STOP DESCRIPTIONS

STOP A: BROWNS CREEK, YORK

Locality: Exposures along Browns Creek 0.3 km north of York Road and 0.1 km west of the trestle for Genesee and Wyoming railroad tracks, York, Livingston Co., N.Y. (Geneseo 7.5' Quadrangle). ~1 hour,
References: Gray (1984); Savarese et al. (1986)

Description

The Browns Creek exposure provides an exceptional section of the Ashantee Member and overlying. Centerfield Member and its contact with the underlying Butternut Black Shale (Skaneateles Formation). This section also affords an excellent area for the examination of a complete gradational sequence from black fissile shale (Marcellus facies) into coral-rich argillaceous limestones and calcareous shales (Moscow facies). It was in many ways the "rosetta stone" for determining the gradient of Hamilton facies (see Brett et al., 2007a).

On the basis of lithology and faunal content a number of units can be differentiated in this 3.2 m section. The contact between the Ashantee and Butternut members was now placed by Gray (1985) at the base of a thin shell bed with large ambocoeliid brachiopods *Cyrtinoides eliei* (Goldman and Mitchell,1990, the lateral equivalent of the Peppermill Gulf bed of the eastern Finger Lakes area. However, dark gray shale rich in leiorhynchid brachiopods similar to the Levanna and a completely gradational succession from these dark shales to limestones occurs above this horizon. This designation includes both fossiliferous, calcareous mudstone and limestone.

Skaneateles Formation

Butternut Black Shale Member

The lowest exposures in the bed of Browns Creek (Fig. 6) are hard, black slightly pyritic, fissile to platy shale which tends to be blocky in exposures due to well-developed jointing. This shale was previously assigned to the undifferentiated Levanna Member but given its lithologic characters as a very dark gray to black shale and correlative bounding basal beds Brett et al. (2023) extended the term Butternut to this upper portion of dark gray shale. This shale contains a low diversity fossil assemblage strongly dominated by leiorhynchid brachiopods (*Eumetabolotoechia* sp.). Certain bedding planes are crowded with the compressed shells of this brachiopod. Other fossils include nuculid bivalves, *Styliolina* and probable prasinophyte algal phycomas or resting/reproductive cysts (*Tasmanites*?).

Ashantee Member (new)

Typical black Butternut Shale is overlain by an interval of about 15-20 cm of dark gray friable shale (Figs. 6, 7) which is softer and somewhat less fissile than the underlying unit and contains a mixture of *Eumetabolotoechia* and the brachiopods *Ambocoelia umbonata*, *Cyrtinoides* (formerly *Mucroclypeus*) *eliei* and the chonetid *Arcuaminetes scitulus*. This interval with its distinctive ambocoeliid brachiopods is traceable eastward to Cayuga Lake, where it overlies the black Butternut Shale with a sharp, but subtle contact. East of Cayuga Lake this bed displays an abrupt increase in faunal diversity and overlies a distinctly

erosional contact on the Buttternut Shale. This thin condensed shell bed, the Peppermill Gulf bed, is traceable eastward to the Syracuse area. It exhibits an abrupt change from low diversity Butternut to high diversity Centerfield-like fossil assemblages. Gray (1985, 1991) therefore used this bed to define the base of the Centerfield and laterally equivalent Chenango members throughout the region. Brett and Baird (1996) used this bed as a reference example of a "precursor bed", i.e. a condensed bed that abruptly begins a shallowing upward cycle. The next 40 cm of the Ashantee Member (as defined herein) consists of medium gray shale or mudstone, which is increasingly calcareous and fossiliferous upwards. An *Ambocoelia umbonata* - *Longispina* dominated assemblage at the base (Fig. 7) gives way to a much higher diversity assemblage including abundant bryozoans (*Sulcoretepora* and fenestellids),various brachiopods (*Pholidostrophia* , *Nucleospira*, *Pseudoatrypa* and *Cyrtina*), disarticulated pelmatozoan debris and the trilobite *Phacops rana*. Small rugose corals (*Stereolasma* and *Amplexiphyllum*) first appear about 20 cm below the lowest limestone nodules and become abundant in the unit immediately below the Centerfield (Fig. 6). Auloporids, small favositids and small specimens of *Heliophyllum* halli occur just below the lowest limestone band. Overall diversity increases steadily from about 25 to about 52 genera (Simpson's index = .75- .93). Trace fossils other than pyritic tubes are generally uncommon but the units 15-20 cm above the black shale unit of the Levanna Shale appear thoroughly bioturbated and bear vague *Zoophycos* spreiten. Body fossils throughout the interval are well preserved, though generally disarticulated and, in some cases, fragmented, as well, indicating prevalent low rates of deposition and frequent biogenic reworking.

The upper Ashantee (Triphammer Falls Submember) at Browns Creek consists of a series of nodular argillaceous limestone bands, interbedded with calcareous gray shales. The percentage of limestone and shale is roughly equal. The lower Ashantee Member in the Genesee Valley is marked by two persistent blocky bands (Figs. 6, 7) of light gray argillaceous, micritic limestone, mutually separated by about 15-20 cm of gray calcareous shale (Unit G). Both units contain scattered *Heliophyllum*, favositids, bryozoans and brachiopods (especially atrypids). The upper unit also contains numerous well-preserved trilobites, notably complete, partially enrolled or flexed specimens of the proetid *Pseudodechenella rowi* as well as *Phacops* and *Greenops* .
These trilobites are associated with abundant large *Heliophyllum* near the upper contact of the bed; about a third of the corals are preserved in apparent life position, with the calyx directed upward. Together these observations suggest that the top of Unit H represents a "smothered bottom" assemblage. This unit is abruptly overlain by a thicker (40-45 cm) interval of friable, calcareous gray shale with nodular argillaceous limestone (Figs. 6,7). This unit contains the typical Centerfield coral biostromal facies. The shales are packed with large rugose corals (*Heliophyllum*, *Enallophrentis*, *Cystiphylloides*) and a variety of auloporid and favositid corals (including large heads of *Favosites hamiltoniae*, smaller domical *F. placenta* and ramose *F. arbuscula*, *Trachypora*, and *Pleurodictyum*. Bryozoans, brachiopods and pelmatozoan debris are common though less abundant and diverse than in the under- lying shales. Many fossil corals in unit I exhibit multiple episodes of encrustation and corrosion suggesting very low rates of burial and thus, long exposure on the sea floor.

