Trip A-1

LATE MIDDLE DEVONIAN BIOTIC AND SEDIMENTOLOGIC EVENTS IN EAST CENTRAL NEW YORK – TULLY FORMATION CLASTIC CORRELATIVE SUCCESSION IN THE SHERBURNE – ONEONTA AREA.

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ABSTRACT

Terrigenous clastic deposits equivalent to the upper most Moscow Formation and Tully Formation record a number of key sedimentological-paleontological events that occurred during the latest part of the Middle Devonian Givetian Stage. These deposits, last mapped in detail by G. Arthur Cooper and H.S. Williams in the 1930s, have been the subject of extensive stratigraphic mapping work by the present authors over the past five years. Goals of this mapping project are: 1) to identify divisions and boundaries correlative to units identified in the Tully Limestone further west through the classic work of Phillip Heckel in the sixties and seventies; 2) to identify key facies that can be interpreted in the context of onshore-offshore paleoenvironmental models; 3) to reconstruct the faunal succession in this thick interval of strata so as to elucidate in greater detail two key levels of faunal change associated with the global Taghanic Bioevent; and 4) to use stratigraphy and sedimentology to identify structural features that were active or present during deposition of these units.

Preliminary results of our work show that most of the lower and medial parts of the Tully Formation clastic correlative succession (here in referred to as "TFCCS") between Sherburne, NY and New Lisbon, NY consist of relatively unfossiliferous strata that record the development of a structural basin (New Berlin Trough) probably centered in what is now the Unadilla Valley. Condensed units overlying regional discontinuities developed at several stratigraphic levels both in the basin and on its western flank; sediment-starvation associated with condensation led to the formation of "oolitic" chamosite under conditions not fully understood. Basin center deposits recorded dysoxic conditions and development of low diversity faunas dominated by auloporid corals and small brachiopods; eastward passage of sparsely fossiliferous deposits near New Berlin to richly fossiliferous equivalent units near Laurens reflects a shoreward basin-to-shelf transition. This contradicts the standard view that the lower and medial Tully record primarily shallow and even lagoonal conditions. Our model does vigorously support (and significantly enhances) Heckel's (1973) view of a "Tully clastic trap" controlled by structure in east-central New York.

Herein, we show that typical oxic Hamilton facies ends with onset of dysoxic, highstand conditions associated with deposition of the New Lisbon Member. We exclude the upper, Tully-equivalent part of Cooper and Williams' (1935) "New Lisbon Member", which is separated from our restricted New Lisbon Member by a basal Tully erosion surface. Currently, we believe that the restricted New Lisbon succession is equivalent to the Gage Gully submember of the Windom Member, although this is still uncertain. The TFCCS contains six internal mappable discontinuities; these are, in upward-succession: a, a base-Tully (DeRuyter Bed-equivalent?) contact; b, a sub-"Laurens" contact, possibly

equating to the base of the Fabius Bed to the west; c, a sub-Symrna Bed disconformity traceable westward into central New York; d, a top-Smyrna flooding surface contact; e, an erosion surface flooring the West Brook Bed; and f, a diastem (base-Moravia Bed? discontinuity) above the West Brook Bed. The upper Tully, base-West Brook contact marks the greatest lowstand event with development of a prolific Hamilton faunal association characterized by diverse brachiopods, and corals, above the contact. East of Otselic, the Tully Formation contact with the overlying Geneseo Black Shale is conformable.

Initial Tully Fauna incursion occurs at the base-Tully (DeRuyter Bed-equivalent?) contact at New Lisbon and Laurens. The Tully Fauna persists above the Smyrna Bed into the middle part of a sparsely fossiliferous post-Smyrna Bed highstand-succession probably correlative with the Taughannock Falls Bed within the Tully Limestone. The uppermost part of the highstand succession is characterized by a return of the pre-Tully Hamilton fauna. The West Brook Bed records a major, anomalous acme ("last hurrah") of the Hamilton Fauna prior to onset of dysoxic and, finally, anoxic conditions associated with uppermost Tully and Geneseo deposition. Preliminary work on eastern sections of the TFCCS suggests that nearshore, Tully equivalent "Chemung-type" facies may yield several taxa of the Ithaca fauna absent from outer shelf, Tully platform carbonates.

INTRODUCTION

The Tully Formation in New York State is an anomalous carbonate unit within the thick terrigenous Devonian foreland basin succession. It was known for the occurrence of *Hypothyridina "cuboides"* (now *Tullypothyridina venustula*; Sartenaer, 2003) and other distinctive taxa as far backs as the mid-nineteenth century. Detailed study of the Tully Formation was initially undertaken by Cooper and Williams (1935) in New York State and by Willard (1937) in Pennsylvania. Cooper and Williams (1935) recognized that clean carbonates comprising the Tully Formation south of Syracuse and in the Finger Lakes region pass eastward into thin, partly oolitic deposits in the Sherburne area in Madison County before grading into a thick correlative clastic succession east of there. We have worked from the initial stratigraphic framework established by these workers (see Figures 1 - 3) in building the correlation schemes presented herein (see Figs. 4 - 11).

The most detailed and important study of the Tully Formation is that of Phillip Heckel in the 1960s and early 1970s (Heckel, 1966, 1969, 1973). Rather than defining large facies tracts within units as was the fashion of the day, Heckel came to recognize specific beds in the Tully Limestone as mappable events.

Figure 1. Named subdivisions of the Tully Limestone in New York. Tully Limestone comprises two members which include all units termed "bed" or "mound." Unnamed sandstone, Unadilla Formation, and West Brook bed east of vertical dashed line are parts of eastern detrital equivalent of Upper Member. Wavy lines are major disconformities; other lines are bed, member, and formation boundaries; zigzag lines represent known facies relations. Datum levels are Bellona Bed and West Brook Bed. BMB – back-mound beds; MB – middle beds; UB = upper beds. From Heckel (1973).

Figure 2. Correlation of key Tully divisions relative to major structural features based on work of Heckel (1973). From Heckel (1973).

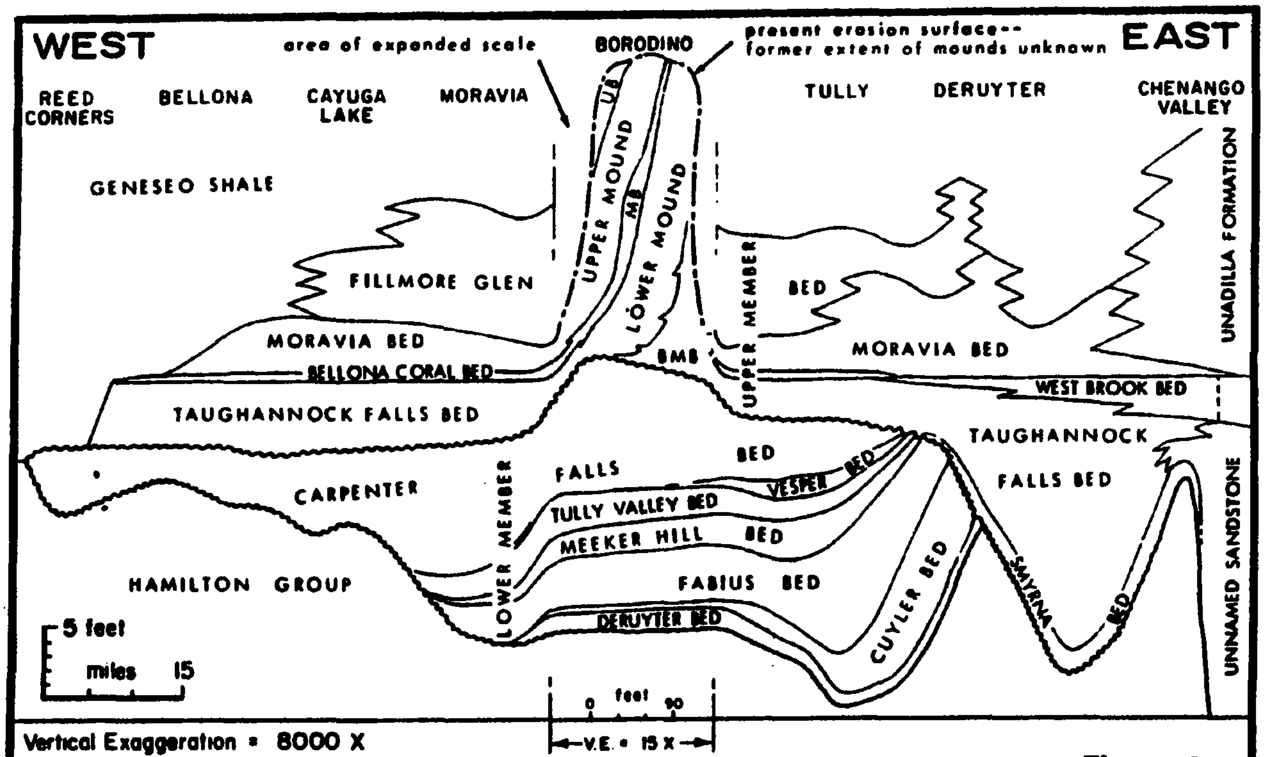

Figure 1

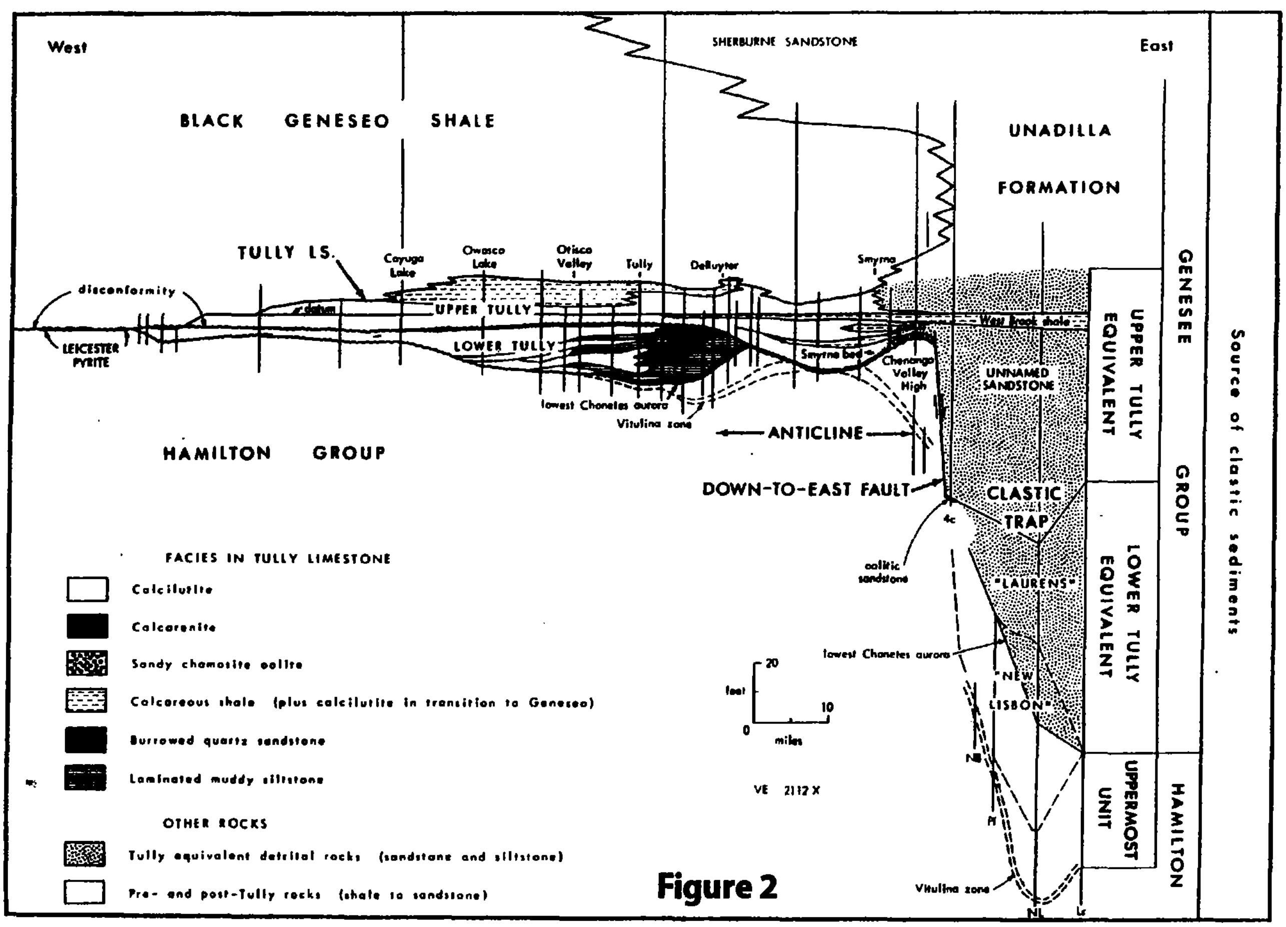

Figure 2

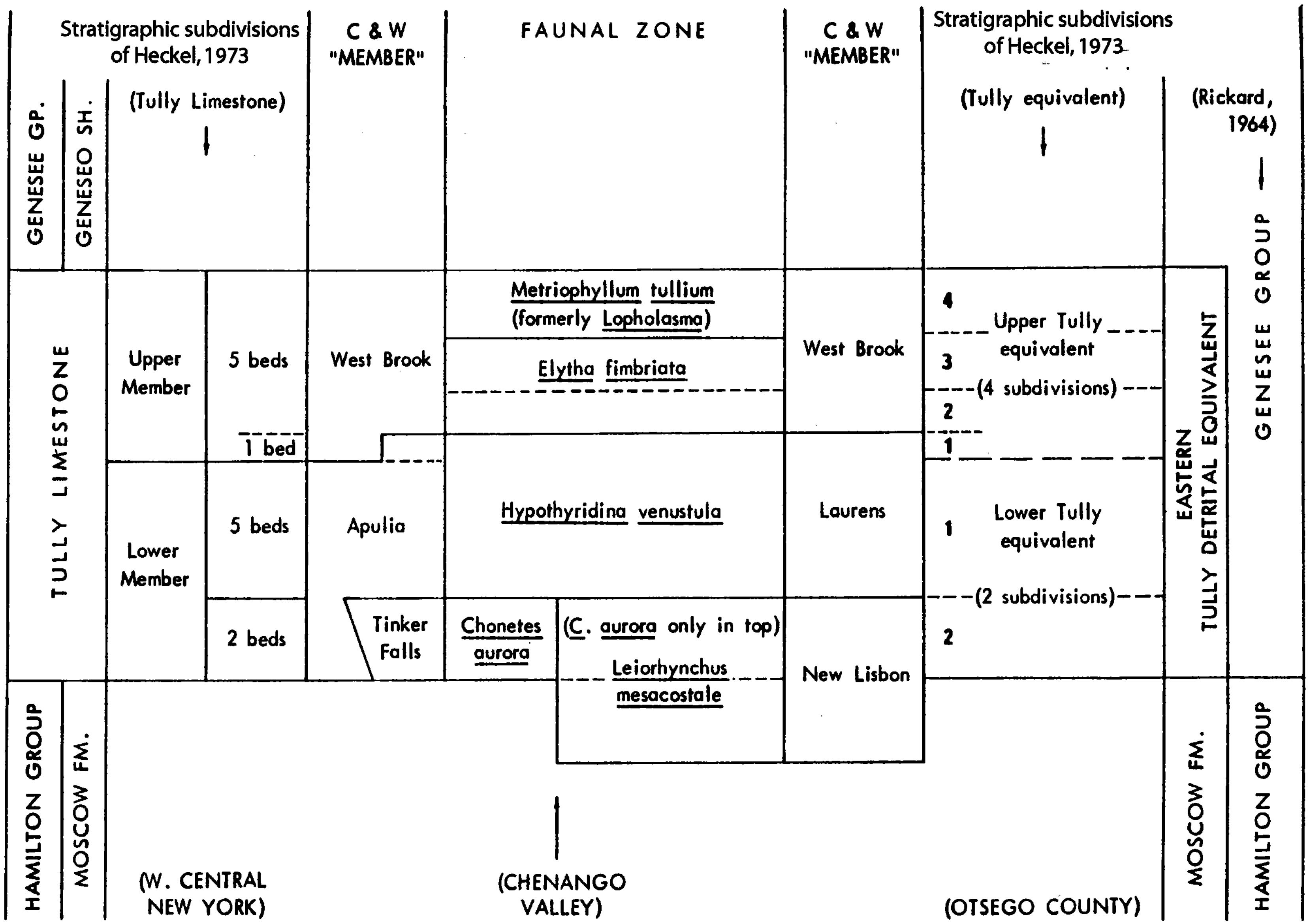

Figure 3. Comparison of Heckel's (1973) internal classification scheme for the Tully Limestone to that of Cooper and Williams (1935). Modified from Heckel (1973).

Numerous such beds were used to establish a detailed correlation network for the Tully (Figures 1 - 3). Using this approach, Phillip Heckel was able to reconstruct a pattern of eastward erosional overstep of lower Tully divisions along a dynamic contact within the Tully (Figures 1, 2). He, further, showed that medial Tully carbonate-rich strata (Taughannock Falls Bed) passed eastward into a thin sandstone and chamositic oolitic interval in the Chenango Valley before expanding into a thick silty-sandy facies succession in the Columbus-New Berlin area (Figure 2). In particular, Heckel (1973) recognized that during Tully time, a structural "clastic trap" represented by thick clastic sediment accumulation had developed east of a Sherburne area structural "high" (Figure 2). Heckel (1973) recognized a rapid and conspicuous eastward facies change within the lower Tully succession between Tully and DeRuyter from limestone to siltstone and fine sandstone towards the area of lower Tully overstep noted above (Figure 2). From this pattern, he concluded that uplift and subaerial(?) erosion of the lower Tully succession had led to redeposition of these clastics in areas within the Tully proximal to the uplift. Moreover, he argued that the clastic trap to the east, and the lower Tully uplift event locally, had blocked the influx of clastics from the east allowing for deposition of clean limestone across central New York. Heckel (1973) further characterized the upper Tully "*Elytha fimbriata*" interval of Cooper and Williams (1935) by defining the West Brook Shale in east-central New York and the Bellona Coral Bed from Tully westward to Gorham near Canandaigua Lake. Detailed faunal lists from each of the numerous Tully Formation divisions greatly improved the resolution of the known Tully faunal succession. Heckel (1973) argued that the Tully generally recorded shallow, even lagoonal conditions. Most important to this argument was the discovery of mud cracks on the top of the Carpenters Falls Bed at many localities.
This contact, marking his mid-Tully erosional unconformity (Figures 2, 3) was found encrusted with stromatolites at Bellona, NY, further supporting his shallow water interpretation of the Tully.

Johnson and Friedman (1969) examined siliciclastic deposits correlative to the Tully Formation from the Susquehanna Valley eastward to the red bed margin east of the Schoharie Valley. This sedimentological study illustrated a variety of nearshore facies proximal to the inferred paleoshore of the "Catskill Delta" within the Gilboa Formation. Similarly, Bartholomew, et al. (2003) are currently examining divisions within the Gilboa Formation and adjacent units in the Susquehanna Valley-Windham region. This work is still in progress.

Baird and Brett (1986) examined the relationship of the Leicester ("Tully Pyrite") Member to the Tully Limestone, the underlying Windom Shale Member and the overlying Geneseo black shale. In contrast to various earlier workers who correlated the Leicester directly to the Tully, they found the Leicester to be a detrital pyrite-bone bed lag deposit that was essentially post-Tully in age and chronostratigraphically correlative with the Geneseo Member (see also, Huddle, 1981). Macrofossils within the Leicester were found to be correlative to underlying Windom and (locally) Tully beds and the conodonts are post-Tully in age. We envision Leicester pyritic clasts and bone debris to be the product of combined processes of submarine erosion and submarine carbonate dissolution acting in a predominantly dysoxic to near-anoxic basin setting (Baird and Brett, 1986). In our reconstruction, Leicester pyrite deposition was associated with a major deepening event (Taghanic Onlap *sensu* Johnson, 1970) responsible for widespread deposition of the Geneseo black shale in the foreland basin. This transgression was apparently the local expression of a global eustatic highstand event (see Johnson, et al., 1985). However, the overspread of Geneseo black mud lithofacies is also believed to be due to a concurrent flexural response of the craton to an inferred thrust-loading event ("Third Tectophase") within the foreland basin (see Ettensohn, 1998). In this model, Tully deposition represented a time of stable tectonic equilibrium prior to thrust loading and consequent shelf collapse.

