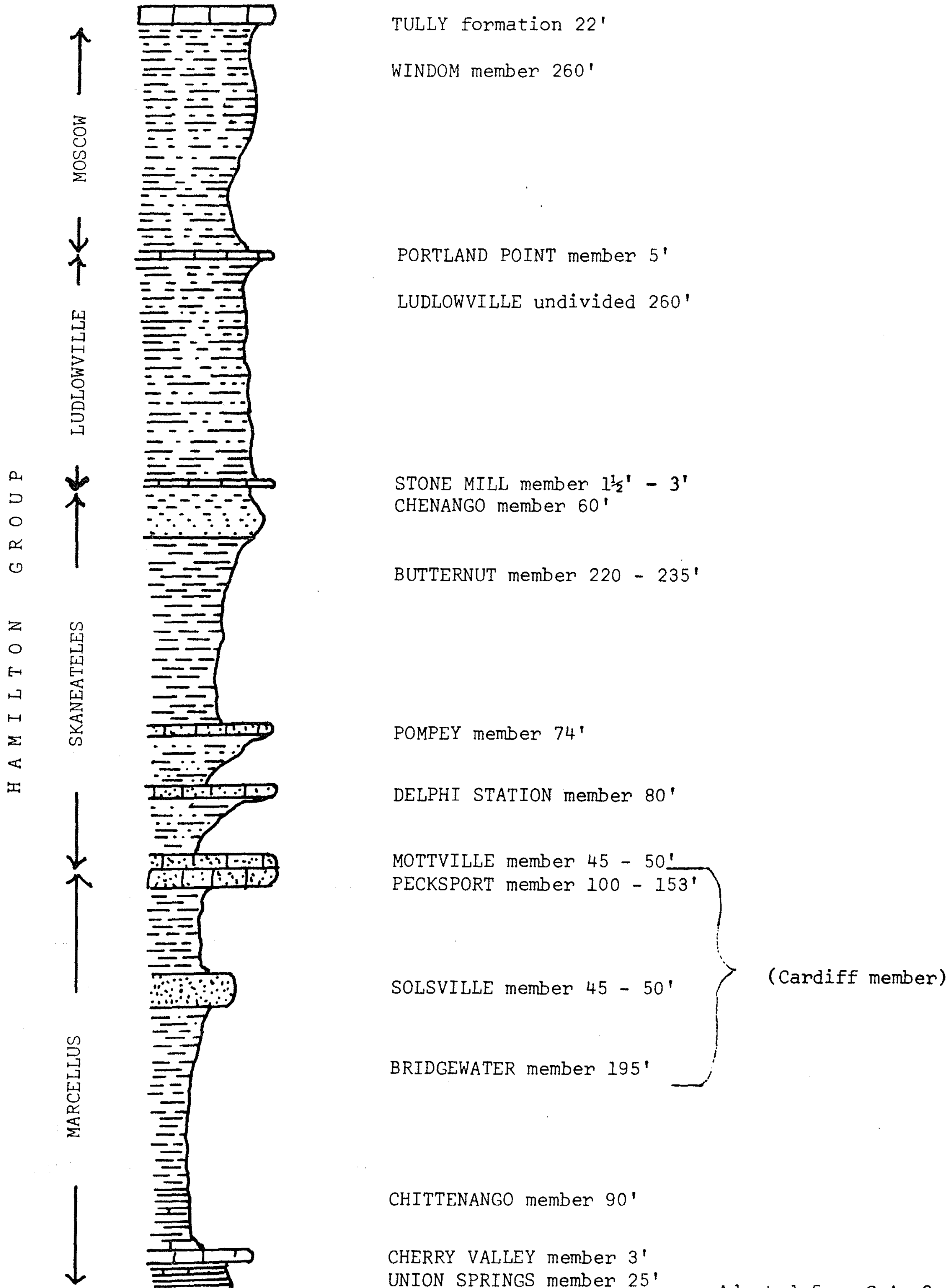
Paleontological Problems of the Hamilton Group
(Middle Devonian)

H.B. Rollins, N. Eldridge, R.M. Linsley

The stratigraphy of the Hamilton Group of the Middle Devonian of New York State was most recently treated in its entirety by Cooper (1930, 1957). The Hamilton Group of the Chenango Valley (see chart 1) consists primarily of fine clastic sediments and occupies a mid position in this wedge shaped body of rock. In the east the wedge is thickest (about 1,680' in Schoharie Valley (Gruban, 1903, p. 213) and it thins to 285' at Lake Erie in the west (Cooper, 1930, p. 121). In the Chenango Valley the Hamilton Group is 1, 465' thick (op. cit. p. 121) and has a dip to the southwest of 65-75 feet per mile (op. cit. p. 119). The Hamilton Group lies unconformably on the Onondaga Limestone and is overlain unconformably by the Tully Formation.

In a very crude sense the Hamilton Group of the Chenango Valley is composed of fine-grained black shales and limestones at the base (the Marcellus Formation) and more clastic units in the upper portion (Skaneateles, Ludlowville and Moscow Formations). However within each of these formations there exists considerable variation from true mud shales through siltstones and up to fine-grained sandstones. The nature of the substrate obviously had a great effect on the faunas associated with them. The black shales are typically associated with a Leiorhynchus fauna, gray shales and siltstones with a Tropidoleptus fauna and the fine-grained sandstones are dominated by bivalves.

A more detailed discussion of some of these problems will follow in sections relating to each of the three stops of this trip.



Adapted from G.A. Cooper

Notes on the Paleontology of the Solsville near Morrisville, New York*

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Location

Borrow pit on east side of Swamp Road, 2.6 miles north of Morrisville, New York. Morrisville, N.Y. 7 1/2' quad.

