FACIES OF THE MANLIUS FORMATION (LOWER DEVONIAN) OF NEW YORK STATE

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INTRODUCTION

The Manlius Formation is the basal unit of the lower Devonian Helderberg Group of New York. The Helderberg Group, itself, is a lithologically and paleontologically diverse sequence of carbonates that ranges from 30 to 300 feet in thickness; it crops out from west of Syracuse, eastward to Albany, and from there southwestward to Port Jervis and into the adjoining states of Pennsylvania, Maryland, West Virginia, and Virginia (Fig. 1).

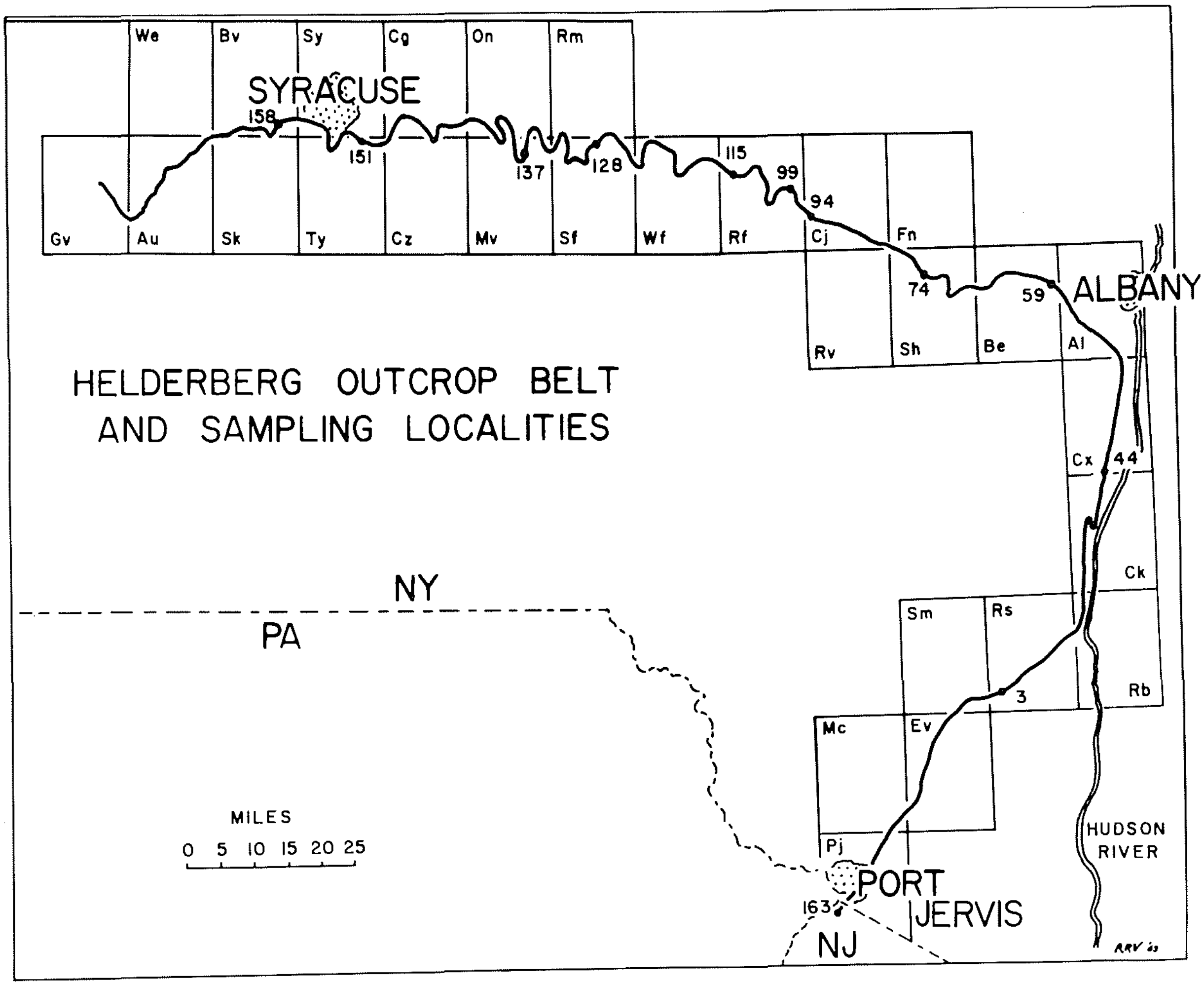

Fig. 1. Line of outcrop of Helderberg Group in New York. Numbers indicate 12 selected localities from which 200 samples of the Manlius have been studied in detail.

In New York, the Helderberg sequence is conformably underlain by the upper Silurian, dolomitic, Rondout Formation; above, a pre-Oriskany erosion surface cuts out increasingly older units of the Helderberg to the west. Detailed stratigraphic studies by Rickard (1962) have demonstrated that the various lithologic types with their associated fossil assemblages within the Helderberg Group are, for the most part, time transgressive units becoming progressively younger to the west. The Helderberg sequence, therefore, represents a series of carbonate environments which migrated westward during early Devonian submergence. These stratigraphic relationships are summarized in Figure 2. In the same report Rickard has reviewed the evidence based upon the faunal studies of Boucot (1960) and others that the Manlius is earliest Devonian, rather than latest Silurian, in age.

The Helderberg carbonates are particularly well suited for detailed paleoecological analysis because of their wide areal extent; their abundant, diverse, and well-preserved fossil assemblages; their excellent field exposures; and because of the excellent stratigraphic background that Rickard's earlier work provides. For these reasons a detailed investigation of these rocks has been begun, starting with the lowest unit in the Helderberg section, the Manlius Limestone, which