The "Taghanic Bioevent", an interval of global faunal incursions and paleocommunity reorganization has been the subject of increased interest in recent years (Aboussalam and Becker, 2001; Aboussalam, et al., 2001). It followed a much longer (6 –7 M.Y.) interval of relative ecological-evolutionary stability that spanned the lower and middle Givetian (Brett and Baird, 1995). This longer period of community-level stability (coordinated stasis) is believed to be responsible for the temporal persistence of the observed long-standing Hamilton Fauna, characteristic of strata below the Tully Formation and its equivalents (Brett, et al., 1994; Brett and Baird, 1995). Onset of Tully Formation (DeRuyter Bed) deposition coincides with the demise of many typical Hamilton Fauna elements and the incursion of several Old World Realm taxa including: *Rhyssochonetes*, *Tullypothyridina*, and *Schizophoria* (Cooper and Williams, 1935; Heckel, 1973; Baird and Brett, 2003). This "first wave" incursion establishes the Tully Fauna typical of the lower Tully succession up through the Carpenters Falls Bed and Smyrna Bed interval (Heckel, 1973). Beginning within the higher Taughannock Fall Bed interval and continuing through the remainder of the Tully is a "second wave" return of the Hamilton Fauna (Cooper and Williams, 1935; Heckel, 1973; Baird and Brett, 2003). The disappearance of many Hamilton taxa followed by the dramatic return of these organisms

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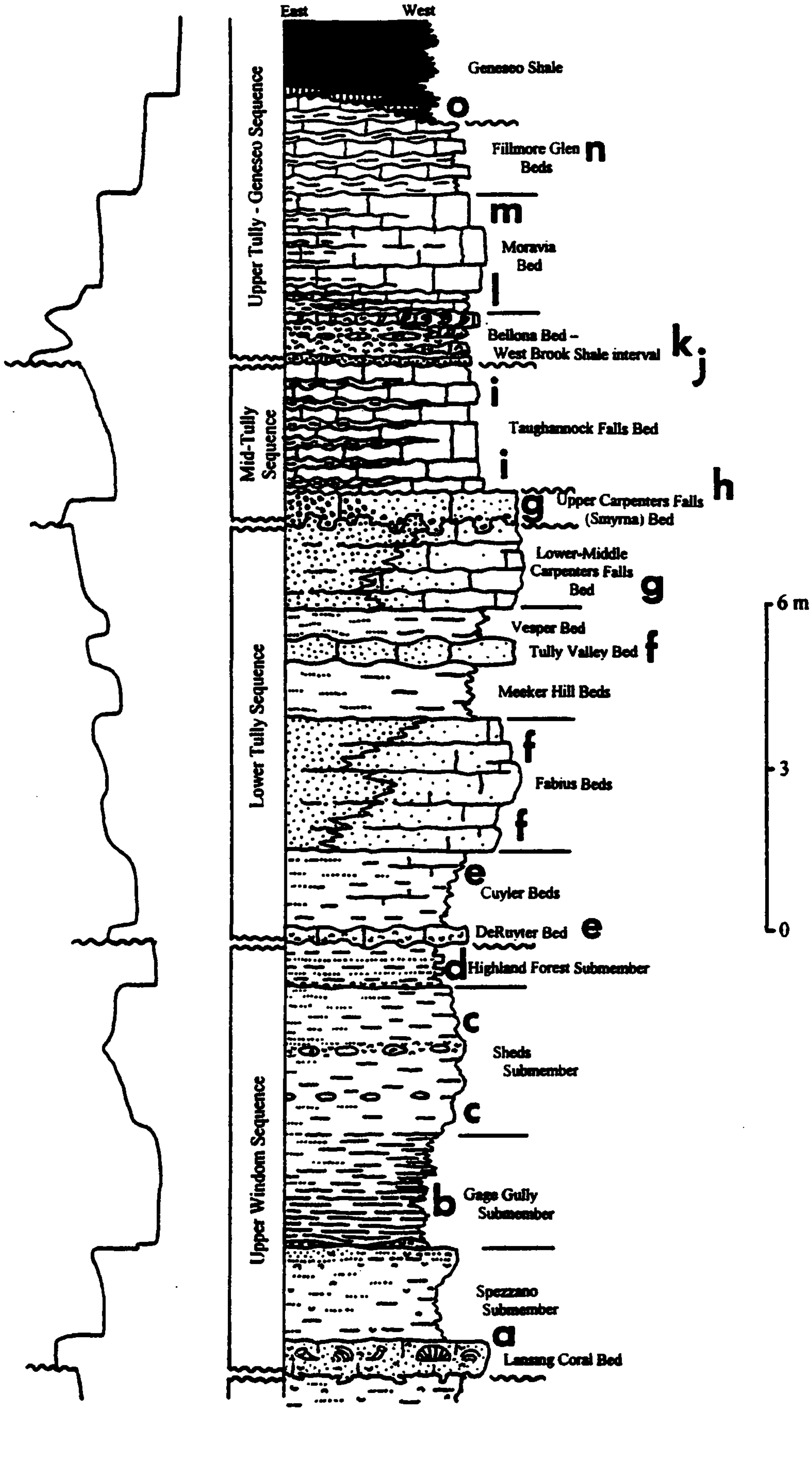
Figure 4. Generalized stratigraphic column for the upper Windom through basal Genesee Formation-succession in central New York region (Tully, New York-DeRuyter, New York area). Left column shows inferred sea level variations (shallower to left). Stratigraphic column uses standard symbols except that coarse stipple denotes chamositic ooids. Lettered features and events include: a, diverse Hamilton large coral biofacies; b, dysoxic small brachiopod biofacies; c, moderate diversity, mid-shelf Hamilton fauna; d, dysoxic, low diversity, outer-shelf Hamilton fauna; e, lower Tully fauna incursion event expressed in minimally oxic, mid-outer shelf, small-brachiopod biofacies; f, moderate diversity, mid-shelf expression of lower Tully fauna; g, peak development of lower Tully fauna; h, peak development of lower Tully fauna; h, "widespread middle Tully unconformity" of Heckel (1973) = maximum flooding surface boundary of present report; i, reappearance of many Hamilton fauna taxa, demise of lower Tully fauna; j, regional disconformity flooring West Brook Shale; k, high diversity middle to inner shelf Hamilton fauna biota of Bellona Bed – West Brook Shale interval; l, approximate level of first appearance of key goniatite *Pharciceras amplexum*; m, low diversity outer shelf biota of Moravia Bed (small rugose corals, auloporids, and phacopid trilobites predominate); n, dysoxic low diversity biota (auloporids and rare small rugosans); o, detrital pyrite lenses (Leicester Pyrite) recording submarine erosion and corrosion of uppermost Tully deposits. From Baird and Brett (2003).



East
West
Geneseo Shale
o
Fillmore Glen Beds
n
m
Moravia Bed
l
Bellona Bed - West Brook Shale interval
k
j
i
Taughannock Falls Bed
i
h
Upper Carpenters Falls (Smyrna) Bed
g
Lower-Middle Carpenters Falls Bed
g
Vesper Bed
Tully Valley Bed
f
Meeker Hill Beds
f
Fabius Beds
f
e
Cuyler Beds
DeRuyter Bed
e
d
Highland Forest Submember
c
Sheds Submember
c
Gage Gully Submember
b
Spezzano Submember
a
Lansing Coral Bed
Upper Tully - Geneseo Sequence
Mid-Tully Sequence
Lower Tully Sequence
Upper Windom Sequence
6 m
3
0

indicates that the "Taghanic Bioevent" is complex and only partly understood. The present authors believe that the thick succession of the TFCCS will reveal much more concerning the dynamics of these faunal changes.

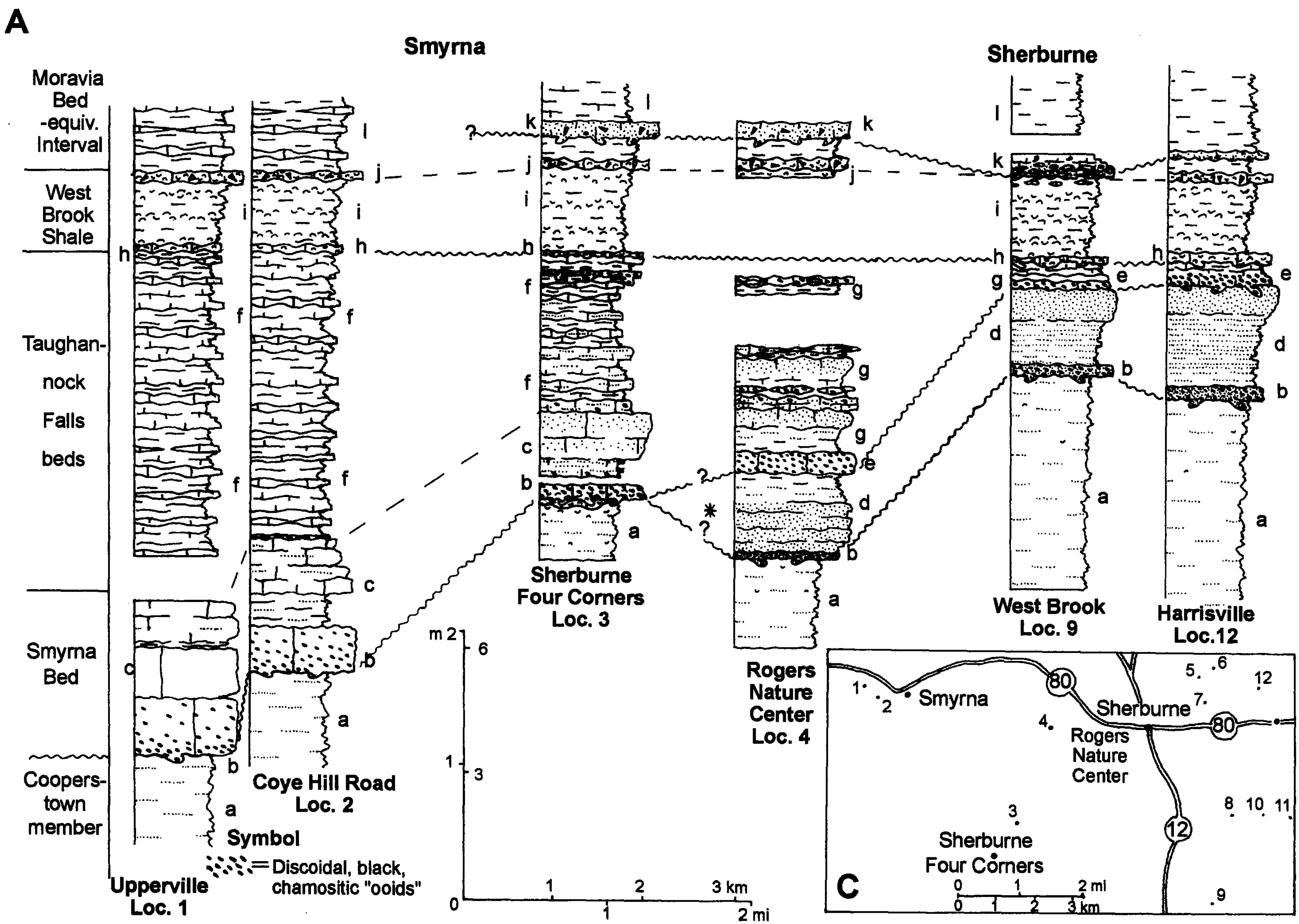
THE TULLY CHALLENGE

Because of unusual lithologies and major patterns of faunal change, the Tully Formation and the TFCCS to its east present a major opportunity to examine a variety of coincident sedimentological, paleontological, eustatic, and structural changes during the latest Middle Devonian. Research during the past five years, involves study of Tully deposits in both New York State and Pennsylvania. In this report the emphasis will be the relationship of the TFCCS to the Tully limestone further west, with some mention of the Pennsylvania Tully sections included. We discuss a variety of units and boundaries in the TFCCS in the context of the reports of Cooper and Williams (1935) and Heckel (1973). New correlations will be presented and correlation issues discussed. The relative depth significance of ecological-evolutionary change will be discussed. Finally, some discussion of chamosite distribution and origin will be included.

STRATIGRAPHIC RELATIONSHIPS: GENERAL OVERVIEW

Strata discussed include the topmost part of the Cooperstown Member, the New Lisbon Member, and the Tully Formation Clastic Correlative Succession (TFCCS). The upper part of the Cooperstown Member (=Windom Member in west-central New York) and the TFCCS correlates westward into the Tully Formation at the Sherburne Meridian and further west (Figures 1 -3, 5 – 8, 11, 12). One unit, the New Lisbon Member, described by Cooper and Williams, 1935, is redefined (restricted) to include only pre-Tully strata and to represent the highest division of the Moscow Formation (Figures 8, 11). Stratigraphic transects included are: 1) condensed easternmost Tully Formation in the Smyrna-Sherburne area in the Chenango Valley (Figure 5); 2) condensed easternmost Tully-into-expanded TFCCS succession transition between the Chenango and Unadilla Valleys (Figures 6, 7); and 3) lower-medial part of TFCCS interval from the Unadilla Valley eastward nearly to the Oneonta meridian (Figures 8, 11, 12).

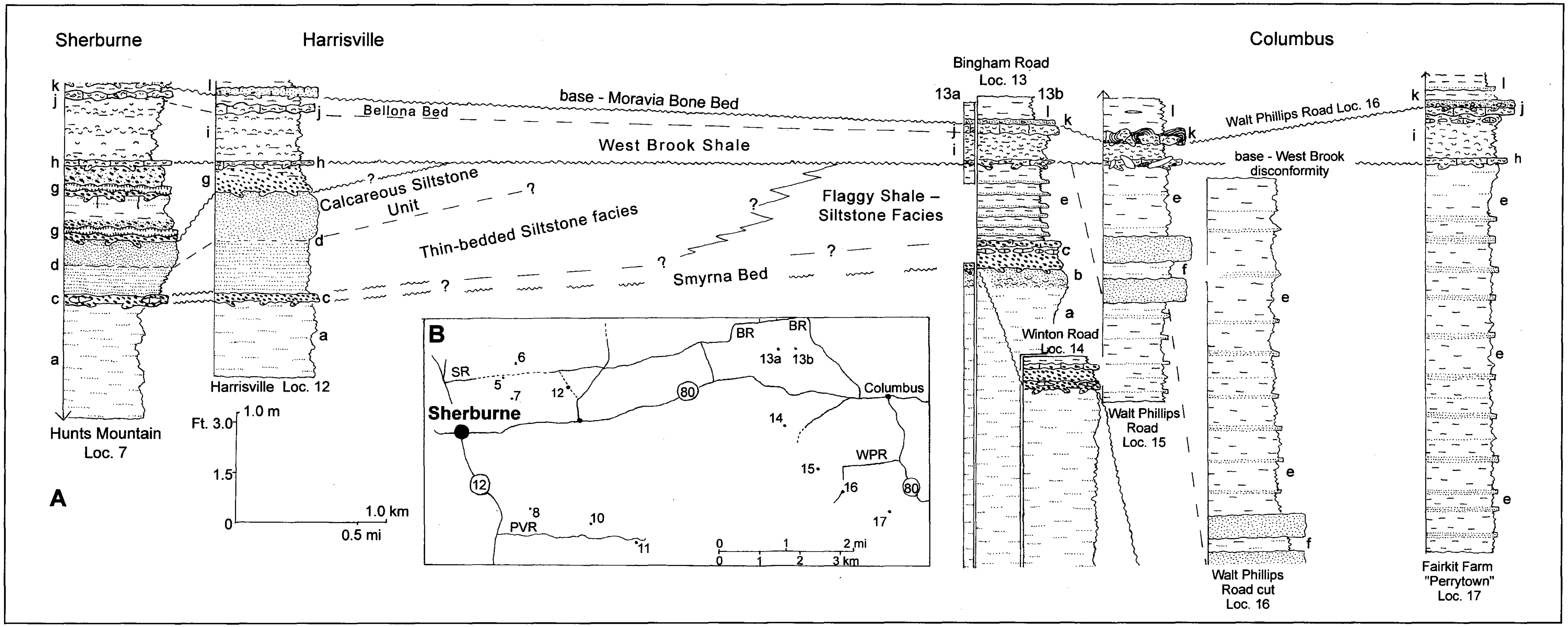
Figure 5. Tully Formation stratigraphic transect across the western part of the "Sherburne High" structural axis showing the thinning of the Tully interval and development of chamosite at several levels. Datum for both A and B set at base of West Brook interval (unit h). A, transect from Smyrna area to Sherburne area. Asterisk between columns for localities 3 and 4, denotes uncertainty as to whether Smyrna Bed at locality 3 is correlative with basal Tully chamositic unit (designated Smyrna Bed on diagram) at localities 4 – 12, or whether is correlates to the higher "Taughannock Falls Oolite Bed at localities 4 – 12 (see discussion in text); B, Tully Formation sections in Sherburne-Harrisville area. Lettered units in A and B include: a, Cooperstown Member (Spezzano submember-equivalent?) strata; b, base-Smyrna Bed disconformity; c, Smyrna Bed succession; d, "unnamed sandstone" of Heckel, 1973; e, "Taughannock Falls Oolite Bed" of Heckel, 1973; f, basal bed of West Brook Shale interval; g, condensed, variably chamositic facies equivalent to Taughannock Falls Bed succession; h, basal bed of West Brook Shale interval; i, fossiliferous West Brook Shale interval; j, coral/crinoid-rich limestone bed above West Brook Shale; k, silty, small-coral and phosphate pebble-bearing limestone unit probably marking base of Moravia Bed-equivalent strata; l, Moravia Bed-equivalent strata. Numbered localities are listed in APPENDIX; C, map of area showing distribution of localities.


A
Smyrna
Sherburne
Moravia Bed -equiv. Interval
West Brook Shale
Taughannock Falls beds
Smyrna Bed
Cooperstown member
Upperville Loc. 1
Coye Hill Road Loc. 2
Sherburne Four Corners Loc. 3
Rogers Nature Center Loc. 4
West Brook Loc. 9
Harrisville Loc.12
Symbol
= Discoidal, black, chamositic "ooids"
m 2
1
0
6
3
1
2
3 km
1
2 mi
C
Smyrna
Sherburne
Rogers Nature Center
Sherburne Four Corners
80
12
0
1
2 mi
0
1
2
3 km

The Tully Formation is essentially a clean, typically micritic limestone forming ledges, quarry walls, and waterfalls from its western terminus near Canandaigua Lake eastward to Tully near the Syracuse meridian. The lower part of the Tully in this region (DeRuyter Bed-topmost Carpenters Falls Bed interval) yields various taxa of the Tully Fauna and is capped by a regional unconformity identified by Heckel (1966, 1973) (Figures 1 – 3). This aforementioned contact, marked by mudcracks at several localities and laminated stromatolites at one locality, was correlated eastward to the Smyrna which is characterized by lag debris and chamosite in the DeRuyter-Sherburne region (Heckel, 1973). Another key marker in the upper Tully Formation from Tully westward is the Bellona Bed which yields abundant rugose and tabulate corals and brachiopods typical of the Hamilton fauna; this unit was roughly correlated to the West Brook Shale Bed in localities east of Tully, though Heckel (1973) speculated that the Bellona Bed actually overlies the West Brook Bed where it first becomes recognizable (Figures 2, 3).

East of the Tully Valley, the lower part of the Tully Formation rapidly becomes silty and marginally sandy before it is erosionally overstepped along a contact at the base of the Smyrna Bed. The lower Tully unit succession (DeRuyter Bed-through-Carpenters Falls Bed) is beveled to the east over an interval of fifteen miles at most (Heckel, 1973; Figures 2, 3). Our work suggests that the beveling takes place over an even shorter distance. East of the lower Tully pinch-out, topmost units of the Windom-Cooperstown transitional succession are overstepped as well (Heckel, 1973).

Figure 6. Stratigraphy of Tully Formation across eastern part of "Sherburne High" axis and westernmost part of Columbus area structural "sag." A, Stratigraphic reconstruction. Datum is base of West Brook Bed (unit h). Note abrupt thickening of Tully Formation southeast of Winton Road (Loc. 14), and also note conspicuous overstep of Walt Phillips Bed (unit f) and overlying sub-West Brook Bed clastic succession. Uncertainties in correlation between Harrisville (Loc. 12) and Bingham Road (Loc. 13a, b) center on whether key chamositic beds shown actually correlate as shown (see text). Note development of stromatolitic overgrowths on reworked limestone clasts of top-West Brook limestone bed (within unit k) at locality 15; these mark position of regional base-Moravia Bed diastem. Lettered units include: a, upper Cooperstown Member (Spezzano submember-equivalent?) succession; b, sub-Smyrna Bed regional disconformity; c, Smyrna Bed; d, "unnamed sandstone" division of Heckel, 1973; e, medial Tully Formation clastic succession probably equivalent to part of Taughannock Falls succession to west; f, Walt Phillips siltstone bed within unit e – succession; g, "Taughannock Falls Oolite Bed" succession of Heckel, 1973; h, basal erosional contact layer of West Brook Bed = datum; i, West Brook Shale succession; j, limestone bed capping West Brook Shale yielding corals, crinoid material and *Spinatrypa*; k, silty, calcareous, (base-Moravia Bed?) lag layer containing phosphatic pebbles and small corals near Sherburne and locally reworked, stromatolite-coated limestone clasts at locality 15; l, gray shale equivalent to lower part of Moravia Bed succession to west; Number sections are listed in APPENDIX; B, Map showing locality distribution. SR = School Road; PVR = Pleasant Valley Road; BR = Bingham Road; WR = Winton Road, WPR = Walt Phillips Road. (fold-out page).


Sherburne
Harrisville
Columbus
Bingham Road Loc. 13
13a
13b
base - Moravia Bone Bed
Bellona Bed
West Brook Shale
Walt Phillips Road Loc. 16
base - West Brook disconformity
Calcareous Siltstone Unit
Thin-bedded Siltstone facies
Flaggy Shale – Siltstone Facies
Smyrna Bed
Hunts Mountain Loc. 7
Harrisville Loc. 12
Winton Road Loc. 14
Walt Phillips Road Loc. 15
Walt Phillips Road cut Loc. 16
Fairkit Farm "Perrytown" Loc. 17
Ft. 3.0
1.0 m
1.5
0
1.0 km
0.5 mi
A
B
SR
BR
Sherburne
Columbus
WPR
PVR
12
80
0 1 2 mi
0 1 2 3 km

The work also suggests that three recently defined submember units of the Windom/Cooperstown members (Gage Gully, Sheds, Highland Forest submembers in ascending order) are progressively beveled out between Sheds and Sherburne. As understood from existing literature (see Heckel, 1973) and on our recent study of Hamilton sections, the Smyrna Bed rests disconformably on Spezzano submember-equivalent strata within the Cooperstown Member in the Sherburne area (Figures 5, 6).

East of Upperville (Locality 1*[1]) Tully sections thin significantly towards Sherburne with notable appearance of oolitic chamosite, a deposit characterized by sand-sized discoidal to sub-spherical black grains which often occur in a mud-silt supported context with bioturbated, calcareous debris (Figures 5, 6, 9, 10). The Smyrna Bed changes eastward from skeletal limestone near DeRuyter to sandy chamosite in the Sherburne area (Heckel, 1973). However, a second major chamosite bed (the "Taughannock Falls Oolite Bed"), believed by Heckel (1973) to be equivalent to part of the Taughannock Falls Beds of the medial Tully limestone further west, appears in Sherburne area localities (Figures 2, 3). An intervening terrigenous unit, the "unnamed sandstone" of Heckel, 1973, was recognized and mapped both by Heckel (1973) and by us (see Figures 2, 3, 5, 6).

Although we formally follow Heckel's correlation scheme, there is a real possibility that the Smyrna Bed of the Smyrna area actually connects to the Taughannock Falls oolite bed as one proceeds from locality 3 to locality 4 (Figures 5, 6). If this is true, the "unnamed sandstone" and the oolite bed beneath it represents a portion of the lower Tully "peeking through" beneath the sub-Smyrna unconformity.

East of Sherburne, Heckel (1973) noted the dramatic thickening of the sub-West Brook Bed Tully succession into a thick clastic wedge (Figure 3). However, the actual nature of the thickening was sketchy owing to availability of few sections. Work by the present authors led to discovery of many new outcrops near the hamlets of Columbus, Shawler Brook, Five Points and New Berlin (Figures 6, 7, 10). Heckel (1973) referred to the area of very thin Tully sections in the Chenango Valley as the "Sherburne high" and the occurrence of the chamosite as representing agitated oolitic shoals. The region of greatly thickened TFCCS deposits south of Columbus suggested the presence of a "down-to-the-east" fault resulting in thick sediment accumulation in a clastic trap (Heckel, 1973). This interpretation is supported by the present authors; our work further constrains the position of the apparent structure (Figures 6, 7).

