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FAUNA OF THE MORROWAN ROCKS OF CENTRAL UTAH

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TABLE OF CONTENTS

Acknowledgments

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INTRODUCTION

The Oquirrh formation of the south central Wasatch Mountains is 26,000 feet thick (Baker, 1947) and chronologically extends from the base of the Pennsylvanian Morrowan into the Permian Wolfcampian series. The Morrowan rocks were measured in detail by the writer at three localities (see index map) as follows: Provo Canyon section (Rotary Park) (N 1/2 sec. 33, T. 5 S, R. 3 E); 1,032 feet; Flatiron Mountain section (NE 1/4, sec. 28, T. 7 S., R. 3 W); 1,233 feet; Five Mile Pass section (SE 1/4, sec. 10, T. 7 S, R. 3 W); 934 feet. Mr. E. Blair Maxfield is making a detailed study of the stratigraphy and sedimentation of the Morrowan rocks in Central Utah. It will be presented as a masters thesis to the Department of Geology at Brigham Young University. The Morrowan rocks are predominantly thickbedded limestones with interbedded shaly limestones and sandstones. The limestone is a dark-gray weathering medium-gray, fine-grained calcarenite. The shaly limestones are black but weather medium gray and are composed of fine calcareous grains. The limestone units are predominantly ledge-formers while the shale units form slopes. A limestone ledge about twenty feet thick forms a remarkable key bed at the top of the Morrowan rocks and separates them from the Atokan strata.

The overlying Atoka is composed predominantly of buff to brown, fine-to-medium-grained orthoquartzites, with minor limestones (Gaines, 1950, p. 46). The underlying Manning Canyon formation is predominantly black carbonaceous shale with minor interbedded limestone, sandstone, and orthoquitzite (Gaines, 1950, p. 42). It contains the Mississippian-

Pennsylvanian boundary, but the exact stratigraphic position of the top of the Chester and base of the Springer is as yet unknown (Baker, Huddle, and Kinney, 1949, p. 1183). The contact between the Manning Canyon formation and the Morrowan Oquirrh is distinctive, for the Manning Canyon weathers away easily to form subsequent valleys and the Morrowan rocks form ledges.

The Morrowan rocks are extremely fossiliferous. They contain nondescript broken crinoid, brachiopod and bryozoan fragments, with an assemblage of numerous nearly complete identifiable fossils near the bottom of the section. The hashy crinoid and brachiopod fragments found near the top of the series are very small and greatly contrast in size with the much larger fragments which are found toward the bottom of the Morrowan rocks. Toward the top the brachiopod fragments diminish in importance and crinoidal debris dominates. This condition is probably due to differential destruction and winnowing of the specimens during transportation, suggesting that at the time the younger Morrowan rocks were deposited the source area was located farther away than when the older units were deposited.

The Morrow fauna is composed of a variety of species, with six phyla being represented. Phylum Echinodermata is the most abundant, but all species are fragmentary and no specific identifications are possible. Phylum Brachiopoda is the most diverse with thirty species identified. Two classes of molluska are present: Pelecypoda, represented by at least four species; and Gastropoda, represented by at least three species. Although

this phylum is diversified, the number of specimens collected is small. Six species of bryozoans occur with a great abundance of material collected. Phyla Coelenterata and Arthropoda are represented by one species each, with the number of specimens collected being small.

Comparison of the Morrow fauna of Central Utah with similar faunas in the Rocky Mountain region suggests a lower Pennsylvanian age for this series of rocks.

A few fossils collected from the Morgan formation (Calkins and Butler, 1943, p. 29) in the Cottonwood-American Fork area, Utah, can be correlated with the fossils of the present study.

Morgan Fauna	Morrowan Fauna
Rhombopora sp.	Rhombopora lepidodendroides
Spirifer rockymontanus	Spirifer rockymontanus
Composita subtilita	Composita subtilita
Griffithides sp.	Ameura sangamonensis
Stenopora sp.	Stenopora sp.
Deltopecten sp.	Pectinid pelecypod
Triplophyllum sp.	
Syringopora sp.	
Fistulipora sp.	Fistulipora incrustans

Similarities between the two faunas are apparent, and even more so if Triplophyllum sp. can be correlated with Lophophyllidium profundum from the Morrowan collection.

Fossils collected in the Rocky Mountains by geologists of the 100th Meridian Survey (Wheeler, 1877, p. 17) and designated as Pennsylvanian in age are very similar to the Morrow Fauna of Central Utah in numbers of species represented in each phylum.

