FACIES AND FOSSILS OF THE ONONDAGA LIMESTONE IN CENTRAL NEW YORK

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INTRODUCTION

Four members of the Onondaga limestone are recognized in the central part of New York State: Edgecliff, Nedrow, Moorehouse, and Seneca. Detailed descriptions of these members may be found in Oliver (1954, 1956) and Feldman (1985). Paleocommunity analyses of the non-reefal aspects of the Onondaga Limestone have been made by Lindemann (1980) and Feldman (1980) while Lindemann and Feldman (1981) have summarized the stratigraphy, lithofacies and paleocommunities of the Onondaga in the Syracuse area. We believe that the formation in this area has been studied thoroughly, consequently, the purpose of this trip is to sample the fauna in order to: [1] Become familiar with the fossils that are characteristic of the Onondaga, and [2] Attempt to correlate the various taxa with their paleoenvironments. This trip, therefore, will concentrate on collecting the fossils of the Onondaga Limestone in the Syracuse area.

The most abundant invertebrate fossils of the Onondaga which lend themselves to collecting in this extremely dense limestone are the brachiopods and corals. Brachiopod collecting is usually best accomplished in the shaly Nedrow Member, at the base of shale lenses, followed by well weathered Moorehouse and Seneca strata. Corals are most abundant in the Edgecliff Member. Since the Onondaga weathers very slowly it is best to locate bedding planes which have not been touched for several years, if possible.

EARLY HISTORY

Students of New York Geology probably require little introduction to the Onondaga Limestone. Firmly established in the geologic literature as the State's lowermost Middle Devonian formation, the Onondaga is one of its most prominent units due, in part, to the fact that it is laterally continuous from the central Hudson River Valley north to the Helderbergs and west to the Niagara River and the Ontario Peninsula. Between Buffalo and the Helderbergs the formation's resistence to erosion, slight southerly dip, and position in section place it atop an escarpment defining the southern margins of the Ontario lowlands and the Mohawk Valley; a situation which provided early explorers and geologists with a wealth of natural exposures.

Following on the heels of the American Revolution, the westward expanding settlement of New York prompted exploration for transportation routes, mineral resources, and building materials. In the bad old days long before central heating, finished lumber, and fiberglass insulation, quarried-stone and kiln-produced mortar and plaster were, where available, valuable building materials. Historic records document the former workings of hundreds of quarries and kilns by which the Onondaga supplied construction industries of the early 1800's. This gives the formation a role in human history and, as 1986 marks the sesquicentennial of the New York Geological Survey, it seems appropriate to note some of the highlights in the history of geologic activities leading to our current understanding of the Onondaga Limestone.

Geologic observations made during the pre-Survey years are summarized by Wells (1963). Even a casual reading of Wells' book leaves little doubt that fossils figured significantly among descriptions recorded during the early 1800's. In 1803 Compte de Volney collected fossil specimens from the strata now referred to as the Onondaga and sent them to Lamarck in France. The first published illustration of a fossil from the New York Devonian, which appeared in 1807, is that of a "sheep horn" collected from the Onondaga. Wells (1963, p. 14), reaching a slightly different conclusion, considered the specimen to be the gyroconic nautiloid Goldringia cyclops. The year 1810 found future New York governor De Witt Clinton in the field checking on potential routes for a proposed canal linking Lake Erie and the Hudson River. Noting details and fossils of the limestone escarpments which traverse the State, Clinton made some of the earliest interpretations of Devonian water depths (p. 18). Furthermore, Wells (1963, p. 38) reported that in 1822 Clinton anonymously published a series of geologic observations among which can be found the statement "...a great limestone ridge runs throught the whole of this country, east to west...north of it a ledge of gypsum commences...." Obviously this is not the first observation of the Onondaga Formation, but it may be the earliest to demonstrate knowledge of a discrete limestone body extending fully across the State. During this time Amos Eaton, Senior Professor of the Rensselaer School (RPI), was hard at work trying to document and make sense of New York's geologic column. The conceptual necessity to reproduce the strata of Europe severely hampered Eaton's work. However, in 1824 (Wells, 1963, p. 42) he recognized a limestone unit with abundant "hornstone" (chert) which he named the Cornitiferous limerock. Four years later, Eaton (1828, p. 153) recognized "lower or compact" and "upper or shelly" divisions within the unit. This then was the status of what would later become the Onondaga Limestone when, in 1836, Governor William Marcy established the Survey of New-York. Within the next decade work of the Survey's principal geologists Emmonds, Hall, Mather, and Vanuxem would alter the course of geologic investigations in North America. Eaton did not live to see his work completed; he died on Tuesday, May 10, 1842.

The completed reports of the original four district surveys brought the Onondaga Limestone into a fairly modern aspect. Since Emmond's Second District lies beyond the formation's limits and Mather contributed little original information in his First District report, we will concentrate on the reports of Vanuxem (1842) and Hall (1843). In examining the writings of these two pioneer geologists we should bear in mind that Vanuxem considered the term "formation" to be ambiguous and eschewed its use while Hall, holding to the principle that similar products result from similar processes, saw no such ambiguity and promoted the term. This dichotomy is clearly shown by the ways in which the two geologists treated similar observations. Relative to the Onondaga Limestone, Vanuxem was a "splitter" and Hall a "lumper."

Following Hall's (1841) nomenclatural lead, Vanuxem (1842, p. 132) recognized the then Onondaga Limestone and described its "light grey color, crystalline structure, toughness, and its organic remains which are very numerous." He noted that the Onondaga contained numerous "smooth encrinal stems" exceeding a half inch in diameter and that the unit maintained a thickness of 10-14'. Succeeding the Onondaga, Vanuxem (1842, p. 139) recognized, as a discrete unit, the cherty Corniferous Limestone, measuring 60-80 ' in thickness at Cherry Valley. Above the Corniferous, Vanuxem (1839, p. 275) identified a set of chert-free limestone beds with abundant *Strophomena* ("*Chonetes*") *lineata* which he referred to as the Seneca Limestone. It is evident from his annual report (1939) and final report (1842) that, while in print he treated it as a subdivision of the Corniferous, Vanuxem considered the Seneca to be a separate unit. He only refrained from completing the divorce in the final report due to uncertainties resulting from the absence of a Seneca lithology and fauna in the Helderberg area.

