35166. The valve is slightly tilted to show the receding dental plates. Note the pustulose surface near the commissure.

Figure 21. Interior view (x2) of brachial valve No. 15810 from the same individual as the valve of fig. 20. The valve is tilted and shows the lirate flange to the visceral area, the large cardinal process, and the character of the medium septum.

Figure 22. Interior view (x2) of another pedicle valve (No. 15811) from locality 35166, showing the deltidium.

Figure 23. Enlarged view (x4) of the posterior part of the valve shown by fig. 21. The apparently trifid cardinal process, the brachiophores, and the median septum are well shown.

Figure 24. Enlarged view (x8) of the anterior face of the cardinal process of the valve of fig. 21.

Petalocrinus mirabilis Weller and Davidson ..... page 25

Figure 25. A cluster of arm-fans partly etched from matrix and probably derived from the same crinoid; No. 15813 from locality 35165.

Figure 26. Enlarged view (x2) of the dorsal surface of arm-fan No. 15814 from locality 35170.

Figure 27. View of the ventral surface of the arm-fan of fig. 26.

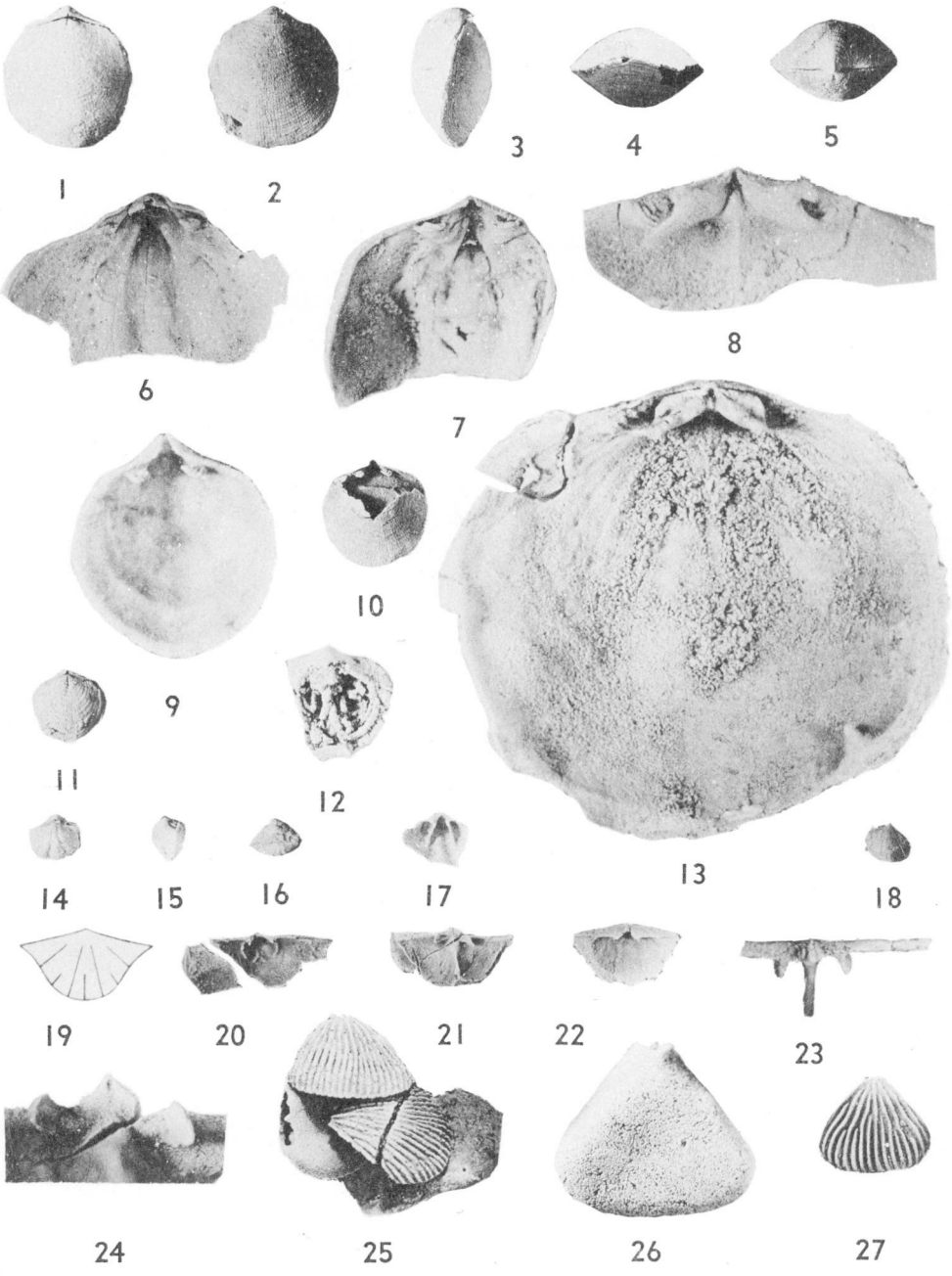
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Plate V

Heliolites cf. *H. megastoma* (M'Coy) ..... page 26

Figure 1. Top view of corallum No. 15816 from locality 35168. Note the variation in the spacing of the tabularia within the corallum.

Figures 2, 3. Top and bottom views of corallum No. 15815 from locality 35165.

Figures 4, 5. Enlarged views (x4) of longitudinal and transverse sections (Nos. 15729 a and b) of a corallum from locality 35170.

Favosites favosus (Goldfuss) ..... page 28

Figure 6. Top view of a fragmentary corallum (No. 15850) from locality 35170.

Figures 7, 11. Enlarged views (x4) of transverse and longitudinal sections (Nos. 15730 b and a) of another corallum from locality 35170.

Thamnopora sp. ..... page 29

Figures 9, 10. Views of a fragment (No. 15852) of a corallum from locality 38279; natural size and x2.

Figure 8. Enlarged view (x4) of transverse section No. 15731a of a poorly silicified corallum from locality 35170.