Resemblances exist between the Morrow Fauna of Central Utah and the Lower Aubrey Fauna of White (1876, p. 88). However, the Lower Aubrey Fauna contains many types which do not occur in the Morrowan Oquirrh. Mather (1915, p. 81) discusses the similarities between his Morrow Fauna and White's Fauna (White, 1876, p. 88). However, Darton (1910, p. 25) places the Supai Formation of Upper Pennsylvanian and Lower Permian age at the base of the Aubrey group, suggesting that the Aubrey Fauna of White is of a later age than Mather's Fauna.

From the Molas and Hermosa formations in Colorado, Girty (1903, p. 246) has made a collection which is similar to the writer's collection. The number of species in the Colorado collection is greater than in the Utah collection. However, the percent of species belonging in each phyla are similar in both collections suggesting that the two fauna are contemporaneous.

Hewett (1931, p. 24) has made a collection from the Bird Springs formation in Nevada, which the writer's collection closly resembles. One species of protozoa is present in the Bird Springs collection (Hewett, 1931, p. 28), but other than this no phyla occur which are not found in the writer's collection. The number of specimens represented in each phyla are very similar in both collections, however, the Bird Springs fauna contains fifteen bryozoans while the writer's collection contains only six. Of the six bryozoan species present in the writer's collection five are found in Hewett's collection (1931, p. 24). The brachiopods are similar in both faunas, with over fifty percent of the Central Utah genera being found in

the Nevada fauna, and many more genera which are similar. Hewett (1931, p. 22) states that fossils are common in the lower part of the Bird Springs formation and abundant in some beds 100 to 300 feet above the base. This is very similar to the lower Oquirrh formation in Central Utah, further suggesting that the lower part of the Oquirrh formation is equivalent to the Bird Springs formation.

From the Oquirrh formation at the Gold Hill Mining District (Nolan, 1935, p. 33), a fauna has been collected which contains an abundance of Mollusks and brachiopods, with a few bryozoans. Of the six species of Bryozoans present at Gold Hill, three are present in the writer's collection. The two brachiopod faunas are very similar with twenty-eight species found at Gold Hill. The two faunas have fifteen brachiopod species in common. Of the remaining species, nine are included in genera which are in common in both collections. The species of molluska at Gold Hill far outnumber the molluskan species in the writer's collection, and similarities between the molluskan faunas are slight.

Gilluly (1932, p. 37) has made a faunal collection from the type locality of the Oquirrh formation at out-crops in the Stockton and Fairfield Quadrangles in Utah. Of thirty-three species of brachiopods, fourteen occur in the writer's collection. Of the remaining ninteen species, twelve are included in genera which are in common in both collections. Fourteen species of bryozoans are included in Gilluly's collection (1932, p. 37), with five of these found in the writer's collection. Only one out of eight species of molluska found in Gilluly's collection is found in the writer's collection.

It is apparent, from several lower Pennsylvanian collections made in the Rocky Mountains and Great Basin regions, that Phylum Brachiopoda is the dominent group in these rocks and should be studied extensively when trying to correlate formations believed to be of lower Pennsylvanian age.

Outside the Rocky Mountain area faunas occur which suggest correlation with the present study. Mather (1915) lists a fauna from the Morrow group in Arkansas and Oklahoma which suggests an equivalent age. However, less than one-third of all species listed by Mather are brachiopods, and two-thirds of the species in the writer's collection are brachiopods. Also, about one-fourth of the species listed by Mather are bryozoans while only about one-seventh of the species in the writers collection are bryozoans. This suggests that the Morrowan seas of Arkansas and Oklahoma were more calcareous and muddier than the Morrowan seas of Utah (Twenhofel and Shrock, 1935, p. 245, 296).

Girty (1909) lists a fauna from the Caney shale of Oklahoma which is lower Pennsylvanian in age. This fauna is dominated by Molluska, with over two-thirds of the species belonging to that phylum. This suggests that the sea depositing the Caney shale was not oxygenated enough for the brachiopods to become dominant (Twenhofel and Shrock, 1935, p. 296). However, the phylum Molluska is able to live within such an extreme range of habitats (Twenhofel and Shrock, 1935, p. 401) that the enviroment of the ancient Caney sea is difficult to reconstruct.

Another deminantly Molluscan fauna is listed by Morning-star (1922, p. 139) from the Pottsville formation of Ohio in which two-thirds of the

species belong to this phylum. However, the number of species of bryozoans as compared to brachiopods is over three times as great as in the writer's collection. This suggests that the Pottsville seas of Ohio were more calcareous and muddier than the Morrowan seas of Utah.

