Paleontology, Stratigraphy, and Paleoecology of the Ludlowville and Moscow Formations (Upper Hamilton Group), in Central New York

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Introduction

The Middle Devonian Hamilton Group of New York State is structurally simple and highly fossiliferous, thereby lending itself to detailed stratigraphic and paleontologic studies.

The writer (1966) examined the Hamilton sequence in the Tully Valley to determine the sequence of lithologies and faunas. The zones thus determined were compared with those defined by Cleland (1903), who made a similar study of the Hamilton Group along the Cayuga Lake meridian, 30 miles west of the Tully Valley (Fig. D-1). A paleoecological interpretation of the Hamilton rocks of the Cayuga Lake region was made by Fernow (1961).

Structure

The Hamilton Group in central New York consists of approximately 1,000 feet of shales, silty shales and siltstones lying above the Onondaga Limestone and below the Tully Limestone. Three thin carbonate beds serve to define the formational boundaries. The stratigraphic relations of the Hamilton Group of New York as now understood were first clarified by Cooper's classic papers (1930, 1933).

The Hamilton rocks in the Tully Valley dip to the south 25^{o} west at approximately 48 feet per mile, based upon the Centerfield Member as a datum (Grasso, 1966).

The value obtained for the dip agrees with Cooper's (1930) estimate of 45 to 50 feet per mile to the southwest. Wedel (1932) suggests a gentle southward dip of 50 feet per mile for the Cayuga Lake Hamilton section.

Superimposed on the regional dip are local low anticlines and synclines and faults. A thrust fault with associated folding occurs just south of Marcellus along N. Y. Route 173 (Smith, 1935). Oliver (1951) shows conclusively that several normal faults, downthrown to the north, occur on the southwest side of the Tully Valley near Lords Hill. A thrust fault in the Onondaga Limestone and overlying Union Springs Member can be seen 1 mile south of Nedrow (Prucha, 1964, p. 99).

At Cayuga Lake, there are at least three low anticlines in the Hamilton Group (Fernow, 1961). The Portland Point anticline, the most conspicuous of the Cayuga Lake folds, is best viewed looking east from Taughannock Point on the west side of the lake. A thrust fault in the Tully Limestone exposed in one wall of the Portland Point Quarry has drag folded the uppermost portion of the underlying Moscow Formation.

Hamilton Section in the Tully Valley and Cayuga Trough

The Devonian System of central New York State varies from carbonates at the bottom (Helderbergian and Ulsterian Series) to coarse continental clastics at the top (Chautauquan Series) and represents a westward regressive sequence of which the Hamilton is a small part (Rickard, 1964).

In the Tully Valley, the Hamilton is composed mainly of two facies that transgress time westward. The lower is a black and dark shale facies referred to as the "Cleveland" facies (Caster, 1934) (Rickard, 1964), the "Marcellus" facies (Cooper, 1932) or the "Leiorhynchus" facies (Cleland, 1903, Cooper, 1930).

Lying above the "Cleveland" facies in the Tully Valley but partly contemporaneous with it farther to the east is the "Big Bend" facies (Caster, 1934), a silty shale and siltstone carrying an entirely different fauna. The fauna of the "Big Bend" facies is sometimes called the Hamilton fauna or the Tropidoleptus fauna (Williams, 1903, Cooper, 1930) and represents better oxygenated bottom conditions than the "Cleveland" facies. A third facies of calcareous shale and thin limestones, the "Moscow" facies, recurs at intervals in the group. It comprises only 35 feet of the Hamilton strata in the Tully Valley, however, it is important stratigraphically as this facies occurs as three thin bands that are major datum planes dividing the Hamilton Group into four formations which are from oldest to youngest the Marcellus, Skaneateles, Ludlowville, and Moscow Formations. The "Moscow" facies is also referred to as the calcareous part of the Hamilton and possesses a Tropidoleptus fauna, although somewhat modified from the standard Tropidoleptus fauna farther east by possessing more of a brachiopod - coral - bryozoan assemblage.

The gradual replacement of the "Marcellus" facies by the "Big Bend" facies migrating in from the east is the history of the Hamilton Group in the Tully Valley. This began in late Marcellus time and was followed by a period of oscillation between the two facies during early and middle Skaneateles time. The "Big Bend" facies completely replaced the "Marcellus" by late Skaneateles time.

The "Big Bend" facies did not reach the Cayuga Lake meridian until late Devonian time. The "Marcellus" facies persisted until Late Ludlowville time when it was replaced by the "Moscow" facies.

These environmental differences are reflected in the distribution of the faunal zones. In the Tully Valley, 26 assemblage zones were distinguished

by the writer (1966) and 25 by Cleland (1903) at Cayuga Lake. However, in the Cayuga Lake section, 20 of Cleland's zones are found between the upper part of the Ludlowville Formation (King Ferry Member) and the base of the Tully Limestone, whereas in the same approximate time interval 9 or 10 zones can be discriminated in the Tully Valley (Fig. D-1).