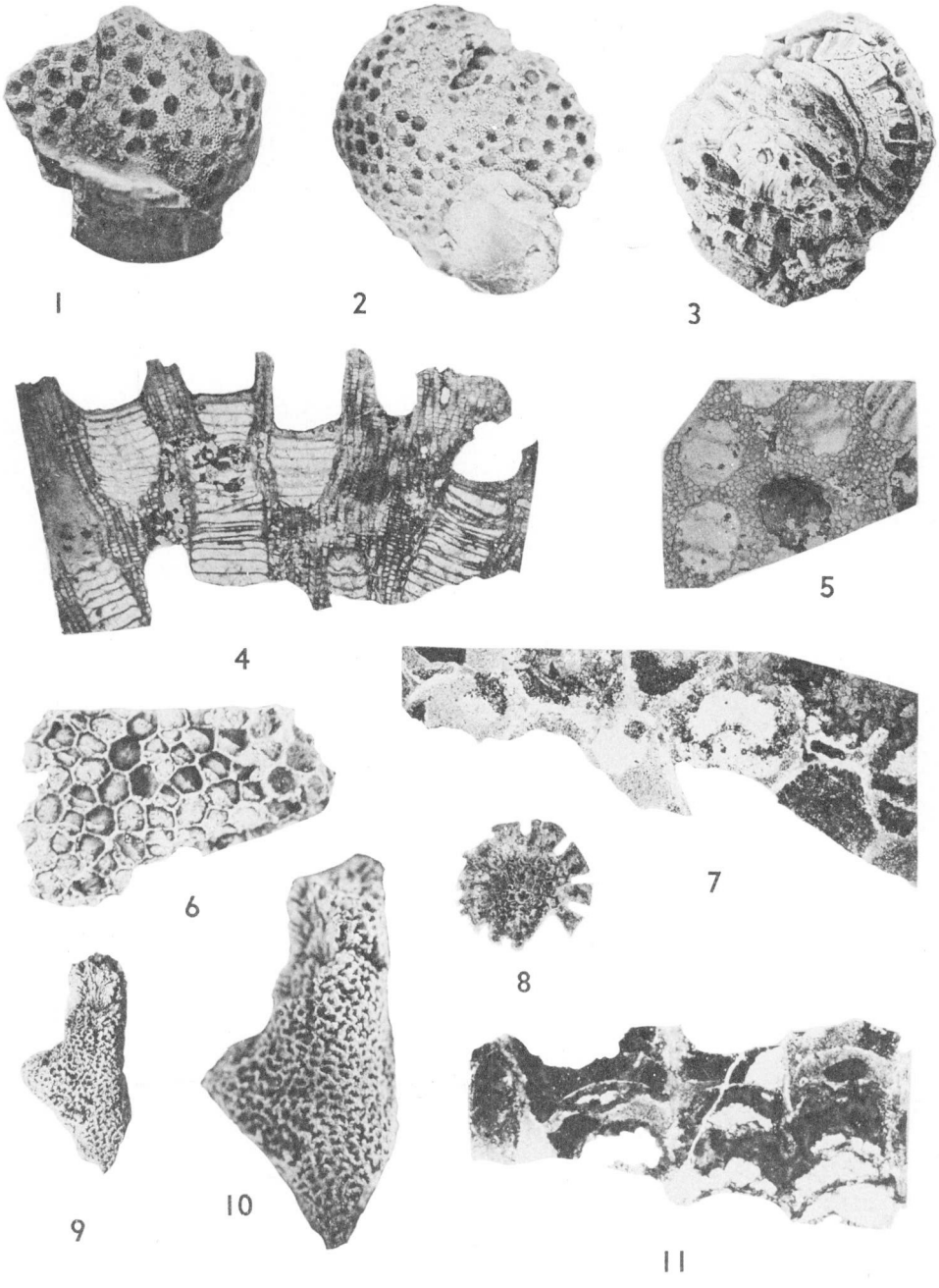
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PLATE VI

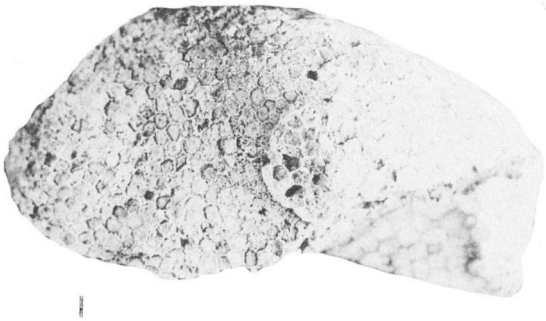
Favosites cf. *F. brownsportensis* Amsden ..... page 27

Figures 1, 2. Top and side views of corallum No. 15818 from locality 38278.

Figure 3. Bottom view of corallum No. 15819 from locality 35165. Growth lines are visible on the epitheca.

Figures 4, 6. Enlarged views (x4) of transverse and longitudinal sections (Nos. 15818 b and a) from the corallum shown in fig. 1.

Figure 5. Top view of corallum No. 15817 from locality 35169.



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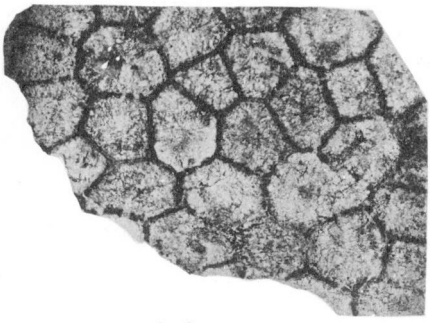

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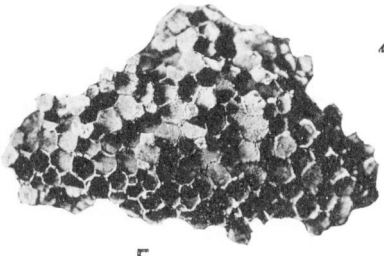

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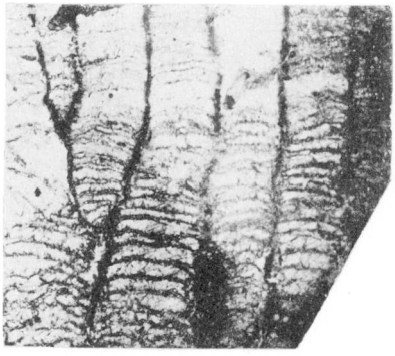

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PLATE VII

Favosites discoideus (Roemer) ..... page 28

Figures 1, 2. Side and top views of corallum No. 15820 from locality 35169. Mural pores are visible in fig. 1.