is some 30 to 90 feet thick. The following discussion is a simplified summary of the initial results of this investigation, which included extensive field examination of the Manlius (47 localities) as well as detailed laboratory study of more than 200 polished slabs and 200 thin sections collected from some 12 selected localities across the state (Fig. 3). A detailed description and interpretation of the Manlius Formation is currently being prepared for subsequent publication elsewhere.

MANLIUS FACIES

General

Examination of the Manlius reveals that, lithologically and paleontologically, the unit is neither homogeneous nor randomly variable. In fact, by combining a variety of rock attributes including grain composition, texture, fossil occurrences, and primary structures three distinct sedimentary facies can be recognized. Furthermore, these facies tend to correspond with particular stratigraphic levels within the Manlius - either with named members in the central part of the state, or unnamed but distinct physical horizons in the eastern part of the state. These three facies are interpreted as being deposited very near (i.e., within several feet) to mean sea level; more specifically, either above mean tide level (SUPRATIDAL), at mean tide level (INTERTIDAL), or below mean tide (SUBTIDAL).

Table 1 summarizes the lithologic and paleontologic character of these facies and their stratigraphic occurrence within the Manlius Formation.

Supratidal Facies

This facies is a laminated, dolomitic limestone which is massive and virtually unfossiliferous. (These are the "waterlimes" of various authors.) The individual laminae, about 1/2 to 1/4 mm thick, are composed of dolomite spar and rhombs which grade into a calcite pelletal mud; the top of the lamina is a very thin, dark bituminous layer which may be the vestige of an algal mat. Deep polygonal mud cracks and "birdseye" structures are common; small burrows and rare ostracode valves are the only organic traces. Horizons rich in carbonate intraclasts, having some rounded chert fragments, and lacking fossils, are also found within this facies.

