Benthic Communities of the Ludlowville and Moscow Formations (Upper Hamilton Group), in The Tully Valley, Onondaga County

Thomas X. Grasso, Prof. Geoscience Dept., Monroe Community College, Rochester, New York 14623

INTRODUCTION

The Devonian System in New York State varies from carbonates below (Ulsterian and lowest Erian Series) to coarse continental clastics at the top (Chautauquan Series), and represents a westward migrating deltaic complex built during Middle and Late Devonian time.

This deltaic complex, the Catskill Delta, is today represented by a wedge of sedimentary rock that thickens and coarsens eastward. The clastic wedge is pierced at several horizons by relatively thin, but geographically widespread, lithologically distinct units that do not change facies as rapidly as the rocks above or below. Serving as time planes, these key beds subdivide the clastic wedge into a number of major time-stratigraphic units.

Three carbonate keybeds in the lower portion of the wedge serve to subdivide the lowest time stratigraphic unit, the Hamilton Group (Middle Devonian), into four formations; which are from oldest to youngest, the Marcellus, Skaneateles, Ludlowville and Moscow Formations.

The Middle Devonian Hamilton Group of New York State is structurally simple and highly fossiliferous, thereby lending itself to detailed stratigraphic, paleontologic, and paleoecologic studies. In Central New York it consists of approximately 1,000 feet of shales, silty shales and silstones lying above the Onondaga Limestone and below the Tully Limestone. 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.

Superimposed on the regional dip are local low anticlines and faults. A thrust fault with associated folding occurs just south of Marcellus along NY 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. 49).

HAMILTON SECTION IN THE TULLY VALLEY

In the Tully Valley, the Hamilton is composed mainly of two facies that transgress time westward. The lower is a fissile black and dark shale facies of the anaerobic distal basin containing a low diversity primarily pelagic fauna. Lying above this facies in the Tully Valley, but partly contemporaneous with it farther to the east, is one representing a subtidal shelf - delta platform environment of silty shales and siltstones carrying a high diversity benthonic fauna. The Ludlowville and Moscow Formation typify this facies in the Tully Valley.

STRATIGRAPHY

Ludlowville Formation

The Ludlowville Formation is the most fossiliferous unit in the Tully Valley. It consists of about 260 feet of interbedded 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. 1).

Centerfield Member (Stops 5, 7, 8)

In the Tully Valley area, the Centerfield Member is lithologically gradational with the underlying Butternut Member of the Skaneateles Formation. 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.

Otisco Member (Stops 2, 6, 7, 8)

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

Fossils in the Otisco are extremely diverse especially in the lower 20 - 30 feet. Bryozoans, brachiopods, bivalves, gastropods, trilobites and echinoderm stems are all conspicuous in these intervals.

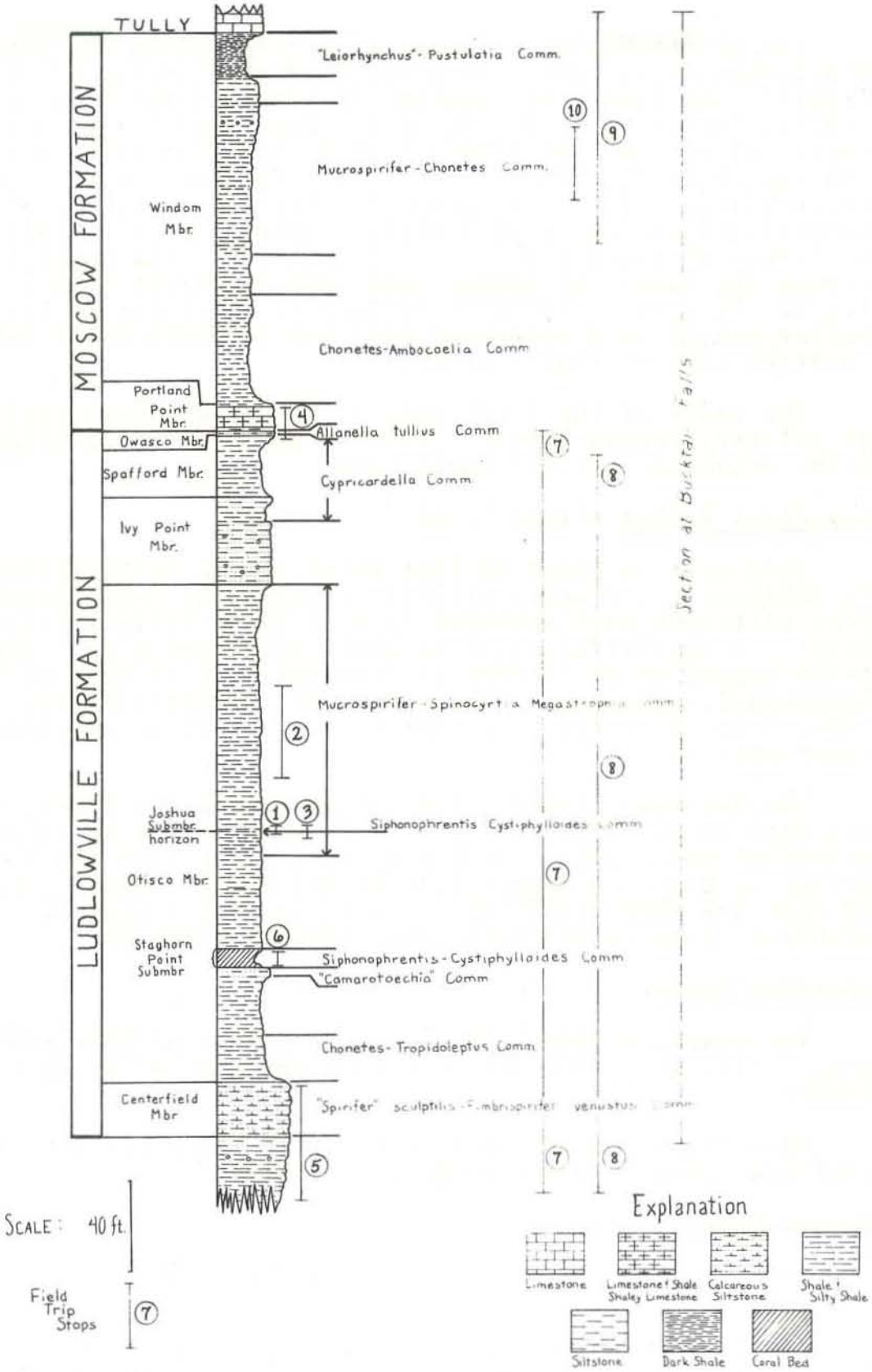


Figure 1. Benthic communities Ludlowville and Moscow Formations, Tully Valley.

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), (Stops 6, 7, 8), is about seven feet thick in the Tully Valley. Oliver (1951) traced this unit over an area of 150 square miles, from Skaneateles Lake eastward to Limestone Creek Valley. It occurs about 50 feet above the top of the Centerfield and rests on a ripple marked, massive, calcareous, siltstone platform about 3 - 6 feet thick. The upper biostrome was named the Joshua Submember by Oliver (1951) (Stops 1,3). 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.

Ivy Point Member (Stops 7, 8)

This unit is about 40 feet thick in the Tully Valley and is dominantly a flaggy, slightly calcareous, cross bedded, gray siltstone that weathers to a distinct yellowish-brown color. 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 and upper portions.

The massive siltstone beds of the lower Ivy Point, 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.

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 similar to the upper Ivy Point, yielding numerous brachiopods and bivalves.

Owasco Member (Stops 4, 7)

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

Smith (1935, p. 50) 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 brachiopods.

Moscow Formation

Exposures of the lower 50 - 70 feet of the 175 foot thick Moscow Formation are limited in the Tully Valley. Therefore, this interval can not be examined throughly. Many of the remarks pertaining to the Portland Point and lower and middle Windom Members were derived from the examination of Bucktail Falls Ravine on the west side of the neighboring Otisco Valley. (Fig. 1).