Figures 3, 4. Top and bottom views of another corallum (No. 15822) from locality 35169; the corallites are small in this specimen. Growth lines are visible on the epitheca in fig. 4.

Figures 5, 6. Enlarged views (x2; x4) of longitudinal and transverse sections (Nos. 15732 a and b) of a third corallum from locality 35169.

Figure 7. Enlarged view (x4) of part of the corallum shown by fig. 4.

?*Striatopora* sp. cf. *S. gwenensis* Amsden ..... page 29

Figure 8. Side view of part of corallum No. 15823 from locality 35165. The outer surface is preserved only in the upper left of the specimen, elsewhere can be seen the thinner intercorallite walls below the outer surface.

Figure 9. Enlarged view (x2) of part of the same corallum, showing the calyxes.

Coenites laminatus (Hall) ..... page 29

Figure 10. View of a well-preserved fragment (No. 15824) in which the upper lips of the calyxes are present; locality 35168.

Figure 12. Enlarged view (x4) of part of the same corallum.

Coenites rectilineatus (Simpson) ..... page 30

Figure 11. View of a typical corallum (No. 15821) from locality 35168.

Figures 13, 14. Enlarged views (x4) of transverse and longitudinal sections (Nos. 15733 b and a) of a fragment from locality 35168.

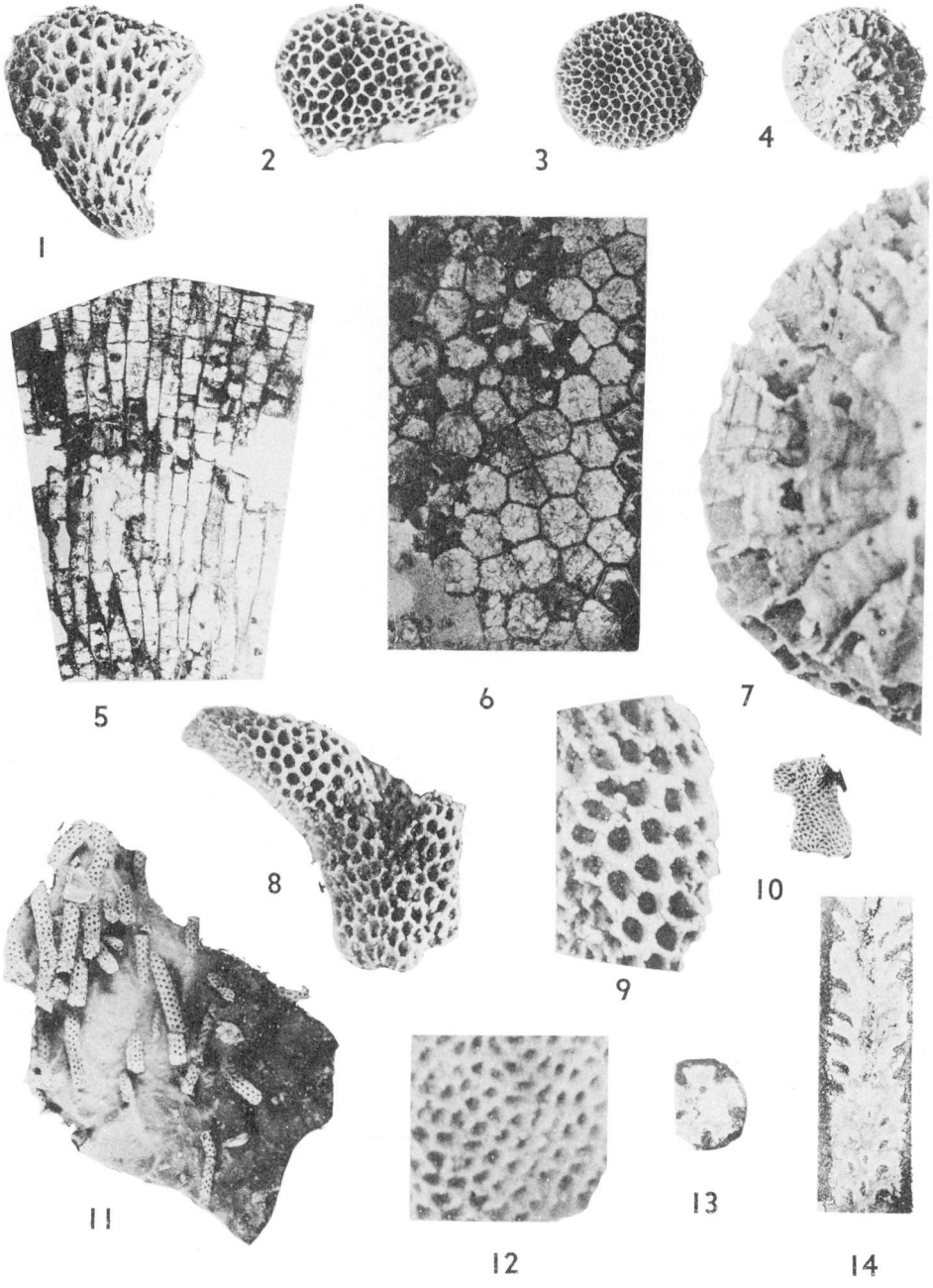
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PLATE VIII

Halysites nitida Lambe ..... page 31

Figure 1. View of part of the upper surface of corallum No. 15825 from locality 35167.

Figures 2, 3. Enlarged views (x4) of transverse and longitudinal sections (Nos. 15825 b and a) from this corallum. The calyxes of the corallites are visible in fig. 3.