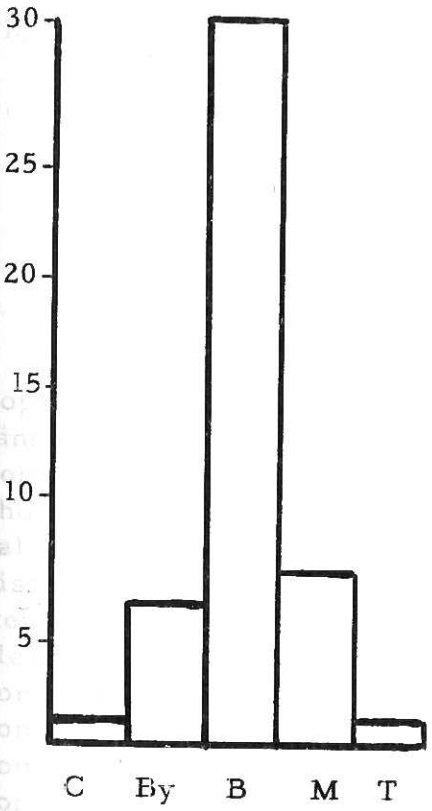


Figure I. Numbers of species of fossil invertebrates in the Morrowan rocks, C, coelenterata; By, bryozoa; B, brachiopoda; M, molluska; T, trilobites.

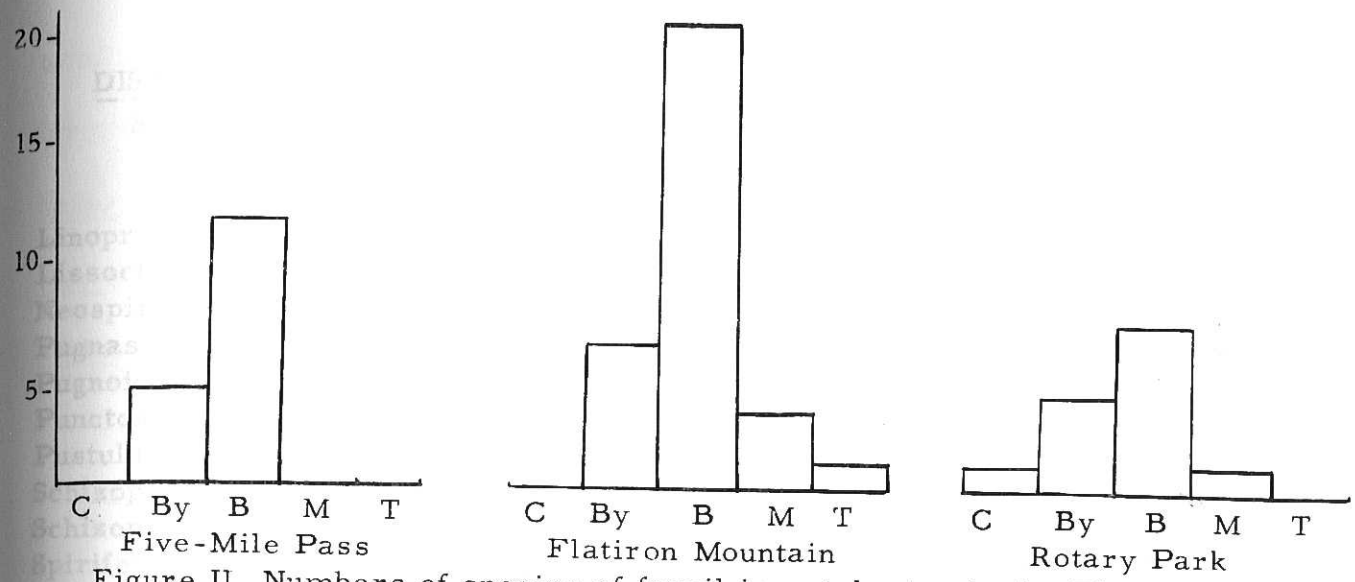


Figure II. Numbers of species of fossil invertebrates in the Five Mile Pass, Flatiron Mountain and Rotary Park sections. C, coelonterata; By, bryozoa; B, brachiopoda; M, molluska; T, trilobiles.