Ludlowville Formation

The Ludlowville Formation is the most fossiliferous formation in the Tully Valley. It consists of about 260 feet of intertonguing silty shales and siltstones and on the basis of these Smith (1935) divided the Ludlowville above the Centerfield into four members, the Otisco, Ivy Point, Spafford, and Owasco (Fig. D-1).

The Ludlowville thickens westward, an anomalous condition for most of the Hamilton formations, to 360 feet on Cayuga Lake where it consists of a lower dark or black shale, the Ledyard Member, and an upper fossiliferous, gray, calcareous, gritty shale, the King Ferry Member (Fig. D-1).

Centerfield Member

In the Tully Valley area, the Centerfield Member is lithologically gradational with the underlying Butternut Member of the Skaneateles Formations. It is a coarse siltstone about 25 feet thick. The lower and upper 10 feet are flaggy but the middle portion is calcareous and fossiliferous. The siltstone beds in the flaggy portions are about one inch thick and at some localities crossbedded. The contact with the overlying Otisco is sharp.

The Tully Valley Centerfield fauna is characterized by a great number of large epifaunal pelecypods. Cornellites flabellum and Actinopteria decussata occur most frequently along with Glyptodesma erectum and Limoptera

macroptera. Corals are not abundant but a few species are found mainly in the calcareous portion of the Centerfield: Favosites turbinata, F. hamiltoniae, Cystiphylloides americanum, and Heterophrentis simplex. The brachiopods are mostly robust forms such as: Fimbrispirifer venustus and Spinocyrtia granulosa. Two other common brachiopods are: "Spirifer" sculptilis and "Camarotoechia" dotis. The occurrence of "Spirifer" sculptilis and Fimbrispiriter venustus in this assemblage is nowhere repeated in the Hamilton section of the Tully Valley.

According to Fernow (1961) the Centerfield Member at Cayuga Lake is a very calcareous relatively even bedded shale, medium to dark gray when fresh, abundantly fossiliferous, weathering to a medium brown color. The uppermost few centimeters are iron stained, very fossiliferous, and characterized in places by phosphate nodules up to one-half inch in diameter.

The fauna of the Cayuga Lake Centerfield, in addition to being more plentiful, contrasts markedly with that of the Tully Valley. Brachiopods dominate the fauna with Longispina vicinus, Douvillina inaequistriata, Spinocyrtia granulosa, "Spirifer" sculptilis, Nucleospira concinna being some of the more common species. Fernow (1961, pp. 52-55) lists the complete Centerfield fauna from Cayuga Lake along with relative abundances of the constituent species. The near absence of Fimbrispirifer venustus is conspicuous. Among the bivalves found in the Tully Valley Centerfield a questionable Cornellites flabellum is reported, Actinopteria decussata is less abundant, Limoptera macroptera is very rare, and Glyptodesma erectum does not occur at Cayuga Lake. The bivalve assemblage instead is headed up by various species of Goniophora, Modiomorpha and Paleoneilo. In short, there is a distinct lack of epifaunal suspension feeders and a preponderance of infaunal deposit feeders.

Some of the infaunal forms may have been asiphonate filter feeders living at or near the sediment water interface. For a detailed analysis of bivalve habitats and feeding mechanisms, see Stanley (1968), and Fernow (1961).

Many more bryozoa and corals occur in the Centerfield on Cayuga Lake than in the Tully Valley.

Fernow (1961, p. 175) concludes that the presence of corals and bryozoa indicates that the Centerfield waters in the Cayuga region were well oxygenated, gently circulating, and carried abundant nutrients in suspension.

The crossbedded coarse siltstones of the Centerfield in the Tully Valley indicate a higher energy shallow water environment of strong currents carrying both organic and inorganic particles in suspension. This may account for the abundance of large eipfaunal filter feeding bivalves and brachiopods. Sedimentation was probably too rapid to permit the firm establishment of a coral-bryozoan community.

Otisco Member

This unit is a soft, thinly bedded, slightly calcareous, silty, medium-gray to medium-dark gray shale, interbedded toward the top with thin siltstone beds. The contact with the Ivy Point Member, about 165 feet above the Centerfield, is sharp.

The Otisco Member is especially interesting for two coral biostromes which have been given submember status by Oliver (1951). The lower, designated the Staghorn Point by Smith (1935) is about seven feet thick in the Tully Valley. Oliver (1951) traced this unit over an area of 150 square miles. It occurs about 50 feet above the top of the Centerfield and rests on a massive calcareous, siltstone platform about three feet thick. The upper biostrome

was named the Joshua Submember by Oliver (1951). It varies from 0 to 55 feet in thickness in the Tully Valley and is less extensive than the Staghorn Point Submember covering some 40 square miles.

The fauna of the coral beds is composed almost exclusively of solitary rugose corals. Aside from a few Favositidae, other organisms are extremely rare (Oliver 1951).