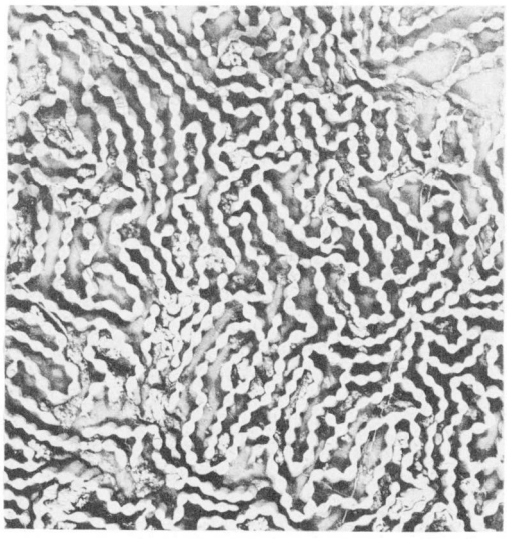
Halysites sandpilensis n. sp. ..... page 32

Figure 4. Top view of the holotype (No. 14485) from locality 35164.

Figures 5, 7. Enlarged views (x4) of transverse and longitudinal sections (Nos. 14485 a and b) from the holotype.

Figure 6. Bottom view of a small corallum (paratype No. 15826) from locality 38278.

Figure 8. Enlarged, retouched view (x4) of a longitudinal section (paratype No. 15730a) from a corallum from locality 38278.



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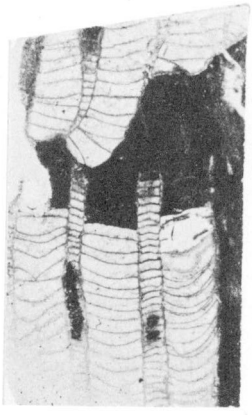

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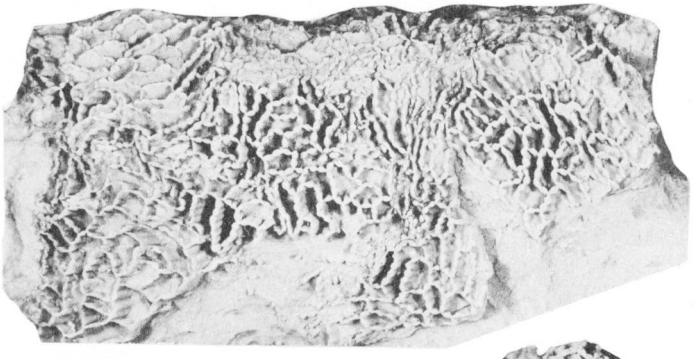

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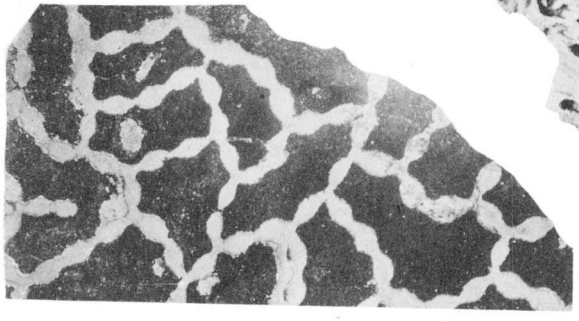

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PLATE IX

Halysites occidens n. sp. ..... page 32

Figure 1. Top view of the holotype (No. 14484) from locality 35170.

Figures 2, 5. Enlarged views (x4) of longitudinal and transverse sections (Nos. 14484 a and b) from the holotype.

Figures 3, 4. Top and side views of a corallum (paratype No. 15828) from locality 38278. Fig. 3 shows small regular lacunae in a part of the corallum; the depths of the calyxes can be judged in the left of the photograph. Fig. 4 shows the rapid divergence of the ranks of corallites at the base of the corallum.

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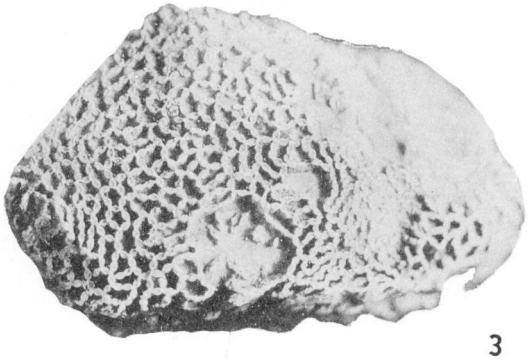

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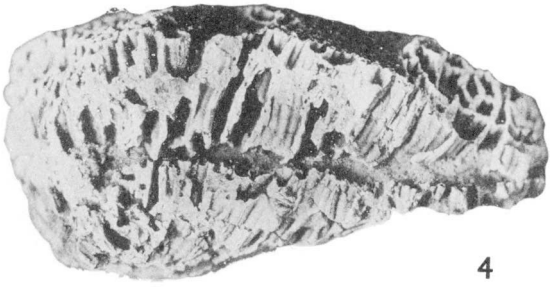

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Plate X

Catenipora simplex (Lambe) ..... page 33

Figure 1. View of corallum No. 15829 from locality 35168.

Figure 2. Enlarged view (x4) of a longitudinal section (No. 15829a) from the corallum in fig. 1; showing intermural increase.

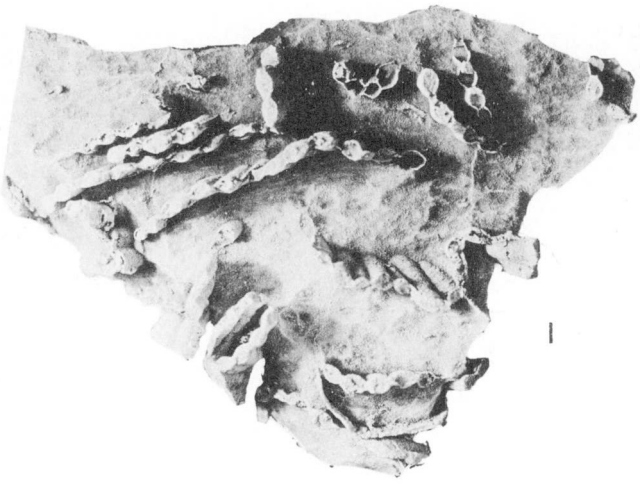
Figure 3. Enlarged view (x10) of a transverse section (No. 15752a) from a corallum in locality 35169. A tiny autocorallite, formed by intermural increase, is visible between two larger ones.