Portland Point Member (Stops 4, 7)

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 to 6 inches thick and about 8 inches apart. Cross laminations occur throughout.

Brachiopods, bivalves and crinoids stems dominate the assemblage, many of which are broken and disarticulated.

Windom Member (Stops 9, 10)

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, noncalcareous, 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 pyrite. Zones of calcareous unfossiliferous, nonseptarian concretions occur 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 intervals 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.

BENTHIC COMMUNITIES AND PALEOENVIRONMENTS

In the last several years paleoecological interpretations have been greatly strengthened through the community analysis approach. This concept pivots around the idea that combinations of certain abundant species define a community. This definition closely approaches that of Peterson (1913) and Molander (1930, quoted in Newell and others, 1959, p. 198) and subsequently utilized by Zeigler (1965); Zeigler, Cocks, and Ranbach (1968); Bretsky (1970); Sutton, Bowen, and McAlester (1970); Bowen, Rhoads, and McAlester (1974); Titus and Cameron (1976) and McGhee (1976).

Some of the communities named and delineated herein may include the habitat community of Newell and others (ref. cit.). An inherent problem in all this is the imperfection of the fossil record. Johnson (1964) presents tables illustrating that soft bodied organisms, almost never known as fossils, constitute anywhere from 33% to 99% of the total living community. From fossils we can make some inferences about past communities, but we must keep in mind they are not the same as the total community.

Other approaches to paleoenvironmental studies used in concert with, and as part of, community analyses would be trophic structure and paleoautecology or general adaptive type. The relative proportions of filter and deposit feeding organisms (trophic structure) has been used with some success in several cases (Driscoll, 1969; Grasso, 1973; Scott, 1976). However, Stanton and Dodd (1976) from benthic community studies in San Francisco Bay and the Pliocene of the Kettleman Hills, California, conclude that feeding type proportions in the fossil community are not always indicative of original environmental parameters.

Paleoautecology of the shelly fauna can be important in arriving at general paleoenvironmental conditions. Lophoporate filter feeders such as articulate brachiopods were probably all stenohaline save for some rhynchonellids and lingulids which were more tolerant of fluctuating salinites. In contrast, many bivalves may be euryhaline. Life habits (adaptive types) of various species of bivalves and brachiopods (Bowen, Rhoads, and McAlester, 1974; McGhee, 1976) through taxonomic analogy with modern taxa and functional morphology can yield significant data.

The communities and paleoenvironments outlined below are based on data such as species combinations, abundance, life habits (adaptive type), and trophic structure in addition to the physical criteria of gross lithology and sedimentary

structures. These are shown on Figure 1. Most of the fossils mentioned below are illustrated on Figures 2 - 12.

"Spirifer" sculptilis - Fimbrispirifer venustus Community

The "S" sulptilis Community restricted to the Centerfield member is a moderate to high diversity community dominated by filter feeding pedunculate brachiopods and large bivalve molluscs. The ichnofossil Zoophycos (Taonurus) probably a deposit feeder is extremely abundant on many bedding surfaces. Corals (microcarnivorous) occur principally in the central more calcareous part of the Centerfield and include the rugose corals, Heterophrentis and Cystiphylloides as well as the tabulate Favosites.

The epibyssate filter feeding bivalves include Cornellites flabellum, Limoptera macroptera and Leiopteria dekayi. Other epifaunal filter feeders are represented by the brachiopods "Spirifer" sculptilis, Fimbrispirifer venustus, Spinocyrtia granulosa and "Camarotoechia" dotis. The infaunal filter feeding forms include the endobyssate (anchored in the substrate by byssus threds, Stanley 1968, 1972) bivalves Goniophora, Actinodesma (Glyptodesma) as well as the mobile filter feeding bivalves Grammysia, and Cimitaria. Fragments of the large trilobite Dipleura (Trimerus) dekayi are occasionally found.

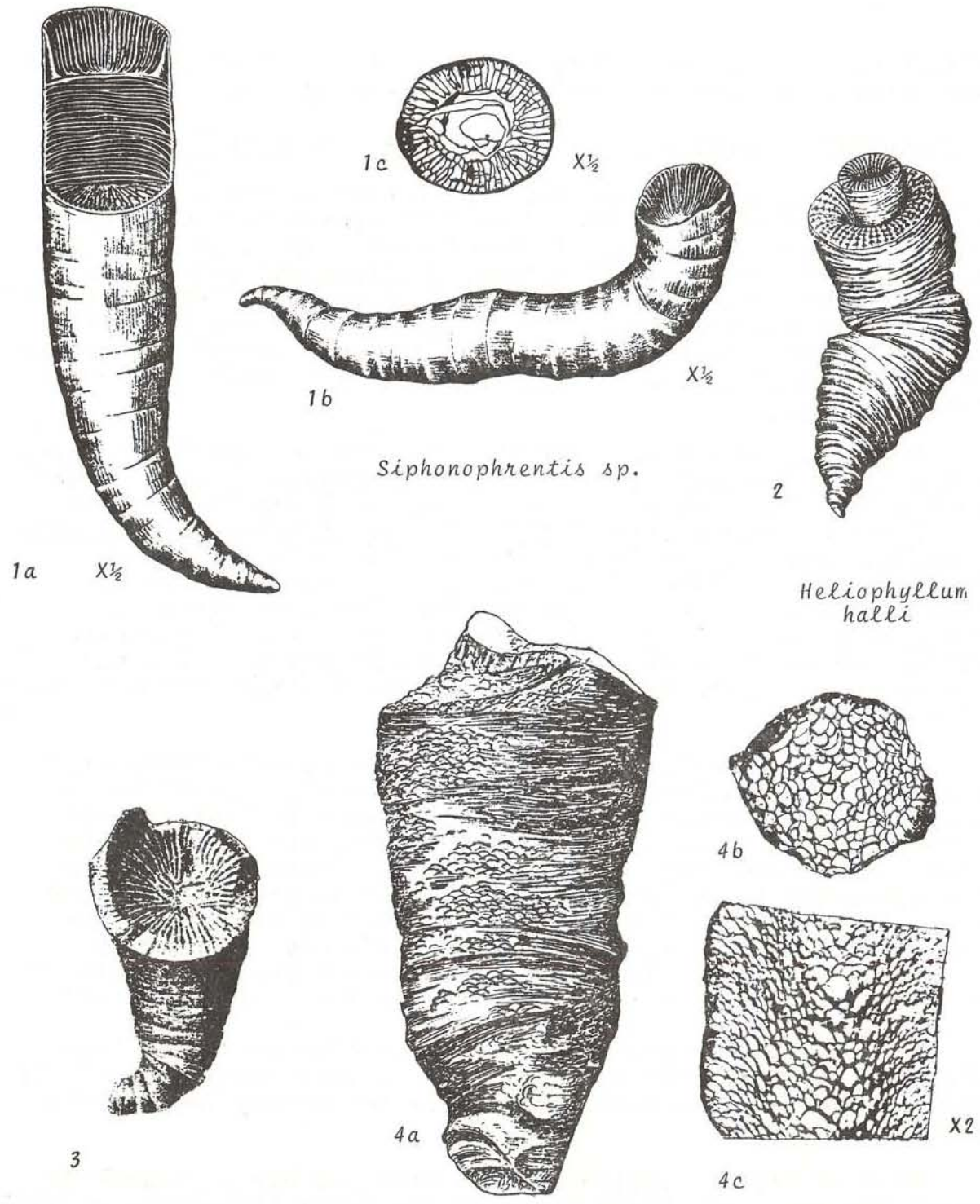
The "S" sculptilis community indicates a relatively high energy, shallow water, environment of the delta platform environment. Current activity was moderate to high, normal marine conditions prevailed, and the substrate was probably firm. Sufficient organic detritus was in suspension and in the substrate to support the varied feeding groups described above. The corals became established during times when the influx of clastic materials were at a minimum as these taxa were probably intolerant of turbid waters because of sediment clogging of their feeding mechanism (Selleck and Hall, 1977).