Oliver (1951, Table 1, p. 712) lists the most abundant species present in the Staghorn Point Submember as: Siphonophrentis halli, Cystiphylloides americanum, Cystiphylloides conifollis, Heliophyllum halli, Bethanyphyllum robustum, and Heterophrentis ampla.

The siltstone platform provided a firm bottom upon which the corals were able to become established. Succeeding generations used the skeleton of their predecessors as substrates (Oliver, 1951).

Faunally, the Joshua Submember is much the same as the Staghorn Point, however, the Joshua rests on a thin bed composed entirely of the colonial rugose coral Eridophyllum subcaespitosum. Oliver (1951) suggests "...these colonial rugose corals colonized the area during an interval of favorable conditions and formed a crude platform for the solitary corals."

The remaining portion of the Otisco Member is also very fossiliferous, especially the first 20 and the uppermost 70 feet.

The lowest 20 feet of the Otisco Member is characterized by the abundance of 3 species of brachiopods: Chonetes vicinus, Chonetes scitulus, and Tropidoleptus carinatus.

The upper 70 feet of the Otisco are marked by the great abundance of Mucrospirifer mucronatus. Associated with this species are large numbers of mostly epifaunal brachiopods and pelecypods such as: Spinocyrtia granulosa, Megastrophia concava, Stropheodonta demissa, Athyris spiriferoides, Cornellites

flabellum, and Pseudaviculopecten princeps. Less abundant though still conspicuous in this assemblage are a wide variety of other typical Hamilton forms, many of which are considered to be infaunal, such as Modiomorpha mytiloides.

Early and late Otisco time in the Tully Valley represents times of diverse ecological conditions. The varied and abundant epifauna and infauna of the lower and upper portions of this unit suggest opulent conditions of a near shore, shallow water, well oxygenated environment. Clastic sedimentation must have been fairly rapid and there was enough organic material in suspension and the substrate to support the faunal association. The absence of corals and to some extent bryozoans in these lower and upper zones is evidence of rapid deposition and excess turbidity.

The two coral biostromes reflect times of different environmental conditions. The circumstances necessary for coral growth and development such as relatively shallow, clear, warm, water implies very little clastic sedimentation during these two intervals. This probably explains the thinning of the Ludlowville east of Cayuga Lake while the other formations of the Hamilton Group thicken in this direction. Currents sufficiently strong to carry abundant food in suspension must have moved across the coral "flats" which were perhaps very near wave base. The corals thrived and were able to compete with other invertebrates to the extent of excluding them completely from these areas.

The Otisco Member changes very rapidly westward where much of it is equivalent to the dark shales of the Ledyard Member (Fig. D-1).

Ledyard Member

Along the Cayuga Lake meridian, the Ledyard consists of 190 feet of dark gray to black, brittle, fissile, slightly calcareous, sporadically fossiliferous

shale. The upper 30 feet contain three zones of concretions, some of which are fossiliferous (Fernow, 1961). The Ledyard is equivalent to Cleland's (1903) Third Leiorhynchus Zone.

The fauna of the Ledyard consists primarily of infaunal pelecypods, small epifaunal and epiplanktonic brachiopods, and cephalopods. Nucula corbuliformis, Pterochaenia fragilis, Nuculites triqueter represent some of the bivalves, Ambocoelia umbonata, Chonetes setigerus, and Leiorhynchus multicosta the brachiopods, and Tornoceras n. sp. and "Orthoceras" sp. the cephalopods identified by Fernow (1961).

The Ledyard lithology and fauna indicate a paleoenvironment dramatically different from that represented by the Otisco in the Tully Valley. The water was probably deeper and poorly oxygenated west of the Skaneateles Meridian. This in combination with the lack of turbulence and material in suspension as evidenced by the fine grained nature of the rocks was inimical to a well developed epifaunal community (Fernow, 1961). The presence of some epifaunal brachiopods and infaunal pelecypods indicates that there was some oxygen in the water with zero Eh surface at or just below the sediment-water interface.

Ivy Point Member

This unit is about 37 feet thick in the Tully Valley and is dominantly a flaggy, slightly calcareous, gray siltstone that weathers to a distinct yellowish-brown color. Most of the siltstone beds are approximately one inch thick. A fossiliferous silty shale unit from 4 to 7 feet thick occurs about 27 feet up from the base of this member. Spheroidal, calcareous, non-septarian, unfossiliferous concretions 3 to 18 inches in diameter are present in the lower 20 feet.

Although the author did not find many fossils in the massive siltstone beds of the lower Ivy Point, they are reported to be moderately fossiliferous containing large epifaunal pelecypods, and brachiopods along with the large trilobite Dipleura dekayi (Clarke and Luther 1904).