Working in the Fourth Geological District, which covers much of New York's western half, Hall (1843) expanded on the detail of Vanuxem's report. Beneath the Onondaga Limestone Hall (1843, p. 151) reported on "a few inches of sandstone" which he referred to the Schoharie Grit. He (1843, p. 152) described the Onondaga as 1-40' of limestone with "light grey color often approaching to white, more or less crystalline in structure, and containing numerous fossils." Noting extreme variations in chert abundance as well as alternating chert-rich and chert-free strata, Hall included the "cherty mass" with the Onondaga rather than with the Corniferous Limestone above. Attending to details, Hall described the now famous Onondaga reefs, complete with various facies, and devoted considerable attention to interpreting depositional environments. Working at a time when many people, geologists included, still believed the earth to be very young, he (p. 156) noted that "the simple fact of the successive growth of coral upon deposits covering other corals, of itself proves a great lapse of time; for the growth of all these forms is exceedingly slow."

Above the Onondaga, Hall found that the Corniferous Limestone thickened westward from less than 30' in Seneca County to in excess of 71' at Leroy, and that its "hornstone content" showed considerable variation between localities. Recognizing, as had Vanuxem, that the upper Corniferous strata lacked chert, it is interesting to note that, in a quarry near Waterloo, Hall (1843, p. 163) found a "separation of the higher and lower strata by a 'wayboard,' or a seam of (yellowish) clay about four inches thick." This is an early description of the Tioga Bentonite which, in modern stratigraphic terminology separates the Moorehouse and Seneca members of the Onondaga Formation. As we have seen, the Onondaga of today was not recognized at the time that Hall wrote the report of the Fourth District. However, noting vertical and lateral lithologic variations within both the Onondaga and Corniferous (including Seneca) limestones which approximate the differences between them, Hall (several pages) was adamant that they be united as "one formation" (p. 152) with divisions based on fossil content. This brought the earlier observations of De Witt Clinton to a full circle in establishing a single unit and set the stage for today's concept of the Onondaga Limestone.

LITHOSTRATIGRAPHY AND BIOSTRATIGRAPHY

In time, the formational name Onondaga Limestone came to encompass the 1836 Geological Survey's Onondaga, Corniferous and Seneca limestones. Based on observations made in Hall and Vanuxem's type areas of Onondaga and Seneca counties, Oliver, (1954) formally divided the Onondaga into four members. In vertical succession these are the Edgecliff (formerly Onondaga), Nedrow, Moorehouse (formerly Corniferous), and Seneca limestones.

The Edgecliff is a thick bedded to massive, light gray to pink, poorly washed to unsorted biosparite. The basal bed(s) of the member contains quartz sand which, in some places, is sufficiently abundant to constitute a quartz arenite. The Edgecliff fauna abounds with rugose corals, tabulate corals and crinoids. At Split Rock, the type locality, the Edgecliff is 8' (2.3 m) thick. Its thickness is highly variable to the west and generally increases eastward to about 48' (15 m) in the Mid-Hudson Valley.

Succeeding the Edgecliff in central and eastern New York, the Nedrow Member is a 10-14' (3-4.3 m) sequence of thinly bedded, dark gray, argillaceous, fossiliferous to sparse biocalcisiltites. While brachiopods dominate the megafauna and the unit is typified by platyceratid gastropods and the small rugosan <u>Amplexiphyllum hamiltoniae</u>, thin sections reveal that in many places the Nedrow is numerically and volumetrically dominated by the microfossil <u>Styliolina fissurella</u>. The Nedrow undergoes an eastward facies change and thickens to approximately 43' (13 m) near Catskill. In western New York it overlies the Clarence Member and is of uncertain thickness.

Gradational with and succeeding the Nedrow, the Moorehouse Member is a 24' (7.3 m) unit of laminated to thick bedded, dark gray, argillaceous, cherty, sparse biocalcisiltite. Shale partings typically separate the limestone strata. The fauna is dominated by a diversity of brachiopods with lesser numbers of trilobites and gastropods. Both east and west of its central New York type section at Jamesville, the Moorehouse thickens and undergoes a facies change to cleaner and coarser grained textures with crinoid-coral faunas.

The Moorehouse is overlain by 4-6' (10-15 cm) of yellowish clay, the Tioga Bentonite, which is the lowermost bed of the Seneca Member. A 26' (7.8 m) unit of dark-gray, fossiliferous and sparse biocalcisiltites, the Seneca becomes increasingly argillaceous upward. In central New York the fauna is dominated by the diminutive strophomenid brachiopod "*Chonetes*" *lineata* which is found in a zone approximately 10' (3 m) above the Tioga. The Seneca is overlain by black shales of the Marcellus Formation.

The base of the Onondaga Limestone has long been considered to coincide with the base of the Middle Devonian in New York State (Rickard, 1975). The biozones of conventional megafossils such as brachiopods, corals and cephalopods are summarized by several authors in Oliver and Klapper (1981); all support this age assignment relative to other North American faunas. Unfortunately, these megafossils are restricted to North America and direct correlation with European biozones is not possible. This difficulty in correlation was recently compounded when the International Union of Geological Sciences ratified the decision of the Subcommission on Devonian Stratigraphy that the base of the Middle Devonian Series and of the Eifelian Stage coincide with the first occurrence of the conodont *Polygnathus costatus partitus* (Ziegler and Klapper, 1985). The subspecies *partitus* is the second in a lineage of three which are sequentially related. Thus, the bottom of the *patulus* Zone is high in the Emsian Stage and the bottom of the *costatus* Zone is well within the Eifelian. Klapper (in Oliver and Klapper, 1981) reported that the upper Nedrow beds at Cherry Valley yield both *Polygnathus costatus costatus* and *P. c. patulus*, placing the member's top well within the *partitus* Zone. Noting this along with the fact that *P. c. partitus* is unknown from the Onondaga, Ziegler and Klapper (1985) suggested, with question marks, that the Edgecliff Member is within the *patulus* Zone and correlative to the Emsian Stage of the Lower Devonian Series. At this time, the absence of definitive taxa from the Edgecliff, Clarence, and lower Nedrow members leaves the precise age of the lower Onondaga in a very gray (N 3?) area.

ONONDAGA LITHOFACIES

Lindemann (1980) identified six carbonate lithofacies of the Onondaga Formation on the basis of relative abundances of calcisiltite, bioclasts, cement, argillaceous mud and pyrite as point-counted in thin section. Four of these lithofacies are well represented in central New York and figure in this discussion. Mean abundances of their constituents are shown in Table 1 and descriptions follow. As the lithofacies do not exactly correspond to formally named carbonate lithologies, they are referred to by Roman numerals.

Lithofacies VI. Lithofacies VI consists of thick bedded to massive, light gray, poorly washed to sorted biosparites. Varying abundances of quartz sand are present in samples from the lower beds of the Edgecliff Member. Comminuted crinoids and bryozoans dominate the fossils seen in thin sectioned samples from central New york. While evidence of bioturbation is rarely observed, vertical burrows are common as are shell lag concentrates and cross-laminae. Rare cryptalgal laminae, oncolites and the calcareous alga *Asphaltina* are present. This lithofacies is characteristic of the Edgecliff throughout the state and also occurs higher in the formation in eastern and western New York.