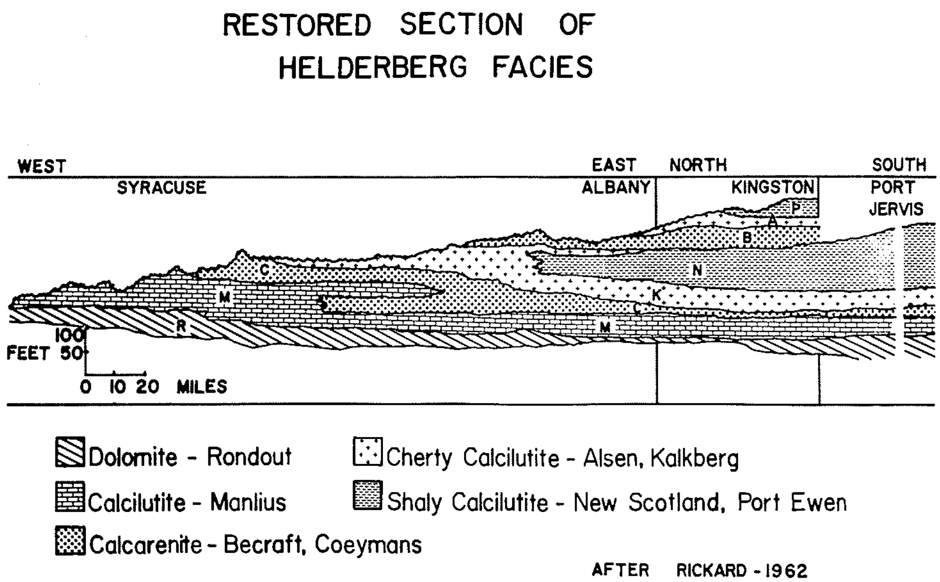

Fig. 2. Restored section of the Helderberg Group (after Rickard, 1962). Note interfingering facies relationships of various units. Rondout formation below, and pre-Oriskany erosion surface above.

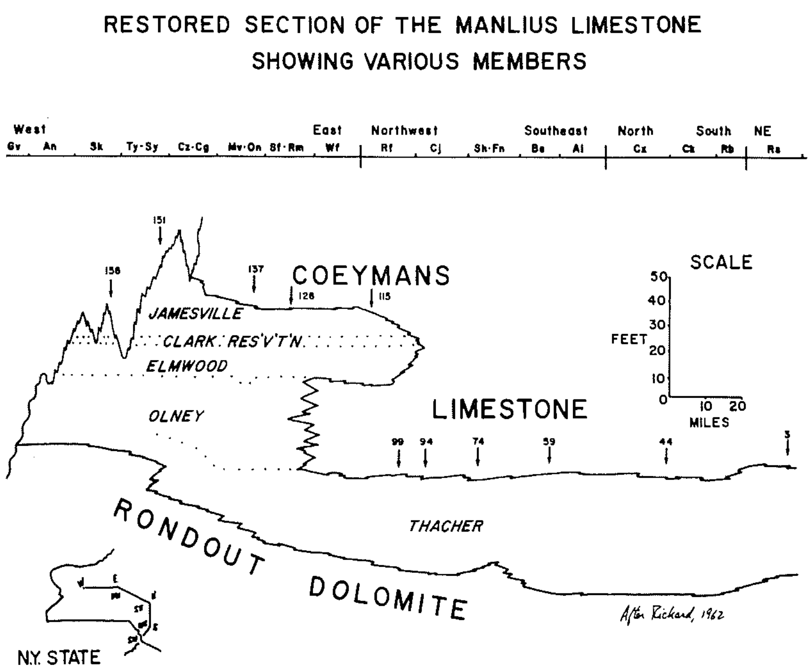

Fig. 3. Stratigraphic section of the Manlius limestone (greatly exaggerated) across New York. Five members in central New York but only one member in eastern New York.