The crossbedded coarse siltstone or fine sandstone lithology of the Centerfield in the Tully Valley region attests to the high energy conditions that prevailed during Centerfield time.

Kramers (1971) hypothesizes an offshore bar or submarine shoal for the Centerfield based on its gross lithology, primary sedimentary structures, and lateral shifts in facies to the east and west of the Tully Valley.

Chonetes - Tropidoleptus Community

The Chonetes - Tropidoleptus Community rests upon the Centerfield member and extends upward into the Otisco for 20 to 30 feet. The faunal diversity of this community is



(ALL FIGURES NATURAL SIZE EXCEPT WHERE NOTED)

Figure 2. Fossils mentioned in text.

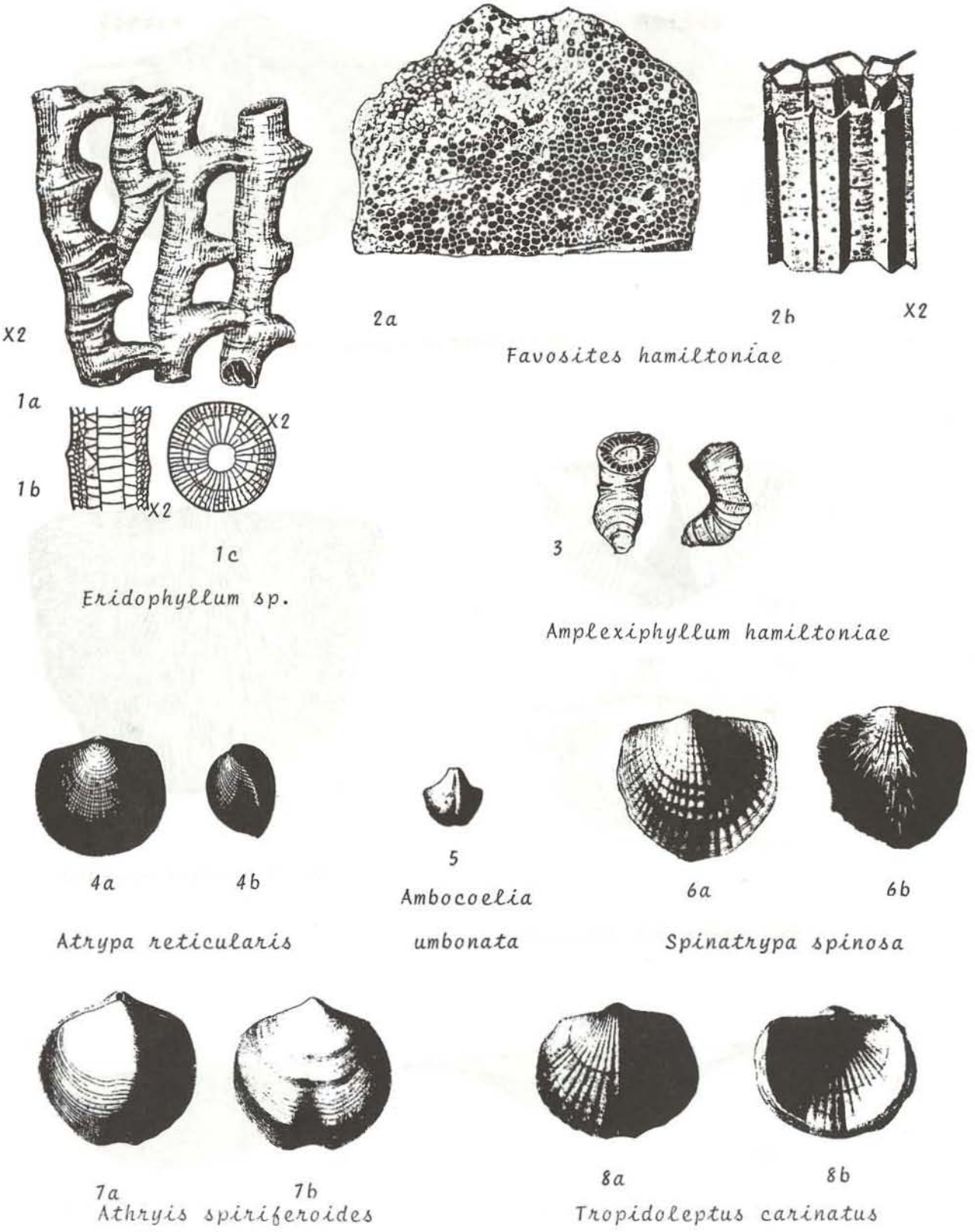
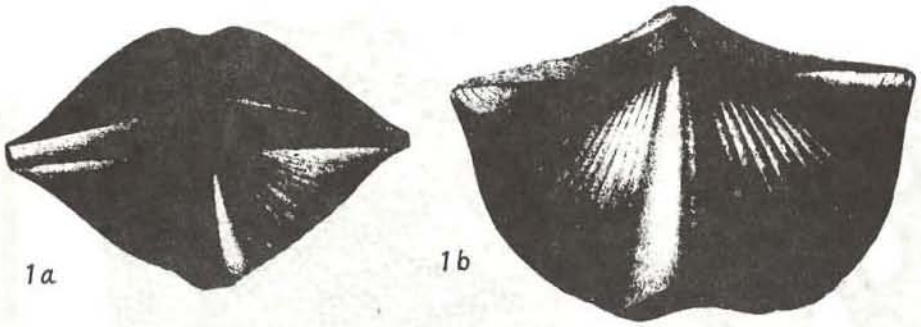
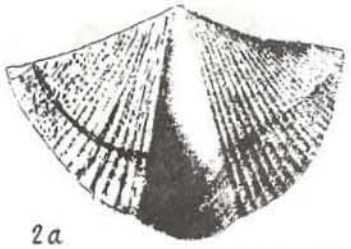
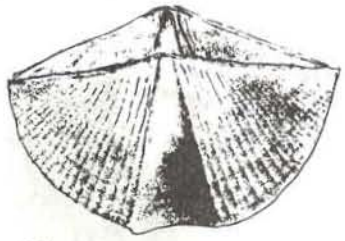


Figure 3. Fossils mentioned in text.

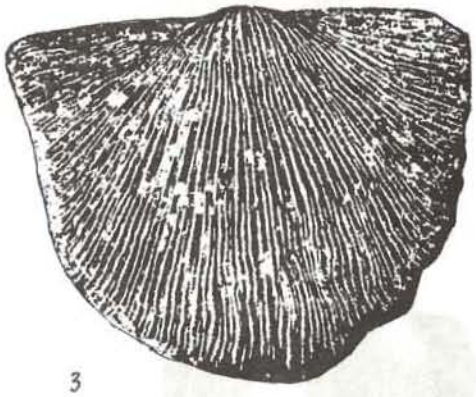


Spinocyrtia granulosa





Mediospirifer audaculus

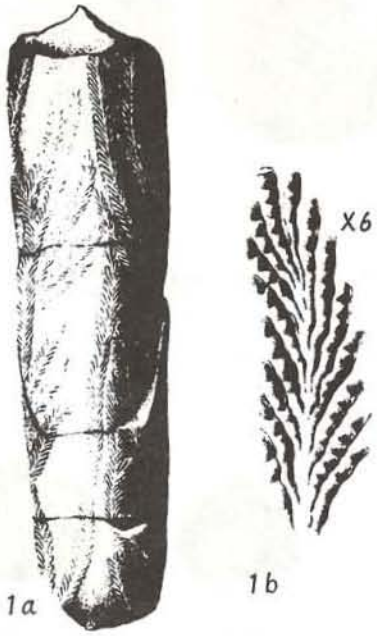


Megastrophia concava

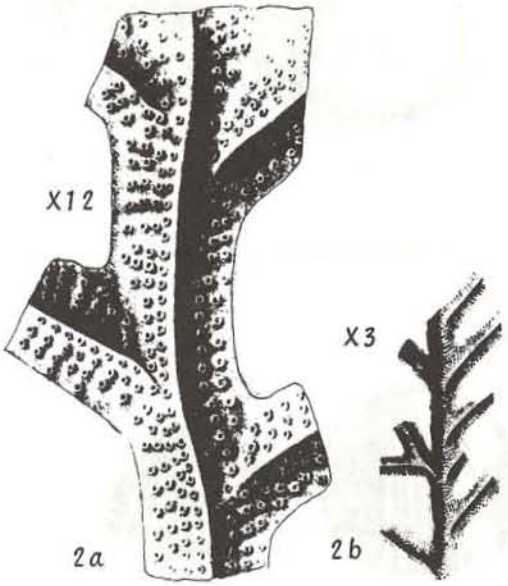
Mucrospirifer mucronatus

Figure 4. Fossils mentioned in text.