Stratigraphy

This small borrow pit exposes an extremely fossiliferous section within the Lower Cazenovian Solsville member of the Marcellus Formation. The only detailed stratigraphic study of Hamilton rocks in the Chenango Valley is that of Cooper (1930), who recognized six members of the Marcellus Formation. In ascending order, these are the Union Springs limestone and shale, the Cherry Valley limestone, the Chittenango black shale, the Bridgewater shale, the Solsville calcareous shale and sandstone, and the Pecksport shales and siltstones. Cooper also noted that the Bridgewater, Solsville and Pecksport undergo a facies change to the west of the Chenango Valley and are there collectively represented by the dark gray Cardiff shale. A detailed study of this facies complex has never been undertaken. This locality is situated beyond the western extremity of the Solsville as delimited by Cooper (1930). Some of the faunal elements are, however, distinctively Solsville, again according to Cooper. These include *Nephriticeras maximum*, *Paracyclas lirata*, *Gosselettia triquetra*, and *Cornellites flabellum*. It was primarily on the basis of this faunal assemblage that Rollins, Eldridge and Spiller (1971) considered this exposure to be in the Solsville facies.

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Fig. 1 presents a very generalized stratigraphic section of the Solsville at this locality. Note the indicated layers of fossil shell concentrations.

Paleontology

This locality has, in the last few years, contributed much to our knowledge of the paleontology of the Hamilton Group. Preservation of the fossils at this locality is perhaps unsurpassed anywhere in the Middle Devonian of New York State. For example, the molluscan shell microstructures are still preserved. Even ghost structures of originally aragonitic shell material can be discerned under thin section and polished-etched slab examination (Rollins, Eldredge and Spiller, 1971). If you carefully examine shell fragments of the large bivalve *Gosselettia triquetra*, you can see with the naked eye preservation of coarse prismatic shell layers. Naturally etched surfaces of *Cornellites flabellum* quite often also display coarse shell microstructure.

This exposure has also provided the earliest occurrence of preservation of the body of a tubiculous spionid polychaete worm (Cameron, 1967). The worm was interpreted as commensal with the bivalve *Cornellites flabellum* (Hall). Shell borings of this polychaete are also common in specimens of *Spinocyrtia granulosa*, *Gosselettia triquetra*, etc., especially in the upper terrace of the exposure. Apparently, only the epifaunal organisms were colonized by this polychaete. The worm tubes are not found on the infaunal bivalves, such as the nuculids. A coaction, perhaps commensal, is indicated, rather than post-mortem colonization of the host shells by the worms.

Critical stages in the evolution and dispersion of the trilobites *Phacops iowensis* and *Phacops rana* were preserved in this small exposure, as discussed by Eldredge (1972, and elsewhere in this guidebook).

Also found at this locality is one of the best preserved and most diverse molluscan faunas in the Hamilton rocks of Central New York State. To date, only the gastropods and monoplacophorans have been studied in detail (Rollins, Eldredge and Spiller, 1971). The pleurotomariacean *Bembexia sulcomarginata*

(Conrad) is very abundant, and can be found throughout the entire exposed section. Spiller (unpublished ms, 1971), following factor analysis of populations of *B. sulcomarginata*, has determined that this species exhibits sexual dimorphism.

Excellent specimens of *Ruedemannia trilix* (Hall), another pleurotomariacean, can be obtained from the upper terrace of this exposure. *Ruedemannia* is considered ancestral to the very common and well-known Worthenia of the Upper Paleozoic.

The lower dark calcareous shales at this locality have provided most of the available specimens of the unusual bellerophontacean gastropod *Praematuratropis ovatus* (Rollins, Eldredge and Spiller). This little snail is interesting for at least two reasons. First, it retains throughout ontogeny a very pronounded midian keel that would have drastically restricted the available space within the shell and presumably would have made impossible total retraction of the cephalopedal mass. This, in conjunction with an extensive inductura, suggests that this gastropod had an internal shell. Secondly, *Praematuratropis ovatus* is one of the few Hamilton forms "missed" by the great James Hall in his monographic treatment of the Paleontology of New York.

Near the top of the exposure can be found slabs of a highly weathered calcareous siltstone which contains beautifully preserved molds, largely molluscs. The greatest diversity of gastropod species was recognized from this thin interval. Diligent collecting should provide you with a rare specimen of the monoplacophoran *Cyrtonella mitella* (Hall), complete with internal mold, preserving the muscle scars. A complete tabulation of the gastropods found to date at this exposure is included in the accompanying faunal list.

It should not be assumed that the paleontological potential of this little borrow pit in the Solsville has been exhausted. The beautifully preserved bivalve fauna has not yet been carefully studied, for example. Also of interest is the occurrence of epizooites. If you look closely at some of the brachiopods and molluscs you collect, you will see epizoic bryozoa, corals, and inarticulate brachiopods, besides the aforementioned worm borings. Gastropod-bryozoan symbiosis is present from the Paleozoic to the Recent, and is very obvious at this locality.

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Locality: Solsville mb., Marcellus Formation borrow pit on east side of Swamp Rd., 2.6 miles north of Morrisville, N.Y. Morrisville, N.Y. 7 1/2' quadrangle