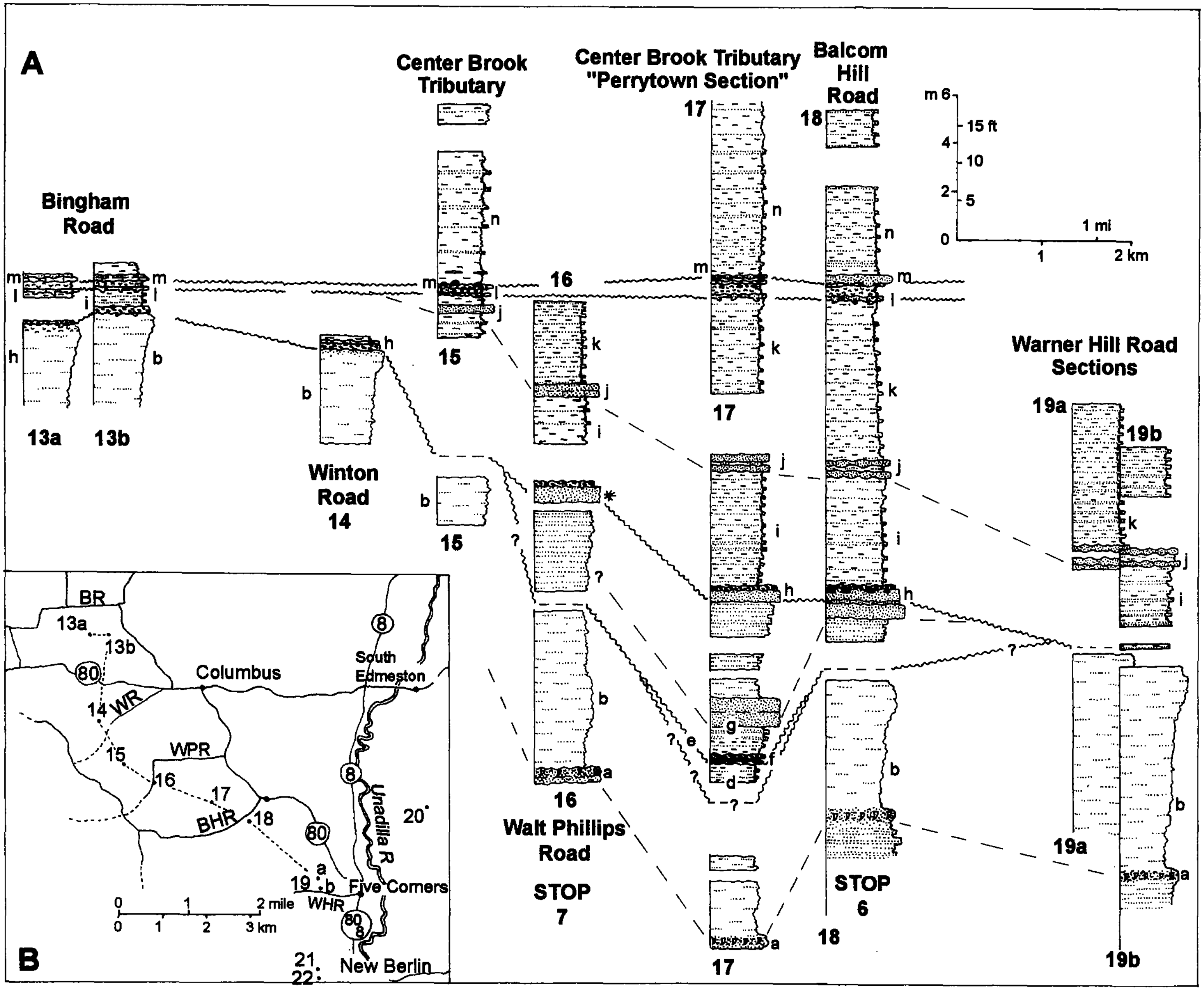
Cooper and Williams (1935) and Heckel (1973) both believed that western New York Tully divisions should theoretically be present in the TFCCS succession given that the lower part of the TFCCS yields typical lower Tully guide fossils (Figures 1, 3). Work by the present authors shows that the Smyrna Bed can be traced eastward to the Pittsfield area and, more problematically to the Otego Valley (Figures 8, 10). We believe that lower Tully divisions appear beneath the Smyrna Bed in the vicinity of Walt Phillips Road and thicken eastward to locality 17 (Cooper and Williams, 1935, "Perrytown section"). Strata probably equivalent to the Fabius and Meeker Hill beds as well as even lower beds of the New Lisbon Member are present at this section (Figures 7, 10). However, information at locality 18 (Stop 6) and localities near New Berlin suggest that the lower Tully component of the TFCCS is again overstepped in the vicinity of that

[1]*Localities numbered in text are listed in APPENDIX.

town (Figures 7, 8, 9). Hence, we refer to the small area where these units are visible below the Smyrna Bed as the "Columbus Sag".

Strata of the medial TFCCS between the Smyrna Bed and the base of the West Brook Bed thicken greatly to the southeast of locality 13 (Figures 6, 7). These sparsely fossiliferous beds, probably laterally equivalent to the Taughannock Falls bed-interval of the Tully Limestone, are abruptly cut out by an erosion surface at the base of the West Brook Bed west of locality 17; at locality 17, 37 feet of this interval is present; at locality 13, only 2.2 feet is observed with demonstrable northwestward overstep of an internal, *Rhyssochonetes* and *Emanuella*-bearing marker unit herein designated the Walt Phillips Bed (Figures 6, 7). To the south and east of locality 17, the fossil-poor, medial TFCCS strata thicken and coarsen from the Unadilla Valley to the Otego Valley (Figures 7, 8). East of "Greens Gulf" (Locality 24) south of New Berlin the sub-Smyrna Bed TFCCS interval reappears and thickens eastward to the Otego Valley (Figure 8). The Smyrna Bed yields dilute chamosite, bioclastic nodular limestone nodules and minor phosphorite that is characteristically concentrated into burrow prods at localities 24, 27a and 28 (Figures 8, 10); this lag is associated with westward cut-out of lower Tully beds and most of-, or all of, the New Lisbon Member (Figures 8, 9).

Figure 7. The Tully Formation stratigraphic transect across inferred Columbus area structural sag; A, Uppermost Moscow Formation-into-upper Tully succession showing unit matches between sections. Datum is base of West Brook Bed (unit L). Note overall southeastward thickening of Tully Formation and localized presence of probable New Lisbon Member (unit d) and lower Tully divisions up to disconformity at base of Smyrna Bed (unit h) between localities 15 and 19a. Asterisk at section 16 denotes loose (glacially dislodged) block believed to be Smyrna Bed; a chamositic interval in the block contains *Rhyssochonetes* and a stromatolitic limestone layer. Note thin, persistant character of West Brook Bed within thick synjacent, basinal facies. Lettered units include: a, Lansing Coral Bed; b, Spezzano submember-equivalent part of upper Cooperstown Member; c, inferred base-New Lisbon Member discontinuity (concealed); d, New Lisbon Member; e, base-"Laurens" disconformity; f, nodular, chamositic and sideritic, condensed lag bed. The marks first appearance of the distinctive Tully Fauna . The level correspond to base of Fabius Bed to west; g, massive, hard, bioturbated siltstone layer. This may correspond to upper part of Fabius Bed; h, Smyrna Bed and associated base-Smyrna Bed disconformity; i, lower part of barren, flaggy shale-siltstone succession. This is believed equivalent to lower part of the Taughannock Falls Bed-succession in west; j, Walt Phillips Bed (bioturbated siltstone) yielding highest occurrence of *Rhyssochonetes* in area; k, upper part of barren, flaggy shale-siltstone succession. This is believed equivalent to upper part of Taughannock Falls Bed succession in west; l, West Brook Bed. Regional discontinuity at base of West Brook is datum; m, discontinuity and silty lag bed capping West Brook Bed. This probably correlates to base of Moravia Bed succession in west. Numbered localities are listed in APPRENDIX; B, Map of area showing distribution of localities. BR = Bingham Road; WR = Winton Road; WPR = Walt Phillips Road; BHR = Balcom Hill Road; WHR = Warner Hill Road


A
Bingham Road
13a
13b
Winton Road
14
Center Brook Tributary
15
16
Walt Phillips Road
STOP 7
Center Brook Tributary "Perrytown Section"
17
Balcom Hill Road
18
STOP 6
Warner Hill Road Sections
19a
19b
m 6
4
2
0
15 ft
10
5
1 mi
1
2 km
B
BR
Columbus
South Edmeston
WR
WPR
BHR
Unadilla R
Five Corners
WHR
New Berlin
0
1
2 mile
0
1
2
3 km

From the Gross Hill School section (Locality 29) westward to New Berlin and also to lower Tully sections near Columbus, the base of the observed TFCCS does not correspond to the lowest divisions (DeRuyter and Cuyler beds) of the classic Tully, but rather to higher layers corresponding, most probably, to the Fabius Bed and Meeker Hill Bed divisions of the Tully Limestone (Figures 8, 11). DeRuyter Bed- and Cuyler Bed-equivalent strata, corresponding to the "Tinkers Falls Member" of the basal Tully Limestone succession of Cooper and Williams (1935) make their eastward appearance at New Lisbon (Locality 34) and in the Otego Valley (Localities 36, 38) near Laurens (Figures 8, 11). Cooper and Williams (1935) originally included these basal TFCCS strata in their upper, *Rhyssochonetes-aurora* and *Tullypothyridina*-bearing part of their "New Lisbon Member" at New Lisbon (Locality 34). We exclude these beds from our revised (restricted) New Lisbon Member succession and assert, along with Heckel, 1973, that they correspond roughly to Cooper and Williams' (1935) Tinkers Falls Member, and to Heckel's, 1973, DeRuyter and Cuyler beds (Figures 1, 3, 8, 11).

Thus, from Gross Hill School (Locality 29) westward to New Berlin and Columbus, observed sub-Smyrna Bed strata corresponds to a portion of Cooper and Williams, 1935, "Laurens Member". Cooper and Williams (1935) defined the "Laurens Member" to include TFCCS strata often yielding more diverse Tully fauna elements (*Tullypothyridina*, *Schizophoria*, *Spinatrypa*, *Pseudoatrypa*), that occurred above "*Leiorhynchus*"-dominated deposits ("New Lisbon Member" of original understanding) and below strata ("*Elytha fimbriata* zone") yielding Hamilton fauna taxa and lacking the distinctive Tully Fauna brachiopods (Figure 1). Thus, this "member" was largely based on zonal fossil content and is not a real lithologic entity as members are understood to be today. Because we have not yet really named member-scale units in the TFCCS succession, we use the term "Laurens Member" in quotation marks only, and herein restrict the interval to include only the lower-to-medial TFCCS interval generally characterized by bioturbated muddy siltstone to find sandstone deposits yielding a variety of Tully Fauna taxa (Figures 8, 11). As presently understood, this interval has a sharp, often erosional, base upon "*Leiorhynchus*"-rich deposits of the lowermost TFCCS interval at New Lisbon (Locality 34) and near Laurens (Locality 38) and the New Lisbon Member from locality 29 westward (Figures 8, 11). This regional contact, yielding dilute chamosite in some sections, is herein referred to as the "base-Laurens disconformity". This contact marks the base of the TFCCS at localities 17, 27a, 28 and 29 (Figures 8, 11). The top of the Laurens is placed at the top of the Smyrna Bed or its eastward equivalents. Excluded from the revised Laurens is a thick unnamed (medial TFCCS) interval of sparsely fossiliferous strata between the Smyrna Bed and the West Brook Bed that are believed to be the eastern equivalents of the Taughannock Falls Bed.

Cooper and Williams (1935) placed strata in the upper TFCCS interval in the "*Elytha fimbriata* zone". Generally, this succession correlates to the upper part of Heckel's (1973) Taughannock Falls Bed, West Brook Shale, Moravia Bed, and, possibly, the Fillmore Glen Bed-division succession of the Tully Formation. Generally, TFCCS strata equivalent to the Taughannock Falls and Moravia Bed are expressed as thick, sparsely fossiliferous highstand facies somewhat resembling the progradational Penn Yan and Sherburne members of the overlying Genesee Formation. However, the West Brook Bed stands out in dramatic contrast to all TFCCS facies in being a richly fossiliferous unit bounded by comparatively barren strata (Figures 5 – 8). Moreover, with exception of locality 26, the West Brook Bed is usually only a few feet thick and is bounded by sharp lower and upper contacts (Figures 5, 8). This unit, when encountered, is unmistakable in sections and constitutes a major datum in mapping. At localities 34 and 37, the base of the West Brook is an encrinitic limestone yielding rugose and tabulate corals as well as reworked concretions, and the overlying shale at all observed localities yields a diverse Hamilton Fauna biota dominated by filter feeding taxa including: brachiopods, bryozoans, camerate crinoids and blastoids. We envision the base of the West Brook Bed to be a major lowstand unconformity. The relative independence of this bed from the pattern of thickening and thinning of surrounding units is striking, both, within the TFCCS and across the central Pennsylvania region where the West Brook is also thin and well developed (Baird and Brett, 2003).

Extending eastward from the Tully Valley to locality 18 (Stop 6) near Columbus a persistent 2 – 8 inch-thick limestone bed yielding crinoidal debris, *Spinatrypa*, corals and both camerate crinoids and blastoids is observed to directly overly the West Brook Shale. Though we are not certain of the match at present, we believe that this unit correlates westward to a position between the Bellona Bed and the massive white limestone facies of the Moravia Bed. This unit is partly to nearly completely overstepped by a still higher thin layer at several localities (Figures 5 – 7). This higher unit, informally designated the "base-Moravia discontinuity bed", can be traced from localities 3 and 4 southwest of Sherburne to Pittsfield (Locality 27b). This bed is silty to sandy in character, yields phosphatic pebbles and small corals, and appears to be weakly chamositic from Columbus southeast to Pittsfield. At locality 15 southwest of Columbus, reworked clasts of the post-West Brook Limestone bed within this unit are encrusted by stromatolitic overgrowths (Figure 6, 7). At Stop 6 (Locality 18) the post-West Brook limestone bed is partially overstepped and both carbonate clasts and possible chamosite can be found within the lag interval. This lag horizon is believed to link westward to the base of (or higher position within-) the Moravia Bed.

Between the Tully Valley and South Lebanon the Geneseo Black Shale rests unconformably on the Tully Formation in most sections and, locally, lenticular lag concentrations of detrital pyrite occur along the contact. At South Lebanon, a 2.5 foot-thick Moravia Bed-succession is directly succeeded by black, laminated Geneseo. However, to the southeast of South Lebanon the Moravia Bed interval thickens and grades to shale with the top contact becoming conformable from Upperville (Locality 1) eastward. The Geneseo Member thins eastward to only 11 – 12 feet in thickness at localities 5, 7 and 11 near Sherburne but is still tentatively recognized at locality 15 and, possibly, even at locality 26 southeast of New Berlin. East of locality 26, no dark, Geneseo-type facies was encountered. In the New Lisbon area (Localities 34, 35) strata of the uppermost TFCCS interval above the West Brook Bed begin to yield numerous fossils offering an opportunity to examine shelly faunas from levels higher than those examined in previous studies.

KEY UNITS AND ISSUES

Introduction

This section of the report focuses on particular aspects of several key stratigraphic (and chronostratigraphic?) divisions in order from oldest to youngest. Definitions of some units are clarified or revised and a few named beds are discussed.

Topmost Cooperstown Member Divisions (see Figures 4 – 8)

Lansing Coral Bed(s) – Several localities in the study area display one to two sandy coral, bryozoan and large brachiopod-rich beds marking the top of a slabby, siltstone interval rich in large *Alanella*. The *Alanella*-rich interval and the overlying coral beds are herein believed to correlate westward respectively to the Taunton submember and Lansing Coral Bed within the Windom Member (Figures 7, 8, 11). Why there are two discrete, closely spaced coral-rich beds above the *Alanella*-rich interval in the Columbus-New Berlin area instead of one further west is still being investigated. In this region, the coral beds are expressed as silty-sandy ledges rich in pelmatozoan debris, occasional large rugosans and *Favosites*, brachiopods, including: *Spinocyrtia*, *Tropidoleptus*, *Rhipidomella*, *Spinatrypa* and *Mediospirifer*, numerous bivalves and occasional bryozoans. The Lansing Bed is understood to mark a lowstand event with a possible sequence boundary at its base (Brett, et al., 1994, Baird and Brett, 2003; see Figure 4).

Post-Lansing Hamilton Succession (unnamed) – From Sherburne eastward into the Otego Valley, the post-Lansing-Pre-New Lisbon Member succession is characteristically a brown, olive-gray weathering, chippy to massive, variably hard silty mudstone to muddy siltstone succession (Figures 4 – 10). Cooper and Williams (1935) reported *Pustulatia* (*Vitulina*) and a few other Hamilton taxa from this interval at several localities in the New Berlin-Laurens area. The present authors found *Pustulatia* in this interval at New Berlin and Laurens, but not at New Lisbon as reported by Cooper and Williams (1935); at the type New Lisbon section (Localities 32, 34) this interval is entirely covered. The post-Lansing Cooperstown succession, ranging from 15 to 46 feet in thickness, yields a rather depauperate, nondescript mixture of Hamilton brachiopods and bivalves. The most common taxa encountered are small to medium size *Alanella* and protobranch bivalves including *Nuculites* and *Paleoneilo*. Other forms encountered include small *Tropidoleptus*, *Mucrospirifer*, *Pustulatia* and" *Eumetabolatoechia multicostatum* (formerly "*Leiorhynchus" multicosta*). The last entity, although rare and spotty in distribution, was encountered in this unit south of Columbus (Locality 17), south of South Edmeston (Locality 20) and near Laurens (Locality 38). *E. multicostatum* suggests the possibility that beds containing it are the eastward equivalents of the Gage Gully submember of the Windom Member. At the very least, the occurrence of small brachiopods and nuculoid bivalves indicates that this interval is transgressive relative to the underlying Lansing Bed. Near Columbus (Localities 13, 17) and south of Pittsfield (Locality 27a), the top of this interval is marked by a thin, silty, falls-capping unit yielding larger *Alanella* and *Spinocyrtia*. Depending on how the Cooperstown Member stratigraphy is constructed, this unit could be a regressive cap division of the Spezzano submember (below the Gage Gully interval if the New Lisbon Member is Gage Gully Member-equivalent; see Figures 8, 11A) or the lower part of the Sheds submember (if the New Lisbon Member is younger than Sheds; see Figure 11B).

New Lisbon Member

The New Lisbon Member, as originally described by Cooper and Williams (1935) from its type section (Localities 32, 34) northeast of New Lisbon, consists of approximately 60 feet of thin-bedded, flaggy siltstone-shale facies yielding numerous *Camarotoechia* ("*Leiorhynchus"*) *mesacostale* in its lower half and abundant *C. mesacostale* with rare *Rhyssochonetes* and *Tullypothyridina* in the upper half. As originally constructed, this unit is "Tully age" in the upper part and problematically "pre-Tully" in the lower half.

Recently, however, the present authors have identified a thin, contact bed yielding dilute chamosite and diagenetic siderite in association with abundant *Emanuella* and rare *Tullypothridina* 28.5 feet below the top of Cooper and Williams' (1935) type New Lisbon section along Otto Stahl Road (Locality 34; Stop 8). This bed marks a physical contact (condensed bed/discontinuity) that allows for redefinition of the "New Lisbon Member" to include only strata in the lower half of the original unit. Hence, we herein restrict New Lisbon to include the flaggy leiorhynchid-dominated beds between the underlying typical Cooperstown facies and the base-Tully Formation contact (Figures 8, 11). To date, this "restricted" New Lisbon Member interval has yielded no bona fide Tully Fauna elements such as *Rhyssochonetes* and *Tullypothyridina*, although *Emanuella* of uncertain species assignment has been found in the lower part (Locality 32) and at the base (Locality 31) of the unit.

In the vicinity of the New Lisbon type section (Localities 21, 32, 34) the restricted New Lisbon Member interval is believed to be about 30 feet-thick although no one section exposes the entire interval (Figure 8). As noted above, we observe a significant discrepancy between the description of Cooper and Williams (1935) and what we actually observed at the New Lisbon type section (Localities 32, 34). They described *Pustulatia* ("*Vitulina*")-bearing Hamilton beds "23 feet" below exposed portions of New Lisbon in implied continuity with the New Lisbon succession. What we actually saw included only the topmost 10 feet of restricted New Lisbon Member along Otto Stahl Road (Locality 34; Stop 8) and a 20 foot-thick "hanging" New Lisbon Member section (Locality 32) along Stony Creek (Figure 8). No strata between the partial New Lisbon Member sections and the Lansing Bed have been observed by the present authors. Hence, the base of the New Lisbon Member succession is concealed at the two type locality sections. However, our recent mapping has led to discovery, not only of the top contact at locality 34 (Stop 8), as noted above, but also the basal contact with the underlying Cooperstown division at locality 31 as well (Figure 8). This past April, a third section (Locality 31) was found less than a mile from the Otto Stahl Road section (Locality 34); this shows the New Lisbon Member in sharp contact with Cooperstown Member strata yielding *Alanella*, *Mediospirifer* and numerous small bivalves. This contact, characterized by dilute chamosite in association with nodular, diagenetic siderite (Figures 8, 9), marks a regional discontinuity that can be traced westward to the Unadilla Valley (Figures 8, 11). East of the Butternut Valley north of Laurens, the base of the New Lisbon Member appears to be conformable and apparently non-chamositic at locality 36 (Figure 8). In the Unadilla Valley (Locality 20, 24) and west of there (Locality 17), the New Lisbon Member is believed to be very thin. South of Columbus (Locality 17) no more than three feet of green, gray fissile shale and thin siltstone beds yielding leiorhynchids (*C. mesacostale*?) are exposed with the base concealed (Figure 7). At "Greens Gulf" (Locality 24) only three inches of chamositic green shale with leiorhynchids is present between the Cooperstown Member and the Smyrna Bed (Figures 8, 9). Although the New Lisbon Member is missing on the east side of the Otego Valley (Locality 38), a fact originally noted by Cooper and Williams (1935) flaggy siltstone facies resembling New Lisbon Member is observed above typical Cooperstown facies in the Susquehanna Valley east of Milford and, still further east near Schenevus. These outcrops are still the object of reconnaissance study by the present authors.