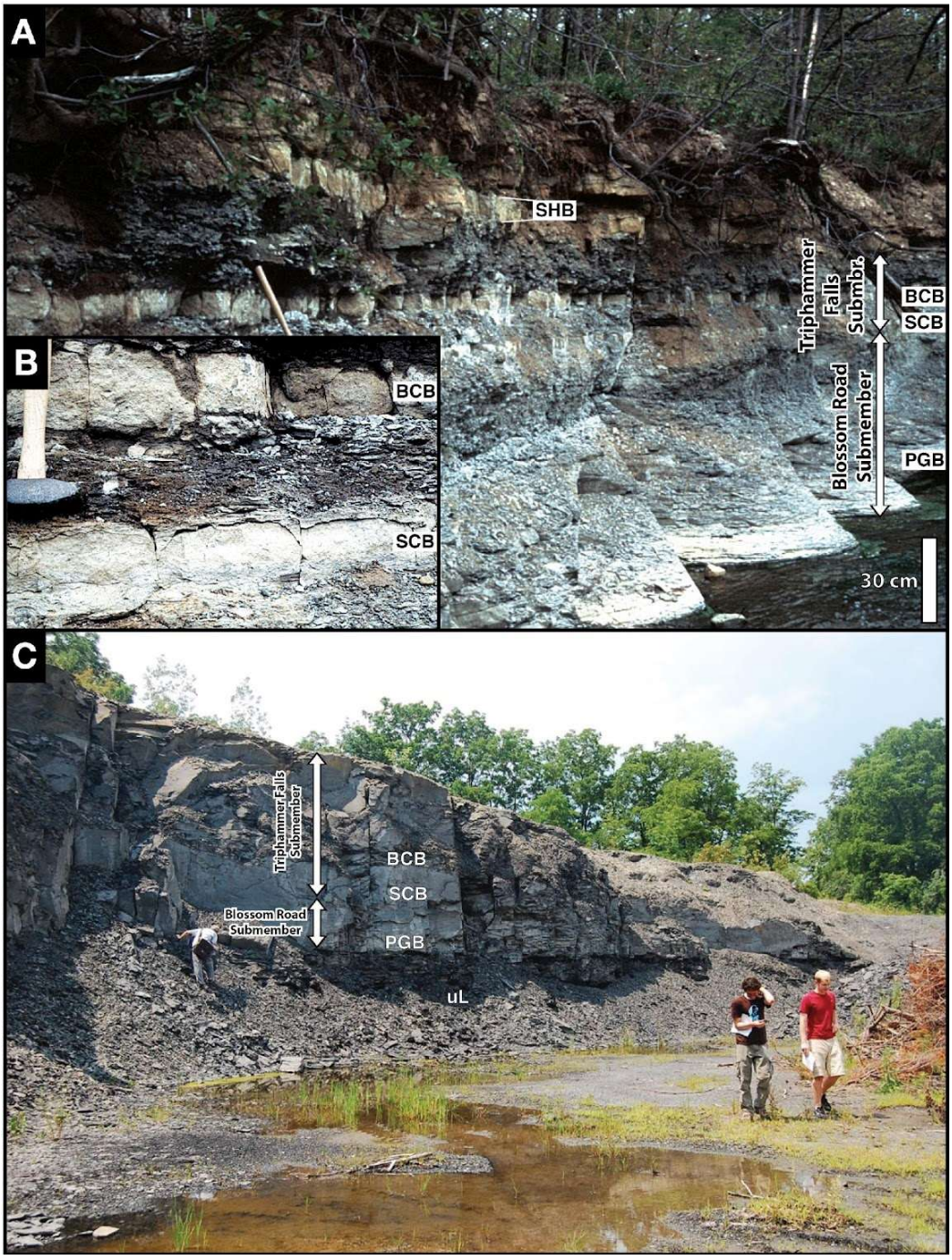


Figure 6. Ashantee Member (formerly lower Centerfield Member) and overlying Centerfield Member. **A,** Photo of Ashantee Member along Browns Creek, York, Livingston County, New York. **B,** Inset shows enlargement of concretionary limestones. C, Equivalent Ashantee interval at Fayette Town Quarry near Seneca Falls, NY; note much thicker mudstone interval; however, the marker beds are still recognizable. Abbreviations: BCB = Browns Creek Bed; PGB = Peppermill Gulf Bed; SCB = Salt Creek Bed; SHB = Schaeffer Creek Submember, base of Centerfield Member; submbr. = submember. From Brett et al. (2023).

Ludlowville Formation
Centerfield Member

The Centerfield Limestone section at Browns Creek rests sharply with slight diastemic surface. The main limestone, termed Schaeffer Creek Bed by Gray (1991) capped by four resistant bands of micritic, slightly limestone separated by thin seams of calcareous light gray shale These uppermost bands are irregularly bedded light gray shaly wackestone (biomicrites) , somewhat less fossiliferous than the underlying units and are thoroughly bioturbated, some showing vague *Zoophycos* spreiten. Scattered rugose corals, especially *Blothrophyllum*, favositids, and crinoid columnals are typically partially silicified (during weathering?) and stand out in relief on weathered surfaces. The top of the upper bed shows large heads of *Favosites hamiltoniae* in the creek bed above the falls.

If conditions permit, a short walk upstream reveals higher beds assigned to the Wheeler Gully Submember. Here a rather dense and diverse coral biostrome rather closely resembling the Triphammer coral beds below the falls, appears just above creek level. Many corals appear to be nearly in life position, and many encrust the coralla of older corals.

The contact of the Centerfield (as presently defined) with the overlying Ledyard Shale is not exposed at Browns Creek, but at Wheeler Gully, 7 km to the southeast this contact can be observed. Here the Centerfield appears gradational into the overlying dark gray to black shale. This transitional interval displays a gradient of lithologies and fossil assemblage~ closely paralleling that of the upper Skaneateles (Butternut-Ashantee) transition at Browns Creek.

Description: In the Genesee Valley the Ashantee-Centerfield succession is interposed between two dark shale units (Butternut and Ledyard). Contacts with both units are similar and marked by shifts from or to dark gray clay shale. thus, the Ashantee-Centerfield cycle occupies the central position of a nearly symmetrical cyclic: sedimentary package. The Levanna-Centerfield-Ledyard is interpretable as a regressive-transgressive cycle, with the transgressive systems tract commencing with the base of the major limestone presently assigned to Centerfield Member sensu stricto. A variety of taphonomic and sedimentologic evidence suggest that the coral beds represent deposition during a major shallowing episode. During these episodes, coral biostromal shelf facies migrated into the northern end of the Appalachian Basin, briefly interrupting black, basinal mud deposition as far south as central Pennsylvania. The Ashantee-Centerfield succession demonstrates a nearly idealized tracking pattern of faunal associations (Fig. 7). Microendoliths as well as upward evidence of intermittent storm stirring of the bottom suggests a shift from dysoxic and dysphotic zone offshore to deep and shallow subtidal euphotic zone communities and thus a shift of perhaps 20-30 meters of water depth. Yet this entire gradient is displayed in less than 2m of sediments (Fig. 7). The thin Ashantee Member package thickens strongly to the east and grades laterally into a coarsening upward succession long assigned to the Chenango member of the uppermost Skaneateles Formation. The fact that the full change is here represented in such a thin package of sediments has long suggested that this pattern is the result of a true forced regression, which triggered progradation of a clastic wedge well east of the Genesee Valley. Hence, the overriding cause is allocyclic and most likely eustatic sea level fall in the Ashantee and rise in the overlying Centerfield Member.