Cystihalysites magnitubus (Buehler) ..... page 34

Figure 4. View of part of corallum No. 15848 from locality 35165.

Figures 5, 6. Enlarged views (x4) of transverse sections (Nos. 15754a and 15757a) from fragments of coralla from localities 35164 and 35166.

Figures 7, 8. Enlarged views (x4) of longitudinal sections (Nos. 15757 b and c) from the same fragment as the section in fig. 6. That of fig. 8 was cut parallel to the rank of corallites, that of fig. 7 orthogonal to the rank and through the central region of a mesocorallite. Note the variation in the appearance of the mesocorallites in fig. 8, according to the accuracy of the centring of the section.



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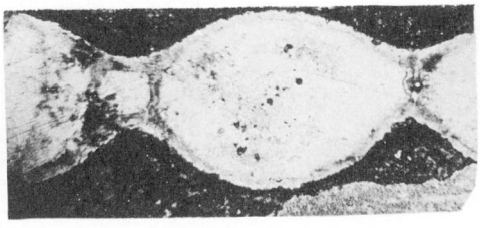

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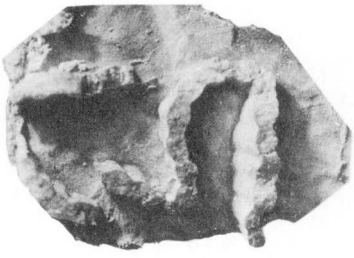

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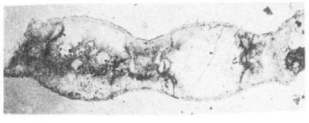

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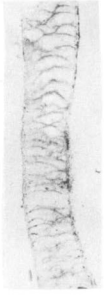

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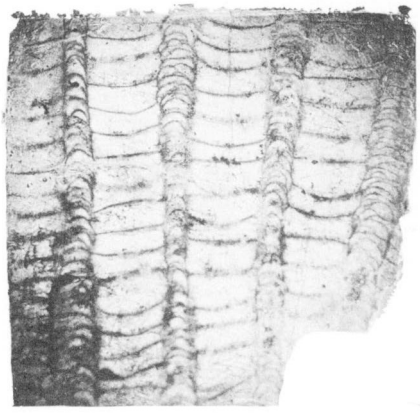

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PLATE XI

Cystihalysites sp. 1 ..... page 36

Figure 1. Top view of corallum No. 15830 from locality 35165.

Figures 2, 3. Enlarged views (x4) of transverse and longitudinal sections (Nos. 15830 b and a) from the corallum in fig. 1. Septal spines are visible in fig. 2.

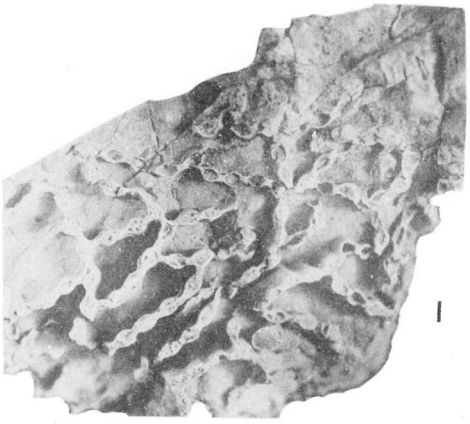
Cystihalysites sp. 2 ..... page 36

Figures 4, 5. Top and side views of corallum No. 15831 from locality 35170.

Figure 6. Enlarged view (x10) of a transverse section (No. 15763a) from another corallum from locality 35170; showing cystose tabulae lining the auto-corallite walls.

Figure 7. Enlarged view (x10) of a longitudinal section (No. 15831a) from the corallum shown in fig. 4.

Figures 8, 9. Enlarged, retouched views (x4) of the section shown in fig. 7, and another (No. 15831b) from the same corallum.



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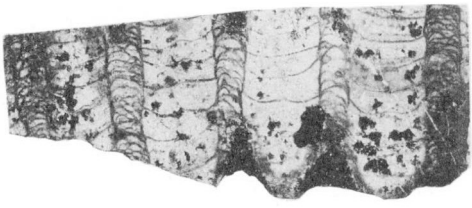

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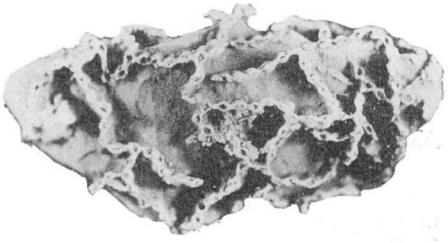

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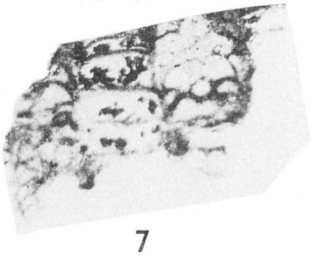

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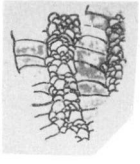

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PLATE XII

Auloporella cf. *A. typa* Grubbs ..... page 37

Figure 1. Enlarged view (x4) of a longitudinal section (No. 15764a) of a fragment from locality 35166. Dissepiments are visible, the apertural part of each corallite is outside the plane of the section.

Figure 2. Drawing of the section shown in fig. 1.

Figure 3. A corallum fragment (No. 15851) from locality 35166. The apertural regions are slightly broken, revealing the dissepiments.

Romingeria niagarensis (Rominger) ..... page 37

Figures 4, 5. Side views (x4) of corallites (Nos. 15832 and 15833) from locality 35165. Note the lateral increase with the offsets forming an umbellate whorl around the parent.

Figure 6. Enlarged view (x4) looking down on the corallites shown in fig. 5.

Romingeria cf. *R. vannula* Davis ..... page 38

Figure 7. Side view of corallum No. 15836 from locality 35165.

Figure 8. Enlarged view (x4) of part of the corallum shown in fig. 7, revealing the umbelliferous lateral increase.

Figure 9. Enlarged view (x4) of corallite No. 15841 from the corallum shown in fig. 7.

Syringopora sp. ..... page 39

Figure 10. Side view of corallum No. 15849 from locality 35170.