The basal New Lisbon contact bed is chamositic at several sections (Localities 20, 24, 27a, 29, 31) and it is spectacularly so at localities 27a and 29 (Figure 9). The fauna of this bed is extremely sparse and poorly preserved. Above the chamosite layer, macrofossils are almost exclusively leiorhynchids (a handful of small *Emanuella* were observed along Stony Creek [Locality 32] at one level). The flaggy siltstone-shale alternation that characterizes this unit resembles intervals within several other dysoxic aggradational deposits such as the Butternut Member in the medial Hamilton Group and the Sherburne Member within the Genesee Formation (Thayer, 1974; Baird et al., 1988, 2000). The New Lisbon Member marks a significant sea level highstand event. It correlates westward either to the Gage Gully submember or to the younger Highland Forest submember of the Windom Member depending on how correlations are reconstructed (Figure 11).

TFCCS Divisions

Basal-Tully Division (DeRuyter-Cuyler beds-equivalent part of TFCCS) – This interval of strata is solely represented by strata at localities 34, 36 and 38 (Figures 8, 11). It is represented by the "quarry sandstone" succession discussed by Cooper and Williams (1935) at locality 34, and by a similar interval of bluff-forming, slabby, cross-laminated siltstone or fine sandstone at "Houghtelings Glen" (Locality 38). The basal 2 to 3 feet of this interval yields abundant *Emanuella* as well as less common *Rhyssochonetes* and

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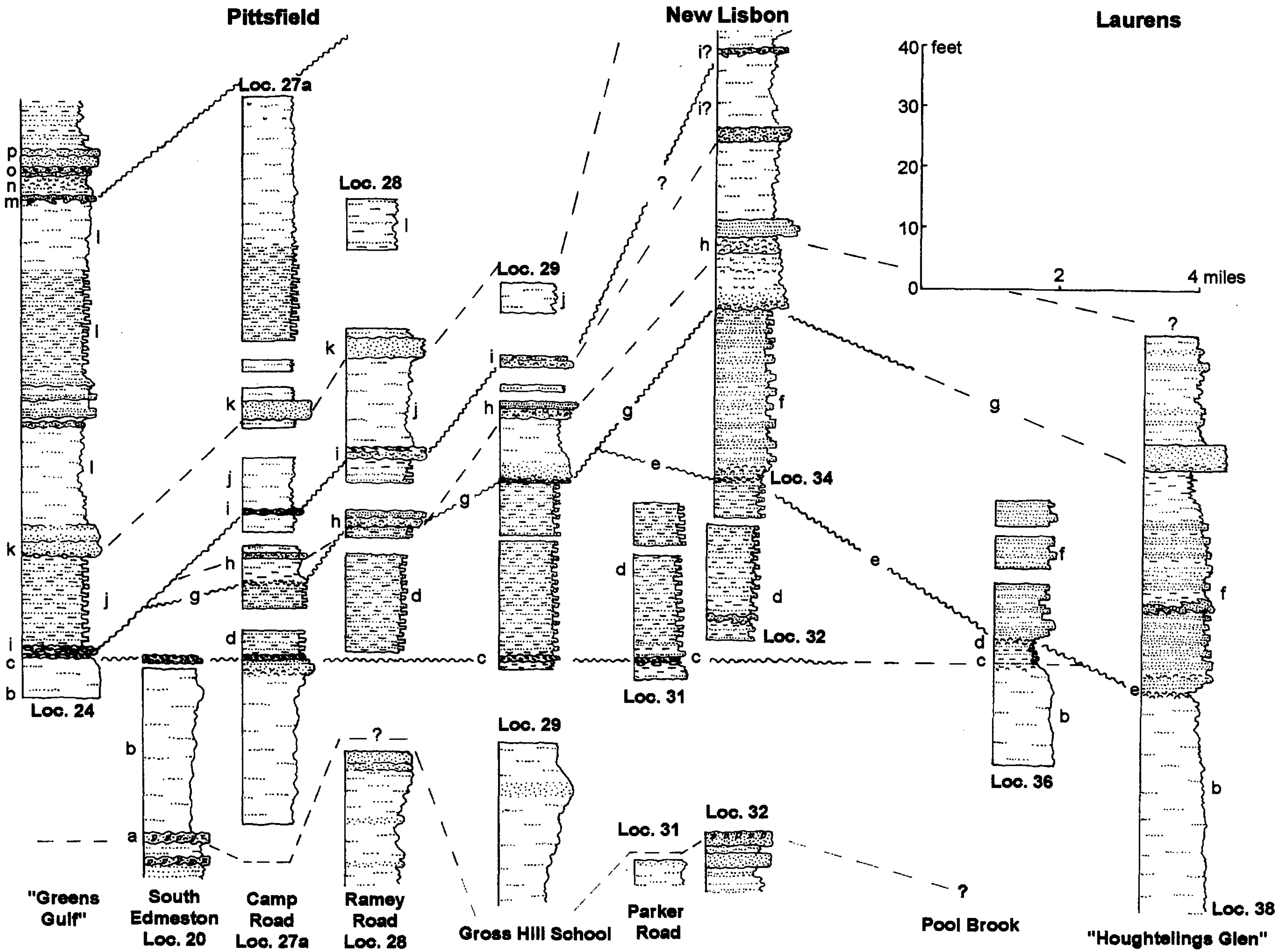
Figure 8. Lower and medial Tully Formation stratigraphy from vicinity of New Berlin in the Unadilla Valley to vicinity of Laurens in the Otego Valley northwest of Oneonta. Datum is basal contact of New Lisbon Member (horizon c) at top of typical upper Cooperstown Member (Spezzano submember-equivalent?) succession (unit b). Note conspicuous westward and eastward erosional overstep of New Lisbon Member (unit d) by Tully Formation units and overall westward thinning and overstep of lower Tully units east of New Lisbon such that probable Smyrna Bed (unit I) is nearly juxtaposed on Cooperstown Member south of New Berlin (Loc. 24), see text discussion. Lettered units include: a, Lansing Coral Bed; b, uppermost typical Cooperstown Member (probable Spezzano submember equivalent) succession; c, basal discontinuity (and continuity) flooring New Lisbon Member with associated chamosite and diagenetic siderite; d, New Lisbon Member (restricted) succession; e, base-Tully discontinuity with associated shell-hash and dilute chamosite flooring lowest Tully Formation division; f, lowest Tully Formation (probable "Tinkers Falls beds"-equivalent succession *sensu* Cooper and Williams, 1935) division; g, discontinuity and eastward continuity flooring "Lauren Member" succession *sensu* Cooper and Williams (1935). Bed above contact yields dilute chamosite in western sections and abundant shells in eastern sections; h, shell-bearing, bioturbated, muddy siltstone bed probably eqivalent to upper part of Fabius Bed to the west. Interval g through h is probably equivalent to entire Fabius Bed succession; i, nodular, calcareous, siltstone bed which yields dilute chamosite at localities 24, 27b, and 28 and abundant brachiopods at localities 34 and 37. This is believed to be expression of Smyrna Bed in this area; units j, k, l, divisional components of medial Tully (probable Taughannock Falls beds-equivalent) succession; units m, n, West Brook Bed divisions; units o, p, q, Moravia Bed equivalent unit divisions. Numbered localities are listed in APPENDIX.



Pittsfield
New Lisbon
Laurens
40 feet
30
20
10
0
2
4 miles
Loc. 24
Loc. 27a
Loc. 28
Loc. 29
Loc. 31
Loc. 32
Loc. 34
Loc. 36
Loc. 38
"Greens Gulf"
South Edmeston Loc. 20
Camp Road Loc. 27a
Ramey Road Loc. 28
Gross Hill School
Parker Road
Pool Brook
"Houghtelings Glen"

Tullypothyridina in association with abundant *Camarotoechia mesacostale*. The remaining 20 – 35 feet of the interval is overwhelmingly dominated by *C. mesacostale* to the near exclusion of other taxa. The facies is problematically coarse but is essentially a leiorhynchid biofacies. We concur with Heckel (1973) who arugued that it corresponded to the DeRuyter-Cuyler interval in the Tully Limestone. We suspect that the basal lag and overlying *Emanuella*-rich interval correspond to the DeRuyter Bed and that the overlying *C. mesacostale*-dominated interval links to the Cuyler Bed (Figure 11). The biggest problem with this reconstruction is that no *C. mesacostale* are found in the type DeRuyter-Cuyler interval (Sessa, 2003). However, in central Pennsylvania, there is a basal-Tully black limestone interval abounding in *C. mesacostale* that appears to link to the DeRuyter-Cuyler succession. The basinal character of the Pennsylvania unit suggests that the DeRuyter-Cuyler beds-interval in the Tully Limestone displays upslope shelf-ward facies relative to equivalent deposits in east-central New York and central Pennyslvania (Baird and Brett, 2003).

"Laurens Member" - As asserted by Cooper and Williams (1935), and reviewed by Heckel, 1973, the "Laurens Member" records some improvement in bottom conditions with an increase in bioturbation and the appearance of shell beds in the easternmost sections. The base of the "Laurens" is sharp and probably erosional in all localities examined (Figure 7, 8). At localities 17 and 29 it is characterized by chamosite and diagenetic siderite; at localities 27a and 28, it is marked by reworked clasts and phosphorite; at localities 34 and 38 it marks an abrupt change from flaggy leoiorhynchid-rich facies below to massive siltstone-sandstone deposits above yielding a variety of brachiopod and bivalve taxa (Figure 8). The base-"Laurens" contact at

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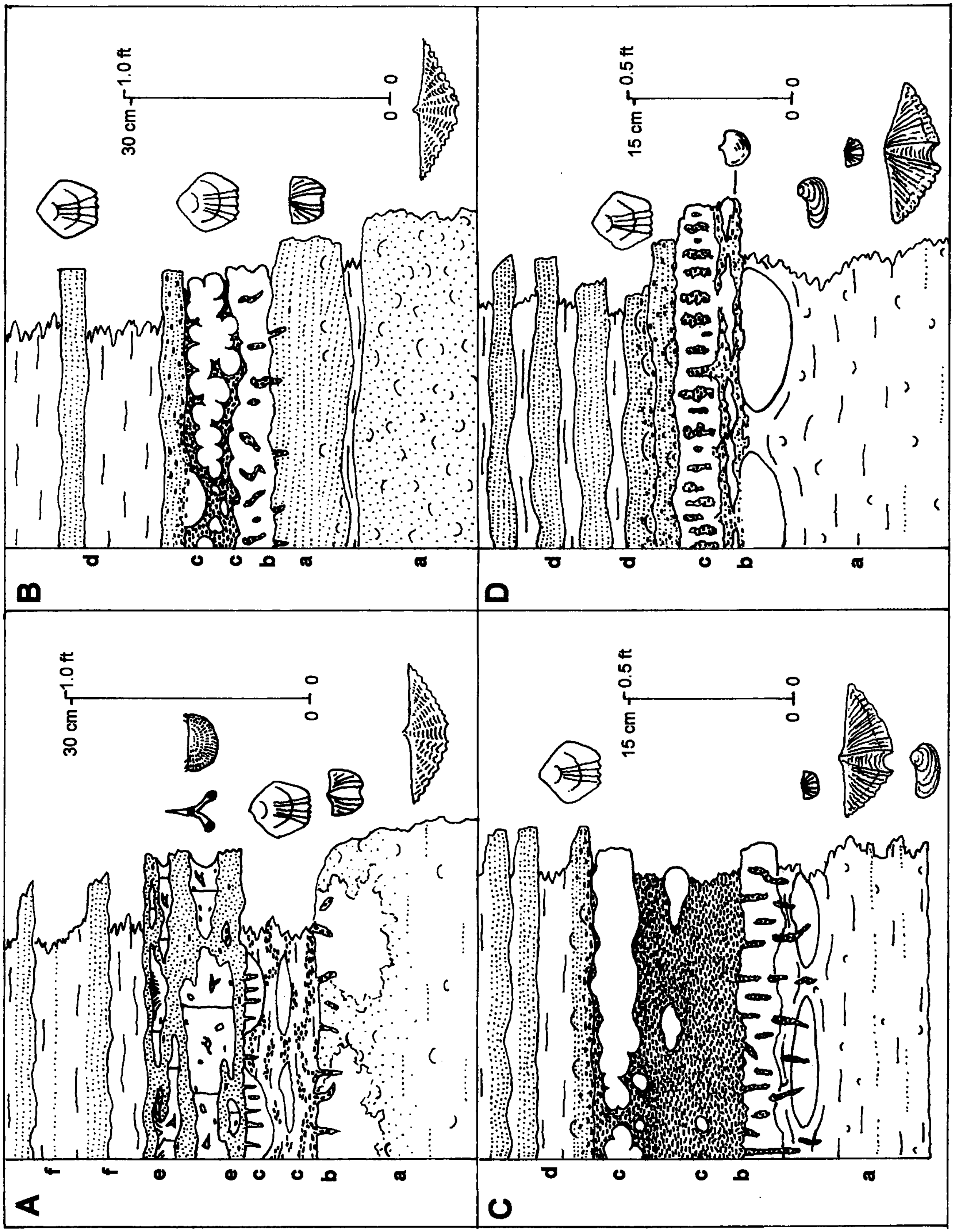
Figure 9. Base-New Lisbon Member unconformity at four key localities (see also Figure 8); A, "Greens Gulf" (Loc. 24) showing three inches of base-New Lisbon chamosite-rich shale overlain by Smyrna Bed (interval now concealed under shallow alluvium); B, Tributary of Wharton Creek (Loc. 27a) showing spectacular nodular diagenetic siderite "marbled" throughout the black, chamositic basal layer (interval now concealed under shallow alluvium); C, Unnamed gully northwest of former Gross Hill School (Loc. 29) showing chamosite with associated nodular diagenetic siderite; D, Tributary of Stony Creek (Loc. 31) near New Lisbon, NY showing easternmost development of chamositic and sideritic sub-New Lisbon Member contact. Note occurrence of thin *Emanuella*-rich layer coincident with base of chamositic bed (see text). Lettered units include: a, uppermost typical Cooperstown Member (probable Spezzano submember equivalent) succession yielding typical upper Hamilton Group taxa such as *Mucrospirifer*, *Mediospirifer*, *Alanella*, and nuculoid bivalves; b, erosional contact showing chamosite disc-infilled open burrows (or borings) as well as underbed diagenetic siderite nodules; c, black, shiny concentration of discoidal (flattened?) chamositic "ooids" and sideritic nodules; d, interbedded, flaggy shale-siltstone facies of basal New Lisbon Member yielding Leiorhynchids, cf. *Camarotoechia mesacostale*; e, Smyrna Bed containing dilute chamosite, phosphatic nodules, nodular limestone and possible stromatolite development at top. Unit yields abundant auloporids and rare *Rhyssochonetes*; f, barren flaggy shale-siltstone interval of post-Smyrna strata. Numbered localities are listed in APPENDIX.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Houghtelings Glen (Locality 38) is at the base of the massive falls-capping bed near the upper end of that section, yielding a variety of taxa (*Tullypothyridina*, *Orthospirifer mesastrialis*, *Stropeodonta*, large pterioid bivalves) that preview the little known proximal Tully biofacies to the east.

At Otto Stahl Road (Locality 34, Stop 8) Cooper and Williams (1935) described two fossil-rich units (respectively a "second" and "third" shell bed) that we have also located in that section (see Stop 8 description) along with still higher shell bed as well. Although correlations are tentative, we link the "base-Laurens" disconformity-through-"second shell bed" interval to the Fabius Bed and the "third shell bed"-to-the highest shell bed to the Tully Valley Bed-Smyrna Bed interval (Figures 8, 11), supported both by the lithofacies succession and by the mix of lower Tully Fauna taxa.

Smyrna Bed – The top of the "Laurens Member" is herein placed at the top of the Smyrna Bed and its possible eastern equivalents (Figure 8). Although, this violates implied principles of sequence boundary usage, the assignment is informal due to uncertainties in correlation. Few mappable boundary strata are recognized in the thick "barren" medial Tully interval between the Smyrna and the West Brook Bed. Hence, the top-Smyrna surface is as good a lithologic change as any so far observed. Moreover, at localities 17, 18, 24, 27a, 28 and 29, the Smyrna Bed is thin and the effect of the arbitrary placement minimal.

As noted earlier, the Smyrna Bed in the Sherburne-Pittsfield region is a nodular, calcareous, chamositic sandstone bed characterized by hypichnial burrow prods, phosphatic pebbles, and occasional fish debris (Figures 5 – 8, 10). Chamositic grains are sand-sized, mud-supported black, discoidal grains that are typically associated with abraded bioclastic debris in a bioturbated fabric (Figure 10). Nodular lentils of bioclastic limestone characterize the bed east to the Pittsfield area (Localities 27a, 28). Although chamosite is not observed at localities 29 and 35, abundant shells make their eastward appearance in these same sections. We believe that this bed is the Smyrna, based both on

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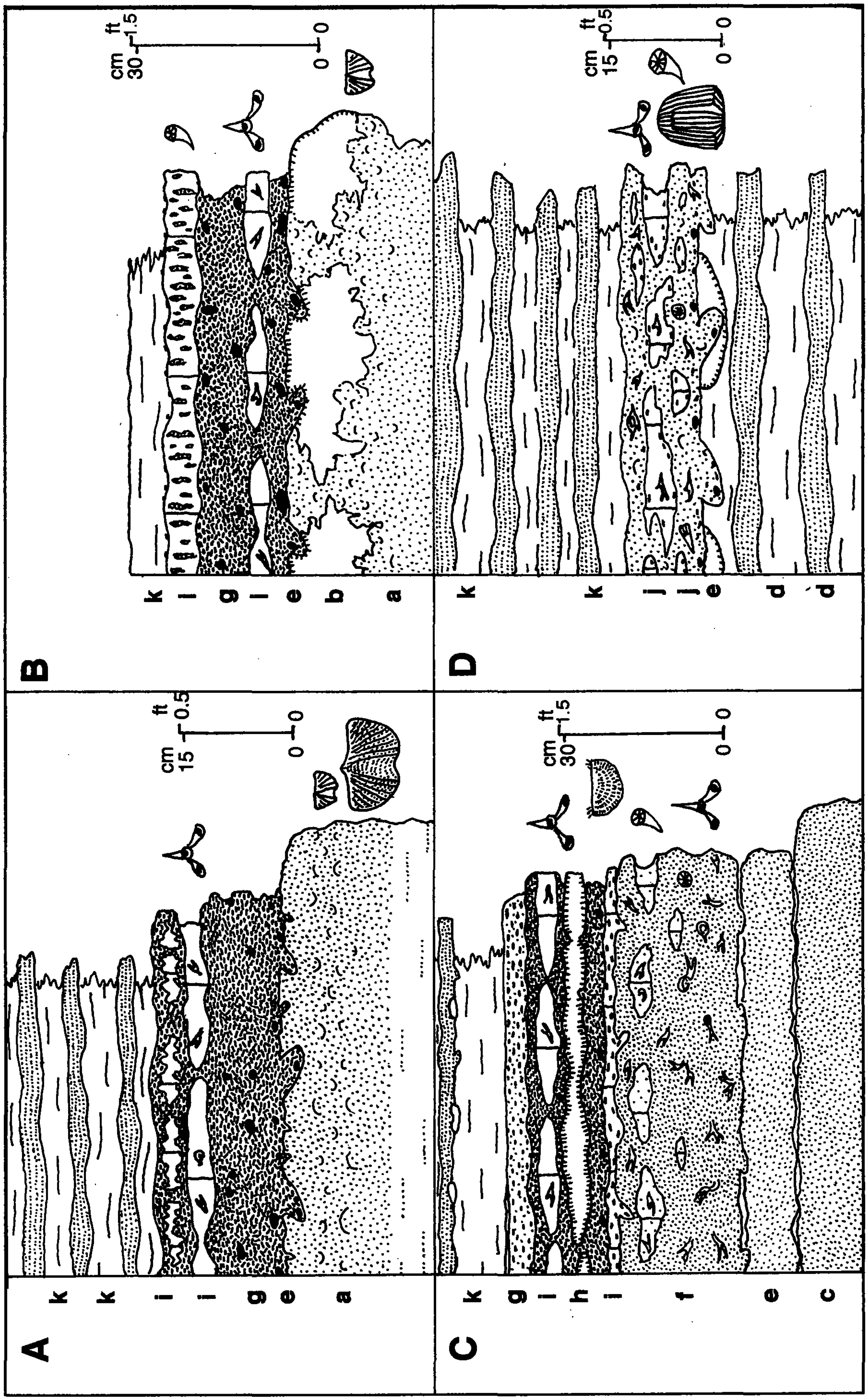
Figure 10. Smyrna Bed in Tully clastic correlative succession (note that Smyrna Bed at locality 24 is shown in Figure 9A). Locality sequence shown includes: Unnamed gully (Loc. 13b) south of Bingham Road (A); unnamed creek (Loc. 14) west of Winton Road (B); unnamed creek (Loc. 18) to be seen at Stop 6 southeast of Balcom Hill Road (C); and section (Loc. 27a) south of Pittsfield, NY (D). Lettered units include; a, uppermost (Spezzano submember equivalent?) division of Cooperstown Member yielding *Alanella* and *Spinocyrtia*; b, Cooperstown Member siltstone suffused with diagenetic, under-bed siderite related to proximity of sub-Tully contact; c, massive, bioturbated (Fabius Bed equivalent?) siltstone bed in lower Tully Formation succession; d, flaggy shale-siltstone facies in lower Tully "Laurens Member" succession; e, sub-Smyrna Bed erosion surface; f, lower Smyrna, non-chamositic, auloporid-pelmatozoan debris-rich calcareous siltstone bed; g, black chamosite concentration with associated phosphatix pebbles; h, diagenetic siderite within chamosite concentration; i, auloporid and pelmatozoan-rich limestone bands and nodules within chamosite; j, bioturbated siltstone with lean chamosite and bioclastic limestone nodules yielding auloporids, rugosans, *Tullypothyridina* and *Rhyssochonetes*; k, barren, flaggy shale-siltstone interval in medial Tully Formation succession. Numbered localities are listed in APPENDIX.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0
B
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l
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b
a
cm
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ft
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0
0
C
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h
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f
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30
ft
1.5
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0
D
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j
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d
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cm
15
ft
0.5
0
0

its lithologic character and its regionally disjunct relationship to underlying units (Figures 7, 8). As with the Smyrna Bed further west, it rests on a variety of underlying units in the Columbus-Pittsfield area (Figures 7, 8). In particular, south of Pittsfield (Locality 27a) it rests upon strata above the Fabius Bed; at "Greens Gulf" (Locality 24) near New Berlin, it rests on the basal feather edge of the New Lisbon Member (Figure 9a).