Lithofacies VI is interpreted as having been deposited under shallow shelf conditions in wave-agitated waters of very low turbidity.

Lithofacies II. Lithofacies II consists of medium bedded to massive, medium gray packed biocalcisiltites. Crinoids and bryozoans dominate the fossils in thin section and in the field. Intimately associated with Lithofacies VI, and occurring in the Edgecliff throughout the state and the upper Onondaga to the east and west, Lithofacies II differs primarily in its paucity of interparticulate cement. There are additional faunal differences, but these do not figure in lithologic descriptions.

Lithofacies II is interpreted as having been deposited under nonturbid carbonate shelf conditions quieter than, but similar to, those of Lithofacies VI. Stratigraphic distribution and association with other moderate energy lithofacies indicate that II was depositied just offshore from, or in slightly deeper water than VI. Lagoonal conditions are not indicated in central New York.

Lithofacies III. Lithofacies III consists of laminated to medium bedded, dark gray, argillaceous calcisiltite, fossiliferous calcisiltite and sparse biocalcisiltite. The pyrite content of this lithofacies does not exceed 1 percent in central New York. Comminuted crinoids and trilobites dominate the megafossils in thin section and the microfossil *Styliolina fissurella* reaches its maximum abundance. Fossils are occasionally concentrated in thin stringers associated with argillaceous laminae. However, most fragments were scattered by intense bioturbation. This lithofacies predominates in the Nedrow of central New York and in the Moorehouse elsewhere in the state.

Lithofacies III is interpreted as having been deposited in quiet, moderately turbid water offshore from Lithofacies VI and II. Restricted circulation and low oxygen levels are not indicated. The sediment's fine grained nature suggests a flocculent or soupy sediment-water interface, a condition not particularly conducive to colonization by the larvae of sessile organisms. This accounts for the relative abundance of calcisiltites and planktonic styliolines.

Lithofacies V. Lithofacies V consists of laminated to medium bedded, dark gray, highly argillaceous fossiliferous calcisiltites and sparse biocalcisiltites. Trilobites dominate the fossils in thin section and share dominance with brachiopods in field observations. *Chondrites* and general bioturbation are abundant. This facies is virtually restricted to the Moorehouse and Seneca members of central New York where it is intimately associated with Lithofacies III. It differs from III in containing about twice as much argillaceous mud and slightly more pyrite (Table 1).

Lithofacies V is interpreted as having been deposited in quiet, relatively deep and turbid water in and near the subsiding axis of the Appalachian Basin. Because this facies occurs in the area of the formation's lowest rate of sedimentation, probably less than half that of some sites to the east for example, the magnitude of real day-to-day turbidity required to attain its approximately 20 percent argillaceous content is uncertain. While fluctuations in argillaceous influx are evident as shale laminae, it appears that the depositional conditions of lithofacies V differ from those of III primarily in geographic proximity to the relatively carbonate-starved and more restricted axis of the Appalachian Basin.

Table 1. Mean percent abundances of lithofacies' constituents in the Onondaga Limestone, central New York.

Facies	Calcisiltite	Bioclasts	Cement	Detrital Mud	Pyrite
VI	15	61	21	4	1
II	38	53	3	4	1
III	84	2	0	10	2
V	67	10	0	21	2+

DEPOSITIONAL HISTORY

The succession of Onondaga members is closely associated with specific lithofacies, as represented by outcrops in the general Syracuse vicinity. The interpretaion below pertains only to this area and does not apply elsewhere.

Onondaga deposition began in clean, shallow, wave-agitated waters on a relatively flat erosional surface during a generally westward transgression of the sea. Quartz sand eroded from Early Devonian units was rounded, sorted, and redeposited as a quartz arenite at the formation's base. As the shoreline progressed westward, the shallow carbonate shelf conditions of Lithofacies VI were established and the supply of quartz sand diminished, eventually ceasing all together. Northward (today) migration of the Appalachian Basin into the area beginning in late Edgecliff time produced a gentle down-warp in the sea floor in which progressively increasing water depths are indicated by the succession of lithofacies VI, II and III. Flocculent bottom conditions reduced the sessile benthonic fauna, thus minimizing carbonate production and paving the way for the lithofacies III, V succession. In the face of argillaceous influx coupled with increasingly deleterious benthonic conditions, shale deposition gradually became dominant over carbonate deposition until the latter virtually ceased. The Marcellus Shale gradually prograded westward over the Onondaga Limestone.

MEGAFOSSILS OF THE ONONDAGA LIMESTONE IN CENTRAL NEW YORK

The predominant megafossils of the Onondaga Limestone in the Syracuse area that will be collected on this trip are brachiopods (Table 2, figs. 1-4) and corals (Table 3). Therefore, these groups will be treated in more detail than other, less common fossils, such as gastropods, trilobites, cephalopods, crinoids, bryozoans and sponges (Table 4). Some common corals and a lithistid sponge, illustrated in Shimer and Shrock (1944), are shown in figures 5 and 6.

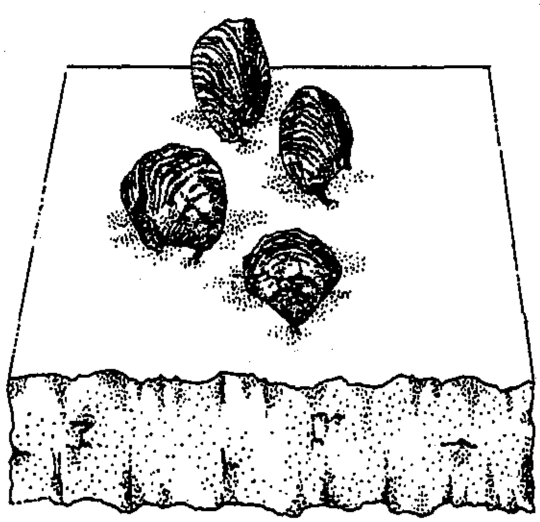

Figure 1. *Athyris* sp. A in plenipedunculate life position on the sea floor. This life strategy refers to those brachiopods in which the pedicle is a single, unbranched muscular structure apart from its distal tip.

Table 2. Brachiopods of the Onondaga Limestone in central New York from Cherry Valley to Syracuse.