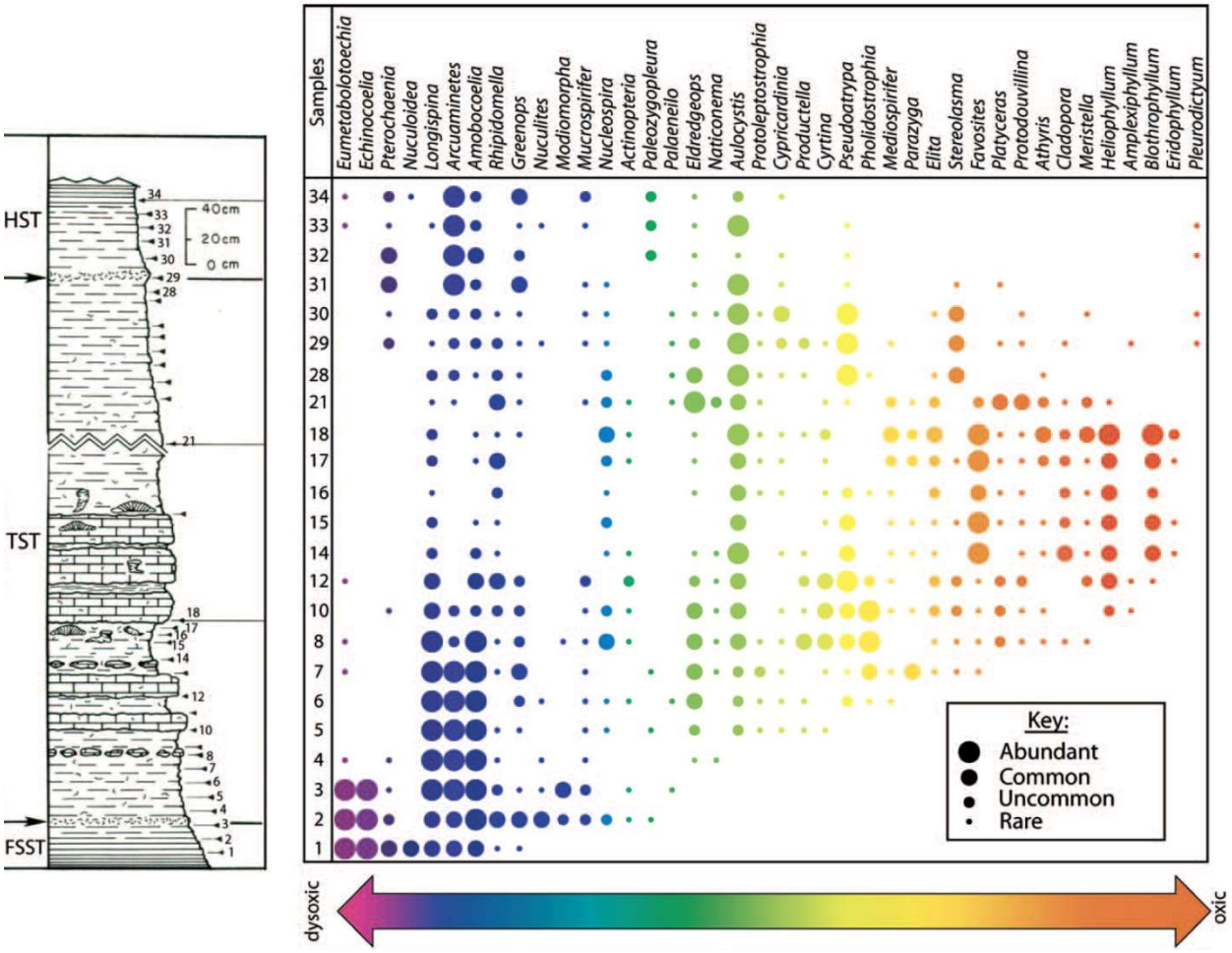


Figure 7. Order of appearance and relative abundance of common species in two major 3rd-order regressive (shallowing)-deepening cycles of the Centerfield cycle (Ashantee= units 1-17; Centerfield 18- 34) at Browns Creek and Triphammer Falls (composited); dot size relative abundance. Color coding based on first appearances of species: violet-blue lowest samples (inferred deepest water); reds samples near cycle center (inferred shallowest water); FSST falling stage systems tract (i.e., regressive or late highstand systems tract); TST transgressive systems tract; HST: highstand systems tract. Adapted from Brett et al. (2007); data from Savarese et al. (1986).

Although the definition for the Centerfield used by Gray (1985) was logical and closely matched the definition of the unit at its type section it is inconsistent with sequence stratigraphic nomenclature. From the standpoint of sequence stratigraphy, the lower transition above the Peppermill Gulf equivalent should be regarded as the late highstand or falling stage of the underlying (Skaneateles) sequence. Moreover, the sharp contact of the central of Schaeffer Creek limestone (unit L) appears to truncate underlying transitional beds in a westward direction.

Hence, this surface is a sequence bounding unconformity and the overlying coral rich compact limestone represents the base of the next sequence. Hence, Brett et al. (2023) have renamed the unit Ashantee Member for outcrops on Conesus Creek near the hamlet of Ashantee Livingston County, NY. Because the type section on Schaefer Creek, near Centerfield, New York shows a complete section of the lower transition beds, as well as the

sharply overlying central limestone, we follow Gray (1985) in assigning that limestone to the Schaeffer Creek Submember, as the basal unit of the Centerfield Limestone Member.

The Middle Devonian Centerfield Limestone (Ludlowville Formation) is the most widely traced stratigraphic unit in the Hamilton Group. The Centerfield has been tentatively correlated with the Hungry Hollow Limestone of Ontario, the Four Mile Dam Limestone of Michigan and the Beechwood Limestone of Kentucky, Indiana and southern Ohio (Cooper and Warthin, 1942) see discussion in Brett et al. (2023). Brett et al. recognize the Centerfield Member (s.s.) as the basal transgressive unit of the Ludlowville of Giv-2 3rd-order sequence. Representatives of have been recognized in Devonshire, Great Britain, the Eifel region of Germany, Morocco and elsewhere (unpublished data, C.E. Brett). Hence, this succession is the local expression of a strong global and probably eustatic.