The upper 10 feet are more fossiliferous than the lower beds and contain abundant diverse epifaunal and infaunal elements. Epifaunal brachiopods include Mucrospirifer mucronatus, Athyris spiriferoides, Protoleptostrophia perplana and Atrypa reticularis. Eipfaunal pelecypods are represented by Cornellites flabellum, Pterinopecten vertumnus, and Actinopteria decussata. The dominant infaunal bivalves include Modiomorpha concentrica, M. subalata, Macrodon hamiltonae, Pholadella radiata, and Nuculites oblongatus.

The lower Ivy Point probably represents a recurrence of the Tully Valley Centerfield conditions discussed above, page 4. The upper Ivy Point is very similar lithologically and faunally to the upper part of the Otisco Member above the Joshua Submember and probably represents a recurrence of those ecological conditions.

The upper part of the Otisco along with the Ivy Point, Spafford, and Owasco Members are equivalent to the King Ferry Member on Cayuga Lake (Fig. D-1).

Spafford Member

The Spafford Member consists of 27 feet of thin bedded gray, silty shale sharply overlying the coarse Ivy Point Member.

Faunally the Spafford is exactly the same as the upper 10 feet of the Ivy Point and represents a continuation of the same environmental conditions.

Owasco Member

This member is a massive, calcareous, well cemented siltstone bed 2 feet thick.

Smith (1935) defined the Owasco on the basis of "...the thin but important Spirifer tullius (Allanella tullius) Zone which follows the Spafford and is limited above by the Portland Point..."

Fossils are difficult to extract and found in discontinuous highly fossiliferous zones consisting mostly of Mucrospirifer mucronatus, Allanella tullius and Tropidoleptus carinatus.

The lithologic character of this unit suggests another recurrence of a shallow water high energy environment near wave base. The occurrence of the fossils in discontinuous zones and the lack of numerous large epifaunal forms contrasts markedly with the underlying Ivy Point, Otisco, and Centerfield. The Owasco fossils may represent current deposits and hence would not be indicative of the Owasco live assemblage. The Owasco probably represents an environment of higher energy than any of the ones discussed thus far.

King Ferry Member

The silty shale and siltstones of the upper Ludlowville Formation in the Tully Valley pass westward into a mass of blue-gray, nonfissile, calcareous gritty shales, the King Ferry Member.

Fernow (1961, p. 64) states "...the fauna of the King Ferry Member is rich and varied but dominated by pelecypods (52 species) and brachiopods (26 species) ..." The infaunal forms predominate over the epifaunal. Cleland (1903) subdivided the King Ferry into 6 zones, none of which can be recognized in the Tully Valley. However, his Michelinia Zone, which is characterized by the tabulate coral Pleurodictyum americanum, has been traced by Cooper (1930, p. 225) westward to Lake Erie.

The King Ferry Member was deposited in deeper, less agitated water than correlative units in the Tully Valley. The relative abundance of infaunal to

epifaunal forms probably reflects a decrease of current in deeper water, with its attendant decrease in organic material available for epifaunal filter feeders.

Moscow Formation

Exposures of the lower 70 feet of the 175 foot thick Moscow Formation are difficult to find in the Tully Valley. Therefore, this interval could not be examined thoroughly and many of the remarks pertaining to the Portland Point and lower and middle Windom Members were derived from the examination of a single selection; Bucktail Falls Ravine on the west side of the neighboring Otisco Valley. Along the Cayuga Lake meridian, the Moscow Formation is completely exposed.

Although lithic and faunal distinctions can be made in the Moscow Formation between Cayuga Lake and the Tully Valley, there are many more similarities, a consequence of uniform paleoecological conditions that prevailed over central New York in late Hamilton time.

Portland Point Member

The upper and lower contacts of the Portland Point Member are sharp in the Tully Valley. A basal crinoidal, shelly limestone about 1 foot thick is succeeded by 11 feet of gray silty shale interbedded with thin crinoidal, shelly limestone bands 2 inches thick or less and about 8 inches apart. The silty shales are sparsely fossiliferous.

On Cayuga Lake, the Portland Point consists of a 5 to 7 foot sequence beginning with a massive crinoidal limestone, followed by a middle zone of less resistant shale and capped by an upper resistant sandy or limey fossiliferous shale. The basal cronoidal limestones varies from 2-5 feet thick.

The Portland Point is not very fossiliferous nor does it carry a distinctive assemblage in the Tully Valley. On Cayuga Lake, however, it is a highly fossiliferous unit of brachiopods, pelecypods, ostracods (from crinoidal basal layer), crinoids, corals, and massive bryozoa.

The crinoidal layer, according to Fernow (1961), was deposited above effective wave base as indicated by its coquina-like character which appears to be a residual lag deposit.

The shales above the basal layer at Cayuga Lake indicate a change to quieter, slightly deeper water which supported a rich benthonic community just below wave base (Fernow, 1961).

In the Tully Valley, the Portland Point Member probably represents an oscillation of the bottom from just below to just above wave base. The paucity of fossils in the shales may be due to the lack of good exposures of this unit in the Tully Valley.