The most exciting discovery associated with the new eastern Smyrna Bed sections are microbiolite stromatolites at the top of the bed at localities 16 and 24 (see Figure 9a; Stop 7 description). A glacial erratic block found in the bed of the creek at locality 16 (Stop 7) corresponds to a dislodged piece of the Smyrna Bed; this is marked by a limestone layer at its apparent top yielding chamosite, fracture networks ("mudcracks") and microbiolitic stromatolites. At "Greens' Gulf" (Locality 24), a 0 – 3 mm-thick crust of stromatolitic carbonate caps the Smyrna Bed at that locality as well (Figure 9A). The associated carbonate at both localities is a white-weathering chamosite-rich limestone which contains numerous auloporids and displays grains often aligned at an angle parallel to laminations or other internal structures. The stromatolite-bearing chamositic carbonate layer is very thin and its top is an undulatory knife-sharp contact with silty mudrock facies (Figure 9A).

Close examination of the microbiolite structures shows that there is a larger-scale lamination, often bordering vertical fractures; laminations are steeply oblique to near-vertical bordering fractures suggesting that much of the stromatolite had since been eroded away leaving only low, peripheral portions adjacent to the low cracks. This type of stromatolite displays an internal micropillar structure normal to the lamination. This type of stromatolite closely resembles that originally described along the intra-Tully unconformity at Bellona by Heckel (1973) (see Stop 11 description), and it is very similar to stromatolites along the same horizon seen by the present authors in the Tully Valley (see Stop 2 description). The second type of stromatolite is a non-chamositic, non-pillared, 1 - 3 mm-thick laminated crust that marks the bed top contact. This orange-red weathering crust is observed not only at localities 16 and 24 but it has recently been observed capping a correlative transgressive surface at Hughesville, Pennsylvania east of Williamsport.

We interpret the fractured, stromatolitic horizon to mark a major deepening event associated with a regional flooding surface marking the top of the Smyrna Bed. This surface corresponds most closely to the very thin, stromatolitic trasngressive interval above Heckel's (1973) widespread unconformity that separates the two members in the Tully Limestone. Heckel (1973) correctly noted that the change from the unconformity horizon into the overlying Taughannock Falls Bed-interval marks a significant transgression. Both in the Columbus-New Berlin area and at Hughesville, the stromatolitic level is succeeded by dramatically, thick barren facies that signals the overspread of apparent dysoxic conditions and low energy early highstand facies.

DISCUSSION

Regional Paleoenvironmental Overview

Heckel (1973) argued that several key Tully facies (chamositic beds, stromatolitic-mudcracked horizon in Carpenters Falls Bed) represented marine shoal and even lagoonal conditions. As such, part of the Tully Limestone would have modern environmental counterparts represented by the Bahama Platform, etc. Comparable facies in New York State would be represented in the Black River Limestone (Upper Ordovician) and in the Lower Devonian Manlius Limestone. The present authors, however, view the Tully Formation as including a broad suite of settings ranging from shallow shelf conditions (Bellona Bed-West Brook succession) to low energy outer shelf settings and even dysoxic basin environments (Baird and Brett, 2003). We believe that the lower and medial Tully succession overall spans a mid-to outer shelf facies range with no preserved lagoonal or "Z" facies observed. We see no stromatoporoids and no pentamerids, often typical of proximal Devonian carbonates, and the stromatolites and "mudcracks" discussed herein are restricted to a single transgressive horizon in contrast to multiple levels typically seen in restricted nearshore deposits. It is very possible that the "mudcracks" are syneresis cracks of diagenetic origin. Stromatolites can occur in deeper subtidal slope environments as well as shallow settings (see Playford, 1980). We suspect that the chamosite, "mudcracks" and stromatolites are a combined depositional and diagenetic effect of carbonate condensation and sediment-starvation associated with widespread transgression. The occurrence of all of these features in close association with thick, unfossiliferous, low-energy, facies successions at New Berlin and Hughesville is more consistent with a comparatively lower energy setting platform margin or outer shelf setting.

As noted above, chamositic, oolitic ironstone facies is quite problematic in any depositional model because it is not convincingly represented by any precise modern analog. Aragonitic ooids, forming in modern carbonate shoals are spherical and often occur in cross-bedded, grain supported deposits (Sellwood, 1986). By contrast, Tully chamosite is characterized by discoidal to elliptical grains that occur in a mud-rich or mud-supported context. Typically the rock is intensely bioturbated, and, along the base of the New Lisbon Member, very dark and shaly (Figure 9). Texturally, the chamositic beds more resemble glauconitic greensand facies except that glauconite grains have a different color and shape. Still other mysteries exist, if chamosite formed under reducing

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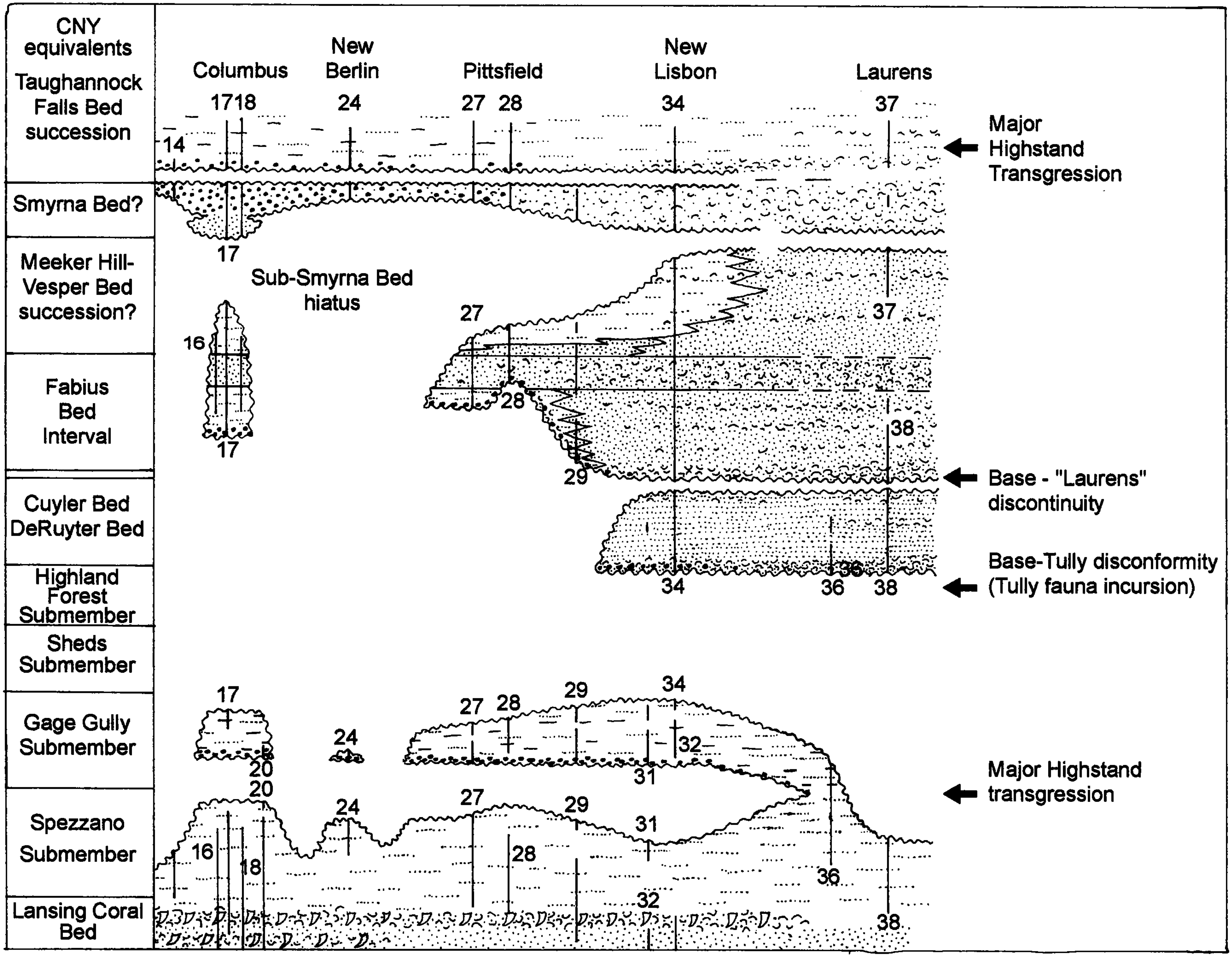
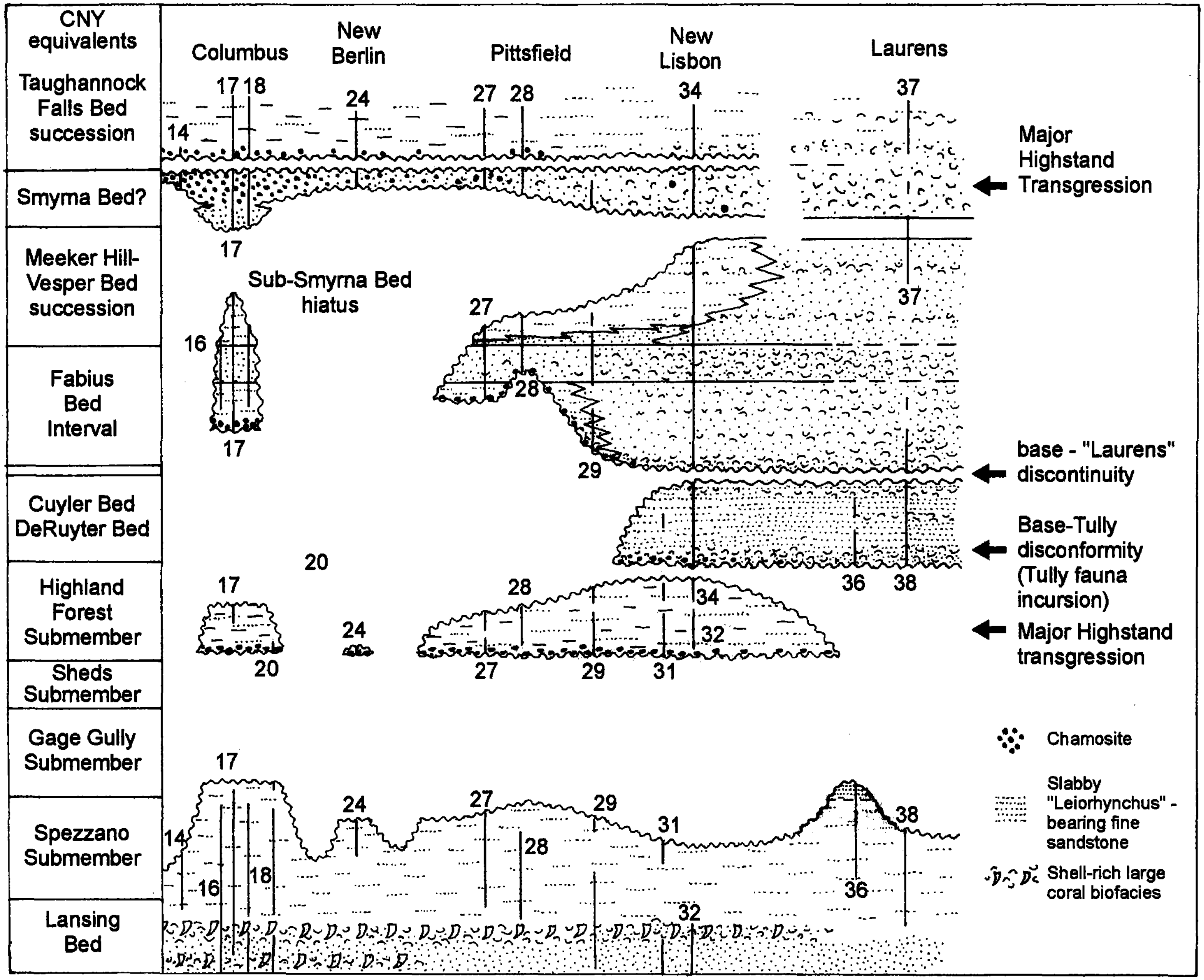
Figure 11. Inferred chronostratigraphy of uppermost Moscow Formation-through-lower Tully Formation clastic correlative succession. Note westward expansion of hiatal intervals due to collective overstep by sub-New Lisbon Member-, sub-base-Tully, sub-base "Laurens," and sub-Smyrna discontinuities. Inferred Columbus area structural sag is indicated by localized "hanging bits" of lower Tully in that area; A, Preferred version showing New Lisbon Member as eastern equivalent of Gage Gully submember of Windom Member; B, Alternative scheme showing possibility that New Lisbon Member may be equivalent to the Highland Forest submember comprising the topmost Windom succession southeast of Syracuse. Lettered units include: a, uppermost part of typical Cooperstown Member succession; b, New Lisbon Member; c, sub-base-Tully discontinuity; d, lower part of Tully Formation clastic correlative succession ("Tinkers Falls" division of Cooper and Williams, 1935); e, base-"Laurens" disconformity; f, key fossil-bearing siltstone marker bed in "Laurens Member" succession; g, sub-Smyrna Bed disconformity; h, Smyrna Bed; i, inferred diastem at top of Smyrna Bed (regional flooding surface); j, sparsely fossiliferous highstand clastic facies comprising medial Tully Formation clastic correlative succession, Numbered localities are listed in APPENDIX. (on following two facing pages).


CNY equivalents
Taughannock Falls Bed succession
Smyrna Bed?
Meeker Hill-Vesper Bed succession?
Fabius Bed Interval
Cuyler Bed DeRuyter Bed
Highland Forest Submember
Sheds Submember
Gage Gully Submember
Spezzano Submember
Lansing Coral Bed
Columbus
New Berlin
Pittsfield
New Lisbon
Laurens
Sub-Smyrna Bed hiatus
Major Highstand Transgression
Base - "Laurens" discontinuity
Base-Tully disconformity (Tully fauna incursion)
Major Highstand transgression


CNY equivalents
Taughannock Falls Bed succession
Smyrna Bed?
Meeker Hill-Vesper Bed succession
Fabius Bed Interval
Cuyler Bed DeRuyter Bed
Highland Forest Submember
Sheds Submember
Gage Gully Submember
Spezzano Submember
Lansing Bed
Columbus
New Berlin
Pittsfield
New Lisbon
Laurens
Sub-Smyrna Bed hiatus
Major Highstand Transgression
base - "Laurens" discontinuity
Base-Tully disconformity (Tully fauna incursion)
Major Highstand transgression
Chamosite
Slabby "Leiorhynchus" - bearing fine sandstone
Shell-rich large coral biofacies

conditions as is argued by Curtis and Spears (1968) why does it occur in such abundance in condensed beds in association with skeletal debris? The concentration of chamosite on the "Sherburne High" is consistent with evidence of winnowing in oolitic ironstones elsewhere; the "Sherburne High" acme of chamosite distribution accords well with the "clastic trap" model of Huber and Garrels (1953) for enhanced chamosite concentration on elevated sediment-starved areas relative to lower areas of differential terrigenous accumulation. Preferential development of chamosite on the east flank of the "Sherburne High" at the western margin of the inferred New Berlin trough and the absence or near-absence, of chamosite on the east margin of that trough (Figure 12) supports the concept that sediment-starvations more than any other presently identifiable factor, allowed the chamosite to become concentrated (Baird and Brett, 2003). As for inferred water depth, chamosite occurs in shelfal settings but accumulates across a broad depth ranges of 10 – 170 meters (Porrenga, 1967) allowing only for a tentative paleoenvironmental "window" of "subtidal shelf" for this facies. (It is interesting to note that there is another deposit of chamositic ooids in the Appalachian Basin that may be coeval with portions of the Tully Formation. The Preston or Boyle Ore of central Kentucky is a chamositic ooid deposit that was the first iron ore mined west of the Appalachian Mountains, being used to make cannon balls of the Battle of New Orleans in the War of 1812.)

Another major pattern we observe within the lower and medial Tully succession is evidence for a region of greater inferred water depth centered on Columbus and New Berlin (Figure 12). This area of differential subsidence is herein referred to as the "New Berlin Trough" with a more local structural feature within it termed the "Columbus Sag" (Figure 7). Tully deposits in the Columbus-Pittsfield area (excluding the West Brook Bed) are sparingly fossiliferous at best. Condensed marker beds yield auloporids and pelmatozoan debris but very few shells. Strata between the marker beds are usually almost barren of macrofossils. Even in the Sherburne area, the sub-west Brook Tully yields very few shells and is notable mainly for auloporids and crinoid debris, a fact also noted by Heckel (1973). The observed rarity of brachiopods may be a taphonomic artifact of shell dissolution associated with condensation and, possibly, chamosite genesis. However the abundance of auloporids and crinoid ossicles, though corroded, indicates that robust shells, if once part of this biofacies, should be observed. Their absence hints at a general unhealthiness of biotas in the Sherburne condensed Tully beds. Examination of lower-medial Tully strata (DeRuyter Bed-Taughannock Fall Bed interval) west of DeRuyter shows that macrofossils are common through this succession (see Stops 1 – 4) in dramatic contrast to the Sherburne sections.

We suspect that the "Sherburne High" of Heckel (1973) may be an east-facing "Sherburne Slope" that recorded sediment-starved conditions on a deeper water sloped sea bed (Figure 12). This model, thus, represents an expansion of Heckel's (1973) "Down-to-the-east" fault and "clastic trap" concepts (Figure 3). We herein argue that the clastic trap (New Berlin Trough) was bigger and deeper than in Heckel's (1973) original reconstruction and that it may have connected southwestward to the large Tully basin in north-central Pennsylvania (Baird and Brett, 2003). Concurrent downwarping and filling of this structural 'moat" could explain coincident accumulation of Tully platform carbonates in a mud-free, craton-ward regime in west-central New York.

East of the New Berlin-Pittsfield area, the near-barren dysoxic facies of the trough axis is increasingly replaced by shell-bearing deposits. Both the "Laurens Member" and the overlying medial Tully succession yield fossils at many levels from the New Berlin

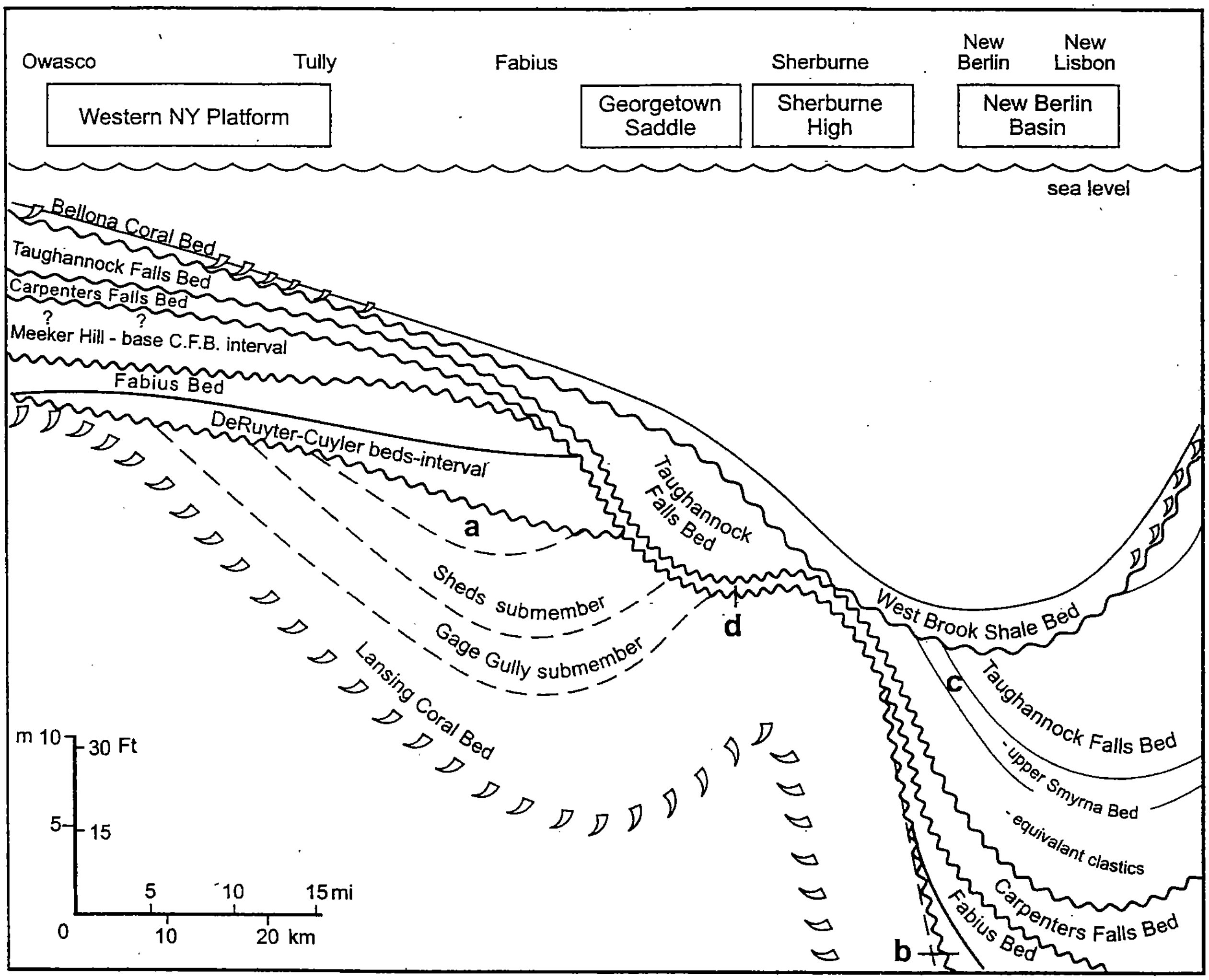


Figure 12. Schematic upper Windom Member-to-upper Tully stratigraphy from west-central New York to the Oneonta meridian. Note prominent erosive effects of the base-Tully, base-middle Tully, and base-West Brook disconformities (see text) and the relationship of component facies units and disconformities in the position of an inferred structural (flexural) basin (New Berlin Trough) centered between Sherburne and New Lisbon. This figure is drafted without a datum to emphasize the west- and east-facing paleoslopes of this basin during deposition of the West Brook Bed. The Taughannock Falls Beds – interval is shown as having the greatest differential paleodepth relief with the east – facing slope commencing well to the west of the "Sherburne High" of Heckel (1973). Lettered units include: a, Highland Forest submember; b, DeRuyter Bed-Cuyler Bed equivalents; c, prominent siltstone bed in medial Tully eastern clastic-succession; d, Smyrna Bed chamositic layer. N. L. = New Lisbon Member; C. B. = Cuyler beds; F. B. = Fabius Bed; C. F. = Carpenters Falls beds; T. F. B. = Taughannock Falls beds. From Baird and Brett (2003).

area (Locality 34) eastward, and all condensed marker beds become notably shell-rich (Figure 12). Although our mapping effort to date has completed work only to the Otego Valley, we recognize that lower and middle Tully facies in that area has a shelly "Chemung" aspect with the appearance of larger brachiopods and bivalves. This "up-to-the-east" faunal gradient serves to show the transition from the New Berlin Trough to an "eastern New York shelf setting" (Figure 12). The characterization of the eastern shelly fauna is work that is still ongoing (see below).