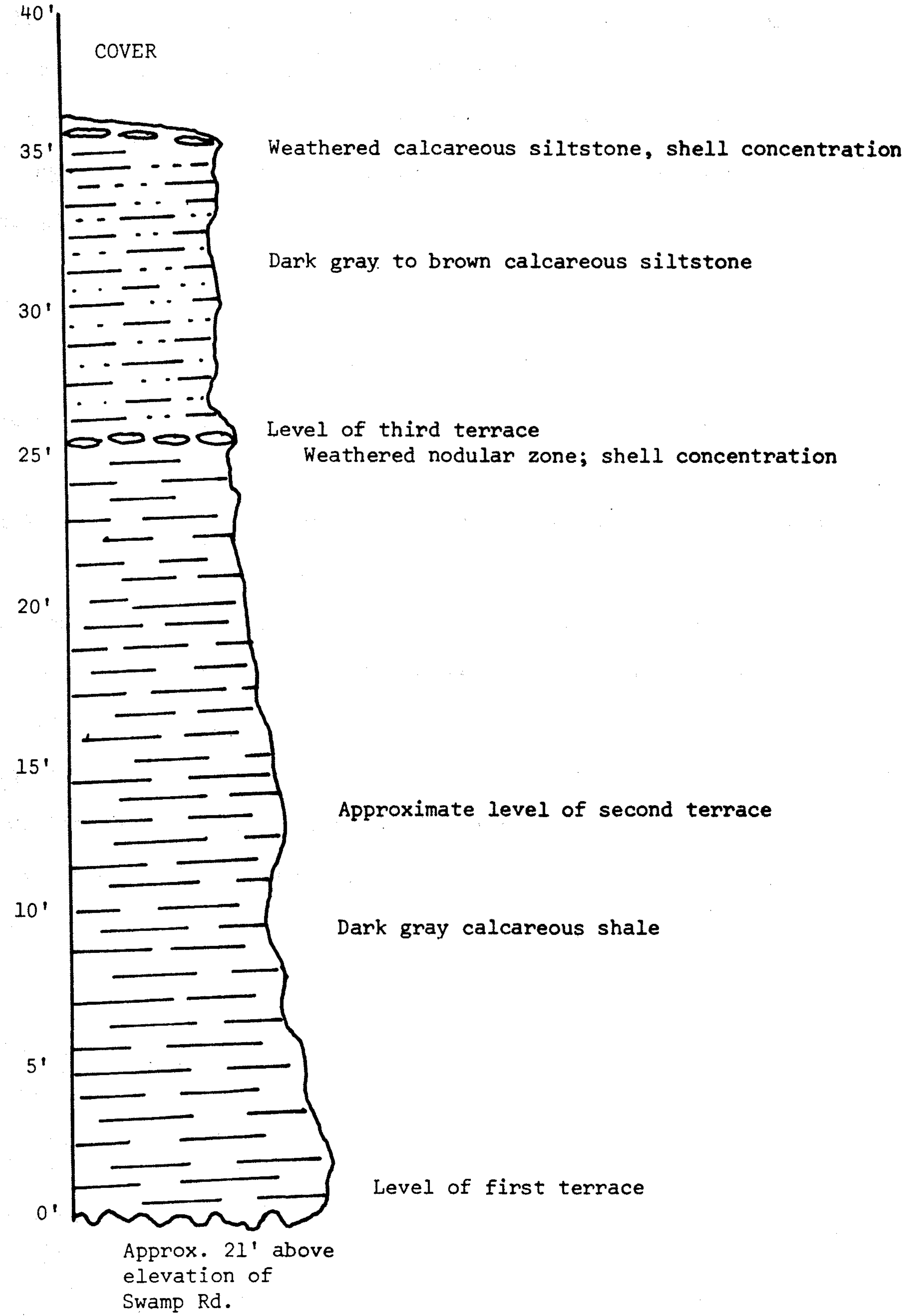


Figure 1

Partial Faunal List

Peterborough South Quarry

Solsville Member, Marcellus Formation

Hamilton Group

Coelenterata

- *Conularia undulata*

Bryozoa

- *Paleschara incrustans*
- *Hederella filiformis*
- *Monotrypella abruptus*
- *Reptaria stolonifera*
- *Taeniopora exigua*
- *Aulopora* sp.

Brachiopoda

- *Orbiculoidea media*
- *Lingula delia*
- *Cupularostrum congregata*
- *Mucrospirifer mucronatus*
- *Spinocyrtia granulosa*
- *Ambocoelia umbonata*
- *Chonetes scitulus*
- *Spinulicosta spinulicosta*
- *Rhipidomella penelope*
- *Mediospirifer audaculus*
- *Protoleptostrophia perplana*
- *Tropidoleptus carinatus*

Mollusca Bivalvia

- *Grammysioidea alveata*
- *Grammysia arcuata*
- *G. bisulcata*
- *G. circularis*
- *G. obsoleta*
- *Nucula lirata*
- *Nuculites oblongatus*
- *Nuculites oblongatus*
- *N. cuneaformis*
- *Cornellites flabellus*
- *Gosselettia triquetra*
- *Modiomorpha mytiloides*
- *M. concentrica*
- *M. subulator*
- *Paracyclas lirata*
- *Goniophora hamiltonensis*
- *Leptodesma spinigerum*

Cephalopoda

Tornoceras discoideum

Michelinoceras constrictum

Bactrites aciculum

Spyroceras crotalum

Gastropoda

Bembexia sulcomarginata

Glyptotomaria (Dictyotomaria) capillaria

Gyronema lirata

?_Holopea hebe_

Mourlonia subzona

Murchisonia micula

Naticopsis sp.

Palaeozygopleura hamiltoniae

Patellilabia (Phragmosphaera) lyra

Platyceras (Platyceras) erectum

Platyceras (Platyostoma) sp.

Praematuratropis ovatus

Ptomatis rudis

Retispira leda

Ruedemannia trilix

Sinuitina brevilineatus

Trepospira (?Angyomphalus) peneglabra

Tritonephon rotalinea

Monoplacophora

Cyrtonella mitella

Arthropoda

Phacops rana

Greenops boothi

Echinocaris sp.

Echinodermata

Ancyrocrinus spinosus

Stop 2 "Pierceville" Quarry (Bradley Brook Quarry)
Paleoecology of the Ludlowville Formation, Hamilton Group

By R. M. Linsley

This quarry exhibits three distinctive facies of the Ludlowville Formation. The lowest unit (the Chonetes facies) is exposed in the front ledge of the quarry nearest Soule Road and consists of about fifteen feet of dark gray shale with small amounts of silt. Faunally this unit is dominated by brachiopods, and the total faunal content will be discussed more fully later. Lying on top of this unit is a thin (six inch) calcareous shale unit (the Spinocyrtia facies). This unit is exposed in a very low ledge about twenty feet back from the front face of the quarry. It consists of densely packed brachiopods (Spinocyrtia, Athyris and Mucrospirifer). Calcite from the shells of these animals has permeated the surrounding sediment and transformed what was probably a fairly soft shale into a durable, hardened calcareous shale. The uppermost unit (the bivalve facies) is exposed in the upper quarry floor and the back wall of the quarry. This unit is a fine grained siltstone and the fauna is dominated by a wide variety of epifaunal and infaunal bivalves.