Figure 11. Enlarged view (x4) of a transverse section (No. 15765a) from another corallum in locality 35170.

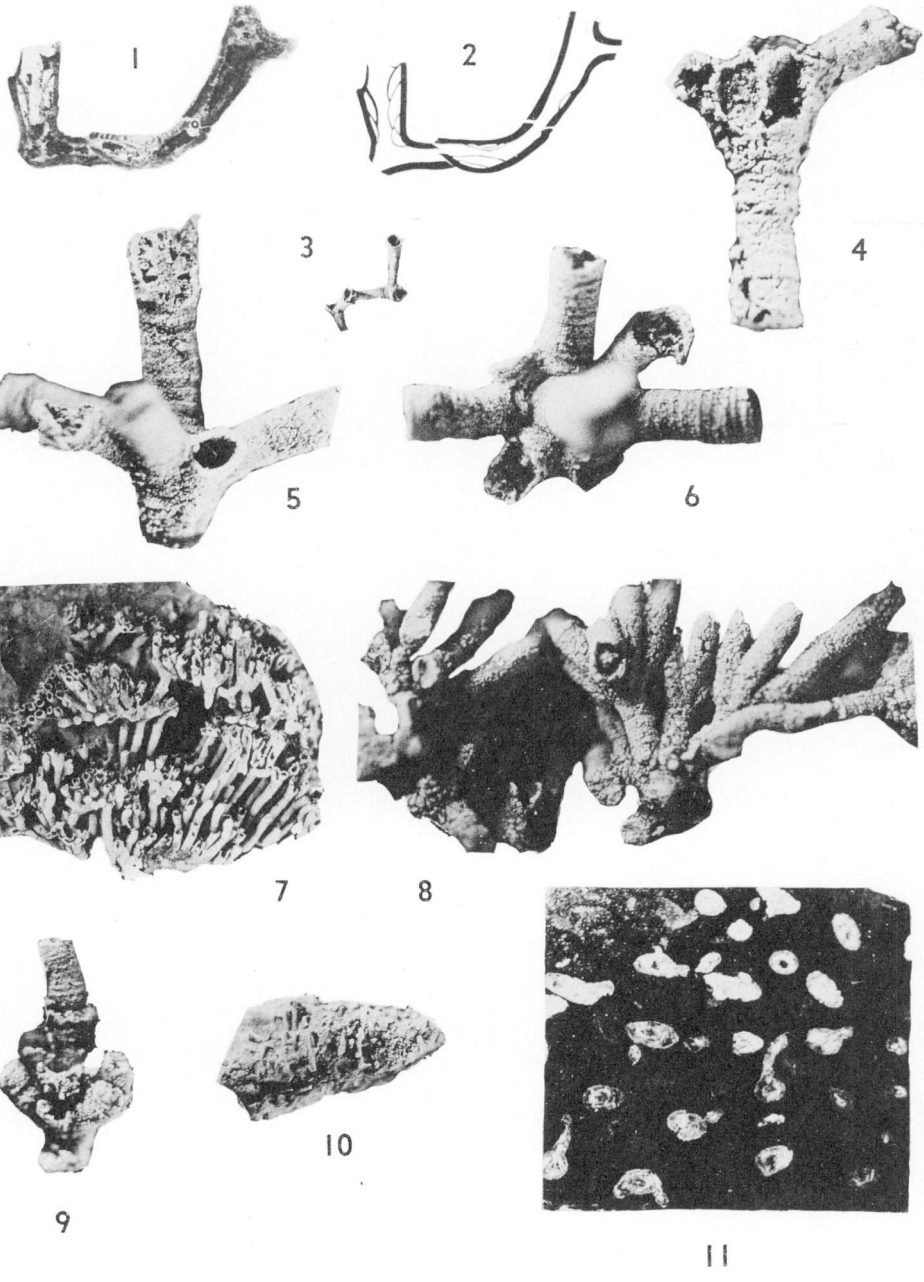
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Plate XIII

Syringopora verticillata Goldfuss ..... page 39

Figure 1. Side view of corallum No. 15827 from locality 35164.

Figures 2, 4, 7. Views (x1; x4; x4) of transverse and longitudinal sections (Nos. 15827b, a, and b) of corallites from the corallum shown by fig. 3.

Figure 3. View of the base of part of another corallum (No. 15827) from locality 35164; showing the lateral increase.

Asthenophyllum cf. *A. occidentale* (Whiteaves) ..... page 40

Figure 5. Lateral view of corallite No. 15847 attached to a specimen of *Atrypa gabrielsi* n. sp.; locality 35166.

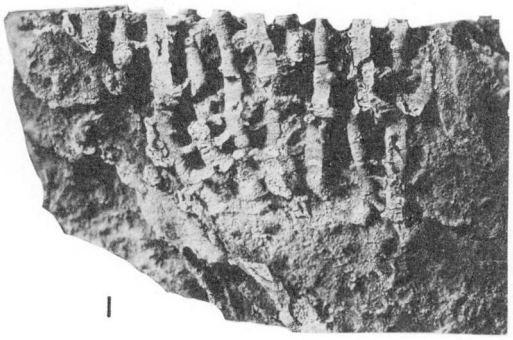
Figure 6. Calyx view of the same corallite, enlarged (x4).

Cystiphyllum cf. *C. tubiforme* Poulsen ..... page 43

Figure 8. Lateral view of a solitary corallite (No. 15838) from locality 35167.

Figures 9, 10. Enlarged views (x4) of transverse and longitudinal sections (Nos. 15838 b and a) from the corallite of fig. 8.

Figure 11. Transverse section (No. 15766a; x2) taken at the site of increase in a corallite from locality 35170.