The last, and final, set of questions regarding the Tully clastic succession concerns the temporal chronology of biotic changes associated with the Taghanic Bioevent (see Baird and Brett, 2003). As noted earlier, onset of Tully deposition is closely timed with initial invasion of the Tully Fauna that dominates the lower Tully succession (Figure 13). During upper Tully deposition, the Hamilton Fauna stages a comeback and persists to the close of Tully deposition (Figure 13).

However, in western and central New York, the succeeding unit is the Geneseo black shale and any possible connective relationship between Tully biofacies and the higher Ithaca Fauna of the Genesee Formation is obscured. Only where the Geneseo Member passes eastward into dysoxic and oxic facies can the intervening faunal story be revealed. This is one goal of ongoing work.

Another goal is to see if the Tully Fauna in the lower Tully succession actually grades into inner shelf, sandy biofacies yielding Ithaca Fauna taxa. Cooper and Williams, (1935) indicated that some "Ithaca-type" taxa were found in Gilboa Formation deposits east of the Susquehanna Valley. It is, thus, possible that nearshore Tully biofacies may have an Ithaca appearance and that the Tully Fauna of the Tully Limestone is actually an outer shelf, carbonate sub-facies of the Ithaca Fauna. This problem will be addressed during the next two to three-year period.

Figure 13. Faunal succession in the upper Windom Member and Tully Formation succession in east-central New York showing in the influx of the Tully fauna ("Lower Tully bioevent") at the base of the Tully Formation and reestablishment of the diverse Hamilton fauna association ("Upper Tully bioevent") in the upper Tully. Key lowstand unconformities include: the base-Tully (1), base-Middle Tully (2), and base-West Brook (4) sequence disconformities. Maximum flooding surface contacts include: the top-Smyrna Bed unconformity (3) and the top-Fillmore Glen corrosional discontinuity (5). Diagnostic and/or common taxa include: a, *Heliophyllum halli*; b, *Spinatrypa spinosa*; c, large bryozoans; d, *Mediospirifer audaculus*; e, *Allanella tullia*; f, *Devonochonetes scitulus*; g, *Camarotoechia* ("*Leiorhynchus*") *mesacostale* [In the Tully, this taxon is restricted to the Tully eastern clastic correlatives in eastern New York and Pennsylvania]; h, *Emanuella praeumbona*; i, *Pustulatia* (*Vitulina*) *pustulosa*; j, *Tropidoleptus carinatus*; k, *Athyris spiriferoides*; l, *Mucrospirifer mucronotus*; m, *Rhyssochonetes aurora*; n, *Emanuella subumbona*; o, *Schizophoria tulliensis*; p, *Tullypothryidina venustula*; q, *Echinocoelia ambocoeloides*; r, *Spinatrypa sp.*; s, *Pseudoatrypa devoniana*; t. *Ambocoelia umbonata*; u, small rugosan; v, auloporids; w, *Leptaena rhomboidalis*; x, styliolines. From Baird and Brett (2003).

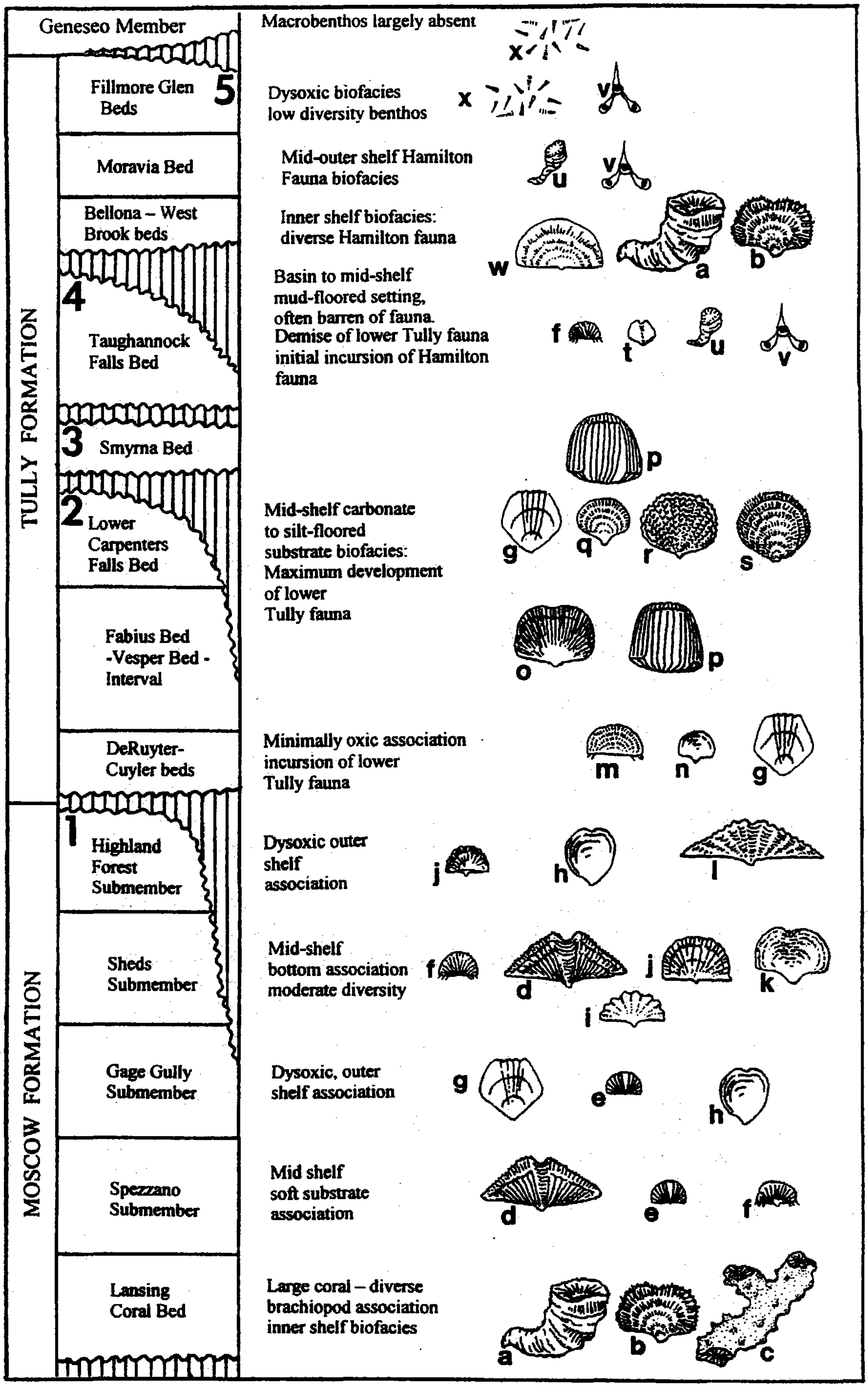

Geneseo Member
Macrobenthos largely absent
x
Fillmore Glen Beds
5
Dysoxic biofacies low diversity benthos
x
v
Moravia Bed
Mid-outer shelf Hamilton Fauna biofacies
u
v
Bellona – West Brook beds
Inner shelf biofacies: diverse Hamilton fauna
w
a
b
4
Taughannock Falls Bed
Basin to mid-shelf mud-floored setting, often barren of fauna. Demise of lower Tully fauna initial incursion of Hamilton fauna
f
t
u
v
TULLY FORMATION
3
Smyrna Bed
p
2
Lower Carpenters Falls Bed
Mid-shelf carbonate to silt-floored substrate biofacies: Maximum development of lower Tully fauna
g
q
r
s
Fabius Bed -Vesper Bed - Interval
o
p
DeRuyter-Cuyler beds
Minimally oxic association incursion of lower Tully fauna
m
n
g
1
Highland Forest Submember
Dysoxic outer shelf association
j
h
l
MOSCOW FORMATION
Sheds Submember
Mid-shelf bottom association moderate diversity
f
d
j
k
i
Gage Gully Submember
Dysoxic, outer shelf association
g
e
h
Spezzano Submember
Mid shelf soft substrate association
d
e
f
Lansing Coral Bed
Large coral – diverse brachiopod association inner shelf biofacies
a
b
c

Figure 13

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APPENDIX (LOCALITY REGISTER)

New Lisbon Member – Tully Formation Localities in study area. (Localities discussed in text and/or shown in figures)

* = Denotes sections listed in Heckel (1973).

Earlville 7.5' Quadrangle:

*1 Unnamed, northeast-flowing tributary of Pleasant Brook, 0.8 mile southeast of Upperville (complete Tully section).

2 Unnamed, northeast-flowing tributary of Pleasant Brook, 0.1 – 0.2 mile northeast of Coye Hill Road and 0.9 mile west of Smyrna (nearly complete Tully section).

*3 Unnamed south-flowing creek, 0.5 – 0.7 miles north-northeast of Sherburne Four Corners (nearly complete Tully section).

4 Very small, unnamed, northeast-flowing gully 0.15 mile north of Cush Hill Road (not shown as actual stream on map). Creek is 1.7 mile due west of Route 80/Route 12 Junction in Sherburne on Rogers Nature Center property (much of Tully section under thin, but removable, alluvium).

Sherburne 7.5' Quadrangle:

5 North-facing cut along School Road 1.3 miles northeast of Route 80/Route 12 Junction in Sherburne (Moravia beds – lower Sherburne siltstone succession).

6 Unnamed northwest-flowing creek 0.2 mile north of School Road and 1.5 mile northeast of Route 80/Route 12 Junction in Sherburne (base and top of Tully not exposed).

7 Unnamed south-southwest flowing tributary of Mad Brook, 1.1 miles east-northeast of Route 80/Route 12 Junction in Sherburne (Tully section mostly complete).

*8 Unnamed, southwest-flowing creek, 0.3 mile north of Pleasant Valley Road which parallels Negro Hollow. Locality is 1.6 miles southeast of Route 80/Route 12 junction in Sherburne (good Tully section; Tully- Geneseo contact not exposed).

*9 West Brook, 0.7 mile upstream from (east of) Route 12 overpass (complete Tully section, West Brook Shale type section). Field trip Stop 5.

10 Unnamed, southwest-flowing creek 0.25 mile upstream from Pleasant Valley Road which parallels Negro Hollow. Locality is 2.4 miles southeast of Route 80/Route 12 junction in Sherburne (some of Tully section under thin, removable alluvium).

11 Negro Hollow Creek (south fork) adjacent to, and upstream from, Negro Hollow Church (top-Tully contact with Geneseo Member and complete Geneseo section upwards into Sherburne succession).

*12 Unnamed, southeast-flowing tributary of Mad Brook parallel to unused road. Section is 0.4 miles north-northwest of hamlet of Harrisville (lower and medial Tully well exposed).

13a Very small, north-flowing gully, 0.45 miles south of Bingham Road and 1.8 mile west-northwest of Columbus and 0.5 miles north of Route 80. Section is nearly due south of the Campbell Cemetery but is not shown as a running stream on map (part of Tully accessible under alluvium).

13b Very small, north-flowing gully, 0.5 miles south of Bingham Road and 1.6 mile west-northwest of Columbus and 0.65 miles north of Route 80. Locality 0.25 miles east of locality 13a but is not shown as a running stream on map (lower and medial Tully accessible under alluvium).

14 East-flowing south fork of Center Brook 0.25 miles west of (upstream from) Winton Road overpass. Section is 1.5 mile west-southwest of Columbus (Smyrna Bed chamosite well exposed above top-Moscow contact.

15 Unnamed, northeast-flowing tributary of Center Brook, 0.5 miles west of (upstream from) southward, right angle turn on Walt Phillips Road. Section is 1.5 miles southwest of Columbus (top-Tully-Geneseo succession is exposed on north [main] fork of gully; Walt Phillips Bed, West Brook Shale, and base-Moravia bone bed are exposed on smaller south fork).

16 Roadcut along Walt Phillips Road 0.4 miles south of the southward right angle turn on Walt Phillips Road and 1.5 miles southwest of Columbus as well as unnamed, northeast-flowing creek parallel to the road (part of lower Tully clastic correlative succession exposed on creek, part of medial Tully and highest Tully –succession exposed along road; Walt Phillips Bed type section). Field trip Stop 7.

New Berlin North 7.5' Quadrangle:

*17 Northeast-flowing tributary of Center Brook 0.6 miles south of Walt Phillips Road and 1.5 miles south of Columbus. Locality is 0.6 miles west of Balcom Hill Road (partial New Lisbon Member section, good Tully Formation clastic equivalent-succession. "Perrytown" section of Cooper and Williams, 1935).

18 Northeast-flowing tributary of Center Brook 0.3 miles southwest of junction of Balcom Hill Road and Route 80 at hamlet of Shawler Brook. Creek runs southeast of, and sub-parallel to, Balcom Hill Road (long section of Tully Formation clastic correlative succession, although top and base of succession is covered). Field Trip Stop 6.

19a Small, east-flowing tributary of Center Brook and adjacent abandoned quarry immediately north of gully, 0.5 miles west-northwest of Five Corners. Section is 0.2 miles north of section 19b (parts of medial Tully Formation clastic equivalent succession exposed).

19b Small, east-flowing tributary of Center Brook, 0.45 mile west of Five Corners. Portion of creek exposing Tully Formation clastic – equivalent beds is parallel to, and immediately north of, Warner Hill Road (part of medial Tully Formation clastic equivalent succession exposed).

20 West-flowing, unnamed tributary of Unadilla Creek, 1.7 miles south of South Edmeston and 1.6 miles northeast of Five Corners (chamositic base of New Lisbon Member exposed in glacially rucked section at approximately 1550 foot elevation on creek north fork).

21\. North-flowing banks of Mill Creek, 0.5 – 0.7 miles west of Route 8 – 80/Route 80 intersection in New Berlin (hanging sections of probable medial Tully Formation [Taughannock Falls beds – equivalent?] clastic equivalent succession).

22 Small, north-facing cut along Terrace Heights Road, 200 feet south of Mill Creek and 0.45 miles west of Route 8 – 80/Route 80 intersection in New Berlin near south edge of quadrangle (uppermost Taughannock Falls beds - equivalent strata and basal part of West Brook Shale).

New Berlin South 7.5' Quadrangle:

23 Small, east-flowing tributary of Unadilla Creek, 0.05 miles south of Angell Road

medial Tully accessible under alluvium).

14 East-flowing south fork of Center Brook 0.25 miles west of (upstream from) Winton Road overpass. Section is 1.5 mile west-southwest of Columbus (Smyrna Bed chamosite well exposed above top-Moscow contact.

15 Unnamed, northeast-flowing tributary of Center Brook, 0.5 miles west of (upstream from) southward, right angle turn on Walt Phillips Road. Section is 1.5 miles southwest of Columbus (top-Tully-Geneseo succession is exposed on north [main] fork of gully; Walt Phillips Bed, West Brook Shale, and base-Moravia bone bed are exposed on smaller south fork).

16 Roadcut along Walt Phillips Road 0.4 miles south of the southward right angle turn on Walt Phillips Road and 1.5 miles southwest of Columbus as well as unnamed, northeast-flowing creek parallel to the road (part of lower Tully clastic correlative succession exposed on creek, part of medial Tully and highest Tully –succession exposed along road; Walt Phillips Bed type section). Field trip Stop 7.

New Berlin North 7.5' Quadrangle:

*17 Northeast-flowing tributary of Center Brook 0.6 miles south of Walt Phillips Road and 1.5 miles south of Columbus. Locality is 0.6 miles west of Balcom Hill Road (partial New Lisbon Member section, good Tully Formation clastic equivalent-succession. "Perrytown" section of Cooper and Williams, 1935).

18 Northeast-flowing tributary of Center Brook 0.3 miles southwest of junction of Balcom Hill Road and Route 80 at hamlet of Shawler Brook. Creek runs southeast of, and sub-parallel to, Balcom Hill Road (long section of Tully Formation clastic correlative succession, although top and base of succession is covered). Field Trip Stop 6.

19a Small, east-flowing tributary of Center Brook and adjacent abandoned quarry immediately north of gully, 0.5 miles west-northwest of Five Corners. Section is 0.2 miles north of section 19b (parts of medial Tully Formation clastic equivalent succession exposed).

19b Small, east-flowing tributary of Center Brook, 0.45 mile west of Five Corners. Portion of creek exposing Tully Formation clastic – equivalent beds is parallel to, and immediately north of, Warner Hill Road (part of medial Tully Formation clastic equivalent succession exposed).

20 West-flowing, unnamed tributary of Unadilla Creek, 1.7 miles south of South Edmeston and 1.6 miles northeast of Five Corners (chamositic base of New Lisbon Member exposed in glacially rucked section at approximately 1550 foot elevation on creek north fork).

21\. North-flowing banks of Mill Creek, 0.5 – 0.7 miles west of Route 8 – 80/Route 80 intersection in New Berlin (hanging sections of probable medial Tully Formation [Taughannock Falls beds – equivalent?] clastic equivalent succession).

22 Small, north-facing cut along Terrace Heights Road, 200 feet south of Mill Creek and 0.45 miles west of Route 8 – 80/Route 80 intersection in New Berlin near south edge of quadrangle (uppermost Taughannock Falls beds - equivalent strata and basal part of West Brook Shale).

New Berlin South 7.5' Quadrangle:

23 Small, east-flowing tributary of Unadilla Creek, 0.05 miles south of Angell Road

and 1.0 miles southwest of Route 8 – 80/Route 80 junction in New Berlin (uppermost Taughannock Falls beds equivalent strata, West Brook Shale, and part of Moravia beds equivalent succession).

*24 Large, steep, east-flowing tributary of Unadilla Creek, 1.5 miles south-southwest of Route 8 – 80/Route 80 Junction in New Berlin (complete Tully Formation clastic equivalent succession. New Lisbon Member feather edge, and Smyrna Bed uncovered through excavation, this is probable "Greens Gulf" section of Cooper and Williams, 1935).

25 Small, west-flowing tributary of Unadilla Creek, 0.1 – 0.2 miles upstream from junction of Route 18 and Shacktown Road. Gully parallels Shacktown Road on south side (parts of medial Tully Formation clastic equivalent succession exposed).

26 West-northwest flowing tributary of Unadilla Creek, 2.1 miles east-southeast of Route 8 – 80/Route 80 junction in New Berlin. Waterfall and bank section 0.15 – 0.2 miles north of closest approach of Route 13 (excellent exposure of upper part of Taughannock Falls beds-equivalent succession, West Brook Shale, Moravia-Fillmore Glen beds? – equivalent strata, Geneseo Member?, and Sherburne Member).

27a Unnamed, north-flowing tributary of Wharton Creek, 0.3 – 0.6 miles south of Pittsfield. Section is west of Ouleout Road and straddles New Berlin North and New Berlin South Quadrangle boundary (long section exposing upper Moscow-through-upper part of Taughannock Falls beds equivalent succession. Base of New Lisbon Member, base of Tully Formation clastic correlative succession, and probable Symrna Bed exposed).

27b West flowing east fork of Locality 27a creek, 0.15 miles east of (upstream from) Ouleout Road overpass and 1.3 miles southeast of Pittsfield (upper Taughannock Falls beds equivalent strata, West Brook Shale, and part of Moravia beds equivalent succession exposed in waterfall).

New Berlin North 7.5' Quadrangle:

*28 Small tributary of larger unnamed tributary of Wharton Creek, 1.5 miles east of Pittsfield. Section is 0.3 – 0.1 mile north of (downstream from) Ramey Road overpass. Creek is not shown as running stream on map (most of New Lisbon Member exposed, base-Tully contact and much of succeeding Tully Formation clastic correlative succession is exposed, this is probable "Pittsfield" section of Cooper and Williams, 1935).

Edmeston 7.5 Quadrangle:

29 Small, unnamed, northwest flowing gully, 0.3 miles northwest of Gross Hill School and 0.9 miles north, northwest of Crystal Lake. (Nearly complete section of New Lisbon Member with base-and-top-contacts exposed. Base-Tully contact and portions of the succeeding Tully Formation clastic correlative succession exposed).

Morris 7.5' Quadrangle:

30 Unnamed, southeast flowing tributary of Butternut Creek, 1.25 miles southwest of intersection in New Lisbon. Section is 0.2 – 0.4 miles northwest of (upstream from) the Route 51 overpass (upper part of Tully Formation clastic correlative succession, including West Brook Shale, exposed).

31 Unnamed, south flowing west tributary of Stony Creek, 0.9 – 1.4 miles north, northeast of New Lisbon and 0.15 – 0.25 miles west of Parker Road (most of New

Lisbon Member, including basal chamositic contact with Cooperstown Member, exposed).

32 East facing banks of Stony Creek both downstream and upstream from Miller Road overpass. Section is 1.3 – 1.6 miles northeast of intersection in New Lisbon (hanging section of New Lisbon Member without base-or top-contacts, this is probably part of Cooper and Williams, 1935, type New Lisbon Member section).

33 Southeast flowing, unnamed tributary of Stony Creek, 1.0 miles southwest of Welcome and 0.15 miles southwest of terminus of Hudson Road (medial Tully Formation clastic equivalent exposed).

*34 Unnamed, west flowing tributary of Butternut Creek, 1.0 – 1.2 miles east, northeast of intersection in New Lisbon. Section extends for 0.4 miles upstream from the New Lisbon-Hartwick Road overpass and includes an abandoned quarry and cuts along Otto Stahl Road which parallels the creek (upper part of New Lisbon Member type section exposed as is the chamositic New Lisbon-base-Tully contact near the lower end of this creek, Tully Formation clastic correlative succession almost completely exposed, West Brook Shale and highest Tully exposed along upstream south fork of creek, "New Lisbon" section of Cooper and Williams, 1935). Field trip Stop 8.