Taxon	Common	Rare	Very Rare
Acrospirifer duodenaria			X
Athyris sp. A		X	
Atrypa "reticularis"	X		
Amphigenia sp.			X
Atlanticocoelia acutiplicata		X	
"Chonetes" aff. lineata	X		
Charionoides aff. doris			X
Costistrophonella cf. punctulifera			X
Coelospira camilla		X	
Dalejina aff. alsa		X	
Gypidula sp.			X
Leptaena aff. "rhomboidalis"	X		
Levenea aff. subcarinata		X	
Meristina cf. nasuta			X
Megakozlowskiella raricosta	X		
Megastrophia sp.		X	
"Mucrospirifer" cf. macra			X
Nucleospira aff. ventricosa			X
Orthotetacid indet.	X		
Pentagonia unisulcata			X
Penatmerella arata		X	
Schizophoria cf. multistriata			X
Strophodonta cf. demissa			X
Stropheodontid indet.			X
Trematospira sp.			X

Note: Although this table denotes relative abundance of brachiopod taxa in the central part of the state in terms of common, rare and very rare, it should be noted that some species are more abundant in specific horizons or beds and are relatively rare throughout the remainder of the formation. For example, "Chonetes" aff. lineata occurs abundantly ten feet above the Tioga Bentonite but rarely in the rest of the Onondaga and Amphigenia sp. occurs only in the basal Edgecliff Member where it is locally abundant.

Table 3. Corals of the Onondaga Limestone in central New York from Cherry Valley to Syracuse.

Taxa	Common	Rare
Tabulates		
Aulopora	X	
Syringopora	X	
Favosites	X	
Lecfedites	X	
Rugosans		
Amplexiphyllum	X	
"_Heterophrentis_"	X	
Acinophyllum	X	
Breviphrentis		X
cf. _Syringaxon_		X
Cystiphylloides	X	
Siphonophrentis	X	
Heliophyllum	X	

Brachiopods. Since most of the brachiopods that will be collected loose consist of articulated specimens, the descriptions below do not include interior morphologies. For more detailed descriptions, including internal features, refer to the Treatise or Feldman (1985). Collecting brachiopods from the Onondaga Formation in central New York is best accomplished by carefully searching weathered outcrops in the Nedrow Member, especially reentrants, which form due to the more rapid weathering of the shale as compared to the dense limestone. Collecting in the other members varies, but is generally difficult. As a rule, the longer the outcrop has weathered the better the chances of finding suitable specimens. Occasionally, due to local diagenetic factors, it is possible to locate silicified material ranging in quality from poor to fair. As one approaches the western and especially eastern areas of the outcrop belt silicification tends to increase in amount and quality.

Acrospirifer duodenaria - Biconvex shells transversely subelliptical in outline; hinge line long and straight; medial open delthyrium with no preserved deltidial plates; pedicle valve bears narrow, triangular, moderately deep, noncostate sulcus; brachial valve bears corresponding fold; five to six rounded plications on each pedicle flank with U-shaped interspaces; anterior commissure uniplicate.

Athyris sp. A - Shells transversely suboval in outline, and subequally biconvex with pedicle valve slightly deeper than brachial valve; ventral beak suberect terminating in, small round foramen; brachial beak smaller and less noticeable; pedicle valve bears shallow sulcus with corresponding low fold on brachial valve; anterior commissure weakly uniplicate; some forms nonsulcate and rectimarginate; fine, concentric growth lines on both valves.

Atrypa "reticularis" - Dorsibiconvex shells with well rounded radial costellae which increase in size and number anteriorly; costellae separated by U-shaped interspaces; concentric growth lamellae cross costellae becoming more distinct and frilly anteriorly; anterior commissure rectimarginate or slightly deflected towards brachial valve.

Amphigenia sp. - Large shells, costellate, elongate in outline; anterior commissure rectimarginate to broadly sulcate; delthyrium wide, triangular and unmodified by deltidial plates; round pedicle foramen present.

Atlanticocoelia acutiplicata - Subcircular in outline with length almost equal to width; brachial valve gently convex, pedicle valve slightly more so; weak pedicle sulcus sometimes noticeable on larger specimens; no corresponding dorsal fold; hinge line very short and becomes rounded anteriorly; no interareas present; anterior and lateral commissures crenulate; ten to twelve plications with U-shaped interspaces; concentric growth lines, two or three per shell, common on ephebic forms.

"Chonetes" aff. lineata - Shells small, subsemicircular in outline and concavoconvex in lateral profile; interareas very narrow; no delthyrial structures preserved; greatest width at hinge line or anterior to midlength; valves covered with fine capillae which increase anteriorly by bifurcation.

Charionoides aff. doris - Biconvex, elongate shells; fold and sulcus often poorly defined; pedicle beak slightly incurved with round foramen; delthyrium triangular; valve exteriors smooth with fine, concentric growth lines present at lateral margins of both valves.

Costistrophonella cf. punctulifera - Shells wider than long, subsemicircular in outline; hinge line long, straight; interarea evident; numerous, subangular, radiating costae which increase anteriorly by intercalation and bifurcation; interspaces broad and shallow with 11 to 12 costae per 5 mm near anterior commissure at midline; costae crossed by about 7 evenly spaced growth lines.

Coelospira camilla - Small, concavoconvex to planoconvex, subcircular to suboval in outline; small, distinct pedicle foramen on incurved pedicle beak; no interarea evident; maximum width about one-third valve length in adults; pedicle valve bears two medial plications usually at least as large as remaining radial plications on flanks; interspaces U-shaped; brachial valve bears medial plication which generally bifurcates at one-third valve length; median interspace usually flat but sometimes bears small ridge; plications broader on flanks and thinner toward lateral commissure; several well-defined, concentric growth lines evident near anterior commissure in adult forms.

Dalejina aff. alsa - Shells ventribiconvex, transversely suboval to subcircular in outline; hinge line very short and straight in apical area but becomes rounded as lateral margins approached; maximum width at or just anterior to midlength; pedicle valve bears slight median depression; brachial valve often bears corresponding median ridge; anterior commissure most often rectimarginate to slightly sulcate; ventral interarea short, narrow; numerous radial costellae which increase anteriorly both by intercalation and bifurcation; at anterior commissure there are 18 to 20 costellae per 5 mm, near midline; costellae occasionally crossed by concentric growth lines near anterior margins.

Gypidula sp. - Elongate oval to subcircular in outline; pedicle valve swollen; costate to multicostate; almost identical to Pentamerella arata (see description below) but can be differentiated by a pedicle fold and brachial sulcus whereas Pentamerella has a pedicle sulcus and brachial fold.