TABLE 1

Summary of Manlius Facies

Facies	Lithology	Paleontology	Horizons
SUPRATIDAL	Dolomitic, laminated muds; mudcracks, birdseye. (Dolomitic micrites)*	Fossils rare; algal laminae, ostracodes, and burrows.	Clark Reservation, Elmwood --------------- Middle and upper Thacher.
INTERTIDAL	Interbedded pelletal lime muds and skeletal sands; occasional limestone-pebble cgls. and mudcracks. (Pelmicrites and biopelsparites)*	Fossil types few but individuals abundant. Ostracodes, tentaculids, brachiopods algal stromatolites and oncolites.	Full Thacher ------------- Lower Thacher
SUBTIDAL	Pelletal lime muds and boundstones. Medium to massively bedded; in places "reefy". (Biopelmicrudites and biolithites)*	Stromatoporoids, rugose corals, brachiopods, ostracodes, snails, and codiacean algae. Biota abundant and diverse.	Jamesville Olney ----------- Upper and middle Thacher

* Terminology after Folk, 1959

Lithologic and paleontologic attributes of various Manlius facies, and their general stratigraphic occurrences in central (above) and eastern (below)

In central New York, this facies is represented by the Elmwood and Clark Reservation Members of the Manlius. In eastern New York this facies occurs in the upper half of the only member of the Manlius occurring in that area (Thacher Member). The facies ranges in thickness from several feet to about 15 feet.

Intertidal Facies

This second facies is composed of thin to medium bedded, poorly fossiliferous, pelletal, lime muds alternating, often unconformably, with pelletal skeletal sands. (These are the "ribbon beds" of various authors.) A variety of primary structures occur in this facies including cross-stratification, ripple marks, and scour-and-fill; limestone-pebble conglomerates are also found. Thin layers in this facies may also contain oolitic grains which are either true oolites or superficially coated skeletal debris or pellets.

Fossils in this facies vary considerably in abundance; often they are found in great numbers but representing just one or two taxa. Leperditid ostracodes, tentaculitid molluscs, spiriferid brachiopods, trepostome bryozoans, and serpulid worms are most typical.

In many places the lowest part of this facies, which is stratigraphically the base of the Manlius, contains well-developed algal stromatolites and oncolites. These algal structures are composed of many thin (1 mm or less), irregular, carbonate laminae which encrust either free-lying grains, such as ostracode valves or intraclasts, ("oncolites"), or the substrate directly, forming heads of various sizes, up to 3' high and 4' long, and shapes ("stromatolites"). The individual laminae are composed of fine-grained calcite which is usually aggregated into dark clots, and fine carbonate sand and mud; some laminae are sinuous layers of sparry calcite (Laporte, 1963).

Studies of recent algal stromatolites (Logan and others, 1964) indicate that these structures are formed by encrusting mats of filamentous blue-green algae which trap and bind fine sand and mud at, and somewhat below, low-tide level. Successive mats construct successive laminations. In well agitated water these algae coat free sediment grains; as the grains roll about multiple concentric layers develop. In quieter water the mats lie on the substrate proper forming more or less continuous structures which build upward into heads, the size and shape of which are related to the strength and frequency of water movement.

In central New York this intertidal facies is represented by the full Thacher Member; in eastern New York the lower half of the Thacher Member contains this facies. The facies ranges in thickness from 20 feet in the Hudson Valley area to 40 feet in the Cherry Valley and Syracuse areas.

Subtidal Facies

This third facies of the Manlius is a medium to massively bedded, pelletal, lime mudstone, often having very abundant stromatoporoids that form a dense and compact rock of encrusting and hemispherical colonies. These stromatoporoid-rich horizons, although they lack the vertical scale and other geometrical properties of reefs, seem to have been wave-resistant structures composed of framework-building and sediment-binding organisms. Despite the presence of a muddy matrix the stromatoporoid colonies apparently were in water that was intermittently strongly agitated, for many large stromatoporoid heads are overturned and abraded.

The biota of this facies, although not as diverse and abundant as in other Helderberg units of New York, is the most diverse and abundant of all the facies within the Manlius Formation. It includes stromatoporoids, solitary rugose corals, occasional tabulate corals, snails, brachiopods, ostracodes, and codiacean algae (presumed green calcareous algae, like the modern Halimeda).

The subtidal facies occurs in the Olney and Jamesville Members of central New York, and in the middle and upper parts of the Thacher Member in eastern New York; it ranges from 5 to 30 feet in thickness.