Figure 5. Fossils mentioned in texts.

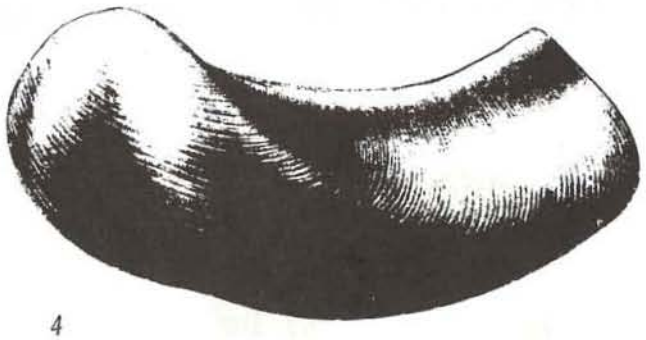


Reptaria stolonifera



Taenipora exigua

Cypricardella bellistriata



Cimitaria recurva

Figure 6. Fossils mentioned in text.

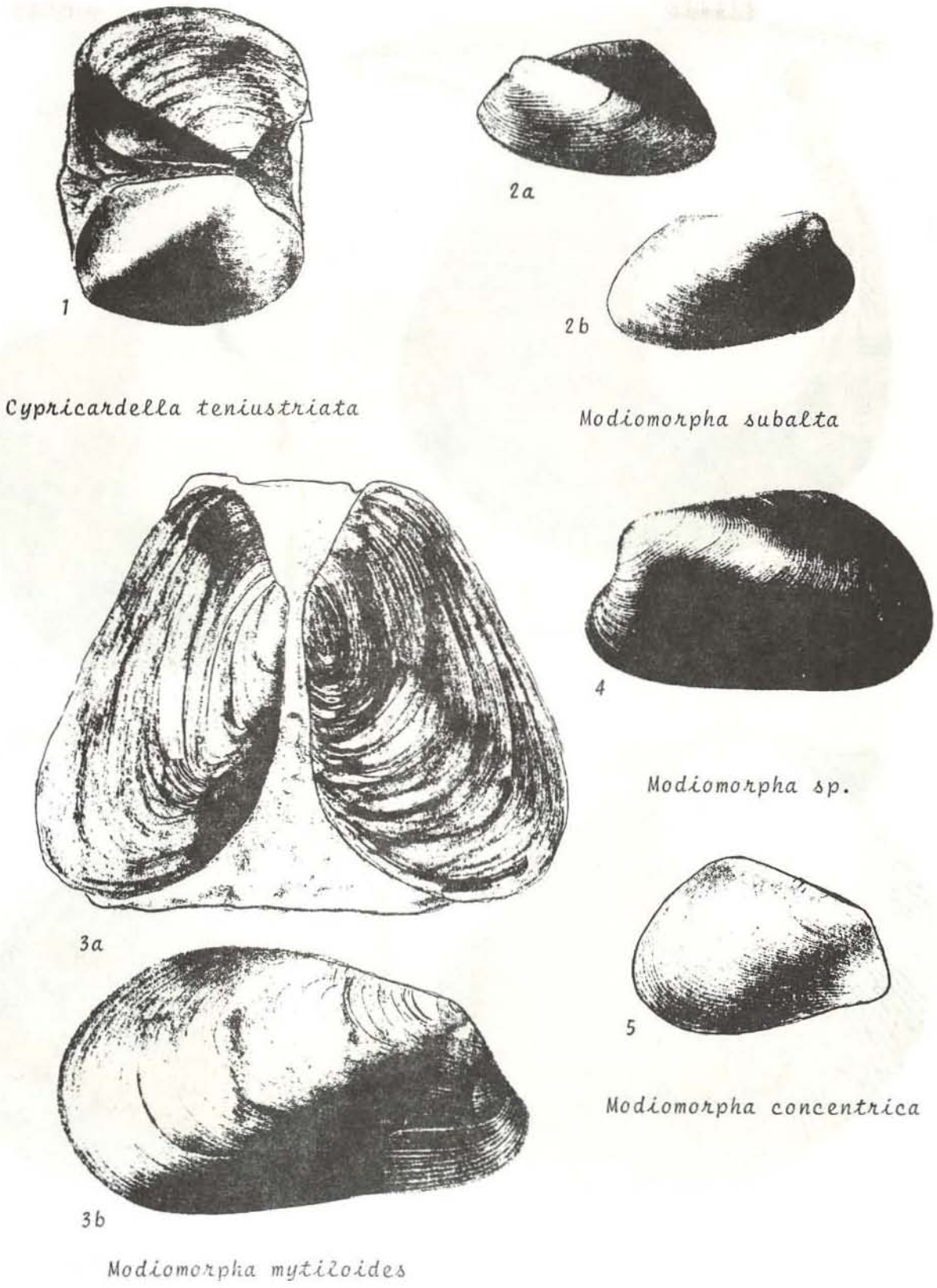
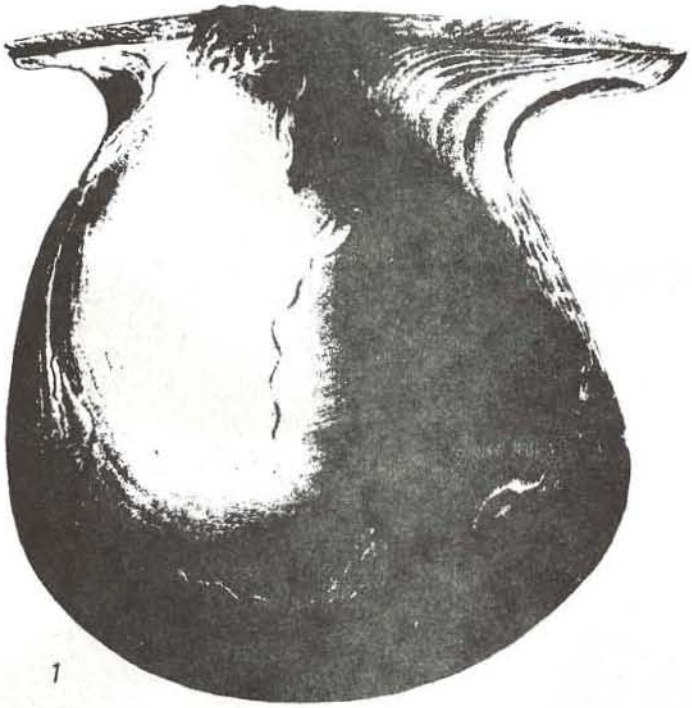
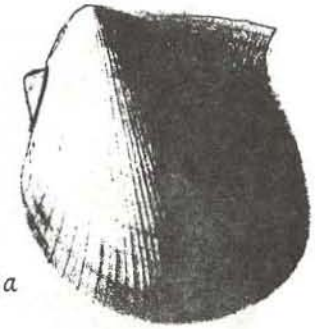


Figure 7. Fossils mentioned in text.