Windom Member

The Windom Member in the Tully Valley is a thin bedded gray to medium gray shale grading upward to medium-gray silty shale to a point 20 feet below the Tully, where a sharp lithologic change takes place to a dark gray or grayish black, non-calcareous, pyritiferous shale and this is in turn sharply overlain by the Tully Limestone. This dark shale appears as a reddish-orange zone beneath the Tully due to the weathering of the pyrite. Zones of calcareous unfossiliferous, non-septarian concretions are recurrnet throughout the Windom. The upper two zones are particularly noticeable and occur 30 feet and 8 feet below the Tully. The lower concretion zone, about 10 feet thick, consists of flattened elliptical concretions under 8 inches in diameter and 2-3 inches thick. The upper concretion zone is 4 feet thick and composed of

round cannon ball type concretions 6 to 10 inches in diameter.

The Windom consists of fossiliferous zones which are separated by intervals of sparsely fossiliferous rocks. The fossiliferous zones contain numerous epifaunal brachiopods, infaunal pelecypods, small corals, bryozoans, crinoid stems and trilobites. Epifaunal pelecypods are conspicuously low in number.

The dark shales at the top of the Windom contain epiplanktonic brachiopods, small epifaunal brachiopods, and small infaunal bivalves. Some of the species represented are: Leiorhynchus multicosta, Pustulatia pustulosa, Allanella tullius, Tropidoleptus carinatus, Camarotoechia dotis, Nucula varicosa and Paleoneilo constricta. The brachiopods Pustulatia pustulosa and Allanella tullius occur in the uppermost 10 feet of the Windom.

At Cayuga Lake, the Windom is predominately a gray, gritty moderately calcareous, non-fissible shale. Fernow (1961) was able to subdivide it into 6 local units. His uppermost unit (Windom Zeta) which immediately underlies the Tully is a "...dark, fissil, non-calcareous, very pyritiferous shale..." He further states it does not occur on the east shore of Cayuga Lake. Most certainly, the Windom Zeta unit is the same as the 20 feet of shales lying below the Tully Limestone in the Tully Valley. Its absence on the east side of Cayuga Lake could be the result of erosion, since the Tully Limestone is known to overlie unconformably the Windom in west central New York.

The Windom fauna at Cayuga Lake is very similar to that found in the Tully Valley area. This is reflected by several of Cleland's (1903) zones being recognized by the author in the Windom in Bucktail Falls Ravine and Tinkers Falls Ravine.

The lithology and fauna of most of the Windom in the Tully Valley and

Cayuga Lake sections indicate a modified King Ferry environment (Fernow, 1961). The marked decrease in epifaunal pelecypods reflects even quieter water conditions.

The upper dark shales of the Windom were deposited in quiet, low oxygenated waters. Its fauna is peculiar in that it contains some genera found in "normal" sediments, although they are smaller in size (dwarfed?). The paleoecologic conditions probably resembled those in operation during the deposition of the Ledyard Member as discussed on pages D-8 and D-9, but even more restrictive.

Acknowledgment

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References Cited

Caster, K. E., 1934, The stratigraphy and paleontology of northwestern Pennsylvania, pt. 1, Stratigraphy: Bull. Am. Paleontology, V. 21, No. 71, 185 p.

Clarke, J. M. and Luther, D. D., 1905, Geologic map of the Tully quadrangle: New York State Mus. Bull. 82, 70 p.

Cleland, H. F., 1903, Study of the fauna of the Hamilton Formation of the Cayuga Lake section in central New York: U. S. Geol. Survey Bull. 206, 112 p.

Cooper, G. A., 1930, Stratigraphy of the Hamilton Group of New York, parts 1 and 2: Am. Jour. Sci., 5th ser., V. 19, p. 116-134.

_____, 1933, Stratigraphy of the Hamilton Group, eastern New York, part 1: Am. Jour. Sci., 5th ser., V. 26, p. 537-551.

Fernow, L. R., 1961, Paleoecology of the middle Devonian Hamilton Group in the Cayuga Lake region: Ph.D. Dissertation, Cornell University, 209 p.

Grasso, T. X., 1966, Faunal zones of the middle Devonian Hamilton Group in the Tully Valley, central New York: Masters Thesis, Cornell University, 64 p.

Oliver, W. A., Jr., 1951, Middle Devonian coral beds of central New York: Am. Jour. Sci., V. 249, p. 705-728.

Prucha, J. J., ed., 1964, Guidebook, 36th Ann. Meeting New York State Geological Assoc., Syracuse, New York, 127 p.

Rickard, L. V., 1964, Correlation of the Devonian rocks in New York State: New York State Museum and Science Service, Geological Survey Map and Chart Series: no. 4.

Smith, B., 1935, Geology and mineral resources of the Skaneateles quadrangle: New York State Mus. Bull. 300, 120 p.

Stanley, S. M., 1968, Post-Paleozoic adaptive radiation of infaunal bivalve molluses - a consequence of mantle fusion and siphon formation: Jour. Paleo., V. 42, no. 1, p. 214-229.