DISTRIBUTION OF THE MORROW FAUNA

Species	5-Mile Pass	Flatiron Mountain	Rotary Park	Fossil Hill
Lophophllidium profundum			X	X
Pinniretopora conferta		X		
Polypora triseriata	X	X	X	
Rhombopora lepidodendroides	X	X	X	
Tabulipora carbonaria		X		
Fistulipora incrustans	X	X	X	
Stenopora sp.	X	X	X	
Cleiothyridina orbicularis				X
Composita elongata		X		
Composita gibbosa				X
Composita ozarkana	X	X		X
Composita subtilita	X	X	X	X
Composita trilobata		X	X	X
Composita wasatchensis	X	X	X	X
Derbyia crassa	X	X		X
Derbyia robusta	X	X	X	X
Dictyoclostus morrowensis	X	X	X	
Dictyoclostus portlockianus	X	X	X	X
Dielasma bilobatum				X
Dielasma bovidens				X
Dielasma subspatulatum				X
Dielasma sp.				X
Hustedia miseri				X
Juresania nebrascensis		X		

DISTRIBUTION OF THE MORROW FAUNA (Continued)

Species	5-Mile Pass	Flatiron Mountain	Rotary Park	Fossil Hill
Linoproductus ovatus	X	X		
Lissochonetes geinitzianus	X	X	X	
Neospirifer cameratus		X		X
Pugnas weeksi				X
Pugnoides triangularis				X
Punctospirifer kentuckyensis	X	X		X
Pustula globosa		X		
Schizophoria altirostri		X		
Schizophoria texana		X		
Spirifer opimus		X		X
Spirifer rockymontanus		X		X
Squamularia perplexa				X
Wellerella osagensis	X			X
Allorisma sp.			X	
Nucula sp.				X
Pectinid pelecypod				X
Pleurotomaria sp. A		X		
Pleurotomaria sp. B		X		
Pleurotomaria sp. C		X		
Schizodus sp.				X
Ameura sangamonensis		X		

ROTARY PARK SECTION

The Morrowan rocks near Rotary Park in Provo Canyon measure 1,032 feet thick with a total of 607 feet being essentially unfossiliferous, 397 feet of limestones containing broken crinoid stems and a few bryozoans, and twenty-eight feet of rocks containing an abundant assemblage of brachiopods, bryozoans, and crinoid stems. The well preserved abundantly fossiliferous rocks occur in the lower 212 feet of the section, and are limited to five separate beds. Above 212 feet from the base crinoid stems are the dominant fossils, but commonly are associated with bryozoans. All of the five fossiliferous units contain abundant crinoid stems. The largest of these measured eight

mm. in diameter. Bryozoans are present in these units with a fenestrate form represented by Polypora triseriata, a twiggy form represented by Rhombopora lepidodendroides, and an encrusting form represented by Fistulipora incrustans. The large brachiopods are represented by two species each of Dictyoclostus and Derbyia. Both species of Dictyoclostus were found in association with both species of Derbyia, but two species of the same genus seldom were found within the same unit. This suggests that the species of the same genus competed in closly related ecologic niches. Composita is the only other genus which is abundant, but it occurs in only two beds. The two species of Composita are very similar and probably were contemporaneous. The only other forms which were collected from these beds are Lophophyllidum profundum, which occurs in only one bed; and Lissochonetes geinitzianus which also occurs in only one bed. Worm burrows and trails are particularly abundant at locality thirty-two. This suggests a loose sand environment in which the mud eating worms could thrive. The unit is very silicious and contrasts greatly in lithology with most of the other units of the section.

FIVE MILE PASS SECTION

The Five Mile Pass section west of Fairfield is 934 feet thick, with a total of 654 feet being essentially unfossiliferous, 257 feet of limestone containing broken crinoid stems and a few bryozoans, and twenty-three feet of rocks containing a varied assemblage of brachiopods, bryozoans and crinoid stems. The most abundantly fossiliferous rocks occur between 144 and 186 feet from the base. Above and below this horizon criniod stems and unidentifiable brachiopod fragments with a few bryozoans comprise the main fossil remains.

The larger fragments are commonly found toward the bottom of the unit with the fragments becomming smaller up the section. The four particularly fossiliferous units also contain an abundance of fossil fragments, but are characterized by Linoproductus ovatus, two species of Derbyia, and two species of Dictyoclostus. Bryozoans are present in these units with a fenestrate form represented by Polypora triseriata, a twiggy form represented by Rhombopora lepidodendroides, a ramose form represented by Stenopora sp., and an encrusting form represented by Fistulipora incrustans. Three species of Composita, Punctospirifer kentuckyensis and Wellerella osagensis also occur in the units. 150 feet from the top of this section is a fossiliferous bed which contains abundant Lissochonetes geinitzianus.