STOP B. LAKE ERIE SHORE BLUFFS NORTH OF EIGHTEENMILE CREEK

Locality: Bluffs along the Lake Erie shore northeast of the mouth of Eighteen Mile Creek, Derby, Town of Hamburg, Erie County, NY (Eden 7.5' Quadrangle). Access to this locality is by means of a gravel road from a private home north of Eighteenmile Creek that leads on to bluffs of Middle Devonian Lower Wanakah shale (permission from the owner is strictly required).

Description: These lakeshore bluffs expose the lower 10m of the Wanakah Shale (Middle Devonian, Givetian; middle *rhenanus-varcus* Zone); lower parts of the section, on the foreshore are variably exposed, depending upon the extent to which sand and shingle have been deposited at the base of the bluffs. Although not seen in place here, the Tichenor Limestone, which overlies the Wanakah Shale is observable in large blocks along the shore which show abundant large corals and a diversity of brachiopods, bryozoans, bivalves, echinoderms, and other fossils.

Ludlowville Formation
Wanakah Shale Member
At its type locality, north of Eighteenmile Creek along Lake Erie Shore the Wanakah Shale Member consists of about 19.8 m of medium gray, soft, fossiliferous shale and shaly mudstone with several calcareous bands and zones of large concretions. The lowest meter of exposure at this section, only exposed at low levels of Lake Erie, constitutes the top of the Spring Brook Submember of the Wanakah Shale, and comprises medium gray, calcareous, and highly fossiliferous mudstone with thin, lenticular to concretionary fossiliferous bands. The lowest beds on the foreshore, the "*Pleurodictyum* Beds" of Grabau (1898-1899), are extremely rich in the small domical tabulate coral, *Pleurodictyum americanum* . This interval illustrates the concept of an ecological epibole, i.e., a thin but widespread stratigraphic interval that carries an anomalous abundance of a normally uncommon fossil taxon (Brett and Baird, 1997). *Pleurodictyum* is found at many levels in the Hamilton Group; but only at a small number of levels - about five in total - is this coral abundant. It reaches its maximal abundance in the lowest interval of the Wanakah Shale. This epibole can be traced across western and west central New York state. A concretionary limestone near the base of the *Pleurodictyum* beds, the Nautilus Bed, has yielded a rich

fauna of brachiopods, bryozoans, trilobites, and echinoderms, as well as the large, planispiral nautiloid genus *Nephriticeras magister* (formerly *Nautilus magister*); but this is only poorly exposed being mainly outcropped beneath the level of Lake Erie.

Above the Pleurodictyum beds is a compact grainstone, Lake View Bed of Kloc (1983) which forms the base of the Darien Center Submember. This bed grades laterally on Erie County into a distinctive biostrome of solitary (*Heliophyllum*, *Enallophrentis*) and colonial (*Eridophyllum*) rugose corals, the Darien Coral Bed (Figs. 7, 8). Articulated specimens of the large spiriferid brachiopod *Spinocyrtia granulosa*, at the top of the bed, are spectacularly overgrown with erect branching colonies of the trepostome bryozoan *Attactoechus*. The colonies are almost invariably attached to the brachial valves of the spiriferid and intergrown with the auloporid coral *Aulocystis*. This "event bed" is traceable for at least 20 km in Erie County. A thin clay layer that weathers as a notch, occurs slightly above the Nautilus bed. This notch forming clay has been identified in several localities and may represent a minor K-bentonite layer within the lower Wanakah.

The interval above the notch, Bowen Road Beds, is typically well exposed in the lower bluff, again, highly fossiliferous mudstone with thin fossil hash beds; it does not generally contain abundant *Pleurodictyum* but is very rich in the small rugose coral, *Stereolasma rectum*, as well as a high diversity of brachiopods, bryozoans, crinoid fragments, trilobites, and other fossils. Each of the thin (5-20 mm) shell beds within this interval have been correlated across across 30 km of the outcrop belt in Erie County (Miller, 1991; Batt, 1996), indicating that these beds represent minor periods of sediment starvation rather than simple, local storm hash beds.

Particularly prominent at this locality are three to four pale gray-weathering, argillaceous limestones that constitute Grabau's (1898-1899) "Trilobite beds." (Miller et al., 1991; Figs. 8, 9) The lowest of the so-called "trilobite beds," Murder Creek bed, consists of about 30 cm of calcareous mudstone and argillaceous limestone, carrying a high abundance of the rugose coral *Stereolasma rectum*, but typified by the small brachiopods *Ambocoelia umbonata* and the nacreous, pink strophomenid *Pholidostrophia*. This calcareous bed is particularly noted for the occurrence of isolated, and clustered specimens of articulated *Eldredgeops rana*. A cluster of over 100 individuals collected on the foreshore immediately south of Eighteen Mile Creek nearby was illustrated by Speyer and Brett (1985), who interpreted the species segregated clusters as possible interest-specific mating clusters. Groups of apparent molt ensembles are also common within the Murder Creek bed. A 10 cm thick gray shale overlying the Murder Creek bed features abundant articulated specimens of the brachiopod *Athyris spiriferoides* . and is also regionally traceable. The second trilobite bed is an argillaceous, somewhat silty limestone containing abundant trace fossils and scattered remains of trilobites and the brachiopod *Ambocoelia.* The third and fourth "trilobite beds" show slightly more calcareous mudstone as opposed to intervening shales (Figs. 8, 9)

A 3m interval overlying the trilobite beds, is sparsely fossiliferous shales representing a relative highstand, or deepening interval within the Wanakah shale, which is regionally recognizable and passes laterally into black shales in the Finger Lakes area. A thin tabular argillaceous limestone, the Bethany Bed, observable approximately 3m above the upper trilobite bed, forms the base of a strongly concretionary middle Wanakah interval referred to the Eighteenmile Creek Submember (Cooper, 1930).

The Wanakah Shale illustrates the "layer cake" stratigraphy aspect of the western Hamilton Group extremely well (Fig. 9); beds even centimeters thick are of regional extent and do not simply represent local storm-winnowed coquinites. Miller (1991) recognized that the major limestones are traceable throughout western New York and Batt (1995,1996) has shown that individual shell beds and concretionary horizons are traceable, at least within Erie County. Conditions on the sea floor were relatively uniform over large areas, and extrinsic factors, such as minor climatic and/or sea-level oscillations that resulted in minor sediment starvation had a strong influence on deposition.