35 Unnamed, northwest flowing tributary of Butternut Creek, 1.25 miles south of intersection in New Lisbon. Creek is immediately north of, and parallel to, Gulf Road (strata probably equivalent to topmost Tully Formation clastic correlatives, exposed at lowest end of section 0.15 miles southeast of Gulf Road/Pegg Road intersection).

Mt. Vision 7.5' Quadrangle:

36 East facing cut-bank of Pool Brook 2.4 miles north, northwest of Laurens, Section is west of Poolbrook Road and 1.85 miles northwest of Poolbrook Road/West Valley Road intersection (top of Cooperstown Member-into-basal Tully Formation succession).

*37 Unnamed, northwest flowing tributary of Otego Creek, 1.2 miles northeast of center of Laurens. Section commences 0.2 miles upstream from Route 205 overpass (fossiliferous upper part of lower Tully ["Laurens Member"] and most medial Tully Formation clastic correlative succession exposed; excellent, easternmost exposure of West Brook Shale; this is "Laurens" section of Cooper and Williams, 1935).

*38 Unnamed, west flowing tributary of Otego Creek, 2.0 miles northeast of center of Laurens. Section extends 0.1 – 0.35 miles upstream from Route 205 overpass (lower Tully clastic correlative succession exposed; Moscow Formation-base-Tully contact exposed; this is "Houghtelings Glen" section of Cooper and Williams, 1935).

ROAD LOG

Leave SUNY Oneonta staging area and proceed to I-88 (westbound). We will proceed from Oneonta to Tully, NY via Binghamton on Interstates 88 and 81 giving us an initial drive of 111 miles. We will stop at a rest area on I-81 (McGraw area or Preble area depending on passenger needs). This part of the trip will involve a driving time of approximately 2 hours and 10 minutes. However, it allows us to proceed from the west towards Oneonta so that the Tully Limestone-to-Tully clastic correlative transition can be viewed fully. The road log starts from the I-81 northbound exit ramp junction with Route 80 west of Tully and ends at the Route 28/I-88 junction northeast of Oneonta. The Sunday trip agenda starts at the east end of the Saturday road log venue and proceeds westward. Additional Sunday stops west of the Tully Valley are included (along with brief routing information) in an appended section following the detailed road log section.

Accum-ulated Miles	Incre-mental Miles	Saturday Road Log
0.0	0.0	Junction of northbound I-81 exit ramp with State Route 11. Turn left (north) on Route 11.
4.0	4.0	Junction of Route 11 with State Route 80 in Tully. Turn left (west) onto Route 80.
4.25	0.25	Leave Tully. Continue west on Route 80.
4.45	0.2	Turn right (north) into entrance for Best Western Motel and Tully Lakes Restaurant.
4.5	0.05	Proceed by car to the rear of the restaurant-motel complex and park by large shale borrow pit and exit vehicles.

Stop 1: Tully Shale Borrow Pit at Tully Center (20 minutes). Windom Fauna and Basal Tully Contact.

This well known stop for professionals and amateurs alike is best known for diverse taxa of the Hamilton Fauna that occur in strata of the Windom Member. Windom divisions exposed here include; in ascending order: The Taunton submember (25 feet); the Lansing Coral Bed (1.5 feet); the Spezzano submember (5 feet); the Gage Gully submember (8 feet); and the Sheds submember (6 feet). The Taunton submember is a shoaling (RST) interval. The Lansing probably marks the base of a subsequence interval. All of it (or part of it) commences a transgressive (TST) succession that continues through the Spezzano submember and into dysoxic early highstand facies of the lower Gage Gully submember. The Sheds marks the return of shoaling condition followed by another transgression recorded by the newly defined Highland Forest submember (here absent due to erosion) that is represented by dysoxic *Emanuella*-bearing strata (Baird and Brett, 2003). Diverse Hamilton taxa (too numerous to discuss here) are characteristic of the shallower facies. Dysoxic taxa, represented by *Eumetabolatoechia* ("*Leiorhynchus*") *multicostatum*, *Emanuella praeumbona*, and diminutive *Allanella tullia* are characteristic of the dark gray Gage Gully submember. Not discussed in most earlier reports is the occurrence of the basal layer (DeRuyter Bed) of the Tully Formation at the top of this section. This bed is represented by a 0.3 foot thick layer of impure limestone abounding in the characteristic lower Tully strophomenid *Rhyssochonetes aurora* and scattered phosphatic pebbles. This layer rests disconformably on the Sheds submember; at Junes' Ravine, 1.3 miles east –northeast of this section, the topmost division of the Windom

Member (here eroded) is represented by the Highland Forest submember. At Junes' Ravine it is represented by 0.9 feet of silty, calcareous shale rich in *Emanuella*, small *Tropidoleptus*, small *Allanella*, and *Mucrospirifer*.

4.55	0.05	Return to motel/restaurant entrance and turn right (west) onto Route 80.
4.7	0.15	Junction of Route 80 and Route 11/Route 281 at red light. Continue straight (west) on Route 80.
4.75	0.05	Pass under Interstate 81. Continue straight (west) on Route 80.
4.95	0.2	View of Tully Lakes (Kettle Lakes) to left (south). Song Mountain Ski complex in distance. For the next 1.8 miles we will cross the Tully Valley on the Valley Heads Moraine. Notice the elevated drift-floored plain to the south and the approaching bedrock valley wall to the west.
5.75	1.8	Long Road/Route 80 intersection. Notice sign for Song Mountain Ski area. This is a sharp hairpin turn. Turn left (south) with caution onto Long Road.
6.3	0.55	Private driveway on right. However, we must turn left into "jug handle' turnaround in order to ascend driveway lane.
6.4	0.1	Park by house at top of driveway incline. We will proceed on foot to outcrop along driveway.

Stop 2: Tully Limestone Divisions in Driveway Section Next to Carrs' Creek – Quarry Locality.

The Carrs' Creek-Quarry section serves to illustrate the typical, prominent carbonate succession of the Tully Formation in west-central New York. Fortuitous excavation of the new driveway and the kindness of the owners who built it, preclude our need to climb the slippery creek section. Moreover, the driveway cut reveals weathered joint surfaces that show excellent textural details and fossils. The driveway section exposes in upward-succession: the Fabius Bed (3 feet visible), the Meeker Hill Bed (3.75 feet), the Tully Valley Bed (1.5 feet), the Vesper Bed (1.5 Feet), the Carpenters Falls Bed lower part (3.4 feet); the upper part of the Carpenters Falls Bed separated from the lower part by a discontinuity (0.5 feet); the Taughannock Falls Bed (2.7 feet); the Bellona Coral Bed (0.3 feet); and the Moravia Bed (2.75 feet visible). Basal Tully units visible in the creek but not along the driveway include: the DeRuyter Bed, the Cuyler Bed, and the lower part of the Fabius Bed.

The present authors believe that the lower part of the Tully Formation succession (DeRuyter Bed-to-the-intra Carpenters Falls discontinuity) records an interval of overall shoaling with increased Tully Fauna diversity upward (see text; Baird and Brett, 2003). The topmost Carpenters Falls Bed and the Taughannock Falls Bed (medial Tully succession) records a time of relative deepening following the intra-Carpenters Falls lowstand event. This is roughly timed with the demise of the Tully fauna and redevelopment of the Hamilton Fauna (see text; Baird and Brett, 2003). A second regressive episode is recorded by the Bellona Bed. The Bellona "coral plantation" (*sensu* Heckel, 1973), yielding large rugosans and tabulates such as *Favosites* and *Alveolites* at this locality and others further west, records maximum return of the diverse Hamilton Fauna Biota. Actually, the basal 0.5 feet of the overlying Moravia Bed is composed of dark limestone yielding corals and *Spinatrypa*; we believe that is interval correlates eastward to a limestone bed that caps the West Brook Shale (Figures 5, 6). The five-six inch thick topmost part of the Carpenters Falls Bed is characterized by "oolitic" grains somewhat resembling chamositic "ooids" in the Smyrna Bed to the east. Moreover, the top of this interval displays fracture systems resembling the "mudcracks" reported by Heckel (1973). Most significant is the presence of laminated carbonate texture resembling algal (microbialite) stromatolites (see text discussion). We believe that these structures underlie Heckel's (1973) regional "intra-Tully unconformity" which we interpret as a flooding surface. We also argue that the topmost part of the Carpenters Falls Bed, as presently defined, overlies a lowstand disconformity and may be the western equivalent of the Smyrna Bed (see discussion).

7.0	0.6	Return to Long Road/Route 80 junction (REMEMBER to use available "jug handle" at base of driveway in order to turn left (north). The right turn onto Route 80 is too sharp to negotiate; we will turn left instead and proceed to one or more turnaround places where we can go eastbound on Route 80. We will then collect together on the shoulder opposite the entrance to the Best Western Motel-restaurant complex.
7.6	0.6	Long Road/Route 80 intersection again. Continue straight (east on Route 80.
9.8	2.2	Temporary pull-off spot to collect vehicles opposite Best Western complex. Continue east on Route 80.
10.25	0.45	Junction of Route 80 with Route 11 at intersection in Tully. Continue straight (east) on Route 80.
10.6	0.35	East edge of Tully
11.25	0.65	Type Tully Formation section (Junes' Ravine) to the north (left) in the uphill woods.
12.35	1.1	Excellent view of glacial U-shaped profile of Labrador Valley to right (south).
12.75	0.4	Middle of hamlet of Apulia. Continue straight (east) on Route 80.
13.55	0.8	Middle of hamlet of Apulia Center. Continue straight (east) on Route 80.
19.2	5.65	Enter town of Fabius. Continue straight (east) on Route 80.
22.7	2.80	Entrance to Highland Forest Park (Onondaga County – Syracuse Metropark System). Turn right (south) and proceed uphill into park.
23.75	1.05	Park headquarters and Visitor Center in Highland Forest Park. Turn right into parking area.
23.80	0.05	Park vehicles at southwest of parking area and proceed on trail to footpath bridge over creek near parking area.

Stop 3: Tully Formation sections adjacent to Highland Forest Metropark Headquarters.

The fortunate location of this section allows for the use of lavatory facilties and time for box lunch consumption. Two Tully sections can be studied, time permitting. The first, below a trail bridge near the parking lot and bordered by paths, will be the main object of attention. This exposes all of the Tully Formation except a portion of the Fillmore Glen Bed-interval near the top of the Tully. In this region, a prominent regional disconformity, first characterized in detail by Heckel (1973) is observed to divide the Tully succession. The lower Tully succession (DeRuyter Bed-into-Carpenters Falls Bed interval) is observed to be overstepped rapidly eastward from the meridian of Highland Forest Park such that no lower Tully is observed in sections east of the meridian of Sheds. This erosion was believed to commence eastward from the level of the post-Carpenters Falls "intraformational unconformity" southeast of Fabius (Heckel, 1973; Figures 2, 3). From DeRuyter Reservoir eastward, this disconformity surface was believed to coincide with the base of the Smyrna Bed (Heckel, 1973) that is traceable to the Sherburne area.

The present authors connect the regional, sub-Smyrna disconformity westward, not to the post-Carpenters Falls contact, as did Heckel (1973), but to the base of what Heckel termed "Carpenters Falls Bed" in the Fabius-Labrador Valley area (Baird and Brett, 2003). The thin "Carpenters Falls Bed" interval of the Fabius-Labrador Valley region is a sandy, abraded grain encrinite characterized by a sharp irregular base marked by giant hypichnial burrow prods and minor phosphorite. Careful examination of sections between Fabius and DeRuyter shows that this unit is present in most sections across the region and that it connects laterally to the Smyrna Bed. At this locality, this bed is present, but is of variable thickness; under the walk bridge it is only a few inches thick, but, at the adjacent south fork section, it is almost a foot-thick. This may reflect local Smyrna Bed cutout beneath the sub-Taughannock Falls Bed flooding surface contact. The intra-Carpenters Falls discontinuity at Stop 2 may connect to the sub-Smyrna disconformity.

Another major aspect of the lower Tully succession in this region is that the Fabius Limestone Bed at Stop 2 has transformed into a calcareous siltstone-silty limestone unit and the underlying Cuyler Bed has thickened considerably. In contrast, much of the upper Tully succession consists of clean limestone and clay shale. This is a major facies change described in detail by Heckel (1973). He related it, in part, to terrigenous sediment-sourcing from the region of lower Tully erosional cutout between DeRuyter and Sherburne (Heckel, 1973).

24.9	1.1	Return to park entrance road/Route 80 Junction. Turn right (east) onto Route 80.
25.2	0.3	Route 80/DeRuyter Road-Oran-Delphi Road intersection. Continue straight (east) on Route 80.
25.7	0.5	Cross Limestone Creek. Morainal deposits exposed in creek banks.
26.2	0.5	East valley rim of Limestone Creek. Valley head moraine plain for next 0.4 miles. Enter Madison County.
28.1	1.9	Enter New Woodstock. Continue straight (east) on Route 80.
28.7	0.6	Leave New Woodstock. Continue straight (southeast) on Route 80.
31.6	2.9	Route 80/Route 13 crossroad in hamlet of Sheds. Continue straight (east-southeast) on Route 80.
32.6	1.0	Junction of Route 80 with Carpenter Road. Turn right (south) onto Carpenter Road.
33.5	0.9	Tully Formation roadcut to left. Pull off on shoulder and proceed

to outcrop.

Stop 4: Tully Formation Roadcut and Road Ditch Section Showing Complete Overstep of Lower Tully Member Division by Sub-Smyrna Bed Disconformity.

This section displays the two uppermost submember divisions of the Windom Member overlain by units of the upper Tully Formation succession. The upper part of the Sheds submember is visible in the lowest 2 – 3 feet of the bank and yields numerous Hamilton Fauna brachiopods and clams. This is abruptly overlain by 2.5 feet of Highland Forest submember that is characterized by siltstone beds and a low diversity association of *Emanuella praeumbona*, small *Tropidoleptus* and *Mucrospirifer*. This section exposes the highest strata of the Windom below the Tully in central New York, although considerably thicker Highland Forest sections are observed in central Pennsylvania (Baird and Brett, 2003).

The visible Tully succession rests disconformably on the Windom. At this locality the basal 16 inches of the Tully is represented by the Smyrna Bed, a hard overhanging ledge composed of abraded calcarenite and minor "oolitic" chamosite. This bed displays a sharp base with development of large hypichnial burrow prods filled with encrinite, minor sand, minor phosphate, and chamosite. Lucky persons will find clusters of 3-D *Tullypothyridina* in some of the basal protruding burrows. As noted by Heckel, 1973, the lower Tully succession is absent due to regional overstep by the sub-Smyrna disconformity. This overstep is characteristic of Tully sections eastward to the Sherburne area. Post-Smyrna strata are represented by an expanded shale-limestone phase of the Taughannock Falls Bed interval. In the road ditch, strata of the West Brook Shale and its capping limestone unit can be seen. These units yield many Hamilton Fauna taxa. Excellent trilobite fossils, camerate crinoids and blastoids are found in this interval.

34.4	0.9	Return to Carpenter Road/Route 80 Junction. Turn right (east) onto Route 80.
39.5	5.1	Intersection of Route 26 and Route 80 in Georgetown. Turn right (south) onto Route 26/80.
39.7	0.2	Pass Spirit House on left. Special ornamentation and rounded corners were devices designed by owner to fool the Devil.
43.1	3.4	Routes 80 and 26 split. Turn right (east) on Route 80.
43.2	0.1	Cross Otselic Creek and enter village of Otselic.
43.5	0.3	Leave Otselic. Continue straight (east) on Route 80.
49.2	5.7	Pass through Upperville. Continue straight (east) on Route 80.
49.6	0.4	Notice major exposure of medial Windom Member/Cooperstown Member strata on floor of Pleasant Brook to the right.
50.1	0.5	More visible Moscow Formation strata on floor of Pleasant Brook. Major Tully Formation exposure (Upperville section: Locality 1) is across brook on along a tributary.
51.5	1.4	Enter Village of Smyrna. Continue straight (east) on Route 80.
52.2	0.7	Leave Village of Smyrna. Continue straight (east) on Route 80.
55.0	2.8	Pass Rogers Nature Center. Geese, giant carp, and snapping turtles can be viewed from a bridge near the parking lot.
55.4	0.4	Cross Chenango Creek.
56.0	0.6	Intersections of Routes 12 and 80 in Sherburne. Turn left (south)

		onto Route 12.
56.5	0.5	Leave Sherburne. Continue straight (south) on Route 12.
59.3	2.8	Turn left (east) onto Park Road from Route 12.
59.8	0.5	Car pull-off to left near Stop 5 (We will pass it and turn around in a driveway so as to be facing west when stopped),
60.1	0.3	Pull off on shoulder of Park Road facing west. Exit vehicles and proceed to stream cut on West Brook.

Stop 5: Thin, condensed Tully Formation Section on "Sherburne High" Structural uplift.

This is an important section (Locality 9) described in Cooper and Williams (1935) and Heckel (1973) publications. This is the type section of the West Brook Shale, a nearly three foot-thick unit of calcareous shale abounding in diverse Hamilton Fauna taxa recorded in extensive faunal lists (Cooper and Williams, 1935, Heckel, 1973). It is the "last hurrah" for the Hamilton Fauna prior to the gradual onset of transgressive anoxia associated with Geneseo black shale deposition.

Eastward erosive downcutting of Hamilton Group strata by the sub-Smyrna Bed disconformity places the Cooperstown Member-Tully Formation contact on the Spezzano submember interval of the Cooperstown (Figures 5, 6). The Smyrna Bed at this locality is a 4 - 5 inch-thick unit of "oolitic" chamosite and subsidiary sandy, bioclastic abraded calcarenite that rests disconformably on underlying Hamilton Group deposits (Figures 5., 6). Discoidal dark gray to black, sand-sized chamosite grains dominate over subsidiary phosphorite pebbles and rare shells within the bed. Though not encountered by the present authors, Heckel (1973) reports a cluster of *Tullypothyridina* within the Smyrna Bed. Above the Smyrna Bed is a 2.2 foot interval of hard, slabby siltstone or fine sandstone facies yielding few fossils. Heckel (1973) referred to this unit as the "unnamed sandstone." Above this unit is a complex interval of "oolitic" chamosite, tabular siderite and limestone comprising the interval between the "unnamed sandstone" and the basal contact of the West Brook Shale (Figures 5, 6). Heckel (1973) referred to this interval of the "Taughannock Falls Oolite Bed" and indicated that it was a condensed lateral equivalent of the Taughannock Falls Bed (Heckel, 1973).

Careful work by Baird and Brett (this paper) shows the probability that Heckel's (1973) correlation is correct. However, the disjunct character of section match between localities 3 and 4 (Figure 5A) and localities 12 and 13a, b (Figure 6) offer the possibility that the Smyrna Bed near Smyrna (Localities 1, 2) and Sherburne Four Corners (Locality 3) may actually connect to the "Taughannock Falls Oolite Bed" rather than the lower chamositic layer (Figure 5A). Thus, from Cush Hill Road (Locality 4) to Harrisville (Locality12), it is possible that a part of the lower Tully Member (Fabius Bed?) may be represented by the lower chamositic layer and the "unnamed sandstone" (Figure 5, 6). Both chamositic beds are well developed at this locality. Chamosite, an iron-rich silicate, of somewhat problematic origin is characteristic of several Tully (and even pre-Tully) levels in east-central New York. The absence of chamosite in western New York and east-central New York sections shows the occurrence of this mineral to be restricted to a particular depositional belt (see text discussion). The absence of common robust fossils in chamositic beds, the mud-rich character of some chamosite-rich layers, and the occurrence of chamosite in dysoxic facies yielding "leiorhynchid"-type rhynchonellid brachiopods suggest that the origin of this unusual deposit may be some physical (or diagenetic) process occurring across a range of outer shelf and dysoxic, sediment-starved environments (see discussion).

63.9	3.8	Backtrack to intersection of Routes 80 and 12 in Sherburne. Turn right (east) onto Route 80.
64.4	0.5	Leave Sherburne. Continue straight (east) on Route 80.
65.5	1.1	Cross Mad Brook. Upper part of Cooperstown Member exposed below bridge.
65.6	0.1	Intersection in hamlet of Harrisville. Continue straight (east) on Route 80.
70.6	5.0	Southward turn of Route 80 in hamlet of Columbus. Turn right and continue south on Route 80.
71.7	1.1	Junction of Route 80 and Walt Phillips Road. Turn right (west) onto Walt Phillips Road.
71.8	0.1	Fairkit Farm to left. Major "Perrytown" section (Locality 17) of Tully clastic correlative succession (see Cooper and Williams, 1935; Heckel, 1973) high up on hill to the south.
72.7	0.9	Southward turn on Walt Phillips. Bear left.
73.0	0.3	Roadcut along Walt Phillips Road. This will be a later stop.
73.7	0.7	Junction of Walt Phillips Road with New Turnpike Road. Turn left (southeast) onto New Turnpike Road.
74.9	1.2	Junction of New Turnpike Road with Balcom Hill Road. Turn left (northeast and east) onto Balcom Hill Road.
75.5	0.6	Continue straight into dead end driveway where Balcom Hill Road bends left down a steep hill. Driveway splits off just before Balcom Hill Road descends over brow of hill.
75.55	0.05	Park cars near house or adjacent available spaces. Proceed across field and down side of unnamed gully (Locality 18) below the end of the field.

Stop 6: Thick Tully Clastic Correlative Succession Along Unnamed Creek (Locality 18) parallel to, and east of Balcom Hill Road.

Cooper and Williams (1935) and Heckel (1973) devoted considerable discussion to the first thick clastic Tully outcrop ("Perrytown" section) that was encountered proceeding east from the area of thin Tully occurrence on the "Sherburne High". That outcrop (Locality 17) is too far from any road to be visited on this trip. However, another adjacent section (Locality 18; Figure 7) that is almost as complete is herein included as a stop. We will intersect this creek at the topmost exposed Cooperstown Member above a small falls. The upper coral layer of the Lansing Bed is 15 feet below the falls lip and the strata comprising the falls is probably equivalent to the Spezzano submember in the Windom (Figures 7, 11). A six foot covered interval follows the Cooperstown succession that is, in turn, succeeded by 5 feet of lower Tully strata and about 45 feet of continuous upper Tully section. At the adjacent "Perrytown" section (Locality 17) part of the New Lisbon Member is exposed, as is the base of the Tully clastic succession above the New Lisbon (see text; Figure 7). The basal Tully contact on that creek is characterized by chamosite, nodular diagenetic siderite, and Tully Fauna taxa (*Hypothyridina*, *Schizophoria*, *Spinatrypa*), probably corresponds to what we call the "base-Laurens" disconformity (see text discussion). Heckel, 1973, (Figure 3) tentatively correlated this bed to (or near) the position of the Smyrna Bed in the Sherburne area.