FLATIRON MOUNTAIN SECTION

The Flatiron Mountain section is 1, 233 feet thick, with 580 feet of essentially unfossiliferous rocks; 367 feet of limestone containing broken crinoid stems and a few unidentifiable brachiopod and bryozoan fragments; and 286 feet of abundantly fossiliferous rocks. The most fossiliferous units occur in the lower 700 feet although a few abundantly fossiliferous units occur higher in the section. Seventeen of the forty lowest stratigraphic units are considered to be densely fossiliferous, while only two of the upper forty-four units are equally fossiliferous. Above the lower 700 feet most of the beds are essentially unfossiliferous, but some contain abundant crinoid stems and unidentifiable brachiopod fragments. Rhombopora lepidodendroides, Polypora triseriata, Fistulipora incrustans, and Stenopora sp. also occur in these units. The seventeen abundantly fossiliferous units contain a host of crinoid

stems and unidentifiable brachiopod fragments. Bryozoans are present in twelve of these units, with Rhombopora lepidodendroides collected from twelve units, Polypora triseriata from eleven units, Fistulipora incrustans from seven units and Stenopora sp. from seven units. The productids are an interrelated group, with Dictyoclostus portlockianus, which is found in eight units, being the dominant species. Dictyoclostus morrowensis is found in four units, Linoproductus ovatus in two units and Juresania nebrascensis and Pustula globosa in one unit each. The spirifers are also an associated group, with Spirifer opimus, which is found in five units, being the dominant species. Associated with it, all being found in the same unit, are; Spirifer rockymontanus, Neospirifer cameratus, and Punctospirifer kentuckyensis. The Compositas are an associated group which are also associated with the spirifers, seldom being described from a unit in which Spirifer opimus does not occur. Composita wasatchensis occurs in four units, Composita subtilita in three units, Composita ozarkanus in two units, Composita elongata in two units, and Composita trilobata in one unit. Derbyia robusta occurs in five units, and Derbyia crassa in two units, one unit containing both species. Derbyia is normally associated with bryozoans, often being the only brachiopod associated with them. Lissochonetes geinitzianus occurs in two units, and is ordinarily not associated with other brachiopods. Locality twelve, which contains the most diversified fauna of any unit in the Morrowan rocks, contains three species of Pleurotomaria. Ameura sangamonensis occurs at localities twelve to twenty-one in association with crinoid fragments and an assemblage of abundant bryozoans. Above 700 feet a fossiliferous zone, in which specific indenti-

fication is possible, exists between 285 and 268 feet from the top of the section. Locality twenty-five contains numerous specimens of Pinniretopora conferta. Locality twenty-six contains abundant Schizophoria texana and Schizophoria altirostri with Rhombopora lepidodendroides, Fistulipora incrustans, and Tabulipora carbonaria also being present.