The upper 3-6 m of the Wanakah Shale are soft, richly fossiliferous clay shale that contains several distinct faunal assemblages and non-septarian carbonate concretions up to 50 cm in diameter. Some concretions contain black sparry calcite and pyrite, associated with fossil accumulations. These concretions and the surrounding shales yield abundant fossils of a moderate diversity assemblage dominated by the small brachiopod *Ambocoelia umbonata*, which frequently occurs in exceedingly dense localized clusters. Concretions

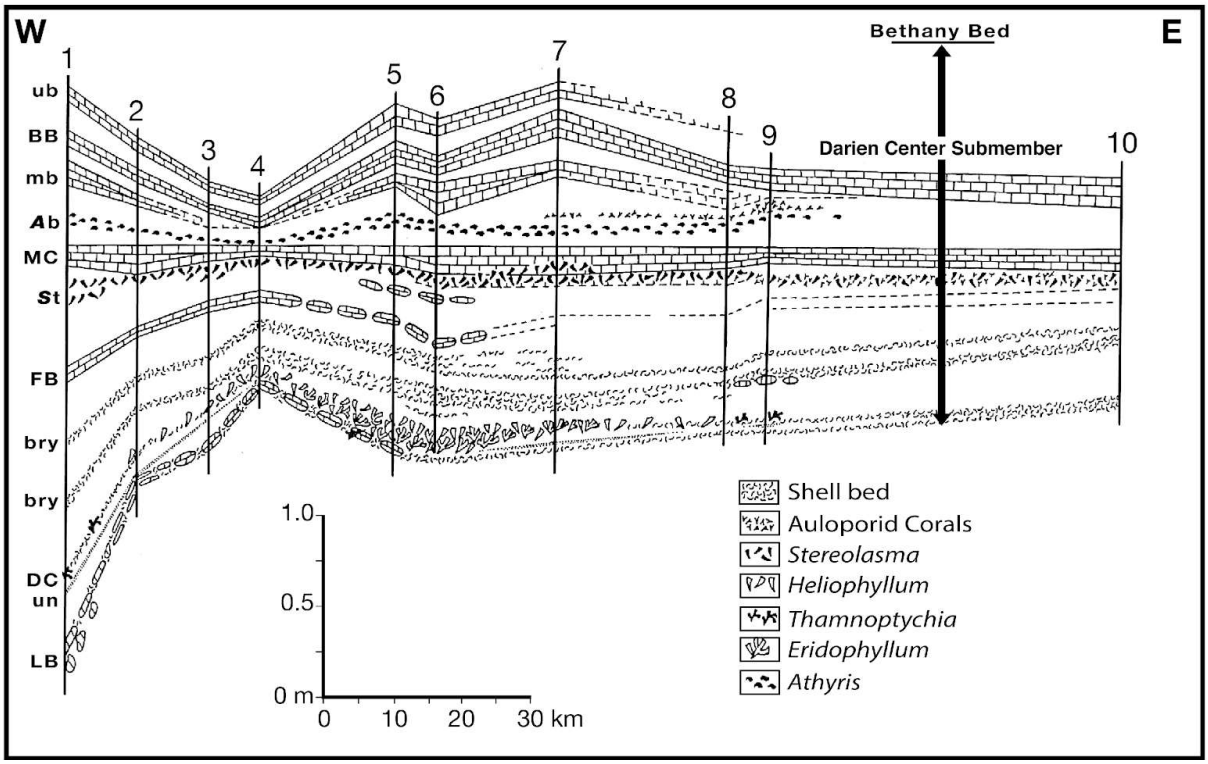


Figure 8. Correlated cross section of Darien Center Submember, Wanakah Shale in western New York. Beds indicated by initials are: LB = Lake View Bed; un = unnamed bed; DC = Darien Coral Bed; bry= rhomboporid bryozoan beds; FB = Fargo Bed; St = *Stereolasma* bed; MC = Murder Creek Bed; Ab = *Athyris spiriferoides*-rich bed; mb= middle trilobite bed; BB = Bidwells Bed; ub= upper trilobite bed. Localities are as follows: **1,** Lake Erie shore bluffs south of Wanakah, New York; **2,** Banks of Rush Creek between Mile Strip Road and South Park Avenue, Blasdell; **3,** Cazenovia Creek, downstream from Transit Road bridge; **4,** Buffalo Creek, between Bullis Road and Pond Brook Road; **5,** Elevenmile Creek, Darien Center, Genesee County; **6,** Murder Creek at Sharrick Road, Darien, Genesee County; **7,** abandoned railroad cut along former Delaware-Lackawanna and Western Railroad, East Bethany; **8,** Salt (Bidwells) Creek, Piffard, Livingston County; **9,** Wheeler Gully north of Nations Road, Geneseo, Livingston County; 10, Hopewell Ravine, unnamed stream near Freshour Road, Hopewell, Ontario County. Modified and used from Miller (1991).

yield well preserved, frequently enrolled specimens of the trilobites *Eldredgeops rana* and *Greenops boothi* as well as rare pyritized nautiloids (*Michelinoceras*) and the goniatite *Tornoceras* (*T.*) *uniangulare*. Immediately overlying shales are particularly rich in specimens of the spiriferid brachiopod *Athyris spiriferoides* and were consequently termed the *Athyris* Beds by Grabau (1899). The highest beds of the Wanakah Shale exposed just below the Tichenor Limestone contain a high diversity fossil assemblage termed the Demissa and Stictopora beds by Grabau (1898, 1899) and presently called the Blasdell Beds (Kloc, 1983). These units yield an assemblage reminiscent of the lower Darien Center beds, with over 80 species of macrofossils and are particularly rich in brachiopods (*Nucleospira*, *Cyrtina*, *Protodouvillina*, *Strophodonta demissa*, *Spinocyrtia* sp., *Pseudoatrypa* and chonetids) and bryozoans (fenestellids, *Sulcoretepora*). Auloporids, *Stereolasma* and, rarely, larger cystiphylloid corals occur in the upper beds, suggesting an approach to a coral bed locally. The Stictopora (*Sulcoretepora*) beds contain scattered thin lenses of crinoid-brachiopod rich limestone. Uppermost units of the Wanakah Shale observed in east central Erie Co., as well as the overlying Spafford and Jaycox Shale members have apparently been removed by pre-Tichenor erosion and are not represented at this locality.

Moscow Formation
Tichenor Limestone Member
As redefined by Baird (1979), the Tichenor Limestone contains the basal unit of the Middle Devonian (Givetian) Moscow Formation. Originally designated the "encrinal band" (Grabau, 1898), the Tichenor Limestone is a thin but widely traceable carbonate unit which has been of considerable importance in establishing regional stratigraphic relationships within the Hamilton Group (Cooper, 1930, 1933). At Eighteenmile Creek the Tichenor is a resistant 30-40 cm thick ledge-forming crinoidal grainstone/rudstone. The limestone is medium to pinkish gray and contains macroscopic pyrite and consequently exhibits a rusty brownish weathering coloration. The Tichenor contains numerous large rugose corals (*Heliophyllum*, *Eridophyllum*) and heads of the tabulate coral *Favosites hamiltoniae*, up to 50 cm in diameter and frequently overturned. Large crinoid columns modified as "runners," and the corroded grapnels of Ancyrocrinus with four prongs. Fenestellid and blade-like cryptostome bryozoans and diverse brachiopods, particularly *Tropidoleptus*, *Pustulatia*, *Centronella* and large, robust and commonly corroded *Spinocyrtia granulosa* are also common in the Tichenor Limestone. The large bivalves *Plethomytilus*, *Actinopteria*, and *Goniophora*, are locally abundant in the upper surface of the Tichenor.