1

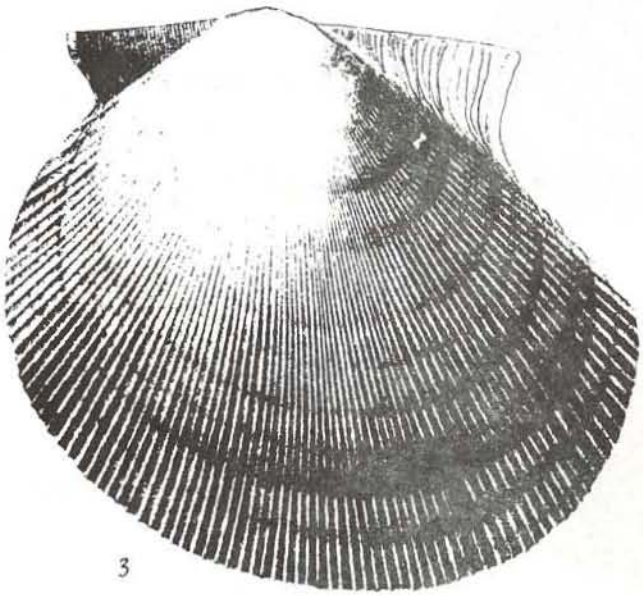
Actinodesma (Glyptodesma) erectum



2a

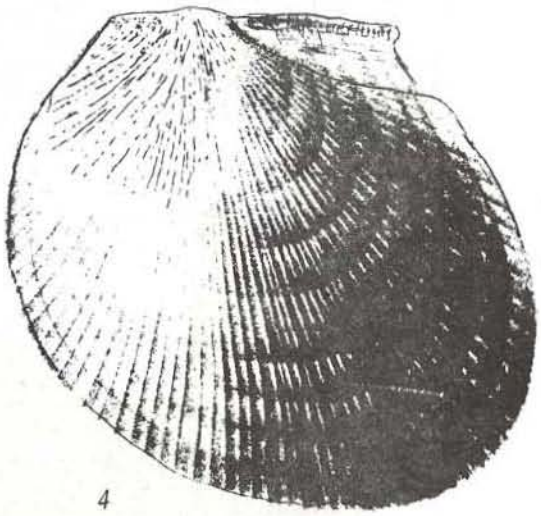
2b

Limopteria macropteria



3

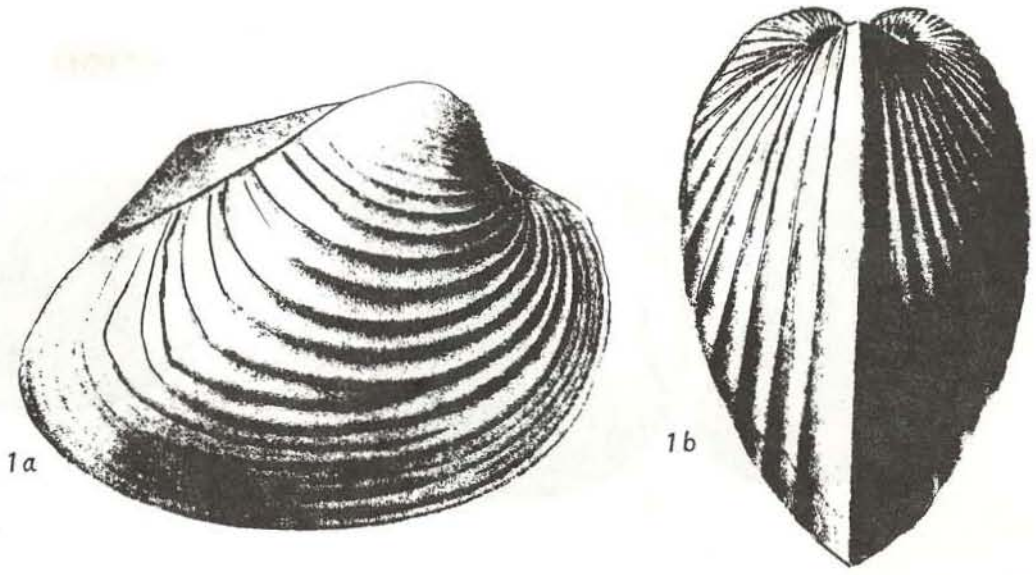
Pseudaviculopecten princeps



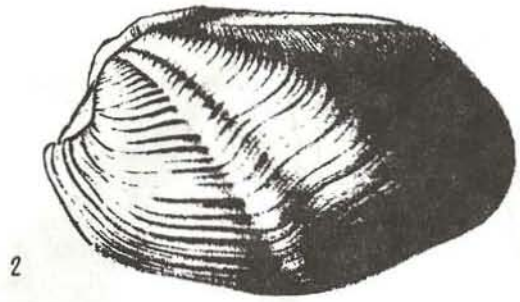
4

Lyriopecten orbiculatus

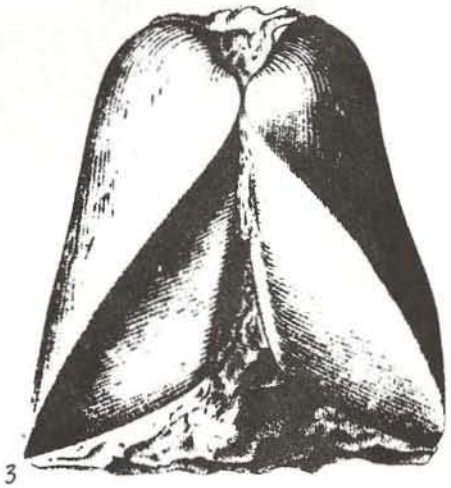
Figure 8. Fossils mentioned in text.



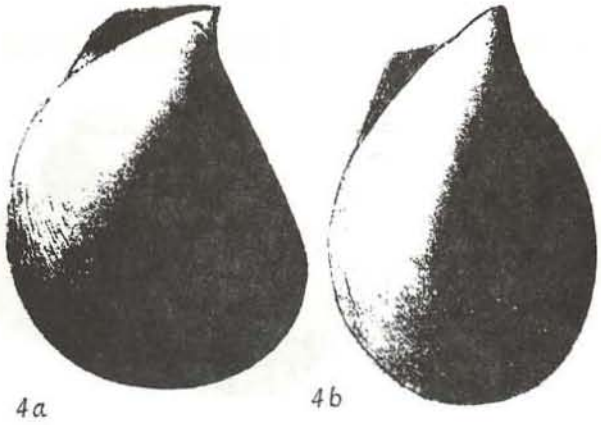
Grammysia alveata



Grammysia bisulcata

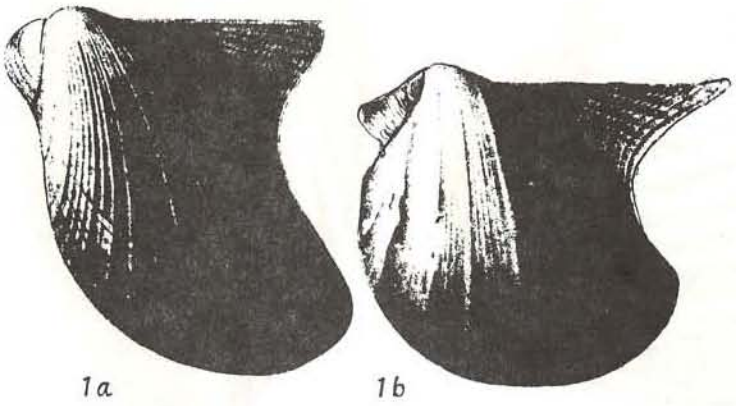


Goniophora hamiltonensis

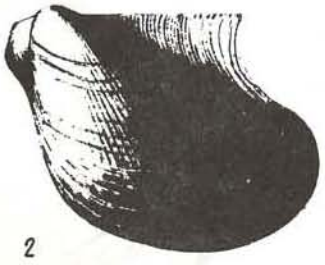


Mytilarca oviformis

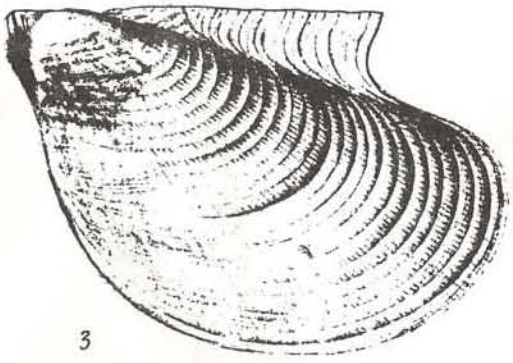
Figure 9. Fossils mentioned in text.