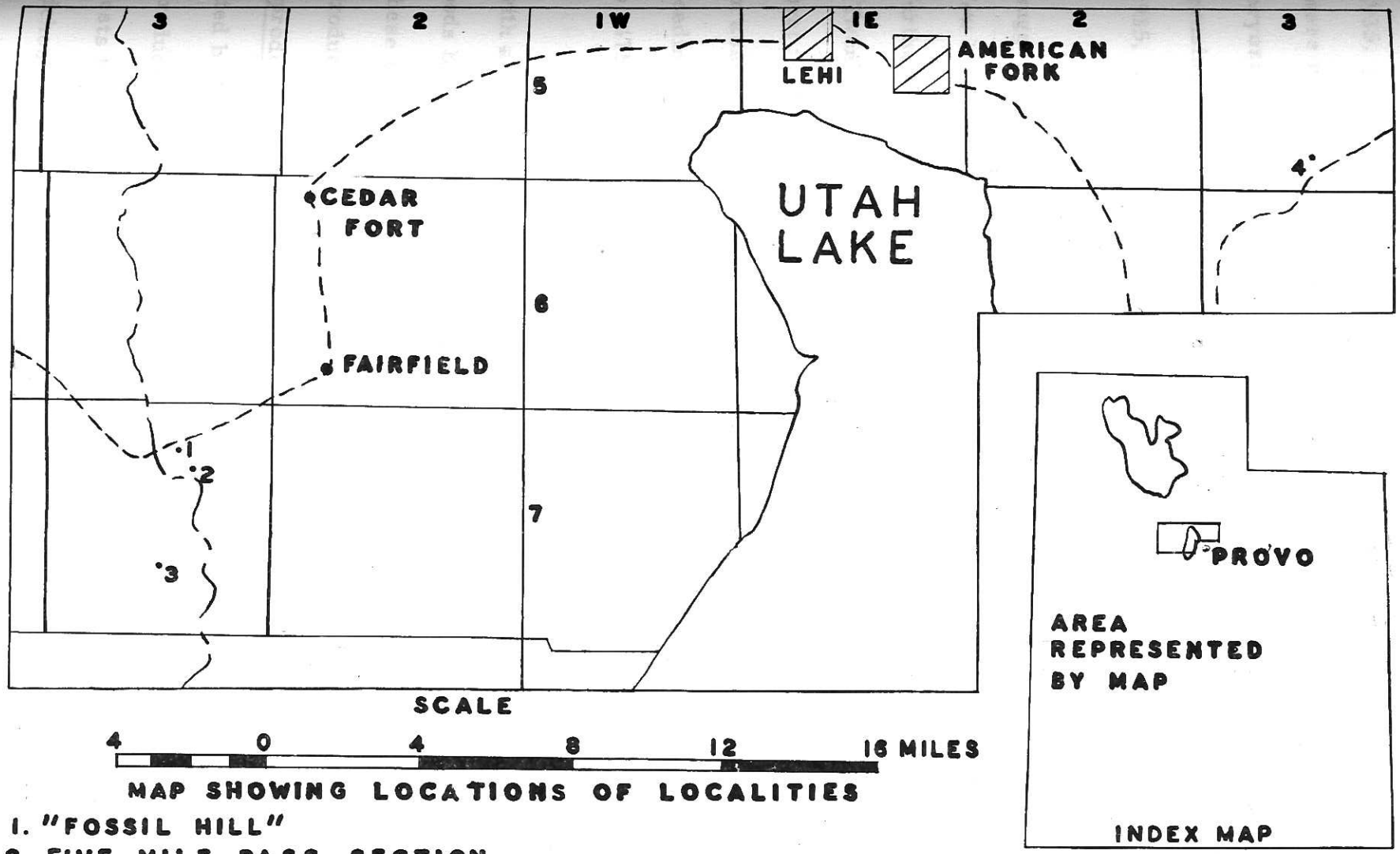
FOSSIL HILL LOCALITY

Abundant fossils have been collected from two small areas on "Fossil Hill" (N 1/2, sec. 10, T. 7 S., R. 3 W). Many of the fossils in the writer's collection are unique to this area; some of these are; Composita gibbosa, Cleiothyridina orbicularis, Squamularia perplexa, Pugnax weeksi, Pugnoides triangularis, Hustedia miseri, four species of Dielasma, Nucula sp. Schizodus sp., and a Pectinid Pelecypod. The "Fossil Hill" localities are in a small fault block, approximately forty to fifty stratigraphic feet above the Oquirrh-Manning Canyon contact.

BIOFACES

The envirenments in which the Morrowan fossils were deposited were variable. The lower rock units are characterized by fossil assemblages which suggest a biocoenosis. The middle units suggest a depositional alteration between biocoenoses and thinatocoenoses. The upper units are dominantly thinatocoenoses, although biocoenoses do occur toward the top of the Morrowan rocks.

The brachiopods being in abundance, suggest that the Morrowan rocks were deposited in well oxygenated, shallow water seas (Twenhofel and Shrock,



MAP SHOWING LOCATIONS OF LOCALITIES

1. "FOSSIL HILL"
2. FIVE MILE PASS SECTION
3. FLATIRON MT. SECTION
4. ROTARY PARK SECTION

1935, p. 296). But, the abundance of bryozoans suggests that the sea bottoms were muddy and calcareous (Twenhofel and Shrock, 1935, p. 245). These bryozoans may have played an important part in checking light ocean currents, causing deposition of material in suspension or solution (Twenhofel and Shrock, 1935, p. 245).

Localities twelve to twenty-one are dominated by bryozoans which suggest a muddy and calcareous sea (Twenhofle and Shrock, 1935, p. 245). A few large productids and derbyias are present in this bryozoan biofaces which further suggest that the sea bottom was receiving a small quantity of mud (Twenhofel and Shrock, 1935, p. 297). Ameura sangamonensis is also present in this biofaces. The presence of Ameura sangamonensis and bryozoans in association with one another suggests that the scavengeristic Ameura was feeding upon the decomposing bryozoan remains (Twenhofel and Shrock, 1935, p. 475).