THE CHONETES FACIES

In 1968 the Paleoecology class of Colgate University, (Austin Belschner, Regis Dandar, Hermann Karl, James Lydic and Robert Marengo) under the direction of R. M. Linsley and J. P. Swinchatt studied the lowest unit (the Chonetes facies) of this quarry. Bulk samples were broken down and a faunal tabulation was made. (See accompanying Table). Obviously the brachiopod Chonetes dominates this fauna to a very remarkable degree. (An interesting note on this is that the total assemblage was tabulated in three separate lots of about 1,000 individuals in each lot. The percentage of Chonetes in each of these lots was 76.98%, 76.23% and 76.48%. I have no explanation for the fantastic consistancy in these counts.) The Chonetes are concentrated in layers throughout this lower unit and locally can form thin coquinas. In between these thin Chonetes

TABLE 1

Table of Faunal Analysis of the *Chonetes* Facies of the Pierceville Quarry

Genus	Number of Individuals	% of Total Sample
Chonetes	2491	76.55
Nucula	156	4.79
Ambocoelia	135	4.15
Mucrospirifer	90	2.77
Nuculites	43	1.32
Grammysia	24	0.74
Ruedemannia	24	0.74
Devonochonetes	22	0.68
Orbiculoidea	18	0.55
Actinodesma	15	0.46
Greenops	15	0.46
Phacops	12	0.37
Palaeoneilo	12	0.37
Protoleptostrophia	12	0.37
Hyolithes	11	0.34
Rhipidomella	11	0.34
Tornoceras	9	0.28
Palaeozygopleura	9	0.28
Bellerophontid	8	0.25
Taeniopora	7	0.22
Wood fragments	7	0.22
Goniophora	6	0.18
Lingula	6	0.18
Spyroceras	6	0.18
Dipleura	5	0.15
all others	101	3.10
Total	3255	

coquinas the fauna consists primarily of the brachiopods Mucrospirifer, Ambocoelia, Chonetes and Devonochonetes, the infaunal, palp-feeding, bivalves Nucula and Nuculites, the filter feeding bivalves Grammysia and Actinodesma and the grazing gastropods Ruedemannia and Palaeozygopleura.

However, the most notable feature of this lower unit is the variable distribution of the brachiopod Chonetes. Four bedding surfaces will be discussed to illustrate the kinds of distribution that have been noted. For ease of discussion these will be called 1. "cluster", 2. "strip", 3. "storm" and 4. "normal."

In order to interpret the significance of these blocks we must make some assumptions regarding the life positions of some of these animals and the hydrodynamics of their dead shells in the presence of waves or currents. I assume that the living position of Chonetes is concave side up (brachial valve up) so that the plane of commissure is held up away from the fine sediment of the substrate. Hydrodynamically this is not a stable position for the shell. Any current tends to move the shell and frequently flips it over. From this fact alone I suggest that the depth of water for the deposition of these beds was below normal wave base, i.e. with depths in excess of eight fathoms.

In flume experiments conducted on Chonetes the shells tended to flip over so that the concave (brachial) valve was down and to orient themselves with the hinge line perpendicular to the current. Because of the near-symmetrical cross-section of the shell from anterior to posterior, there is not much distinction in the direction that the shell faces relative to the current. Most frequently the beak points into the current, but it is only a slightly statistical advantage over the 180° rotated position. In experiments with wave action the chonetids tended to align themselves with the hinge line at a 45° to 90° angle to the wave front, although there was a great deal of variation in these results.

Similar experiments with Mucrospirifer gave much more consistent results than did those with Chonetes. I assume that Mucrospirifer was attached by the pedicle to the substrate with the plane of commissure perpendicular to the sea floor. Therefore it makes little sense to talk about pedicle or brachial valve up as the normal living position. In current experiments there was a decided tendency for these shells to come to rest with the sulcus down and the interarea parallel to the current direction. In wave experiments these shells act as rollers and align with the interarea perpendicular to the wave front, but no particular directional orientation.

As a result of these experiments it is theoretically possible to distinguish between current and wave oriented shell deposits. In current orientation the interareas of Mucrospirifer and Chonetes should tend to be at right angles to each other, while wave orientation should cause them to have parallel alignments.

THE CLUSTER BLOCK

The cluster block is relatively typical of the bedding planes in between the storm layers. Figure 1 shows a portion of this block with one of the clusters in the upper left corner. On the original block there were three such clusters. Within the clusters the ratio of upright to overturned shells is seven to forty-seven, whereas in the central (non-clustered) portion of the block the ratio is eleven to twenty one. From this I conclude that these clusters are not normal living "nests" of brachiopods, but are accumulations of dead shells. A size frequency distribution graph for the entire block shows a bell shaped distribution curve which supports this conclusion. A rose diagram showing orientation shows some preferential orientation in a N-W, S-E direction. In summation, the cluster block shows the effects of current orientation, but because of the lack of sufficient numbers of Mucrospirifer it is impossible to differentiate between waves and unidirectional currents. The fact that the

CLUSTER
fig. 1

clusters exhibit more evidence of current action than the central area suggests that possibly there were other factors influencing this distribution. The results would be similar if the central area had a plant cover which diminished the current action in these areas. The clusters then could be attributed to current swept barren areas within the plant cover.

THE STRIP

The block containing the strip is a rather unusual block in that it contains a two inch wide strip of shells down the center of the block. These strips can be seen at various levels throughout the lower Chonetes facies of this quarry. Some of them have been seen to reach lengths of six or seven feet, although most of them have lengths of one or two feet. Unfortunately it is very difficult to trace these because of the difficulty of stripping these rocks along a given bedding plane.

The shells of Chonetes found within the strip were predominately overturned (93 overturned to 23 upright) whereas in the areas adjacent to the strip the number of upright and overturned was equal (12 overturned to 12 upright). Once again this suggests current as an active agent within the strip, tipping the shells over, but somehow not affecting those areas surrounding the strip. Rose diagrams of shell orientation show very strong alignment trending NE - SW with less well demarked alignment of the shells outside of the strip. Likewise the shells within the strip are predominately larger individuals suggesting that the current which aligned the shells also winnowed out the smaller individuals.

As in the cluster block, vegetational cover would explain the relatively undisturbed appearance of the larger portion of the block, while the strip would be consistently interpreted as a barren patch between current dampened (vegetationally covered?) areas.