Leptaena aff. "rhomboidalis" - Transversely subquadrate in outline, concavoconvex to slightly biconvex with pedicle valve strongly geniculate at anterior and lateral commissures; brachial valve correspondingly geniculate within pedicle trail; hinge line straight, pedicle interarea flat; ornamentation consists of radial costellae which extend past point of geniculation and continue on trail of valves; concentric rugae cross costellae becoming larger anteriorly.

Levenea aff. subcarinata - Shells small to medium sized, transversely suboval in outline, ventribiconvex in lateral profile; brachial valve bears shallow, rounded sulcus which broadens anteriorly; length slightly greater than width; maximum width at or just anterior to midlength; ventral interarea short, slightly incurved; triangular delthyrium encloses angle of approximately 60 degrees; delthyrium often widens apically into small, circular foramen; ornamentation consists of rounded, radial costellae which increase in number anteriorly by bifurcation.

Megakozlowskiella raricosta - Shells subtransverse in outline, strophic, medium to large, ventribiconvex; hinge line straight; pedicle interarea moderately narrow with striae which parallel hinge line; brachial interarea extremely narrow; distinct slightly flattened fold on brachial valve and corresponding deep, U-shaped sulcus on pedicle valve; commonly three plications on flanks; delthyrium includes angle of approximately 60 degrees; no deltidial plates preserved; anterior commissure uniplicate; strong, concentric growth lamellae with anterior frills; radial ornamentation consists of very fine striae or capillae.

<u>Megastrophia</u> sp. - Medium sized to large, subsemicircular to transversely suboval in outline; somewhat alate, concavo-convex in lateral profile; maximum width attained at hinge line; unequally parvicostellate to subuniformly costellate; psuedodeltidium flat, complete, with narrow median ridge; chilidium flat, complete, with median ridge; hinge entirely denticulate.

<u>Meristina</u> cf. <u>nasuta</u> - Convex, elongate and suboval in outline with no noticeable interarea. Unequally biconvex, with pedicle valve much deeper than brachial valve; maximum width commonly anterior to midlength; delthyrium broad, triangular and opens apically into semicircular foramen; faint pedicle sulcus modified by development of low, rounded medial plication that extends anterior commissure in tongue-like projection; concentric growth lamellae evident at anterior portion of valves but remainder of shell smooth.

"<u>Mucrospirifer</u>" cf. <u>macra</u> - Small to large alate shells transversely subtrigonal to subsemicircular in outline; biconvex in lateral profile with brachial valve slightly flatter than pedicle valve; ventral interarea moderately high, long, somewhat curved; ventral beak, posterior to interarea, short and stubby; open, triangular delthyrium present which divides interarea medially; dorsal interarea long, thin, ribbon-like; brachial valve bears high, medial fold flattened at top; pedicle valve bears corresponding U-shaped sulcus; surface of shells covered by sharply defined plications ranging from U-shaped to subangular in cross section; numerous, concentric, frilly growth lines present; no fine radial ornamentation.

<u>Nucleospira</u> aff. <u>ventricosa</u> - Small, transversely suboval in outline, biconvex in lateral profile with pedicle valve slightly deeper than brachial valve; hinge line curved; brachial beak fits into anterior end of delthyrium which is partially covered by concave pseudodeltidium in some specimens; both beaks erect, no interarea evident; shell surface lacks radial ornamentation; no fold or sulcus present; pedicle valve shows faint median depression in some specimens; concentric growth lamellae present, more concentrated towards rectimarginate anterior commissure.

Orthotetacid indet. - Small to medium sized shells, generally poorly preserved as internal impressions; hinge line straight; ornamentation finely costellate;

<u>Pentagonia</u> <u>unisulcata</u> - Medium sized, nonstrophic, pentagonal in outline when viewed posteriorly; beak suberect, dorsibiconvex with greatest width attained between midlength and anterior commissure; brachial valve cariniform due to presence of raised, rounded fold bearing narrow, median groove; in some forms groove widens slightly anteriorly forming two parallel to subparallel ridges extending almost half the valve length; flanks concave, dropping steeply away from sulcate fold; sulcus broad, shallow with two

distinct ridges which define sulcus laterally and extend from umbo across posterolateral margins of flanks to uniplicate anterolateral commissure; vague, concentric growth lines on anterior portion of shell.

Pentamerella arata - subglobose and broadly pyriform in outline with strongly convex pedicle valve and weakly convex brachial valve; hinge line short, curved, narrow; no interarea evident; pedicle valve beak short, strong, incurved, not closely pressed against brachial beak; brachial beak small, less erect and less incurved; maximum width attained at or about midlength; weak sulcus present on anterior half of pedicle valve with corresponding fold on brachial valve (note: this morphological feature is the key to differentiating Gypidula from Pentamerella; see Gypidula above); both valves ornamented with numerous, rounded, bifurcating plications which become narrower on lateral slopes than near midline; interspaces between plications U-shaped and wider than plications which tend to become slightly V-shaped in cross section on some specimens; About 5 plications in sulcus and 6 on fold; concentric growth lines more numerous anteriorly.

Schizophoria cf. multistriata - Shells medium sized, suboval to subquadrate in outline, unequally biconvex; brachial valve deeper and more uniformly convex; in juveniles both valves become almost equally biconvex; pedicle valve develops broad, shallow sulcus on adult forms; brachial valve bears indistinct fold; hinge line short, slightly rounded; maximum width attained at or just past midlength; ventral interarea triangular, fairly high in larger shells, relatively narrow in younger ones; dorsal interarea narrower; interareas of both valves equal to about one-half width; ornamentation consists of rounded to subangular radial costellae with broad, flat inter spaces; about 11 costellae in a 5 mm space near anterior commissure at midline.

Strophodonta cf. demissa - Subcircular to shield shaped shells, concavoconvex in lateral profile; shells wider than long; point of maximum width at hinge line; lateral margins almost straight posteriorly; anterior margins evenly rounded; all margins crenulate; anterior commissure rectimarginate; costellae coarse, bifurcating with angular interspaces in cross section.

Stropheodontid indet. - Small, subcircular in outline, alate; Smooth exterior with irregularly spaced growth lines.

Trematospira sp. - Elongate, suboval, moderately biconvex; dorsal fold and ventral sulcus; hinge line curved, narrow interarea; conjunct deltidial plates; pedicle foramen mesothyridid; approximately 45 rounded, bifurcating costae on dorsal exterior and 19 on ventral exterior; beak pointed and apically twisted.

Table 4. Other faunal constituents of the Onondaga Limestone in central New York.