The Tichenor provides an excellent example of a moderately condensed skeletal lag; many fossils within the limestone exhibit abrasion and/or faceting suggestive of long-term exposure and reworking by current or wave action. Both contacts of the Tichenor Limestone are disconformable. The base of the unit exhibits a sharp erosional contact with the underlying Wanakah Shale. Undersides of Tichenor ledges are typically irregular, coated with pyrite and contain abundant large prod marks and hypichnial trace fossils.

Description: The bridge over the Eighteenmile Creek provides an overlook upon banks of the creek to the east. These cliffs show the middle and upper portions of the Wanakah Shale, the overlying Tichenor limestone, which protrudes from the bank as approximately 30 cm-thick ledge, and overlying Windom gray shale. A second thin ledge, the Genundewa Limestone protrudes from the bank about 4 m above the Tichenor. Dark shales of the Genesee and Sonyea groups form the top of the cliff.

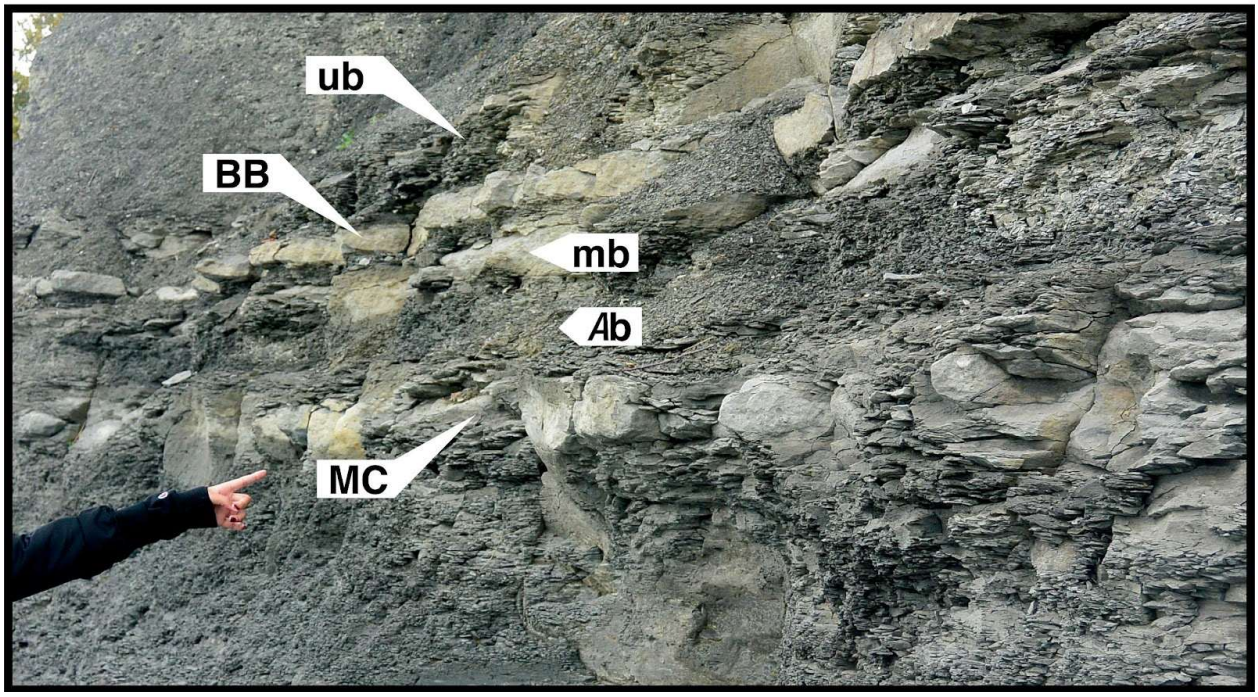


Figure 9. Section along Lake Erie shore just northeast of Eighteenmile Creek, showing trilobite beds of the Darien Center Submember, lower Wanakah Shale. Abbreviations: MC = Murder Creek Bed; *A*b = *Athyris* bed; mb = unnamed middle bed; BB = Bidwells Bed; ub = unnamed upper bed.

STOP C. PENN DIXIE FOSIL PARK AND OUTDOOR EDUCATION CENTER

Location: Large shale pit formerly operated by the Penn Dixie Cement Company and now preserved as a fossil park and education center, located northeast of the junction of Big Tree and Bay View Roads; accessible by a main entrance gate at 4050 North Road, Blasdell (Hamburg Township), Erie County, NY (Fig. 10). For detailed discussion of the history of the quarry, see Bastedo (1999) and Stokes (2017). This disused shale pit has served as an important reference section for the upper Hamilton Group for more than 40 years. Originally a quarry for clay for the Penn Dixie Cement company, this shale pit has been conserved as the site of the Penn Dixie Paleontological and Outdoor Education Center operated by the Hamburg Natural History Society for the past two decades. This is a highly active educational and fossil collecting site recently rated as the number one fossil park in the US (see http://www.penndixie.org).

The complete exposure of the Windom Member along the gently sloping quarry floor provides a reference section for this unit, which is here exposed to better advantage than those along Smoke Creek in the nearby village of Windom; it still affords the most accessible section for the entire Windom Member and adjacent units; fossil collecting is permitted here for a small fee. The Penn Dixie succession was originally described by Brett and Baird (1982), who provided a stratigraphic column, herein reproduced with minor revisions (Fig.11).

The contact of the Tichenor Limestone and lower Windom beds, a focus of this trip, are exposed in the northeast corner of this quarry (Fig. 10). As at Pike Creek the lower Windom

Ambocoelia beds are highly condensed and overlain by the richly fossiliferous Bay View bed that here yields thousands of specimens of *Cystiphylloides, Heliophyllum*, and other rugosans as well as *Spinatrypa*, *Pseudoatrypa*, *Mediospirifer*, *Rhipidomella Protodouvillina*, *Megastrophia* and others. Of note here are the excavations by amateur fossil collectors in the Smoke Creek Bed (Figs. 11,12). This bed yields very abundant *Amplexiphyllum*, and *Stereolasma* corals and the brachiopods *Ambocoelia umbonata*, "*Mucrospirifer*" *consobrinus* and several others, but it is most noted for its abundant and frequently articulated trilobites.