Wedel, A. A., 1932, Geologic structure of the Devonian strata of south-central New York: New York State Mus. Bull. 294, 74 p.

Williams, H. S., 1903, The correlation of geologic faunas: U. S. Geol. Survey Bull. 210.

COMPARISON OF FAUNAL ZONES

HAMILTON GROUP - CENTRAL NEW YORK

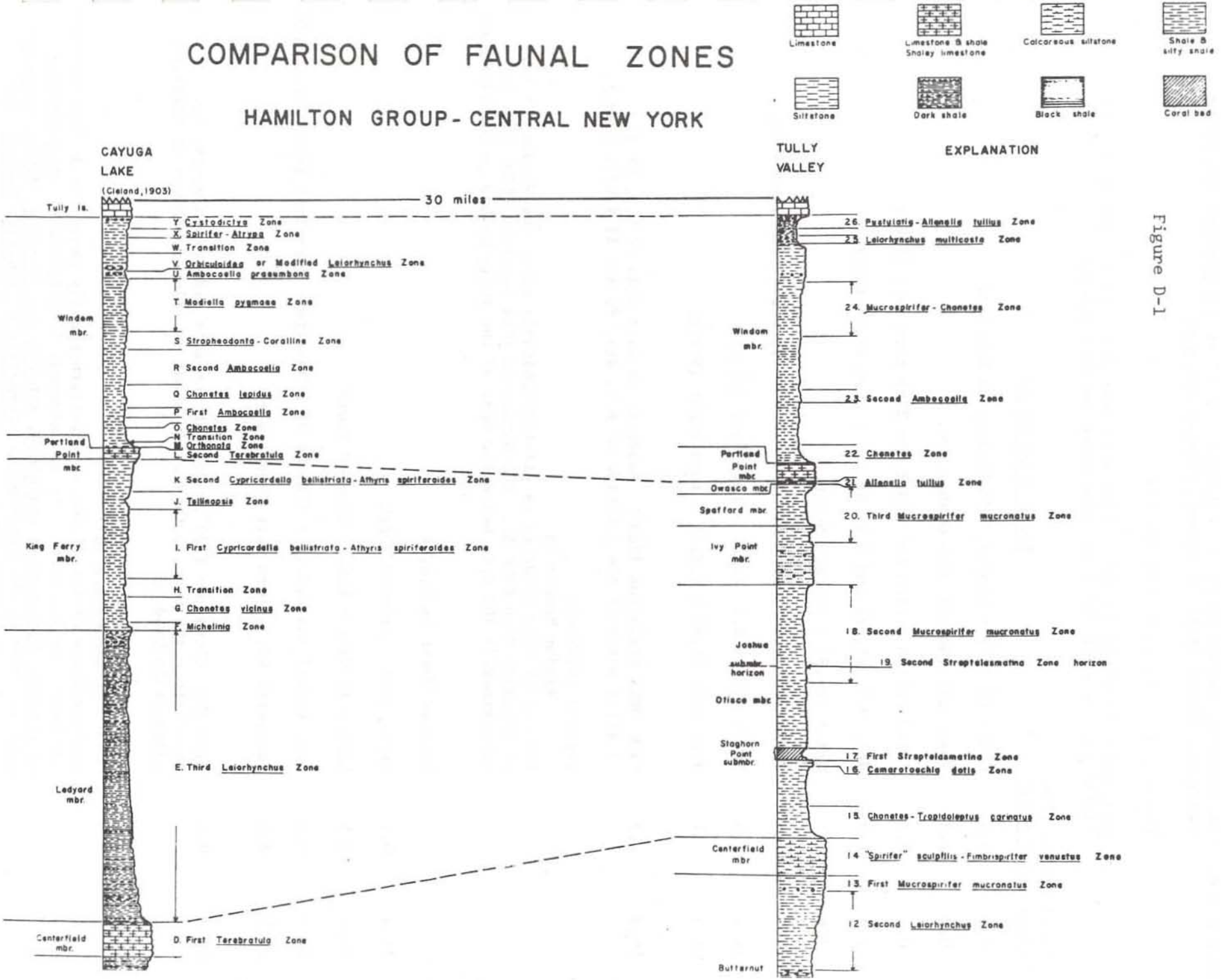

Figure D-1

TRIP D & H: STRATIGRAPHY, PALEONTOLOGY AND PALEOECOLOGY OF THE LUDLOWVILLE AND MOSCOW FORMATIONS (UPPER HAMILTON GROUP), CENTRAL NEW YORK

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Quadrangles referred to are 7½ minute quadrangles. Elevations after the "STOPS" are those of the first continuous bedrock exposure.