STRIP

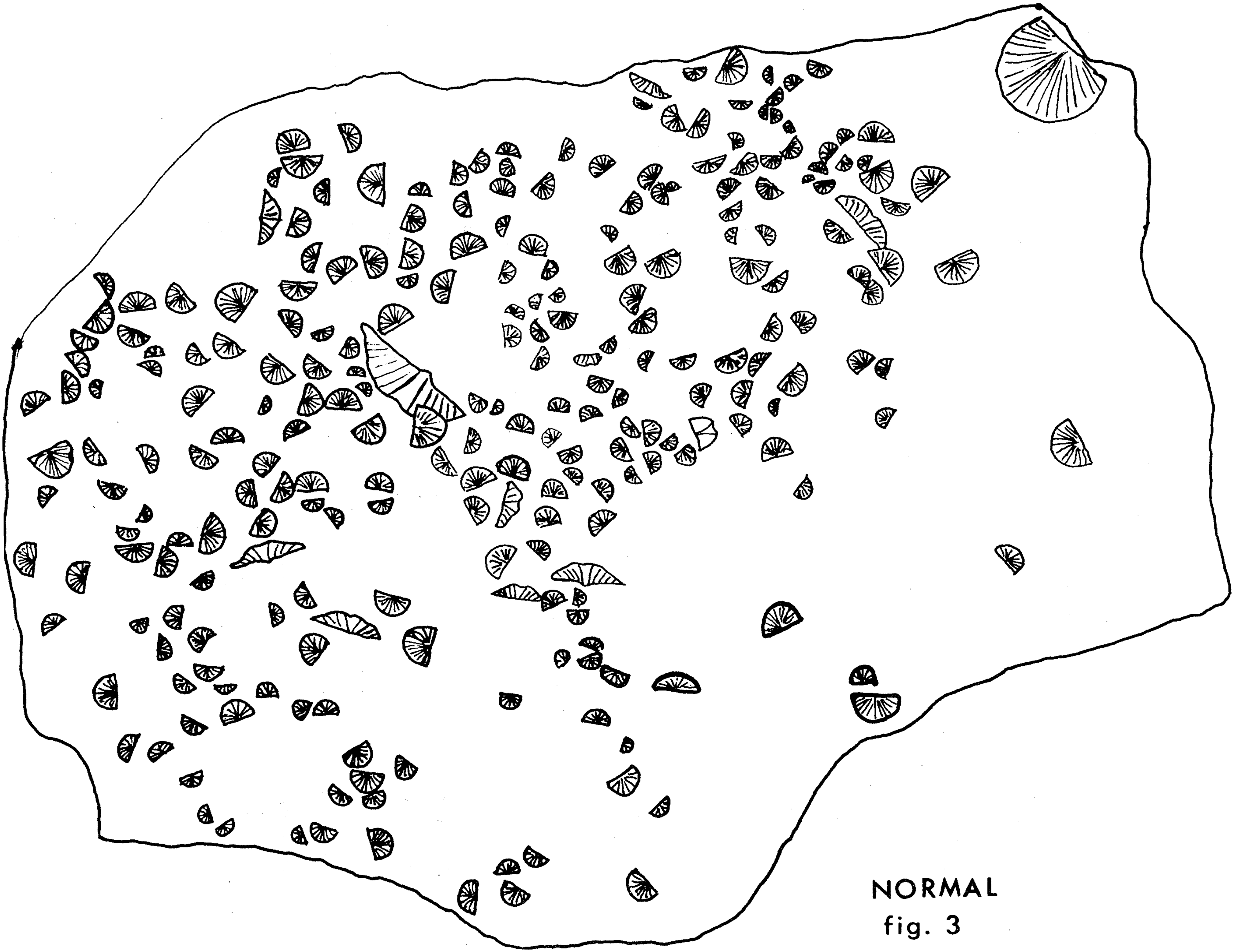
THE STORM BLOCK

Both the Storm Block and normal block have similar outward appearances and although figure 3 is actually a diagram of the normal block it greatly resembles the storm block as well. Throughout the _Chonetes_ facies these units consisting of thin pavements of _Chonetes_ can be found every one or two inches. Many of these layers can be traced along the entire quarry face, a matter of one or two hundred feet.

The ratio of overturned to upright shells in the storm layer is 66 to 16. This strong preponderance of overturned shells suggests that the area was strongly current swept. In this block were found enough specimens of _Mucrospirifer_ so that orientation rose diagrams could be constructed for both _Mucrospirifer_ and _Chonetes_. Both diagrams show strong preferential orientation with the axis of _Mucrospirifer_ at right angles to that of _Chonetes_. According to our flume experiments this would indicate orientation by currents rather than by wave action. This is further substantiated by the size frequency diagram which indicates that most of the small specimens have been winnowed out and primarily large specimens are left.

THE NORMAL BLOCK

The final block that was studied was collected with the presumption that it was another example of a storm layer. However subsequent analysis of the block showed it to be quite different indeed. To begin with on this block the number of upright specimens greatly outnumbered those that were overturned (170 to 66) which certainly suggests that this particular bedding surface was relatively unaffected by any major currents. The orientation rose diagram for this block showed more or less random orientation of both _Chonetes_ and _Mucrospirifer_. Finally the size distribution plot is definitely bimodal and the block has far more small individuals than any of the others.



NORMAL
fig. 3

It thus seems obvious that this block had a considerably different history from the others. The bimodal size distribution of Chonetes strongly suggests that this is an example of an instantaneous census of a catastrophic mass mortality. Most of the sample consists of small individuals (3mm to 6mm along the hinge line). Small individuals of this size range are quite rare on all of the other blocks. There is also a fairly large population ranging from 7-10 mm with a gap between these two populations. It seems obvious that <u>Chonetes</u> was a seasonal breeder (perhaps annually) and that the population consists of adults plus young that were growing up. This entire population was then killed more or less instantly preserving these ratios. Yet this mass mortality was accomplished without disturbing the living position of our sample, probably by a period of rapid sedimentation. This thesis suggests that this bedding plane was exposed for a considerable period of time (perhaps more than one year) and yet was covered with relative suddenness, perhaps by the influx of sediments caused by a major storm.