However, on that same creek, and on this section as well, there is a second, more complex and prominent bed characterized by calcareous, auloporid-rich sandstone in the lower part and nodular chamositic limestone and siderite in the upper part (Figures 7, 10). The present authors correlate the upper part (and tentatively the lower part) of this unit to the Smyrna Bed instead (Figures 7, 11). The coarse, hashy mix of fossil debris and the nodularity of the carbonate component are texturally similar to the Smyrna Bed though the unit is sandier overall.

Although the "base-Laurens" disconformity is covered here and the underlying New Lisbon is concealed (or absent due to overstep: see text discussion and Figures 7, 11), we will see higher divisions of the lower Tully clastic succession. A massive two foot-thick siltstone bed exposed above the covered interval may correspond to part of the Fabius Bed. Above this, participants can view the 8-inch-thick nodular, calcareous auloporid-pelmatozoan-rich sandstone ledge of the lower Smyrna Bed. Calcareous chamosite and diagenetic siderite are characteristic of the upper Smyrna (Figures 7, 10). This is a condensed, presumably transgressive, phase probably corresponding to a major mid-Tully deepening event. In this interpretation the lowstand (sub-Smyrna) erosional contact is understood to be at the base of the chamositic bed or at the base of the 8-inch auloporid-rich sandstone (Figures 7, 10).

Above the Smyrna Bed is a 37 foot-thick interval of flaggy to slabby thin siltstone beds with shale interbeds. With exception of a thin medial layer, the Walt Phillips Bed, this interval yields very few macrofossils. Auloporid corals, sparse pelmatozoan debris, plant fragments and the occasional mollusk comprise the observed biota. We will view this interval at greater advantage at Stop 7. The present authors correlate this thick "barren" unit to the Taughannock Falls Bed in the Tully Limestone, although the upper part of it may be missing due to regional overstep to the west of this area (Figure 11).

One may properly question correlations based mainly on lithologic and textural parameters and minimally on distinctive guide fossils. We acknowledge this problem with numerous caveats, but have to point out that lower and medial Tully deposits in this area are conspicuously poor in fossil content. Although Tully Fauna taxa occur both in the lower and medial Tully, they are uncommon to rare. Even in the Sherburne area, the chamositic beds contain few shells and these are mostly small. The only unifying taxon that characterizes this facies is the auloporid coral that abounds in the condensed units. In fact much of the Tully clastic correlative succession in this area resembles portions of the Penn Yan and Sherburne members of the Genesee Formation. It is, thus, not surprising that Thayer (1974) described the biota of the dysoxic prodelta slope facies of the Genesee Group as the "*Cladochonus*" (auloporid) biofacies. As such, we interpret this region to be a structural subsiding basin relative to a platform setting for the Tully Limestone further west.

Another line of evidence for subsidence of this area is the dramatic thickening of Tully units and the reappearance of lower Tully beds east of the "Sherburne High" (Heckel, 1973). Heckel (1973) correctly envisioned a "down-to-the-east" fault and a clastic trap within the basin that prevented clastics from overspreading the Tully platform. We confirm this model (Figures 5 - 8) but show that lower Tully beds are, again, overstepped to the southeast of this section before reemerging to the east of New Berlin (Figures 6, 8). At the upper end of this transect, we will see the West Brook Bed and a capping discontinuity probably corresponding to the base of the Moravia Bed. The West Brook is richly fossiliferous and astonishingly thin relative to surrounding units. Corals, diverse brachiopods, bryozoans and other stenotopic Hamilton Fauna taxa can be found here. The West Brook has an erosional base marked by burrow prods and encrinite; this contact marks a significant lowstand event and it is responsive for conspicuous overstep of the medial Tully section west of this locality (Figures 6, 7).

77.4	1.85	Retrace to junction of New Turnpike Road and Walt Phillips Road. Turn right (northeast) onto Walt Phillips Road.
78.1	0.7	Roadcut to left. Pull off on shoulder above adjacent creek and proceed to the roadcut section.

Stop 7: Walt Phillips Bed and Associated Medial Tully Strata on Roadcut Along Walt Phillips Road (Locality 16).

This short stop serves to show the sparsely fossiliferous medial Tully clastic interval in good light. In particular, this outcrop is the type section of the Walt Phillips Bed a 16 inch-thick double-ledge interval of bioturbated siltstone that can be regionally correlated across the Columbus area (Figures 6, 7). At this section, this unit is at least 10 feet below the sub-West Brook disconformity. At locality 15, 0.5 miles northwest of this section, the Walt Phillips Bed is 18 inches below that contact and at locality 17, 0.9 miles east of this section, it is 17 feet below the West Brook. This pattern shows that there is a major trend of westward erosional overstep of the medial (Taughannock Falls Bed equivalent?) Tully succession below the sub-West Brook disconformity (Figures 6, 7, 11).
The Walt Phillips Bed is notable for the highest occurrence of *Rhyssochonetes* aurora in this region. It is a rare component along with *Emanuella subumbona* and scattered auloporids within the bed. This distribution shows that a diminished Tully Fauna component did survive within the Tully well past deposition of the Smyrna Bed.
In the creek below the road is an incomplete in-place succession of lower Tully beds probably corresponding to the Fabius Bed succession to the west. In addition to this, however, are large loose Tully blocks derived from the till upstream from the actual outcrop. One of these blocks, resembling the lower Smyrna auloporid-rich sandstone unit at Stop 6, is capped by a thin, chamositic limestone bed yielding abraded calcarenite with auloporids, and rare *Rhyssochonetes*. Moreover, this bed displays "mudcrack"-like fractures and well-developed microbialite stromatolites similar to those originally described by Heckel (1973) along the intra-Tully discontinuity at Bellona and those observed by the present authors in the Tully Valley (see Stop 2). We believe the loose block to be a Smyrna Bed erratic and that the stromatolitic bed is associated with the top-Smyrna transgressive flooding surface (see text for discussion).

79.4	1.3	Retrace to junction of Route 80 and Walt Phillips Road. Turn right (south) onto Route 80.
80.0	0.6	Strata of lower part of Cooperstown Member in stepped ramp falls

		in floor of Center Brook to the right.
82.3	2.3	Junction of Routes 8 and 80 at Five Corners. Turn right (south) on Route 8/80.
83.0	0.7	Enter New Berlin.
83.6	0.6	Route 80 splits to east (left) from Route 8 at center of New Berlin. Continue straight (south) on Route 8.
83.9	0.3	Junction (fork) of County Route 13 and Route 8. Continue straight (south) on County Route 13.
84.1	0.2	Cross Unadilla Creek, leave New Berlin and enter Otsego County.
85.0	0.9	Creek to left displaying Cooperstown Member strata including two separated ledges of the Lansing Coral Bed.
85.7	0.7	Borrow pit on right displaying strata of Sherburne Member.
85.8	0.1	Upper Tully Formation clastic correlative succession in creek (Locality 26) below road on left.
89.4	3.6	Borrow pit on right displaying Sherburne Member strata.
91.7	2.3	Enter Town of Morris.
91.9	0.2	Junction of Routes 51 and 13 in Morris. Turn left (east) onto Route 51.
92.2	0.3	Leave Morris on Route 51. Butternut Valley to right.
95.8	3.6	Junction of Route 51 and Route 12. Turn right (east) onto Route 12 and proceed towards New Lisbon and Gilbert Lake.
96.0	0.2	Cross Butternut Creek.
96.2	0.2	Enter New Lisbon.
96.5	0.3	Junction of Route 12 with Route 14. Turn left (north-northeast) onto Route 14 and leave New Lisbon.
97.5	1.0	Junction of Route 14 with Otto Stahl (dirt) Road. Turn right (southeast) onto Otto Stahl Road.
97.6	0.1	Pull off on shoulder bordering tributary of Stony Creek. Exit vehicles and examine adjacent creek and abandoned quarry sections as well as outcrops along Otto Stahl Road.

Stop 8: New Lisbon Member Type Section and Higher Tully Clastic Correlative Units in the Vicinity of Otto Stahl Road.

This section (Locality 34 of present paper) was the focus of detailed study by Cooper and Williams (1935) particularly for definition of the New Lisbon Member. However, a long and nearly complete section of the Tully clastic correlative succession is also present along and near this creek. Cooper and Williams (1935) established the New Lisbon Member as a 60-foot-thick succession of flaggy siltstone beds and shale interbeds rich in the brachiopod *Camarotoechia* ("*Leiorhynchus*") *mesacostale*. The lower-middle part of the type section of this unit is exposed on adjacent Stony Creek (Locality 32) and the upper 38 feet of Cooper and Williams (1935) original "New Lisbon Member" is present at Stop 8. Cooper and Williams (1935) and Heckel (1973) both recognized that this unit was pre-Tully in its lower half and Tully equivalent (yielding *Rhyssochonetes* and *Tullypothyridina*) in its upper half. Thus, this unit filled the interval between the underlying Cooperstown Member, yielding *Pustulatia* ("*Vitulina*"), and fossil-rich strata of the overlying lower-middle Tully succession ("Laurens Member" of Cooper and Williams, 1935; Figures 1, 3).

As noted in the text, the present authors have found a chamosite-bearing bed on this creek yielding *Rhyssochonetes*, rare *Hypothyridina*, conularids, and abundant *Emanuella* 28.8 feet below the base of the "Laurens Member" and 10 feet above the lower end of this outcrop (Figure 7). This unit, located nearly at road level in the creek, is herein taken to be the base-Tully contact (Figures 7, 11). Moreover, a chamosite-rich contact bed is now observed to floor the New Lisbon interval at nearby locality 31 allowing us to formally bracket the unit with physical contacts (Figures 7, 11). With this new information, we herein restrict the New Lisbon Member to include only pre-Tully highstand deposits between the two chamositic beds (Figures 7, 11). The "upper New Lisbon" of Cooper and Williams (1935) is herein included in the basal Tully clastic succession. We agree with Heckel (1973) that the 28.8 foot-thick succession of *C. mesacostale*-rich slabby siltstones and sandstones in the abandoned quarry and creek walls near the car pull off probably corresponds respectively to the DeRuyter and Cuyler beds in the Tully Limestone. Also significant is the fact that this pre-"Laurens Member" Tully interval appears to be absent in all localities between this section and Sheds (Figures 7, 11).

A few hundred yards east (uphill) from the car pull off are a few small road ditch cuts in the "Laurens Member" succession. The first of these exposes a 20 inch-thick silty mudrock unit abounding in *Emanuella*, *Echinocoelia*?, *Hypothyridina*, *Schizophoria*, *Spinatrypa*, and *Mucrospirifer*. This corresponds to Cooper and Williams, 1935, "second shell bed" of section parlance. 14 feet further up the road is another bed yielding abundant, well preserved *Tullypothyridina* and *Pseudoatrypa*. This is Cooper and Williams' (1935) "third shell bed" of the section. Finally, 12 feet above that unit is a thin, shell hash bed rich in *Emanuella*, *Echinocoelia*?, large burrow prods and phosphatic pebbles. We tentatively link the first shell bed in the road ditch to part of the Fabius Bed and one (or both) of the two higher shell beds to the Carpenters Falls-Smyrna bed interval in the Tully Limestone (Figures 7, 11).

Higher strata of the clastic Tully succession can be viewed only from private land in the creek. Hence, we will not see this part of the section. It is worth noting that the West Brook Bed is spectacularly developed on the south fork of this creek and is floored by an eleven-inch-thick clean, crystalline calcarenitic limestone bed yielding rugose and tabulate corals. It appears that there is eastward overstep of medial Tully strata by the sub-West Brook disconformity beneath this limestone layer.

98.0	0.4	Junction of Otto Stahl Road with Buck Schoolhouse Road at acute Y-intersection. Continue straight on Buck Schoolhouse Road. Strata of medial Tully Formation clastic correlative succession visible in creek falls to the right.
98.05	0.05	Intersection of Buck Schoolhouse Road with Gross Road. Turn right (south) onto Gross Road.
98.1	0.05	Cross north fork of Stony Creek tributary.
99.5	1.4	Junction of Gross road with County Route 12. Turn left (east) on Route 12.
101.2	1.7	Entrance to Gilbert Lake State Park on the left. Continue southeast on Route 12.
104.6	3.4	Enter Town of Laurens.

104.8	0.2	Junction of Route 12 and Main Street in Laurens (T-junction). Turn left (east) on Main Street.
105.2	0.4	Turn right on Otsego County Route 7A.
105.25	0.05	Bridge over Otego Creek.
105.5	0.25	Junction of Route 7A with Route 205. Turn left (north) onto Route 205.
106.9	1.4	"Houghtelings Glen" section of Cooper and Williams, 1935, to right. This outcrop (Locality 38) exposes an excellent lower Tully Formation clastic correlative succession (see text) and was intended as a stop. However, a major windstorm has tumbled trees blocking the stream course for the immediate future.
107.4	0.5	Junction of Route 205 with Dutch Hill Road. Turn right (east) onto Dutch Hill Road.
107.9	0.5	Region of smashed and toppled trees. This was the result of the same tornado (or downburst) that flattened trees at "Houghtelings Glen."
108.9	1.0	Intersection of Dutch Hill Road and East Road. Continue straight (east) on Dutch Hill Road.
109.0	0.1	Fork junction of Dutch Hill Road with Concrete Road. Bear right (east) on Dutch Hill Road.
111.9	2.9	T-junction of Dutch Hill Road with County Route 44. Turn right (south) on Route 44.
112.6	0.7	Junction of Route 44 with State Road 28. Turn right (west) onto Route 28.
113.1	0.5	Hamlet of Milford Center. Susquehanna Valley to left. Continue south on Route 28.
114.7	1.6	View of Goodyear Lake to left.
114.85	0.15	Pull off on right shoulder by long roadcut along Route 28. Exit vehicles and examine section.

Stop 9: Tully Clastic Correlative Succession (or Tully equivalent Gilboa Formation) on South Side of Route 28 by Goodyear Lake.

This is a "floating section" probable corresponding to part of the middle-upper part of the "Laurens Member" (Cooper and Williams, 1935). About 35 feet of section is exposed; spectacular flow rolls (seismites?) are visible in the lower third of the section; about two thirds-up is a 20-inch bed rich in *Tullypothyridina*, *Echinocoelia*, *Mucrospirifer*, *Spinatrypa* and bivalves. In the topmost 5 feet, pelmatozoan debris is prominent at several levels. This section, and, to a lesser extent, Stop 8, stand in stark contrast to the sparsely fossiliferous sections (Stops 5, 6, 7) of lower-middle Tully facies in the Sherburne-New Berlin area (Figures 7, 8, 11). We hypothesize that a structural, bathymetric trough centered at New Berlin separated the Tully carbonate platform in west-central New York from a sandy shelf area in eastern New York (Figure 12). Hence, the coarse, fossil-rich, Tully clastic deposits of the Otego and Susquehanna Valleys corresponds to the "Chemung" facies belt for the Taghanic Stage (Baird and Brett, 2003). Current explorational work is directed to localities in this valley and further east to

characterized both the biofacies and stratochronology of this poorly known interval. We hope to determine whether inner shelf biotas at the Taghanic level have a unique taxonomic composition or correspond to the Ithaca Fauna of overlying units.
A great final mystery is centered on the relationship of various marine units (Cooperstown Member, clastic Tully succession, and Geneseo Member) to the Gilboa Formation. This problem is beyond the scope of the present report, but is the subject of ongoing investigation (see Bartholomew and Brett ???).

115.2	0.35	Junction of Route 28 with Route 7. Continue straight (south) on Route 28.
115.4	0.2	Bridge over Susquehanna River.
116.4	1.0	Junction of Route 28 with Interstate 88. Enter I-88 westbound to Oneonta.
		End of Saturday Road Log

ROAD LOG ADDENDUM

This is Sunday's Road Log venue following completion of Saturday stops (in reverse). The addendum has an abbreviated road route description for two stops west of the Tully Valley.

Leave from Carrs' locality driveway section (Stop 2 of Saturday venue) to junction of Long Road and Route 80. Turn left onto Route 80 (dangerous right turn) and turn around to be eastbound on Route 80.
Enter Interstate 81 (southbound) and continue south to Cortland.
Exit Interstate 81 at exit 11 and take Route 13 southwest towards Ithaca.
Route 13 merges with Route 34. Continue south on Route 13/34 into Ithaca.
Junction in Ithaca with Route 89. Turn right onto Route 89 and proceed northwest out of Ithaca along west side of Cayuga Lake.
When you get to Taughannock Falls State Park, turn left into parking area at foot of hill just south of bridge over Taughannock Creek. Waterfalls over Tully Formation visible from road. Park vehicles and proceed to falls overlook.

Stop 10: Tully Formation Section on Taughannock Creek. Type Section for the Taghanic Stage.

This outcrop provides an excellent look at the Tully Formation section and adjacent units. Several feet below the base of the Tully is the westernmost occurrence of the Lansing Coral Bed; *Favosites*, *Heliophyllum* and other corals can be found as well as large fistuliporoid bryozoans and diverse brachiopods. The Spezzano submember is recessive below the disconformable base of the Tully. Large hypichnial burrow prods characterize the basal Tully surface where the Hamilton shale has eroded away below it. The remaining Tully succession to the base of the 5-foot-thick Fillmore Glen succession is massive, dove-white weathering fine limestone that is clean enough for quarrying as is done at Portland Point across the lake. Key interval units and contacts will be pointed out at this stop.

This is the key reference section for the Taghanic provincial stage, the Taghanic Unconformity and the Taghanic bioevent (see Johnson, 1970; Heckel, 1973; Aboussalam and Becker, 2001; Baird and Brett, 2003). However, it is significant that this Tully section is very incomplete due to westward erosive beveling of most lower Tully strata between Skaneateles Lake and this locality (Heckel, 1973). As such, the Carpenters Falls Bed, yielding *Tullypothyridina* and other lower Tully taxa, rests disconformably on the Hamilton. This is Johnson's (1970) "Taghanic Unconformity" which was believed to mark the start of a major craton-ward stratigraphic onlap event. Careful examination of higher Tully in western New York suggest, however, that the lowstand base-line for the transgressive Taghanic onlap event is at a higher level within the upper Tully Member or near the top of the Tully (Baird and Brett, 2003). The lowstand base-line for the upper Tully TST interval is the regressive Bellona Coral Bed and the actual transgressive onlap is understood to commence at one or more horizons bounding (or within) the Fillmore Glen Bed (Baird and Brett, 2003). The top-Moravia Bed omission horizon (knobbly surface) and five calcilutite-shale repetitions comprising the Fillmore Glen succession are well displayed at this section. Note the black, fissile strata of the Geneseo Member in the bank walls. This unit records major transgressive deepening in the foreland basin owing to combined effects of eustatic transgression and thrust loading to the east (Johnson et al., 1985; Ettensohn, 1998). Higher outcrops of this unit and overlying deposits, exposed in the great fall on this creek, are worth seeing, but are too far upstream to be accessed on this trip.

Continue northwest on Route 89. Turn left (west) at sign for Interlaken.

Turn right (north) onto Route 96 in Interlaken and continue northwest to Ovid.

Route 96 splits into Routes 96 and 96A. Continue straight (west) on Route 96A. Route 96A passes Willard, the now-defunct Seneca Army Depot, and Sampson State Park.

Junction of Routes 96A and US 5/20 and continue to west edge of Geneva.

Junction US 5/20 with Preemption Road near west edge of Geneva. Turn left (south) onto Preemption Road.

Enter village of Bellona. Just past bridge over Kashong Creek in middle of village, pull left (or right) into available parking. Exit vehicles and proceed to bridge near abandoned stone mill building.

Stop 11: Tully Limestone section on Kashong Creek; Stromatolites Above Mid-Tully Unconformity; Bellona Bed; Undulatory Top-Tully Erosion Surface.

We will descend into Kashong Creek upstream from the bridge and proceed to a breached up-fold of Tully in the creek floor. Along the contact between the underlying Carpenters Falls Bed and the overlying Taughannock Falls Bed is a layer of fracture networks, domal limestone knobs and stromatolitic carbonate deposits filling low areas peripheral to the knobs. This is Heckels', 1973, stromatolitic horizon associated with his regional intra-Tully unconformity. Close examination of the stromatolite texture shows that the lamination is arrayed concentrically around the structureless limestone knobs and parallel to fracture networks. Very close examination of the laminite shows that it has a perpendicular "pillared" microstructure that is normal to the visible lamination, a characteristic that Heckel, 1973, also noted. The stromatolitic layer is usually only millimeters-thick in swales and it is erosionally breached over knobs. The base of the stromatolitic layer contains skeletal debris, pyrite, phosphate grains and some fish bones; this marks the horizon of the discontinuity surface. It is important to compare the stromatolitic surface at this locality with material from Stops 2 and 7 as these latter occurrences are believed to be essentially the same level.

Several feet above the stromatolitic horizon is the Bellona Coral Bed which is thin, muddier than surrounding Tully facies, and profusely fossiliferous. Where it is swept clean on bedding surfaces, hundreds of corals can be seen. Easily spotted taxa within the bed include: *Heliophyllum*, *Cystiphyllum*, *Favosites*, *Alveolites*, and the brachiopod *Spinatrypa*. This is the "coral plantation" of Heckel, 1973, that serves as a key datum in mapping over huge areas. Above the Bellona Bed are clean carbonate deposits of the Moravia Bed. However, Heckel, 1973, correctly noted that the top-Tully contact at this locality is undulatory. Up to a foot of Moravia is present above the bridge, but, below the bridge, the Geneseo black shale rest directly on coral-rich Bellona deposits.

The Geneseo Member rests on the Tully with knife-sharp definition. Tully carbonate is locally separated from the well-jointed Geneseo by a thin lag bed of pelmatozoan calcarenite, but not detrital pyrite or bone debris. However, at Gorham, the next section to the west, detrital pyrite and bone debris characteristic of the Leicester pyrite rests on the Bellona Bed. Still further to the west, the base-Geneseo corrosional discontinuity is observed to cut out the Tully Formation and truncate the topmost beds of the Windom Member (Baird and Brett, 1986). The occurrence of channel-like grainstone lentils within the Geneseo Shale 16 inches above the Tully contact at Bellona, suggest the possibility that the real Leicester horizon is actually within the basal Geneseo on this creek and that the observed Tully-Geneseo contact at Bellona is a pre-Leicester surface that may project eastward to some level within (or at the base of-) the Fillmore Glen Member. This issue is still being investigated.

End of Sunday Road Log.