Several localities are dominated by abundant productids and derbyias with a few compositas, spirifers, and bryozoans being present. The brachiopods being dominant suggest well oxygenated shallow-water environments for these localities. Many of these brachiopod biofaces are dominated by large productids; Dictyoclostus portlockianus, Dictyoclostus morrowensis and Linoproductus ovatus having been collected. Others of these biofaces are dominated by two species of derbyia. Derbyias being dominant in some biofaces and productids dominant in others, with bryozoans present in both biofaces, suggests that the productids and derbyias competed in closly related ecologic niches. At some localities the productids and derbyias are found in assoc-

iation with one another. However, when this occurs many other genera of brachiopods are always present.

Locality twenty-five is dominated by Pinniretopora conferta, with no other species being present. This bryozoan biofaces suggests a muddy calcareous bottom (Twenhofel and Shrock, 1935, p. 245) in which the species could thrive.

Schizophoria texana and Schizophoria altirostri are found in association with one another at locality twenty-six. The similarities between these two species suggests that they were contemporaneous. Rhombopora lepidodendroides and Fistulipora incrustans also occur at this locality. Schizophoria texana is also found in abundance at locality twelve.

Locality six is dominated by Lissochonetes geinitzianus which is always found in local groups and oriented in a flat lying position.

Gastropods occur at locality twelve, but the diversity of ecology of this class (Twenhofel and Shrock, 1935, p. 401) does not suggest any further types of biofaces.

Fossil assemblages suggesting thinatocoenosis consist of broken crinoid stems and unidentifiable brachiopod fragments associated with bryozoans.

DESCRIPTIONS OF SPECIES

COELENTERATA

LOPHOPHYLLIDIUM PROFUNDUM (M-E & H)

Plate I, fig. I.

1858. Cyathaxonia profunda Milne-Edwards and Haime, Mon. des Polyp. Foss., p. 323.

1872. Lophophyllum profunda, Foerste., Bull. Sci. Lab. Denison Univ. vol. III, p. 136.

The lone representative of the phylum Coelenterata in the Morrow collection is Lophophyllidium profundum. This is a small species which is usually found in fragments . An average specimen measures 21 mm. long and 9. 5 mm. wide at the base of the calyx. Internally the species is divided by approximately thirty or more septa which join together in the center to form a columella. No short secondary septa can be seen. Externally the inter-septa ridges are very prominent, but intersity of growth lines varies.

Locality: 1, 28.

ARTHROPODA

AMEURA SANGAMONENSIS (Meek and Worthen)

Plate I, Fig. 2.

1865. Phillipsia sangamonensis Meek and Worthen, Acad. Nat. Sci. Philapelphia Proc., p. 271.

1936. Ameura sangamonensis, Weller, Jour. of Paleo. vol. 10, no. 8, p. 713.

This species is the lone representative of the phylum Arthropoda which occurs in the Morrow collection. Only the pygidium has been found, the cephalon and thorax do not occur in the writer's collection. The pygidium

varies from six to ten mm. long and eight to ten mm. across at its anterior margin. It is sharply divided into an axial lobe and two pleural lobes. A fine groove occurs near both lateral margins of the axial lobe. The four specimens at hand have from ten to twenty segments in the pleural lobes, and from thirteen to twenty-four segments in the axial lobe.

Locality: 12, 13, 14, 15, 16, 17, 18, 19, 20, 21.

MOLLUSKA

PLEUROTOMARIA? SP. A.

Plate I, Figs. 3a-3c.

Two steinkerns representing possibly two species of Pleurotomaria are included with the Morrow collection. Specific identification is difficult due to lack of ornamentation. Both specimens are moderately high spired, and both have three whorls. The aperatures are suboval and about four mm. in diameter. The apical angle is about 73º Fine longitudinal lirae are visible on the second specimen. The larger of the two is six mm. high, with a width about equal to the height. The smaller is three and one half mm. high and has a width equal to the height.

Locality: 12.

PLEUROTOMARIA? SP. B.

Plate I, Fig. 4.

Two poorly preserved steinkerns identified as Pleurotomaria are included in the Morrow collection. Specific identification is difficult due to poor preservation. The specimens are moderately high spired with three

whorls being present. The apical angle is about 82.° The best preserved of the two specimens measures nine mm. high and twelve mm. across.

Locality: 12.

PLEUROTOMARIA? SP. C.

Plate I, Fig. 5.

One poorly preserved individual identified as Pleurotomaria was found in the Morrow collection. Specific identification is difficult due to poor preservation. It is a nearly complete steinkern. Fine lirae are present which form angles of 132° with the whorls. Three whorls are present on the specimen. The specimen is eleven mm. high and twelve mm. across.

Locality: 12.

NUCULA SP.

Plate I, Figs. 6a, 6b.