Thus the environment of deposition for the <u>Chonetes</u> facies of this quarry is interpreted to be a quiet current swept sea bottom with periodic periods of rapid sedimentation. The presence of <u>Lingula</u> would suggest water no deeper than thirty feet, but the apparent lack of wave orientation of shells suggests that the sea floor was below average wave base, i.e. deeper than fifty feet. Yet within this layer we have indirect evidence that these sediments were deposited within the photic zone. This is suggested by the areas on blocks where the current was dampened (by beds of algae?) and also by the abundance of <u>Phacops</u> and <u>Greenops</u>. It seems improbable that trilobites with eyes as well developed as those two genera would live below the photic zone. I thus conclude that the water depths for these beds were between fifty and one hundred feet.

THE SPINOCYRTIA FACIES

The Spinocyrtia facies is a thin calcareous shale overlying the Chonetes facies. It is characterized by closely packed clusters of brachiopods, particularly Spinocyrtia granulosa, Athyris spiriferoides and Mucrospirifer mucronatus. The development of this layer is attributed to a long period of very slow deposition which has allowed the development of crowding by successive spat falls. This layer seems distinctly different from the brachiopod nests that have been developed in western New York (Beerbower, 1971), in that they seem to cover very broad areas. However this bed has not been treated in any detail and I hesitate to make any elaborate conjectures in the absence of any detailed studies. The hardened calcified nature of this layer I believe to be attributable to the migration of calcite from the brachiopod shells into the surrounding sediment as a post depositional event.

THE BIVALVE FACIES

The sediment of the upper facies is a good siltstone perhaps even grading into a fine sandstone. Presumably this represents a shallower water regime, although no sedimentological studies have been carried out on this unit as yet. Faunally this unit is dominated by bivalves with Grammysia, Modiomorpha, Palaeoneilo and various pectinoids as the most noticeable elements. In general the individual members of this fauna are markedly larger than those of the Chonetes facies. Chonetes is replaced in abundance by Spinocyrtia, Greenops by Dipleura, Nucula by Grammysia etc. Another aspect of this unit is the abundant burrows of Taonurus attesting to the thorough reworking of this sediment after deposition.

I would expect this unit to have been deposited in water above wave-base (less than fifty feet) so that the substrate was frequently current swept creating a shifting substrate. This would account for the replacement of the small sessile brachiopods by the more mobile molluscs. Further elaboration of the paleoenvironments will have to await an analysis of the sedimentological and paleontological features of this unit.

Partial Faunal List

Pierceville Quarry

Ludlowville Formation, Hamilton Group

Coelenterata

- *Aulopora elleri*
- *Favosites* sp.

Bryozoa

- *Sulcoretepora incisurata*

Brachiopoda

- *Petrocrania hamiltoniae*
- *Lingula punctata*
- *Lindstroemella aspidum*
- *Oehlertella pleurites*
- *Mucrospirifer mucronatus*
- *Spinocyrtia granulosa*
- *Mediospirifer audaculus*
- *Ambocoelia umbonata*
- *Athyris spiriferoides*
- *Tropidoleptus carinatus*
- *Rhipidomella penelope*
- *Protoleptostrophia perplana*
- *Devonochonetes coronatus*
- *Longispina mucronatus*
- *Devonchonetes syrtalis*
- *Chonetes vicinus*
- *Spinulicosta spinulicosta*
- *Cyrtina hamiltonensis*
- *Elytha fimbriata*

Mollusca - Bivalvia

- *Solemya vetusta*
- *Orthonota undulata*
- *Grammysia bisulcata*
- *G. arcuata*
- *G. cuneata*
- *G. globosa*

Bivalvia (cont)

- Nucula corbuliformis
- N. opima
- N. lirata
- Nuculites oblongata
- N. triqueter
- Palaeoneilo constricta
- P. emarinata
- P. fecunda
- P. muta
- P. plana
- Parallelodon hamiltoniae
- Actinoptera decussata
- A. boydi
- Cornellites flabellus
- Leiopteria sayi
- L. rafinesquii
- Aviculopecten fasciculatus
- Lyriopecten macrodontus
- Pterinopecten undosus
- Modiomorpha cencentrica
- M. mytiloides
- Pholadella radiata
- Cypricardella tenuistriata
- Cimitaria recurva
- Goniphora hamiltonensis

Gastropoda

- Ptomatis rudis
- Naticonema lineata
- Palaeozygopleura hamiltoniae
- Ruedemannia trilix
- Platyceras sp.
- Dictyotomaria capillaria

Cephalopoda

- Tornoceras discoidea
- "Orthoceras" sp.
- Spyroceras crotalum

Hyolithida

Hyolithes neapolis

Tentaculitida

Styliolina sp.

Arthropoda

Greenops boothi

Phacops rana

Dipleura dekayi

Echinocaris punctata

Rhinocaris columbina

Annelida

Taonurus

Plants

Protolepidodendron sp.

Notes on the Trilobites of the Hamilton Group of the Chenango Valley Region

Niles Eldredge

The American Museum of Natural History

There are but three trilobite species commonly occurring in the Hamilton Group in the Chenango Valley region: *Phacops rana* (Green, 1832), *Greenops boothi* (Green, 1837), and *Dipleura dekayi* (Green, 1832). As indicated, these three speices were among the first trilobites to be described in North America, and with the possible exception of *Elrathia kingii* (Meek) from the Middle Cambrian Wheeler shale of Utah, one of these -- *Phacops rana* -- has come to be perhaps the most familiar of all trilobites of this continent.

All presumably valid trilobite species of the Hamilton Group of New York are listed in Table 1. A comparable list for the midwest is given by Stumm (1953). Hall and Clarke (1888) remains the most complete and indispensable source of information on the morphology of these trilobites. Of the remaining species not mentioned above, only the proetid *Dechenella rowi* (Green, 1838) is likely to be encountered in the Chenango Valley area, especially in the Stone Mill limestone exposed in the quarry along Roberts Road in West Eaton. This and other remaining taxa will be discussed only insofar as they bear on the biogeography and provenance of the Hamilton fauna.

BIOSTRATIGRAPHY: *Dipleura dekayi*, *Phacops rana*, and *Greenops boothi* occur nearly throughout the Hamilton Group; *P. rana* and *G. boothi* also occur in the younger Taghanic Tully limestone. Though not yet documented in the Taghanic of New York, *D. dekayi* has been reported from the Taghanic Thunder Bay limestone of northeastern Michigan (Stumm, 1953).