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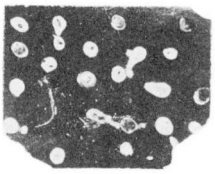

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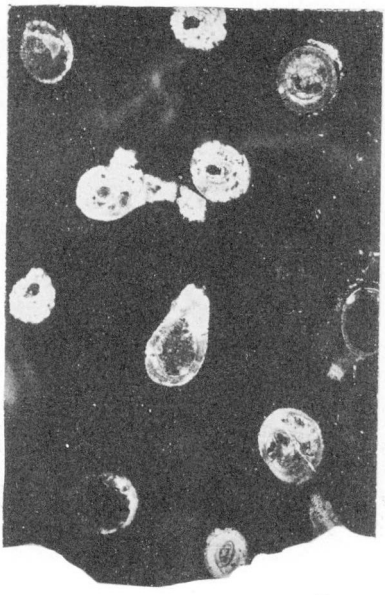

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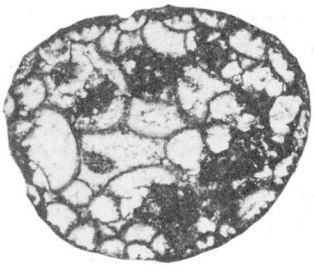

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Plate XIV

?Entelophyllum sp. ..... page 40

Figures 1, 2. Top and lateral views of an incomplete, partly etched corallum (No. 15839) from locality 35168.

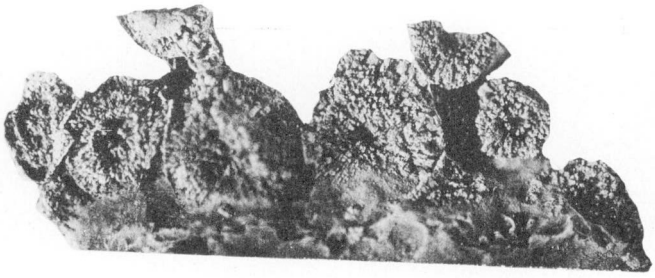
Figures 3, 4. Enlarged views (x2) of transverse and longitudinal sections (Nos. 15839 b and a) of corallites from the corallum shown by fig. 1.

Ptychophyllum sp. ..... page 41

Figures 5, 6. Lateral and calyx views of corallite No. 15845 from locality 38278. The axial part is very poorly preserved.

Figure 7. Enlarged view (x2) of a transverse section (No. 15767a) from another corallite from locality 38278.

Figure 8. Lateral view of corallite No. 15840 from locality 35164. The epitheca is missing.



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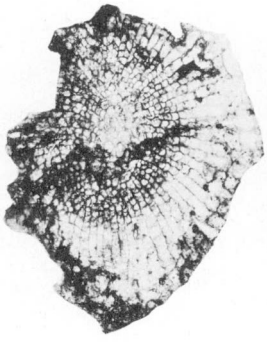

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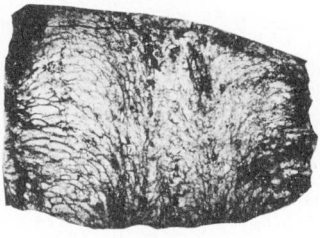

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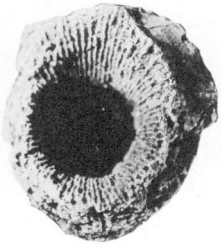

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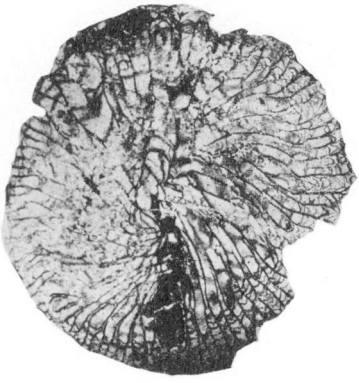

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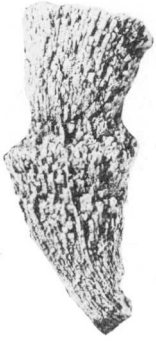

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PLATE XV

Fletcheria deadwoodensis n. sp. ..... page 41

Figure 1. View of one of the two pieces of the holotype (No. 14488 from locality 35168).

Figures 2, 3. Enlarged views (x4) of longitudinal and transverse sections (Nos. 14488 a and b) from the holotype. Immediately before increase, corallites are larger than those shown.

Figure 4. View of part of another corallum (paratype No. 15843) from locality 35168.

Figure 6. Enlarged view (x4) looking down into the calyx of the corallite shown by fig. 11.

Figures 7, 10. Enlarged views (x4) of longitudinal and transverse sections (paratypes Nos. 15751a and 15750a) of corallites from locality 35164. Fig. 7 shows a section through a site of increase.

Figures 9, 11. Enlarged lateral views (x4) of corallites (paratypes Nos. 15835 and 15834) from locality 35168, showing the quadripartite axial increase.

Fletcheria major n. sp. ..... page 42

Figure 5. Lateral view of the holotype (No. 14489 from locality 35170). The specimen is slightly tilted. The lower right-hand corallite shows the quadripartite axial increase, several broken corallites reveal the short septa lining the inside of the wall.

Figures 8, 12, 13. Transverse and longitudinal sections (Nos. 14489b, a, b; x2, x2, x4) from the holotype.

Figure 14. Longitudinal section (paratype No. 15746a; x4) from another corallum in locality 35170.