Total miles	Miles from last point	Route Description
0.0	0.0	Start of trip - Campus SUNY College at Cortland
0.0	0.0	Turn left (North) onto Graham Ave.
0.2	0.2	Intersection Groton Ave. (N.Y. Rt.222) turn left (West)
1.2	1.0	Jct. N.Y. Rt.222 and N.Y. Rt.281 - turn right (North)
2.4	1.2	Enter Int.81 - proceed North
3.4	1.0	Roadcut on east side of I-81 is in the Upper Devonian Ithaca Fm.
16.4	13.0	Tully Exit - N.Y. Rt.80 - turn left (West)
16.5	.1	Jct. N.Y. Rt.80 & U.S.11 - turn right (North)
16.8	.3	STOP ONE Elevation 1280': Roadcut, on east side of U.S. Rt.11, .3 miles north of the junction of N.Y. Rts. 80 and 11 (Tully Quad.).

Exposed thickness:
Windom Member 35'
The top of this exposure is stratigraphically below the Windom outcrop on Kingsley Road (STOP 5). The Windom at this locality (STOP ONE) is approximately 100 feet below the base of the Tully Ls and is fossiliferous.

Proceed North on U.S.11

16.9	0.1	Enter I-81 - proceed North
24.4	7.5	LaFayette Exit - U.S.11 proceed South
24.5	0.1	Jct. U.S.11 and U.S.20 - Village of LaFayette - turn left (West) on U.S.20
24.7	0.2	LaFayette Rd. - turn left (Northeast)
25.1	0.4	STOP TWO Elevation 1330': Roadcut, on west side of LaFayette Rd. just before the bend in this road, about .4 miles northwest of LaFayette (Jamesville Quad.).

Exposed thickness:
Otisco Member 30'
This exposure of the Otisco is stratigraphically above the Joshua Submember and below the Ivy Point. It is extremely fossiliferous. Mucrospirifer mucronatus, Spinocyrtic granulosa, Athyris spiriferodes, Megastrophia concava are some of the brachiopods, Cornellites flabella, Modiomorpha mytiloides, Pseudaviculopecten princeps, Paleoneilo constricta, Cypricardella bellistriata are some of the pelecypods found here.

Proceed North on LaFayette Road

27.6	1.5	Reidy Hill Road on right - proceed North
29.9	2.3	Bull Hill Road - turn left (West)
31.0	1.1	Intersection Bull Hill Rd. and Sentinel Heights Rd. - turn left (South) onto Sentinel Heights Rd.
31.2	0.2	Road leading to WSYR TV Tower - turn right (West)
31.3	0.1	STOP THREE Elevation 1400': Base of WSYR TV Tower on Miller Hill, .3 miles southwest of the intersection of Sentinel Heights Road and Bull Hill Roads (Jamesville Quad.).

Exposed thickness:
Joshua Submember 15.5'
Numerous solitary rugose corals occur here such as Cystiphylloides, Siphonophrentis, and Heterophrentis. The colonial rugose coral Eridophyllum sabcaespitosum is also abundant.

31.4	0.1	Return to Sentinel Heights Rd. - turn right (South)
33.8	2.4	Intersection of Sentinel Heights Rd. and Commane Rd. - turn right (West)
34.0	0.2	Intersection of Commane Rd. and U.S.11 - turn left (South)
37.0	3.0	Jct. U.S.11 and U.S.20 - LaFayette - turn right (West)
44.0	7.0	Jct. U.S.20 and N.Y.80 - turn left (South) proceed several hundred feet
44.2	.2	STOP FOUR Elevation 1380': Lords Hill, on N.Y.80, south of the junction with U.S.20 (South Onondaga Quad.).

Exposed thickness:
Portland Point Member 10'
Owasco Member 2' Elev. 1380'
Spafford Member 2'
Ivy Point Member - not measured - small exposures on both sides of road
Joshua Submember - 70' (projected) Elev. of top 1280' (Oliver, 1951)

Joshua corals are found in the regolith on both sides of the road. The Owasco contains an abundance of Allanella tullius and Mucrospirifer mucronatus. The basal crinoidal layer of the Portland Point nests directly on top of the Owasco Member. This is succeeded by 9 feet of interbedded shales and thin limestones.

Proceed South on N.Y.80

45.2	1.0	Kingsley Rd. - turn left (East)

46.7	1.5	STOP FIVE Elevation 1500': Roadcut, on both sides of Kingsley Road just west of the intersection of Hitchings Rd. (South Onondaga Quad.).

Exposed thickness:
Windom Member 28'
The top of this exposure is about 20 feet below the base of the Tully Limestone. The Windom here is unfossiliferous.

Turn left (North) onto Hitchings Rd.

48.7	2.0	Intersection - Hitchings Road and U.S.20 - turn left (West)
51.7	3.0	Intersection - U.S.20 and Hogsback Rd. - turn right (North) and proceed several hundred feet.
51.8	0.1	STOP SIX Elevation 1050': Peppermill Gulf, parallel to and just east of Hogsback Rd., 1.3 miles west of the junction of U.S.20 and N.Y.80 (South Onondaga Quad.).