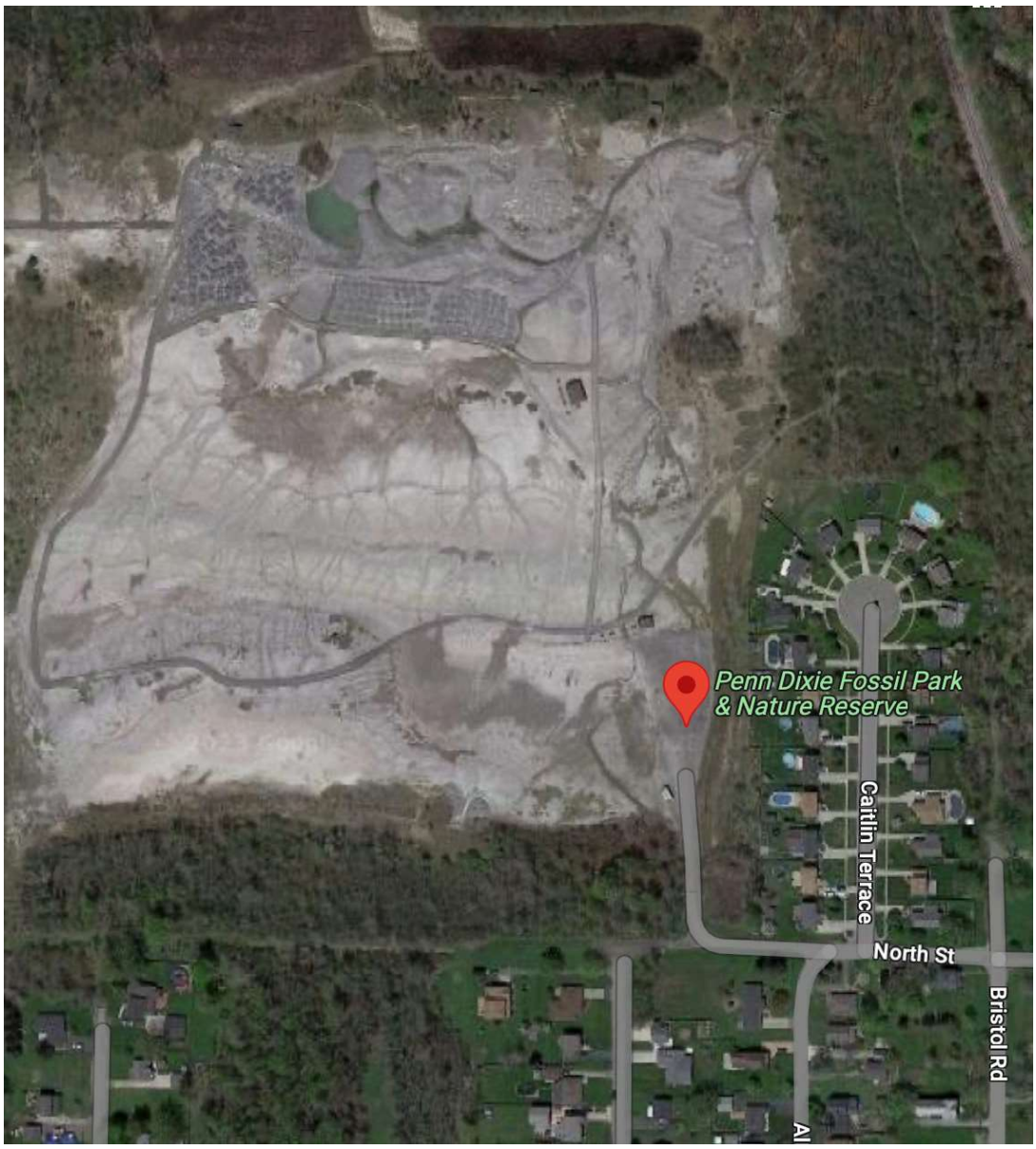


Figure 10. Aerial view of Penn Dixie Quarry. Note the nearly east-west strike of beds with younger layers toward the south. Tichenor limestone is exposed along small water-filled ditch near top of view. Rows of dots in upper view are shale piles which have been excavated and left to weather for collectors.

Since its discovery and description by Brett and Baird (1982, 1983) and Speyer and Brett (1986) this thin calcareous mudstone has yielded many hundreds of complete prone and enrolled specimens of the trilobites *Eldredgeops rana, Bellacartwrightia calliteles* and *Greenops barberi*; with rare *Pseudodechenella rowi.* A number of clusters of up to dozens of completely articulated trilobites are a noted feature of this outcrop (Speyer and Brett, 1985; Fig. 12).

The remainder of the Windom Shale, substantially thicker here than at Pike Creek is sparsely fossiliferous shale (Fig.11). However, there are several other interesting levels including the A, B and C, D, E beds, comprising thin concretionary limestones in the mid Windom Shale and the overlying "Penn Dixie" pyritic beds, which have yielded abundant pyritic and limonitic molds of nuculid bivalves, nautiloids and less common goniatites and enrolled *Greenops* trilobites (see Brett et al, 1991; Fig. 12). The Amsdell bed forms a low platform in the quarry floor and yields prolific specimens of the large ambocoeliid, *Emanuella praeumbona*.

The southern rim of the quarry shows the upper contact of the Windom with the North Evans Limestone (Fig. 11), which here has yielded abundant placoderm plates, cladodid shark teeth and ptyctodont crushing teeth. This unit also contains reworked clasts and *Emanuella* brachiopods, derived from the Windom Shale.

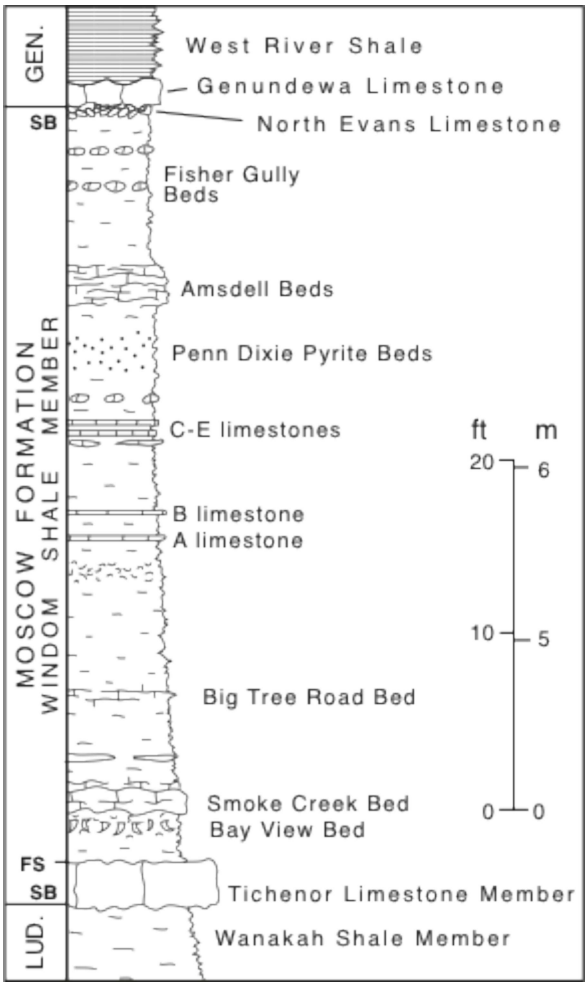


Figure 11. Generalized stratigraphic column for Penn Dixie shale pit, Blasdell, NY showing major beds of the Windom Shale. Modified from Brett and Baird (1982). Abbreviations related to sequence stratigraphic surfaces. FS: flooding surface; SB: sequence boundary. GEN = Genesee Group; LUD = Ludlowville Formation. Modified from Brett and Baird (1982).