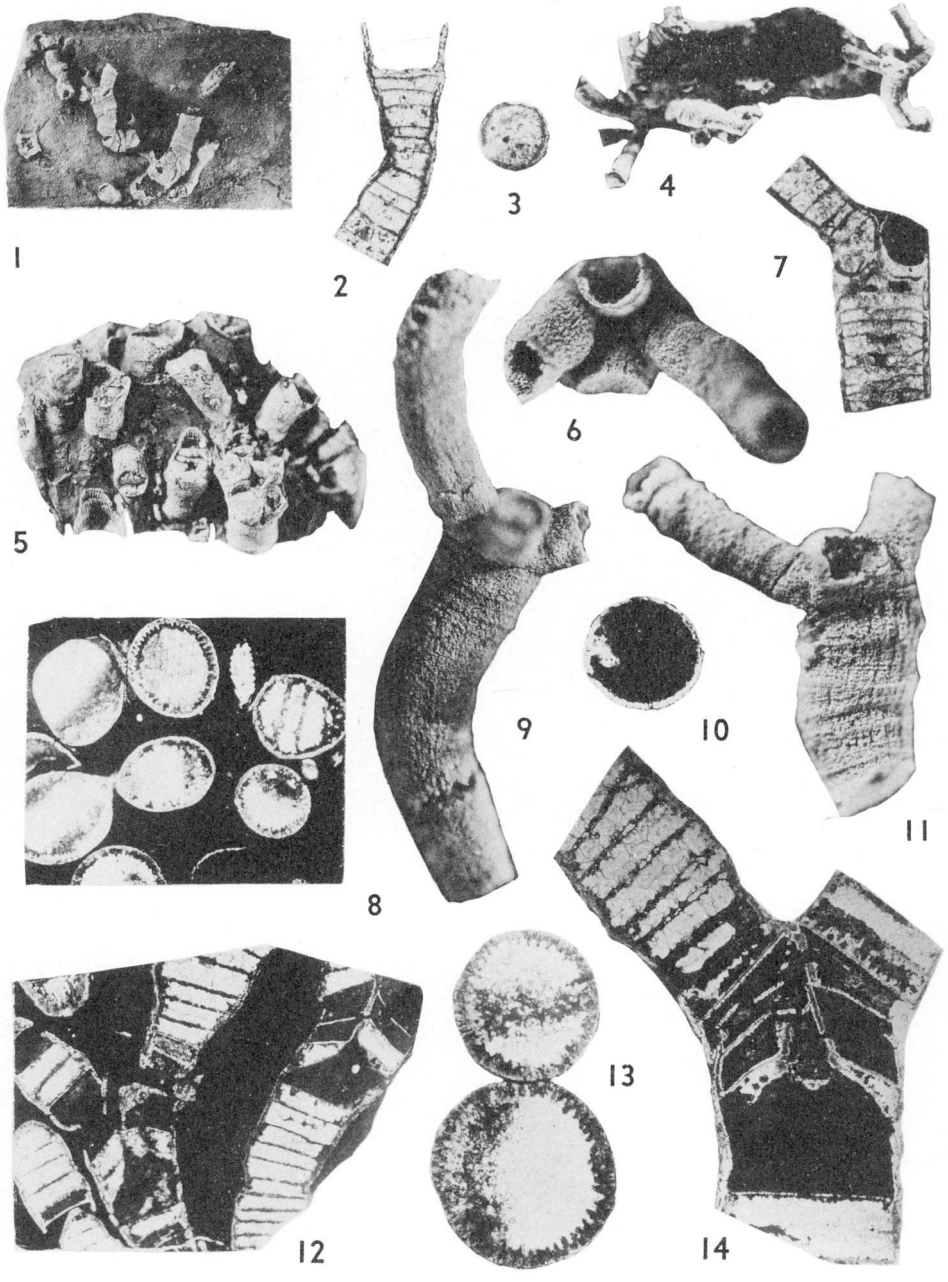
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PLATE XVI

"Cyathophyllum" aff. *"C" pennanti* Billings ..... page 42

Figures 1, 4. Lateral and top views of corallum No. 15844 from locality 35165. Note the variable size of the offsets, and also the small talons.

Figures 2, 3. Enlarged views (x4) of transverse and longitudinal sections (Nos. 15844 b and a) from the corallum shown by fig. 1.

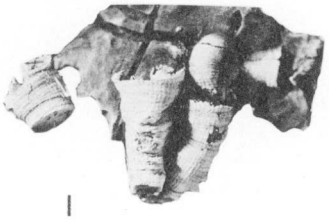
Figure 8. Enlarged view (x4) of a longitudinal section (No. 15769a) from another corallite from locality 35165, showing the depth of the calyx and the nature of the increase.

Cystiphyllum sp. 1..... page 44

Figure 5. Lateral view of part of corallite No. 15846 from locality 38278. On the left the epitheca is preserved, to the right it is missing and the dissepiments are visible.

Figure 7. Enlarged view (x2) of a transverse section (No. 15846b) from the corallite shown by fig. 5.

Figure 6. Enlarged view (x2) of a transverse section (No. 15770a) of a smaller corallite from locality 35168.



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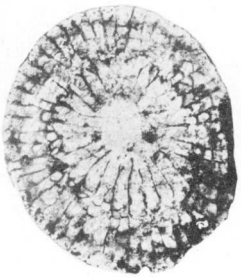

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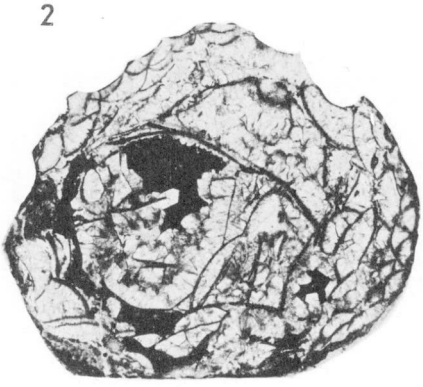

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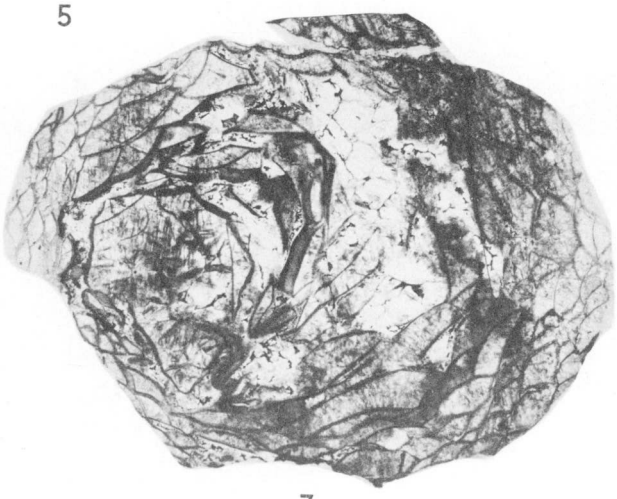

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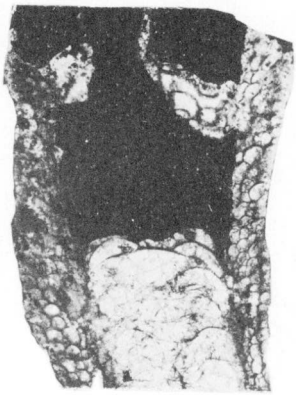

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