Taxa	Common	Rare	Very Rare
Gastropods			
Platyceras		X	
Tropidodiscus			X
Straparollus			X
Liospira			X
Ecculiomphalus			X
Loxonema			X
Platystoma			X
Euomphalacean fragments			X
Cephalopods			
Foordites			X
Halloceras			X
cf. Goldringia			X
Trilobites			
Phacops cristata	X		
Odontocephalus	X		
Dechenella			X
cf. Otarion			X
cf. Proetus			X
Dalmanitid fragments			X
Crinoids			
Camerate columnals	X		
Calyces			X
Bryozoans			
Dyoidophragma			X
Fistulipora			X
Sponges			
Hindia	X		

DISTRIBUTION OF MEGAFOSSILS

Corals dominate the shallow water habitat of the Edgecliff and Lithofacies VI. Common rugosans include Acinophyllum, Cystiphyloides, Heliophyllum, Heterophrentis, and Siphonophrentis while the tabulates are represented by Emmonsia, Favosites and Lecfedites. Brachiopods include Amphigenia, Atrypa, Elytha, Leptaena and Levenea. The trilobite Phacops is present in small numbers; platyceratid gastropods are locally common and crinoid coulmnals abound. Bryozoans are rare and almost never intact.

In the field trip area, the fauna of the upper Edgecliff and lithofacies II differs little from that of Lithofacies VI. While most of the fauna remains unchanged, though somewhat less abundant, Lecfedites and fenestrate bryozoans become more common. This appears to be in response to diminishing water agitation.

Brachiopods, including Atrypa, Megakozlowskiella and Megastrophia, dominate the fauna of the Nedrow member and Lithofacies III. The lithistid sponge Hindia is quite common low in the section. The rugose corals Amplexiphyllum, Heliophyllum and Heterophrentis are present, though not particularly common in central New York. Phacops and Odontocephalus are common trilobites while the gastropods are represented by Platyceras and Platystoma and the cephalopods by Goldringia? and Foordites.

The offshore habitat of the Moorehouse and Seneca members and Lithofacies V is, in the field trip area, dominated by trilobites (Phacops, Odontocephalus) and a diversity of brachiopods including Atrypa, Athyris, Coelospira, Leptaena, Mucrospirifer and Strophodonta. "Chonetes" is relatively common in the Moorehouse and extremely abundant high in the Seneca. The rugose coral Heterophrentis as well as the tabulates Aulopora and Syringopora are often present though not at all common.

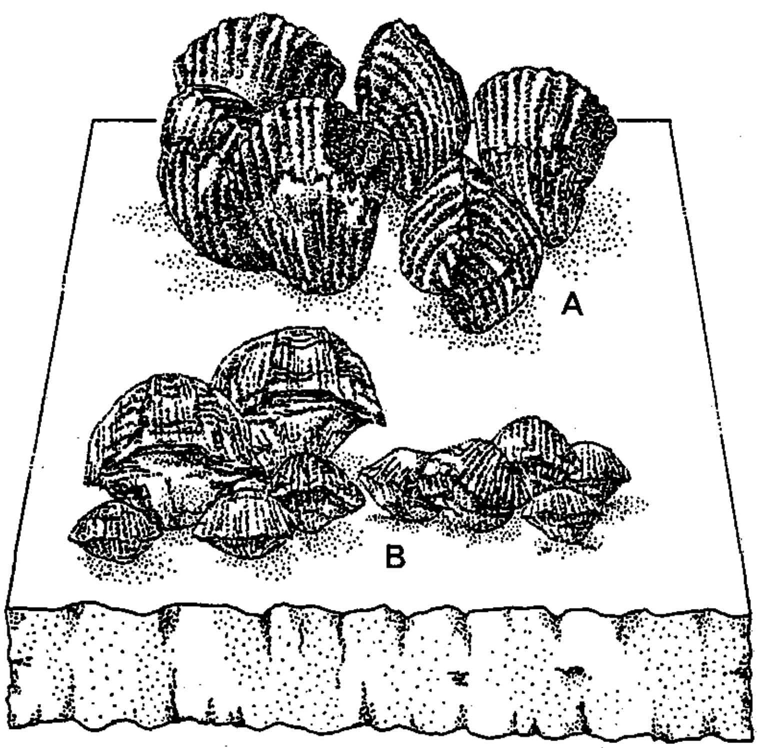

Figure 2. A, Pentameralla arata and B, Atrypa "reticularis" shown in cosupportive life habit. This refers to those ambitopic brachiopods which maintain an umbo-down posture and are packed tightly together often growing on one another.

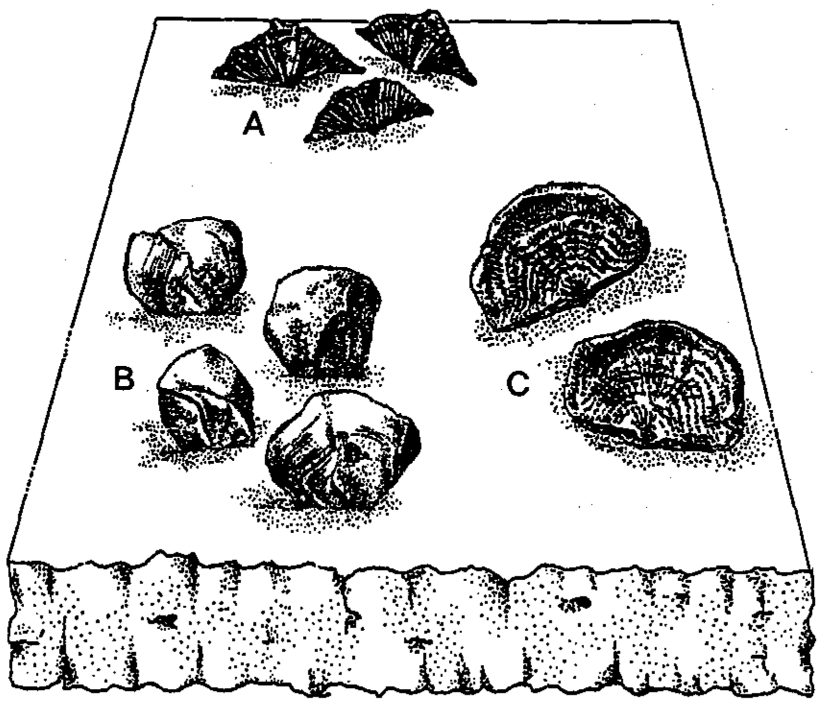

Figure 3. A, Mucrospirifer cf. macra (rhizopedunculate); B, Pentagonia unisulcata (ambitopic); C, Leptaena aff. "rhomboidalis" (quasi-infaunal).