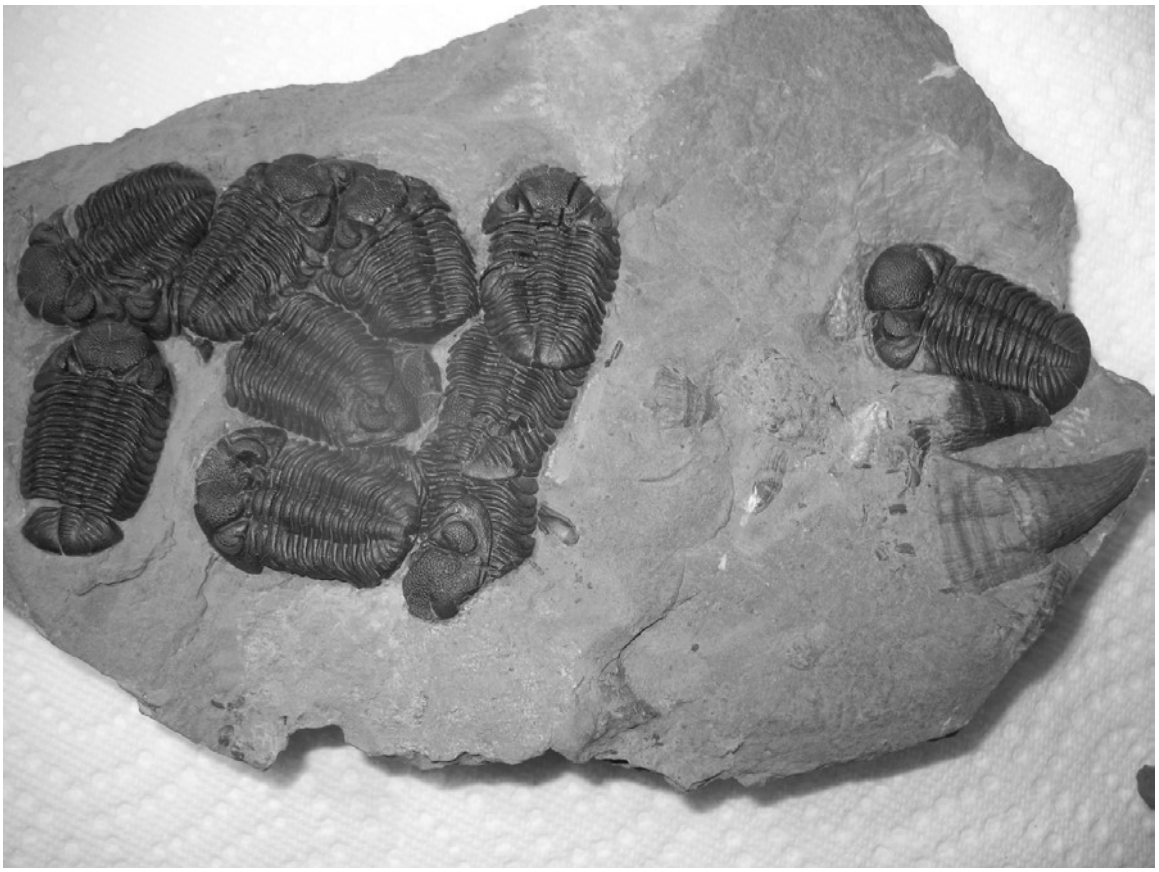
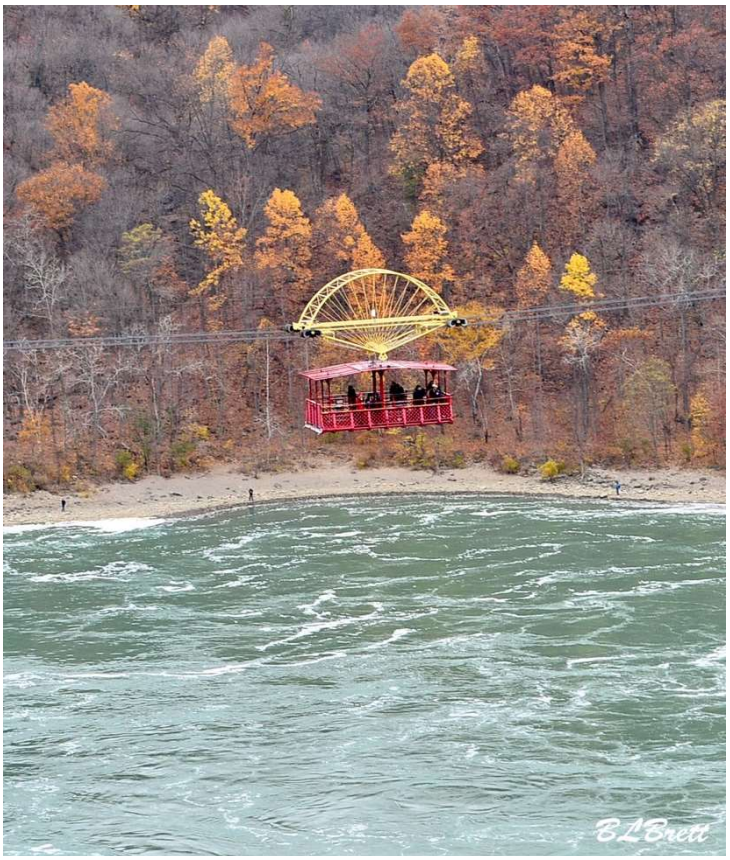


Figure 12. Cluster of articulated specimens of the trilobite *Eldredgeops rana* (Green) and the rugose coral *Stereolasma rectum* from Smoke Creek bed, lower Windom Shale at the Penn Dixie shale pit. Specimens are approximately 1.5 cm in length. Note slight disarticulation suggesting minor decay prior to burial. Photo courtesy of Matt Phillips.



Aero Car over the Whirlpool portion of the Niagara River, 2012