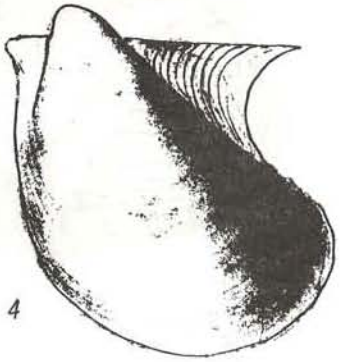
Cornellites flabellum



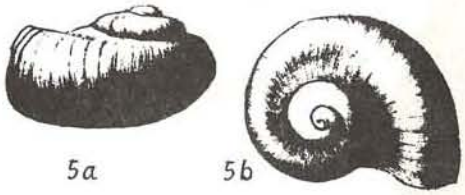
Actinopteria bodyi



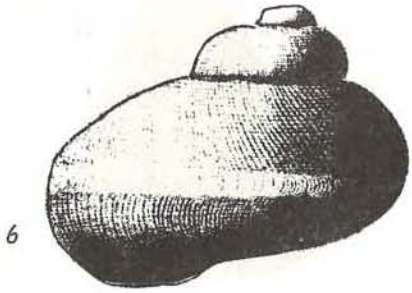
Actinopteria decussata



Leiopteria dekayi

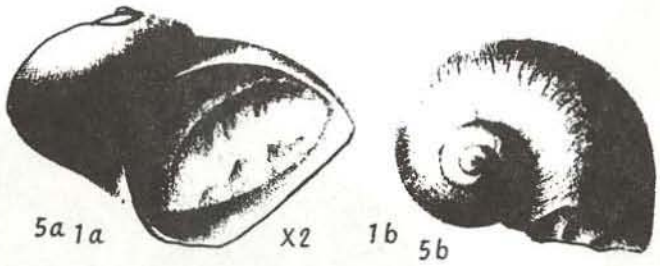


Platyostoma eumphaloides



Mourlonia lucina

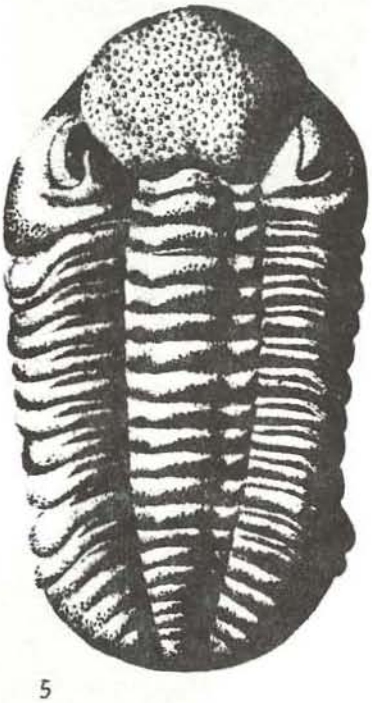
Figure 10. Fossils mentioned in text.



Naticonema (Platystoma) lineata

Loxonema hamiltoniae

Platyceras thetis



Greenops boothi

Phacops rana

Figure 11. Fossils mentioned in text.

1a

2

Zoophycos
(*Taonurus cauda-galli*)

1b

Dipleura dekayi

Figure 12. Fossils mentioned in text.

extremely high yielding over 60 species of typical Hamilton forms. The community is dominated by unattached and attached filter feeding articulate brachiopods such as Chonetes, Tropidoleptus carinatus, Protoleptostrophia perplana Spinocyrtia granulosa, Mediospirifer audaculus, Athyris spiriferoides, Mucrospirifer mucronatus, and Rhipidomella vanuxemi. Numerous worm trails are evidence of infaunal deposit feeders as well as the palp feeding bivalves Nuculites and Paleoneilo. Large epifaunal bivalves constitute a minor fraction of the total community.

The environment occupied by this community, was of low stress, located along the outer muddy-silty edge of the delta platform. Moderate energy for this environment is thereby implied along with low sedimentation rates. Vigorous current action was non operative and the substrate was probably soft to moderately firm. The attached pedunculate brachiopods such as Rhipidomella, Athyris, and Spinocyrtia probably anchored to abandoned shells, where as the strategy of unattached brachiopods was aimed at keeping the commissure free of mud by the snow-shoe effect of a deep incurved pedicle valve and spinose hinge line, e.g. Chonetes and the wide alate hinge of Mucrospirifer.

Camarotoechia Community

This low diversity community is restricted to the 6 to 7 feet of the hard, coarse, massive, siltstone platform that underlies the Staghorn Point Submember.

Camarotoechia dotis and Spinocyrtia granulosa dominate the assemblage with Athyris spiriferoides, Tropidoleptus carinatus and Mucrospirifer mucronatus playing minor roles.

A relatively high stressed, high energy environment is inferred, with abundant organic detritus in suspension.

This community may have inhabited a submarine shoal on the floor of the Ludlowville sea, similar to the one envisioned for the Centerfield in the Tully Valley region (Kamers 1971) reactivated during early Otisco time.

Siphonophrentis - Cystiphylloides Community

The Siphonophrentis - Cystiphylloides Community is conterminous with the Staghorn Point Submember and is characterized by moderate diversity with high density.

Oliver (1951, Table 1, p. 712) lists the dominate rugose species in this community in order of relative abundance as follows: Siphonophrentis halli, Cystiphylloides americanum, Cystiphylloides conifolis, Heliophyllum halli, and Heterophrentis ampla.

This community represents a dramatic change in paleoenvironmental conditions during Otisco time. Being composed nearly 100 percent of turbitidy intolerant microcarnivores, precludes rapid clastic sedimentation. The corals enjoyed optimal conditions for profuse growth such as relatively shallow, well oxygenated, clear, warm marine waters of normal salinities. Currents sufficiently strong to carry organic materials in suspension must have operated over the coral "gardens" which were, probably near wave base. The thriving corals were able to compete with other invertebrate groups so well that they virtually excluded them from becoming established members of the community. Maybe their food source was the larval forms of these invertebrates. With the return of relatively turbid waters and rapid, clastic sedimentation of the Otisco shale the Siphonophrentis Community came to an abrupt end.

The siltstone platform provided a firm substrate upon which the initial coral spat falls were able to become firmly established. Succeeding generations used the skeletons of their predecessors as substrates (Oliver 1951).

Mucrospirifer - Spinocyrtia - Megastrophia Community

This community occupies the upper 65-70 feet of Otisco silty shales beginning approximately 43 feet above the Staghorn Point Submember.

Mucrospirifer mucronatus is extremely abundant throughout but completely dominates the lower 20-30 feet of this community where species diversity is low.

Above this point diversity increases rapidly as epifaunal and infaunal filter feeding brachiopods and bivalves, infaunal filter feeding bivalves, infaunal deposit feeding bivalves and worms, and vagrant gastropods and trilobites make their apperance.

In the upper 30 feet the large attached brachiopods Spinocyrtia granulosa and the large unattached brachiopod Megastrophia concava are very abundant, occuring with numerous other brachiopods both attached and unattached. The large epifaunal bivalves Pseudaviculopecten, and Cornellites are also common along with the infaunal endobyssate Modiomorpha mytiloides. Nuculites and Paleoneilo are present as well as the trilobites Phacops rana and Greenops boothi.