In those areas where the Manlius grades laterally or vertically into the Coeymans Limestone (a crinoidal-brachiopod skeletal sand with little or no interstitial mud) there is an intermediate or transitional rock type between the subtidal facies of the Manlius and the Coeymans proper. This rock type is a pelletal, skeletal limestone with varying amounts of lime mud and many small echinoderm ossicles scattered throughout.

INTERPRETATION

If one compares the biologic, lithologic, and primary structural features of the Manlius with present day shallow-water carbonate environments, a number of striking similarities are evident. In particular, there is strongly suggestive evidence that parts of the Manlius Formation were deposited at, or slightly above mean sea level:

Manlius	Recent Analogue	Reference
1) Algal stromatolites and oncolites	Intertidal and just below low tidal level in Florida Keys and Andros Island, Bahamas	Ginsburg, 1960; Logan and others, 1964
2) Laminated, dolomitic, pelletal muds with stromatolites, birdseye, and mud cracks.	Supratidal areas in Florida Keys and Andros Island	Shinn and Ginsburg, 1964
3) Limestone-pebble conglomerates; interbedded skeletal sands and lime muds.	Intertidal zone of the Florida Keys	Baars, 1963; Laporte, personal observation.
4) Oolites and coated grains.	Just below intertidal zone, Great Bahama Bank.	Newell and others, 1960.

The marine character and relative diversity of the biota of the third facies (Subtidal) demands continuous marine submergence; and yet, if the other facies closely stratigraphically associated with it are truly supratidal and intertidal, then the submergence could not be great, perhaps just several feet. This subtidal facies would have developed in broad and slightly submerged muddy areas, marginal to the supratidal "islands" and intertidal flats.

If the sediment/water interface sloped gently from the supratidal zones to the completely submerged subtidal areas, there would be extensive portions of the bottom between the supratidal and subtidal zones that were alternately inundated and drained with successive high and low tides (diurnally, monthly, or seasonally). Tidal waters flooding and draining the flats would cut low gradient channels or creeks across the flats; the moving water in the continuously submerged parts of the creeks might favor establishment of stromatoporoid banks, analogous to the way modern mussel and oyster banks develop in tidal creeks cutting the broad mud flats of the Dutch Waddens (van Straaten, 1954) and the Gulf Coast (Emery and others, 1957).

Varying rates of subsidence and sediment production would influence sediment accumulation so that the sedimentary environments (and hence the individual sedimentary facies) migrated laterally, producing the Manlius' present-day aspect of relatively complex lateral and vertical lithologic and biologic variability. Radical facies changes would be expected in these sorts of depositional environments which lie so close to mean sea level. For slight changes in sea level, either tidal or eustatic, would effect major changes in many ecologic characters linked to amount and duration of submergency by marine waters.

Although particular members or parts of members of the Manlius seem to represent dominantly one facies or another, it should be realized, of course, that at any one time during Manlius deposition all three environments were present. Hence, it is predictable that careful tracing out of individual thin beds of the Manlius would demonstrate the change from one environment to another. Such detailed, bed-by-bed, stratigraphic analysis is presently being pursued, and the results should test the validity of the interpretation of Manlius facies genesis as presented here.

CHECKLIST OF MANLIUS FOSSILS

Syringstroma barretti	A	Stromatoporoid coral
Spongophylloides sp.	C	Solitary rugose coral
Favositids	R	Tabulate coral
Howellella vanuxemi	A	Spiriferid brachiopod
Brachyprion varistriatus	C	Strophomenid brachiopod
Tentaculites gyracanthus	A	Coniconchoid mollusc
Actinopteria sp.	R	Pterioid clam
Unidentified high spired snail	C	
Spirorbis laxa	C	Serpulid worm
Leperditia alta	A	Ostracode
Garwoodia gregaria	C	Green Codiacean alga
Algal stromatolites and oncolites	C	Structures formed by blue-green (?) algae

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