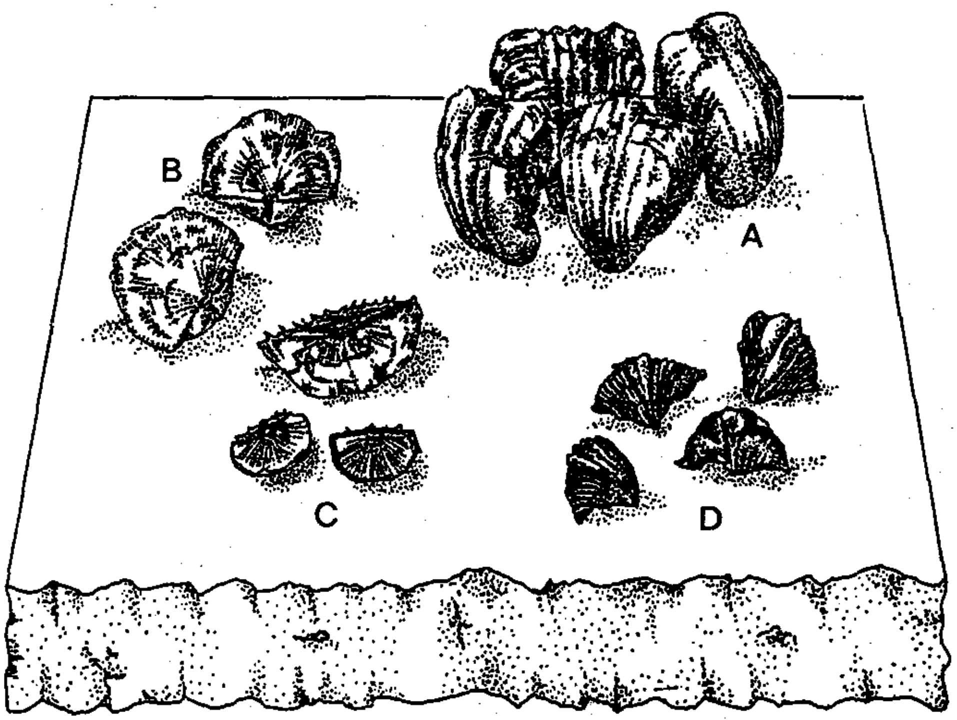

Figure 4. A, Gypidula sp. (Cosupportive); B, Orthotetacid indet.; C, "Chonetes" sp.; D, Cyrtina hamiltonensis (extremely rare in central New York) (all ambitopic).

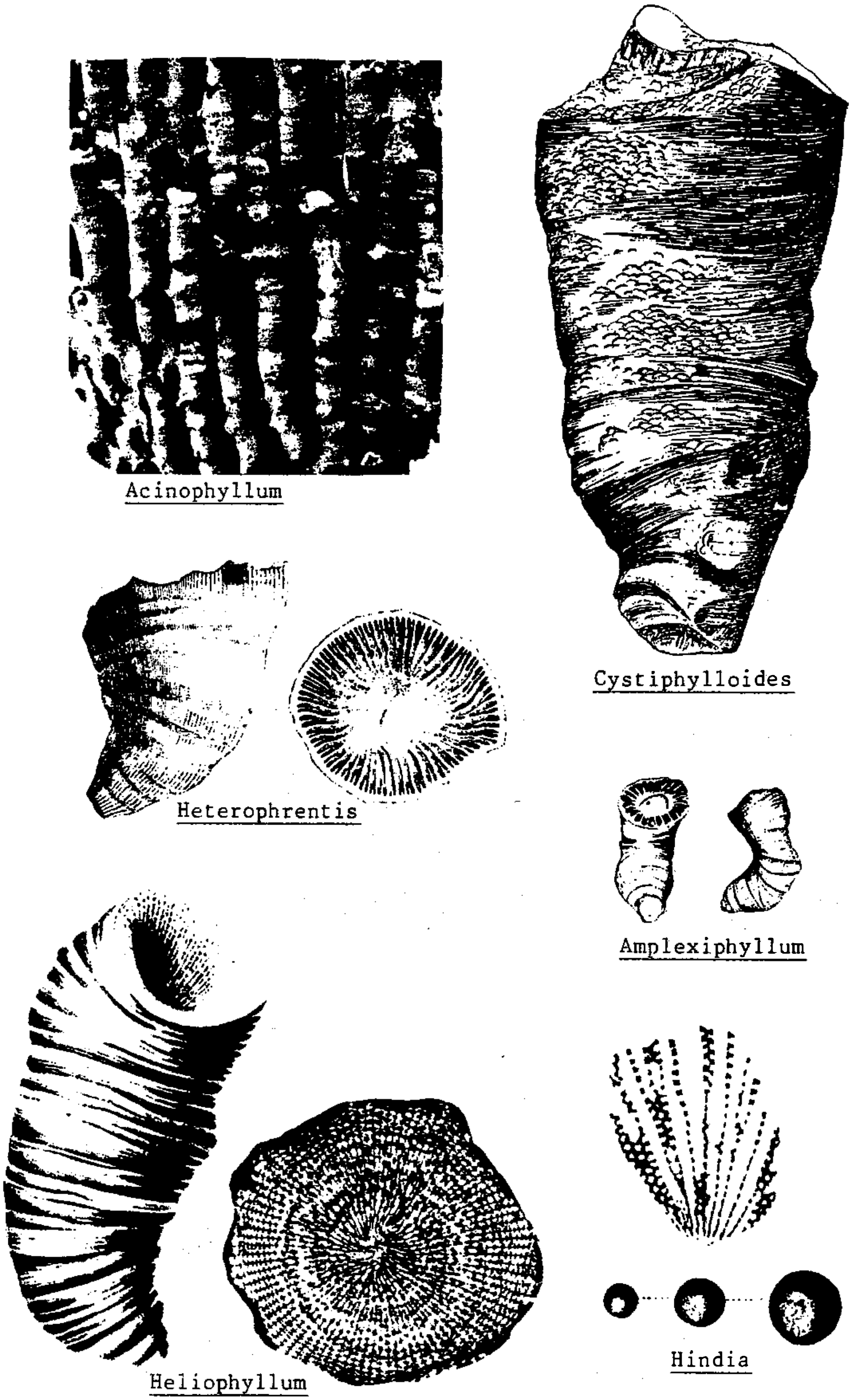

Figure 5. Corals and sponges of the Onondaga Limestone.