The oldest rocks bearing Hamilton trilobites in the Chenango Valley region are exposed in the Peterborough South quarry and have been assigned to the Solsville Member of the Marcellus Formation (Rollins, Eldredge, and Spiller, 1971). *Phacops rana crassituberculata* and *Greenops boothi* constitute rare elements of the fauna of the dark shales at the base of the quarry. *Phacops* becomes more common in the calcareous siltstone nodule fauna higher in the quarry.

The distribution of the three major species in the Skaneateles Formation seems to be facies controlled. The Mottville, Delphi Station, and Pompey Members rarely produce *Phacops rana*. Occasional specimens of *P. rana rana* are found, but this species does not become abundant until the Butternut Member. In contrast, *Dipleura dekayi* and *Greenops boothi* are locally abundant in the various members of the Skaneateles Formation; *D. dekayi* is particularly common in the sandy upper beds of both the Delphi Station and Pompey Members. A quarry in the Colgate sandstone on the campus of Colgate University has produced a large number of small *D. dekayi* reported by Cooper (1935). *Greenops boothi* is found in both the lower shales and upper sandy beds of these members.

All three species occur in fair numbers in the Ludlowville and Moscow Formations of this region, associated with a well developed *Tropidoleptus* fauna. *P. rana rana* and *Greenops boothi* are common in the Stone Mill limestone and overlying Panther Mountain Member of the Ludlowville Formation. Particularly fine, frequently complete specimens of *G. boothi* are abundant in some exposures of the Panther Mountain Member. *Dipleura dekayi* is less common, and when found in sediments of the Upper Hamilton Group, is usually associated with *Greenops* and *Phacops* in the Moscow Formation.

In sum, *P. rana* only occurs with the *Tropidoleptus* fauna in the Chenango Valley region; it becomes even more abundant in the calcareous shales and limestones in western New York and the cratonal interior. *Greenops boothi* and *Dipleura dekayi* occur both in the normal *Tropidoleptus* fauna and in coarser clastics associated with epifaunal bivalves, large bellerophontacean gastropods, and the rhynchonellid *Camarotoechia*. *Greenops boothi*, like *P. rana*, also occurs in the western facies, but becomes far less common than *P. rana* except in certain units (e.g. Deep Run Member of the Ludlowville Formation near Avon, New York; Centerfield Member of the Ludlowville Formation at Blossom, N.Y.; Widder Formation near Ardona, Ontario). Dipleura dekayi becomes rare in Hamilton rocks west of the vicinity of Pompey, New York.

BIOGEOGRAPHY: There seems to be at least two separate sources for the Hamilton trilobite fauna. A distorted view of the problem arises if only the three common species are considered, since it is highly unlikely that any of them were derived from older North American species. There are species of Otarion, Cordania (Mystrocephala), and Dechenella in Gedinnian, Siegenian, Emsian, and Eifelian rocks which may (or may not) be closely related to those from the Hamilton Group. I have not studied these trilobites in detail, however, and there is as yet little evidence on which to determine the provenance of the Hamilton species of these genera. It seems likely, however, that at least some of these species are in fact closely related to older species, particularly those of the Onondaga limestone.

This is emphatically not the case for P. rana, G. boothi, and D. dekayi. Of these three -- the most common elements of the Hamilton trilobite fauna -- the first two are definitely, and the third probably, derived from Old World Province Eifelian species. Phacops rana, as suggested by Hall and Clarke (1888, p. 24) is the sister species of Phacops schlotheimi (Bronn) of the Eifelian of Germany, and is unrelated in any meaningful way to the "native North American" Phacops lineage which includes, among others, P. logani, P. cristata, and P. iowensis (Eldredge, 1972). In addition, P. rana occurs in the Eifelian of the Spanish Sahara (Burton and Eldredge, in press). Greenops boothi is the sole described North American representative of the Asteropyginae, a subfamily of dalmanitids of the Lower, Middle, and Upper Devonian of Europe and Africa. It is therefore clearly a migrant to the Appalachian faunal province. Early reports of Greenops in Eifelian North American rocks are in error (Stumm, 1954); however, P. J. Lespérance (pers. comm.) has recently collected an asteropyginid in the Lower Devonian of the Gaspé Peninsula.

There are few Emsian (Esopus, *not* Schoharie) and no Eifelian homalonotids in North America. The Lower Devonian *Trimerus vanuxemi* (Hall) is clearly related to the Silurian *Trimerus delphinocephalus* (Green), but seems quite different from *Depleura dekayi*. Valid species of *Dipleura* do occur, however, in the Eifelian of Europe and South America, and it seems likely, although by no means proven, that *D. dekayi* was also derived from a stock living outside the Appalachian faunal province. Thus the most conspicuous trilobites -- both in terms of size and numbers -- seem to be migrants which, to some extent at least, were able to supplant native North American taxa which might have occupied comparable niches in the Middle Devonian.

VARIATION AND PHYLOGENY IN *PHACOPS RANA*: Specimens of *P. rana* from various quarries in the Chenango Valley region figured prominently in a recent study of this species (Eldredge, 1972). I recognize five subspecies of *P. rana*, of which *P. rana crassituberculata* Stumm and *P. rana rana* occur in the Hamilton Group of New York; *P. rana norwoodensis* (Stumm) is found in the Tully Formation. These subspecies are distinguished by a variety of ornamental features, and especially by the number of vertical columns of lenses (dorsoventral files) in the eye. Nearly all population samples of *P. rana* show no variation in number of dorsoventral files. *P. rana crassituberculata*, for instance, always has 18 dorsoventral files wherever it occurs over the cratonal interior (e.g. Silver Creek limestone of Indiana; Silica shale of Ohio; lower Arkona shale of Ontario). All *P. rana* of Cazenovian age (Marcellus and Skaneateles Formations and their correlatives) over the cratonal interior have 18 dorsoventral files (both *P. rana crassituberculata* and *P. rana milleri* (Stewart); there is one exception). There is no intergradation ever seen between the 18 dorsoventral file forms and the 17 dorsoventral file form *P. rana rana*, which first appears in the midwest in correlatives of the basal Tioughniogan Centerfield limestone.