The Otisco Shale is finer grained in the lower, Mucrospirifer bearing, 30 feet and gradually coarsens upward coincident with the increase in diversity.

Mucrospirifer probably represents a relatively high stressed pioneer community well adapted to the softer muddy bottoms that existed early. As a response to the moderately

increased energy later in time more adaptively varied filter and deposit feeders become established. Lack of disarticulated specimens and the abundance of unattached forms attest to moderate current activity supplying nutrients in suspension for filter feeders yet leaving the substrate rich in organic material for deposit feeders. Any outer delta platform environment is probably represented herein.

Second Siphonophrentis - Cystiphylloides Community

This community is found in the northern part of the Tully Valley region, which marks it farthest extent to the northeast. Southwestward it can be traced to the east side of Skaneateles Lake. It is entirely wanting in the Ludlowville Formation exposed south of Cardiff, New York.

This community is co-extensive with the Joshua Submember and existed simultaneously with portions of the Mucrospirifer-Spinocyrtia-Megastrophia Community in the southern Tully Valley.

The paleoecologic parameters necessary for this community mirror those of the first rugose coral community in the Staghorn Point and need not be reiterated here.

One striking difference, however, is the absence of a siltstone platform in the upper coral bed. Instead the Joshua rests on a thin bed composed entirely of the colonial rugose coral Eridophyllum subcaespitosum. Oliver (1951, p. 717) suggests "...these colonial rugose corals colonized the area during an interval of favorable conditions and formed a crude platform for the solitary corals."

Cypricardella Community

The Cypricardella Community is found in the Spafford silty shales and also includes the upper portion (10') of the Ivy Point Member. Epifaunal filter feeders and infaunal filter feeders dominate the assemblage. Mucrospirifer mucronatus is the dominate brachiopod while the bivalves are represented by Cypricardella, (perhaps a free burrowing filter feeder), Cornellites, Modiomorpha, Actinopteria, Pterinopecten, and Nuculites. An outer delta platform environment was inhabited by this community.

Allanella tullius Community

Restricted to the Owasco Member this low diversity community is characterized by the epifaunal filter feeding brachiopods Allanella, Tropidoleptus and Mucrospirifer. This community probably inhabited a relatively high stressed environment of the middle to inner delta platform.

Chonetes - Ambocoelia Community

This community is characterized by a low diversity assemblage of small epifaunal filter feeders without a functional pedicle in the adult stage. The deep incurved pedicle value of Ambocoelia and Chonetes, and the spinose hinge of Chonetes seem to make these taxa ideally suited for life on soft substrates. The infaunal deposit feeding bivalves Paleoneilo and Nuculites are also fairly conspicuous in this community.

A low energy environment characterized by low oxygen levels of the outer delta platform or prodelta slope is suggested. Abundant organic detritus was available in the substrate, for deposit feeders. It characterizes the lower 40 to 50 feet of the Windom Member in the Tully Valley and will not be observed on the trip.

Mucrospirifer - Chonetes Community

This community is found in the middle and upper Windom Member, from about 80 feet below to approximately 30 feet below the Tully Limestone. Its high diversity suggests opulent ecological conditions on and in the substrate. Numerous filter feeding, deposit feeding, and vagrant invertebrates typify the assemblage. The brachiopods Mucrospirifer, Chonetes, Tropidoleptus, Spinocyrtia, Mediospirifer and Athyris are forms associated with the bivalves Aviculopecten, Nuculites, Paleoneilo, Sphenotus, and Modiomorpha and trilobites and nautiloids. The ichnofossil Zoophycos (Taonurus) is very abundant.

Leiorhynchus - Pustulatia Community

The 20 or so feet of dark shales at the top of the Windom contain epiplanktonic brachiopods and bivalves, small epifaunal brachiopods and small infaunal bivalves. Some of the species found include Leiorhynchus multicosta, Pustulatia pustulosa, Allanella tullius, Pterochaeina fragilis, Nucula varicosa, and Paleoeilo constricta.

This community is a mixture of pelagic and benthonic forms indicative of deeper, poorly oxgenated waters of the lower prodelta slope. The presence of some epifaunal brachiopods and infaunal bivalves indicates some oxygen in the water with the zero Eh surface coincident with or just below the sediment water interface.

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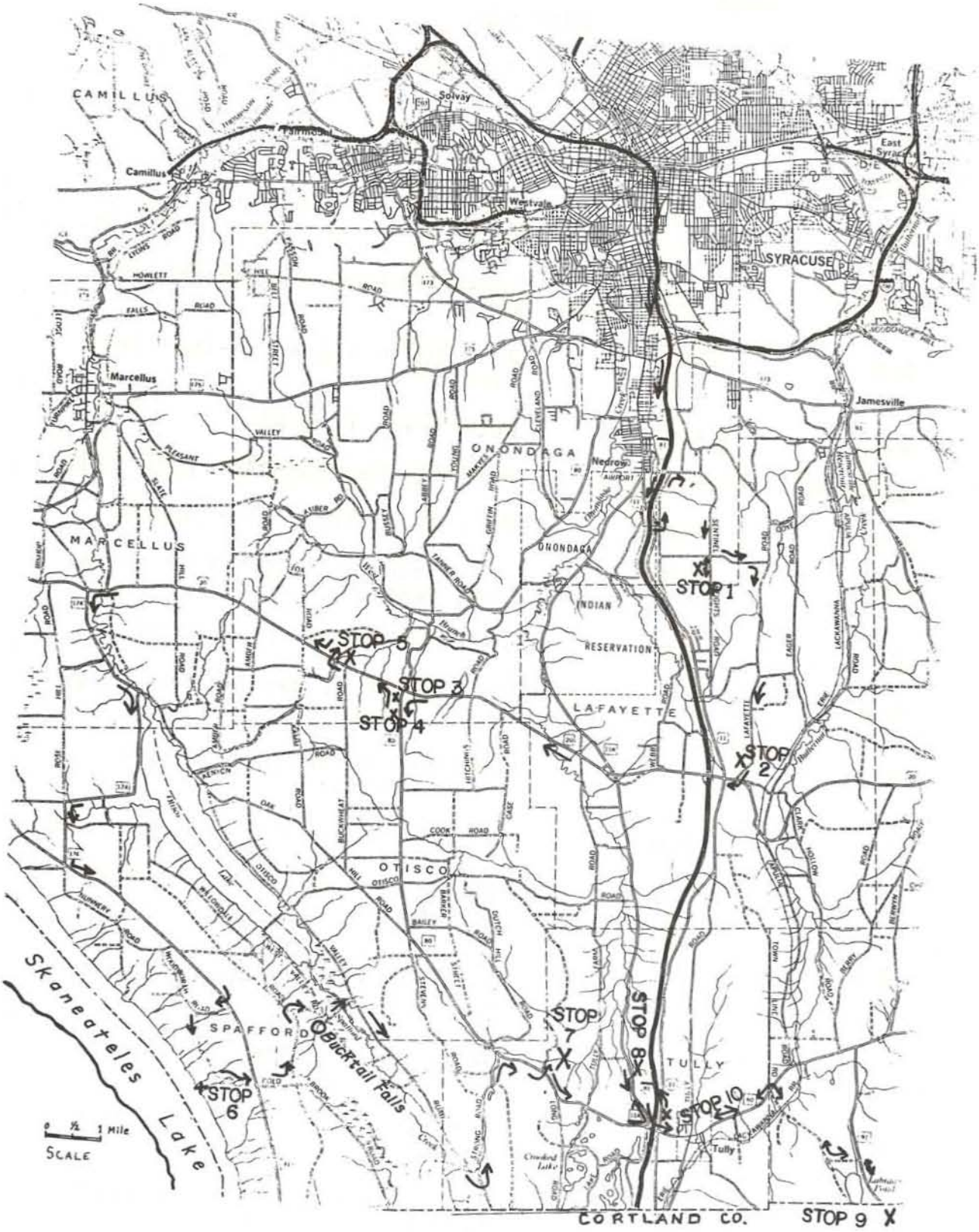
CAMILLUS
Solvay
Camillus
Westvale
SYRACUSE
East Syracuse
Marcellus
Jamesville
ONONDAGA
Nedrow
AIRPORT
MARCELLUS
INDIAN
RESERVATION
LAFAYETTE
OTISCO
SPAFFORD
TULLY
Tully
Skaneateles Lake
Otisco Valley
Buckwheat Hill
STOP 1
STOP 2
STOP 3
STOP 4
STOP 5
STOP 6
STOP 7
STOP 8
STOP 9
STOP 10
CORTLAND CO.
0 ½ 1 Mile
SCALE

ROAD LOG

NOTE: Quadrangles referred to are 7½ minute. See map for stops and route.