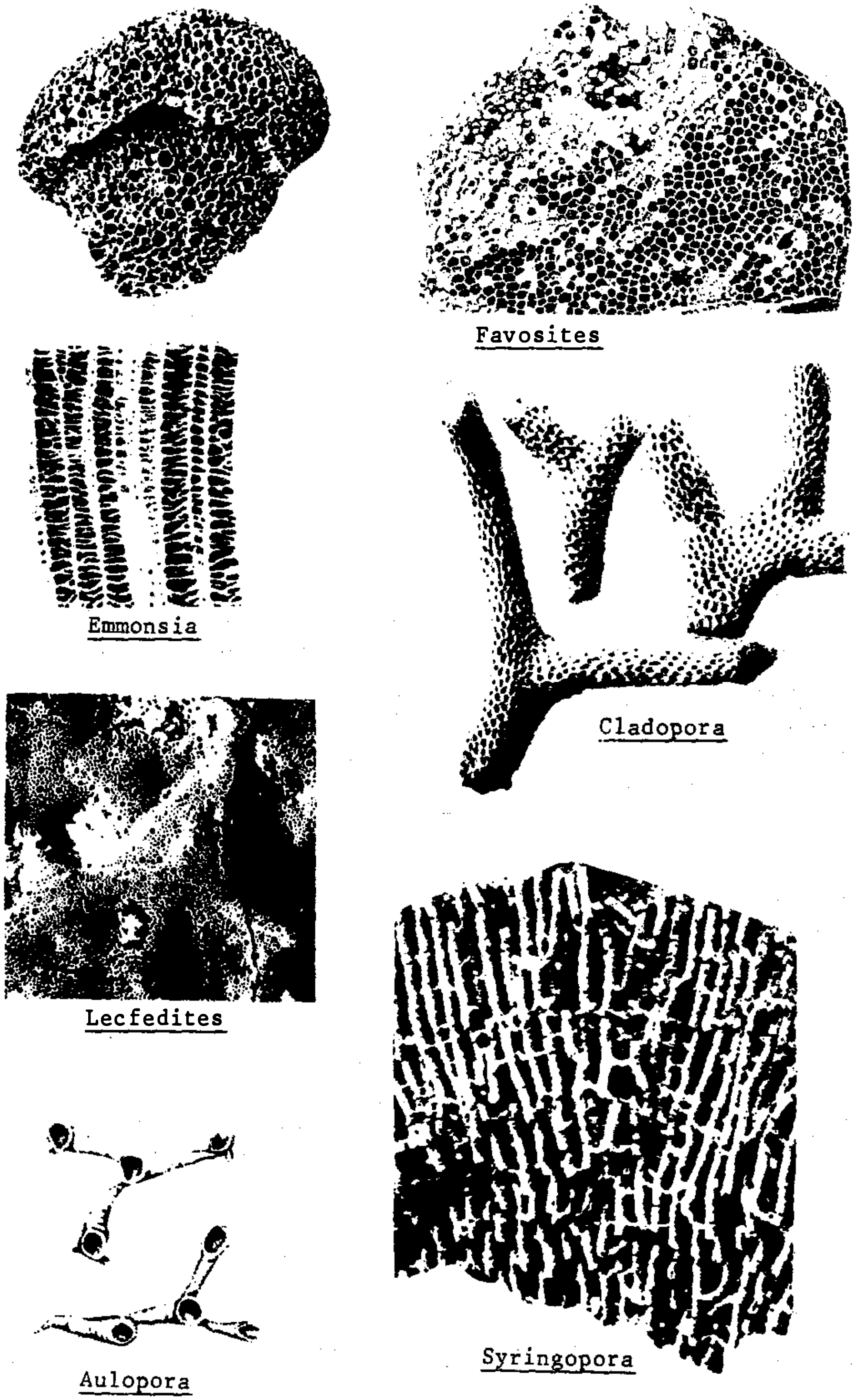

Figure 6. Corals of the Onondaga Limestone.

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ROAD LOG FOR THE ONONDAGA LIMESTONE IN CENTRAL NEW YORK

CUMULATIVE MILEAGE	MILES FROM LAST POINT	ROUTE DESCRIPTION
		Leaving Ithaca take N.Y. Route 13 east to I81 north, approximately 27 miles.
0.0	0.0	Leave I81 at exit 16 and turn left onto U.S. Route 11 north, approximately 24 miles. Log mileage begins at this point.
0.7	0.7	Immediately after passing beneath I81 turn left from Route 11 onto Quarry Road.
1.0	0.3	STOP 1: Park on the road shoulders and walk into the south end of the quarry which lies between Quarry Road and the Interstate.

NOTE: This quarry is on the Onondaga Indian Reservation. Do not, under any circumstances, enter without prior permission from the Tribe!

The quarry's south end is floored by the Edgecliff Member. Above this about 13' of Nedrow is exposed (type section). The Moorehouse is 19' thick and is overlain by an incomplete section of the Seneca Member. The Tioga Bentonite horizon is evident as the glacially scoured surface above the quarry's northeast wall where it forms a reentrant high in the southeast wall (it can be located between two chert horizons).

1.3	0.3	STOP 2: Return to Route 11 and park in the lot on the road's west side. Walk across the road to the outcrop between Route 11 and the I81 exit ramp.

The entire Edgecliff and lower Nedrow are exposed here in a weathered condition which may be more suitable for collecting than the quarry exposures.

		Leave the parking lot and head left (north) on Route 11.
4.2	2.9	Turn right (east) onto Route 173.
8.3	4.1	In Jamesville turn left (north) onto Solvay Road.

9.0	0.7	Turn right (east) onto the entrance road to the Jamesville Quarry.
		STOP 3: Continue along the entrance road and stop at the quarry office.

This is reputed to be the largest quarry in New York State. Hard hat and prior permission are required. The entire thickness of the Onondaga, from the phosphatic "Springvale Sandstone" to the Seneca and Marcells Shale, is exposeed near the quarry's southeast corner. However, quarry operations have left only the "Springvale," Edgecliff and Nedrow section readily accessible. The Tioga Bentonite and Seneca/Marcellus at the quarry top can be safely seen only from a distance. Exercise extreme caution in proximity to the quarry walls; hard hats offer little protection from large falling rocks.

9.7	0.7	Leave the quarry via Solvay Road, return to Route 173 and turn right (west) back toward Syracuse.
18.9	9.2	Turn left onto Slpit Rock Road. The road sign may not be visible, so watch for a yellow-and-blue state historical marker.
19.6	0.7	STOP 4: Continue to the end of Split Rock Road and into the quarry entrance.

This is the type section of the Edgecliff Member which is named for Edgecliff Park, located just to the west. The member's full thickness of 2.3 m is exposed in the upper areas of the main quarry and its erosional base is marked by the presence of phosphate nodules. It is interesting to note the pronounced difference between the "Springvale" horizon here and in the Jamesville Quarry. In the southern quarry wall, 3 m of Nedrow are exposed, but the top of the Nedrow has been removed by glacial scour.

END OF TRIP