Exposed Thickness:
Centerfield Member 30'
Butternut Member --
A waterfall just north of U.S.20 exposes approximately 30 feet of Centerfield. The Butternut - Centerfield contact is gradational - is therefore difficult to establish. The Centerfield is a coarse siltstone at this locality. Fossils are difficult to extract because of the lack of good bedding plane exposures.

Return to U.S.20 - turn left (West)

64.8	13.0	Village of Skaneateles
68.8	4.0	Entering City of Auburn - LUNCH STOP
70.3	1.5	Jct. U.S.20 and N.Y.34 and 38 - turn left (South)
71.3	1.0	N.Y.38 on left - proceed straight (South) on N.Y.34
75.8	4.5	Settlement of Fleming Jct. N.Y.34 and N.Y.34B - turn right onto N.Y.34B
86.8	11.0	Settlement of Poplar Ridge - intersection of N.Y.34B and Poplar Ridge - Aurora Rd. - turn right (West)
90.3	3.5	Intersection of Poplar Ridge - Aurora Rd. and unnamed gravel road (Prospect Corners) - turn left (South)
90.9	0.6	Unnamed gravel road on right leading downhill to a bridge over Paines Creek - Walk down road to Paines Creek and then downstream to Moonshine Falls.

STOP SEVEN Elevation 475': Moonshine Falls on Paines Creek, 1 mile south of Aurora (Sheldrake Quad.).

Exposed thickness:

Ledyard Member	--
Centerfield Member	25'

Centerfield at this locality is abundantly fossiliferous with numerous species of brachiopods, pelecypods, corals, and bryozoaus. The Ledyard Member sharply overlies the Centerfield and carries a fauna of small, thin shelled pelecypods and brachiopods. The contact between these 2 units occurs just upstream from the waterfall.

Return to buses - proceed Southeast and east on unnamed road.

92.4 1.5 Intersection of unnamed road and Black Rock Road - turn right onto Black Rock Rd.

93.8 1.4 Settlement of Black Rock - turn right (West)

STOP EIGHT Elevation 720': Black Rock on Paines Creek (Sheldrake Quad.).

Exposed thickness:

Portland Point Member	Dense fossiliferous shale	28"
	Blue-gray fossiliferous shale	8"
	Basal crinoidal layer	16-20"
King Ferry Member		8'

The lip of the falls is 8 feet lower than the base of the crinoidal limestone, therefore the uppermost King Ferry is accessible here. The Portland Point is very fossiliferous containing numerous brachiopods, pelecypods, ostracodes, crinoids and trilobites.

Return to buses - proceed West

94.8 1.0 Intersection N.Y.90 - turn left (South)

98.8 4.0 Junction N.Y.90 and N.Y.34B - Settlement of King Ferry - turn right onto N.Y.34B

111.8 13.0 Portland Point Road - turn right

112.4 .6 Entrance to Portland Point Quarry on left

113.1 .7 STOP NINE Elevation 620': Portland Point Quarry on east lip of Cayuga Trough (Ludlowville Quad.).

Exposed thickness:

Geneseo Black Shale	15'
Tully Limestone	16'
Windom Member	5'

This locality is one of the most fossiliferous exposures along the Cayuga Lake meridian. Numerous corals, bryozoa, crinoids, brachiopods, pelecypods, trilobites, and gastropods are found in the upper 5 feet of the Windom. (see Guidebook - 31st Annual Meeting N.Y.S.GA) Ithaca, N.Y.)

		At the south end of the quarry a thrust fault overthrust to the northwest occurs in the Tully Limestone and has drag folded the upper Windom at this locality. On the east side of the quarry an alnoite dike about 1 foot thick occurs in one of the N-S joints.
113.8	.7	Return to Portland Point Road - turn left
114.6	.8	STOP TEN Elevation 460': Roadside quarry on Portland Point Road (Ludlowville Quad.). Exposed thickness: King Ferry Member -- The King Ferry Member exposed here is about 20 feet below the Portland Point Member.
116.0	1.4	Return to N.Y.34B - turn right (East)
116.6	.6	Jct. N.Y.34 and 34B - proceed straight (East) on N.Y.34
117.4	0.8	N.Y.34 turns left (North) - continues straight on Old State Road
124.4	7.0	Intersection Old State Rd. and N.Y.38 - continue east on Old State Rd.
127.6	3.2	Intersection - Dryden Rd. - turn left - enter McLean
127.8	0.2	Intersection - Dryden Rd. and Gulf Hill Rd. - continue straight (Northeast) on Cortland Rd.
130.6	2.8	Lime Hollow Road off to the right - turn left - continuing on Cortland Rd.
133.0	2.4	Intersection - Cortland Rd. and N.Y.281 - continue straight (East) on Cortland Rd.
133.4	0.4	Intersection - Cortland Rd. and N.Y.13 - turn left onto N.Y.13
134.2	0.8	Cortland City limits