Miles from last point	Cumulative Miles	
0.0	0.0	Manley Field House parking lot-turn right (west) on Colvin St.
0.1	0.1	Cross Comstock Avenue-proceed west
0.8	0.9	Jct. South State St.-turn left (south)
0.7	1.6	Enter ramp to I-81
3.6	5.2	Exit 16 (Nedrow)-take exit ramp
0.3	5.5	Jct. US 11-turn left (south)
0.2	5.7	Jct. Kennedy; Camping Rd.-turn left (east)
0.1	5.8	Left (north) on Kennedy Rd.
0.9	6.7	Jct. Sentinel Heights Rd. - turn right (east)
0.7	7.4	Sentinel Heights Rd. curves right (south)
1.6	9.0	Jct. Bull Hill Rd.-proceed south
0.2	9.2	Access road to WSYR-TV tower-turn right
0.2	9.4	STOP 1 - Base of tower on Miller Hill (Jamesville Quad.) - Joshua Submember (15')
0.2	9.6	Return to Sentinel Heights Rd. turn left (north)
0.2	9.8	Jct. Bull Hill Rd.-turn right (east)
1.1	10.9	Jct. LaFayette Rd.-turn right (south

2.0	12.9	Reidy Hill Rd. on left proceed south
1.7	14.6	STOP 2 - Roadcut on west side of LaFayette Rd. (Jamesville Quad.) About 30' of the Upper Otisco Member and the Mucrospirifer-Spinocyrtia-Megastrophia Community is exposed here. Proceed south on LaFayette Rd.
0.3	14.9	Jct. US 20-turn right (west)
0.2	15.1	Jct. US 11-proceed west on US 20
0.3	15.4	Jct. I-81 proceed west on US 20
0.9	16.3	Descend east side Tully Valley
1.1	17.4	Jct. NY 11A Cardiff-proceed west on US 20
2.2	19.6	US 20 build on surface of large hanging delta
1.3	20.9	Jct. NY 80-turn left (south)
0.3	21.2	STOP 3 - Roadcut on NY 80 (South Onondaga Quad.) Joshua Submember (Elev. top 1280')-Proceed south on NY 80
0.5	21.7	STOP 4 - Roadcut on NY 80 (South Onondaga Quad.) Owasco (2') Portland Point (10') Members (Elev. 1380') - Return North on NY 80
0.8	22.5	Jct. US 20- turn right (west)
1.3	23.8	Jct. Hogsback Rd.-turn right (south)
0.1	23.9	STOP 5 - Peppermill Gulf just east and parallel to Hogsback Rd. (South Onondaga Quad.) Centerfield Member (20-30') - Return to US 20-turn right (west)
1.6	25.5	Navarino-proceed west on US 20
1.9	27.4	Descend Eastside Tyler Hollow Nine Mile Creek (Otisco Lake outlet)

0.9	28.3	Jct. NY 174-proceed west on US 20 - NY 174
0.4	28.7	Jct. NY 174-turn left (south)
6.4	35.1	Jct. NY 41 at Borodino turn left (south)
1.2	36.3	Old Borodino Quarry-bioherm in Tully Ls. on left and roadcut on NY 41
2.8	39.1	Jct. Woodworth Rd.-turn right (west
0.7	39.8	Jct. Bacon Hill Rd.-turn left (south)
1.2	41.0	Jct. dirt road on right (west) leading down to shore of Skaneateles Lake-leave bus and walk down road .7 miles to shore of lake
		STOP 6 - Staghorn Point (Spafford Quad.). This is the type section of the Staghorn Point Submember (4'). The siltstone platform and overlying Otisco shales are well exposed here. Return to bus-proceed south on Bacon Hill Road.
0.9	41.9	Jct. NY 41 at Spafford-take slight jog to right and proceed east on Cold Brook Road.
0.7	42.6	Jct. Willowdale Rd.-turn left (north)
1.2	43.8	Jct. Moon Hill Rd.-turn right (east)
0.8	44.6	Bucktail Falls Ravine on right-exposing the entire Upper Hamilton Group from the Center-field Member to the Tully Ls. Jct. Sawmill Rd.-turn left (east)
0.6	45.2	Jct. Otisco Valley Rd.-turn right (south)

4.0	49.2	Jct. Strong Rd. at Bromley- turn acute left (north)
2.5	51.7	Jct. NY 80-turn right (east)
0.8	52.5	Jct. Woodmancy Rd.(Hallinan Rd. on Quad.) turn left (north)
0.2	52.7	STOP 7 - Fellows Falls Ravine down from Woodmancy Rd. (Otisco Valley Quad.). A complete section in the Ludlowville Form. Is exposed at this locality as follows:

Owasco	2'	Elev. 1120' Falls at top of ravine
Spafford	25'	
Ivy Point	40'	
Otisco	165'	Staghorn Point 7'
Centerfield	20'	Elev. 880'

0.2	52.9	Return to NY 80-turn left (east)
0.7	53.6	NY 80 follows crest of Tully Moraine
1.7	55.3	Jct. NY 11A-turn left (north)
0.6	55.9	Descend north side of Tully Moraine
0.7	56.6	STOP 8 - Unamed ravine on east side of Tully Valley up from NY 11A (Otisco Valley Quad.). The section exposed here is similar to Fellows Falls Ravine (STOP 7) with the exception of the lower Otisco covered from the Upper Centerfield to the Staghorn Point siltstone platform. The Owasco is also not exposed here. (NOTE: This stop may be omitted depending on time schedule). Return south on NY 11A.
1.3	57.9	Jct. NY 80-turn left (south)
0.2	58.1	Jct. US 11 and I 81- proceed east on NY 80, US 11
0.4	58.5	Enter Tully

0.2	58.7	US 11 Turns south-proceed east on NY 80
1.7	60.4	Jct. Markham Hollow Rd. at Fabius Town Line-turn right (south)
1.7	62.1	Jct. Labrador Rd.-turn left (east)
0.5	62.6	Jct. NY 91-turn right (south)
0.9	63.5	Cortland Co. line
0.4	63.9	STOP 9 - Tinkers Falls Ravine-up from eastside of NY 91 (Tully Quad.). About 80' of Windom is exposed here with the Tully Ls. forming the cap rock of Tinkers Falls (Elev. 1380'). The Mucrospirifer-Chonetes Community is well exposed in the first exposure upstream at base of falls. (Elev. 1300'). Return north on NY 91
1.3	65.2	Jct. Labrador Rd.-turn left (west)
0.5	65.7	Jct. Markham Hollow Rd.-turn right (north)
1.8	67.5	Jct. NY 80-turn left (west)
0.2	67.7	Enter Tully
0.4	68.1	Jct. US 11
0.5	68.6	US 11 bends right-to the north-proceed on US 11
0.3	68.9	STOP 10 - Roadcut on eastside of US 11 (Tully Quad.). About 30' of Windom is exposed here carrying the Mucrospirifer - Chonetes Community. Return to Manley Field House via I-81.