The sole exception to this generalization occurs in the Peterborough quarry, where a variable population sample has been amassed. Some specimens have the full 18 dorsoventral files, while others show only a partial development of the 18th file: still others have but 17 files. Above the Solsville, all _P. rana_ of the Hamilton Group have 17 dorsoventral files and are referred to _P. rana rana_. Thus _P. rana rana_ occurred in the exogeosynclinal sea during Upper Cazenovian time, while its more plesiomorphic relatives persisted throughout this interval in the epeiric seas to the west. A more extended discussion of the evolutionary significance of this pattern -- and of a second, similar pattern in sediments of Taghanic age -- is given in Eldredge (1971), and the study is more fully documented in Eldredge, 1972.

The Peterborough quarry has also produced a single cephalon of _Phacops iowensis alpenensis_ (Stumm). This specimen, along with a single pygidium of this species from the Frame Member of the Mahantango Formation in southern Pennsylvania, constitutes the only known sample of _P. iowensis_ east of Arkona, Ontario. This occurrence is of further interest since _P. rana_ and _P. iowensis_ are almost never found in even the same formation. A discussion of the interactions between these two species can be found in Eldredge (1972).

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Table 1

Distribution of trilobites in the Hamilton Group of the Chenango Valley region. The fifth column refers to occurrences known outside of the immediate vicinity of the Chenango Valley.

TAXON	MARCELLUS	SKANEATELES	LUDLOWVILLE	MOSCOW	HAMILTON GROUP
Phacops rana crassituberculata	X				X
Phacops rana rana		X	X	X	X
Phacops iowensis alpenensis	X				X
Greenops boothi	X	X	X	X	X
Dipleura dekayi		X	X	X	X
Dechenella rowi			X		X
Dechenella macrocephala					X
Otarion craspedota					X
Cordania gemmaea					X

Partial Faunal List

Deep Spring Quarry

Moscow Formation, Hamilton Group

Bryozoa

- _Stictopora_
- _Reptaria stolonifera_

Brachiopoda

- _Lingula punctata_
- _Rhipidomella penelope_
- _Tropidoleptus carinatus_
- _Cupularostrum congregata_
- _Devonochonetes coronatus_
- _Atrypa "reticularis"_
- _Ambocoelia umbonata_
- _Elytha fimbriata_
- _Mucrospirifer mucronatus_
- _Spinocyrtia granulosa_
- _Athyris spiriferoides_

Bivalvia

- _Grammysioidea alveata_
- _Grammysia arcuata_
- _G. bisulcata_
- _G. elliptica_
- _G. cuneata_
- _G. globosa_
- _G. lirata_
- _G. constricta_
- _Orthonota undulata_
- _Tellinopsis subemarginata_
- _Parallellodon hamiltoniae_
- _Palaeoneilo muta_
- _Nucula corbuliformis_
- _N. opima_
- _N. bellistriata_
- _N. lirata_
- _Nuculites oblongatus_
- _Prothyris lanceolata_
- _Cornellites flabellus_
- _Aviculopecten fasciculatus_
- _Actinoptera decussata_
- _A. boydi_
- _Pterinopecten undosus_
- _Leiopteria rafinesquii_
- _Glyptodesma erectum_
- _Modiomorpha concentrica_
- _M. mytiloides_
- _Goniophora rugosa_
- _Cypricardella bellistriata_
- _Paracyclas elliptica_
- _Sphenotus truncatus_

Gastropoda

Mourlonia lucina

Dictyotomaria capillaria

Platyceras sp.

Nautiloidea

Spyroceras crotalum

Paradiceras

Hyolithida

Hyolithes ligea

Arthropoda

Phacops rana

Greenops boothi

Dipleura dekayi

Echinocaris punctata

Plants

Protolepidodendron sp.

TRIP F ROAD LOG

Cumulative Mileage	Miles since last point	
0.0	0.0	Begin trip at traffic light in Hamilton, New York (junction of Broad Street and Payne Street. Head North on N.Y. 12B
0.6	0.6	Hamilton village limits
0.9	0.3	Road climbs up onto Kame terrace
1.7	0.8	Outcrop of Pecksport Shale Member, Hamilton Group, on right
1.9	0.2	Road forks. Take left fork, N.Y. 46
2.8	0.9	Junction with N.Y. 26. Continue straight on N.Y. 46
3.2	0.4	Junction with U.S. 20. Turn left (west)
3.5	0.3	Continue on U.S. 20, taking left fork
6.4	2.9	Morrisville village limits.
7.0	0.6	Turn right (North) at second light onto Cedar Street
9.1	2.1	Stop #1. Solsville Member, Marcellus Formation, Hamilton Group
		Turn around and return to Morrisville
11.2	2.1	Junction with U.S. 20. Turn left, then immediate right (South) onto Eaton Street.
12.4	1.2	Turn right at junction
14.2	1.8	Enter village of West Eaton. Turn left on N.Y.26.
14.9	0.7	Enter village of Pierceville. Turn right onto Bradley Brook Road
16.5	1.6	Bradley Brook Reservoir on right. Continue straight
17.1	0.6	Turn right on Soule Road
17.2	0.1	Park on shoulder
		Stop #2. Ludlowville Formation, Hamilton Group
		Turn around and return to Bradley Brook Road
17.3	0.1	Turn right on Bradley Brook Road
19.9	2.6	Enter village of Lebanon. Turn left
20.6	0.7	Take right fork (Reservoir Road)
21.5	0.9	Turn right onto Deep Spring Road
22.6	1.1	Park on shoulder. Outcrop on the right is
		Stop #3. Moscow Formation, Hamilton Group
		Turn around and return to Reservoir Road

Cumulative Mileage	Miles since last point	
23.7	1.1	Turn right on Reservoir Road
25.0	1.3	Turn right at junction
26.0	1.0	Cross River Road. Continue straight on Nower Road
26.6	0.6	Junction with N.Y. 12B. Turn left
31.9	5.3	Stoplight at Hamilton

End of log

COMMON HAMILTON TRILOBITES