Two individuals of this genus were found in the Morrow collection. Specific identification is difficult due to poor preservation. Both individuals are nearly complete steinkerns. The valves and beaks are evenly convex and the shell has a suboval outline. Concentric growth lines are present, one individual having coarser markings than the other. Two different species may be present.

Locality: 1, 66.

length	width	thickness
11.5 mm.	16 mm.	8.6 mm.
10.0 mm.	12 mm.	6.8 mm.

SCHIZODUS? SP.

Plate I, Figs. 7a, 7b.

One individual of this genus was found in the Morrow collection. Specific identification is difficult due to poor preservation. It is a nearly complete steinkern. The shell is suboval in outline. Both valves are evenly convex as are the beaks. The specimen measured 23.5 mm. long, 26 mm. wide, and 14 mm. thick.

Locality: 1.

ALLORISMA? SP.

One poorly preserved fragment was found in the Morrow collection which is believed to be an Allorisma. Specific identification is difficult due to poor preservation. The valves are evenly convex and display a system of concentric costae.

Locality: 33.

PECTINID PELECYPOD

A few scattered pectinid pelecypods occur in the Morrow collection. Due to poor preservation generic classification is impossible. The specimens are coarsely plicate with the plications being broad and rounded. At thirty mm. from the beak seven to nine plications occur within a space of thirty mm. At regular intervals the plications are crossed by heavy concentric serrate growth lines, giving the shell a crenulated appearance.

Locality: 1.

BRYOZOA

STENOPORA SP.

Plate I, Figs. 8a, 8b.

One species of Stenopora is found abundantly in the Morrow collection. Specific identification is difficult and the species may be undescribed. The zoaria is ramose. The zooecia are thickwalled and circular. The zooecia are about .4 mm. across and one or two zooecia occur within one mm. Acanthopours are abundant between the zooecia tubes.

Locality: 4, 13, 14, 18, 19, 20, 21, 23, 27, 28, 29, 32.

FISTULIPORA INCRUSTANS Moore

Plate I, Figs. 9a, 9b.

1929. Fistulipora incrustans Moore. Jour. of Paleo. vol. 3, pl. I. figs. 1-4, 6, 8.

Fistulipora incrustans is abundant in the Morrow collection. It is always found encrusted upon other forms of life, usually brachiopods. The apertures are circular and measure .2 or .3 mm. across. Two or three zooecia occur within one mm. The zoarium is about one half mm. thick, this thickness representing the maximum length of the zooecia tube. The apertures do not maintain a symmertrical pattern. A few small mesopores occur in association with the zooecia.

Locality: 4, 13, 14, 18, 19, 20, 21, 23, 26, 27, 28, 29, 32.

POLYPORA TRISERIATA Mather

Plate I, Figs. 10a, 10b.

1915. Polypora triseriata Mather. Bull. Sci. Lab. Denison Univ. vol. XVIII, p. 116, pl. V, figs. 2-3.

Polypora triseriata is abundant within the Morrowan rocks. Its zoaria are characteristically fenestrate and fan shaped. The fenestruls are circular, oval, or kidney-shaped. An average circular fenestrule is from 0.2 to 0.4 mm. in diameter and thirteen or fourteen fenestruls occur in ten mm. longitudinally. The apertures average 0.1 mm. in diameter and are arranged in three rows along the branch. Fourty-five or fifty apertures occur within ten mm. Seven adjacent apertures form a hexagonal pattern.

Locality: 2, 9, 13, 14, 15, 17, 18, 19, 20, 21, 23, 24, 27, 28, 29, 32.

TABULIPORA CARBONARIA (Worthen)

Plate I, Figs. 11a, 11b.

1875. Chaetetes? carbonaria Worthen, Geol. Surv. III., vol. 6, p. 526. pl. XXXII, fig. 5.

1887. Stenopora carbonaria, Foerste, Bull. Sci. Lab. Den. Univ., vol. 2, p. 85, pl. VIII, figs. 13a-c.

1912. Tabulipora carbonaria, Lee, The British Carb. Trepostomata. G. Brit. Geol. Surv., Mem., Paleo. vol. 1, pt. 3, p. 135-195, pl. 14-16.

Tabulipora carbonaria occurs at only one locality in the Morrowan sections, and is not very abundant. The zoaria forms a branch measuring from four mm. to ten mm. across. No zoarium was found with a length greater than twenty-six mm. The zooecia are circular and measuretwo mm. across. Three or four zooecia occur within one mm. The zooecia do not maintain a

symmetrical pattern. Abundant acanthopores occur with the zooecia. They are circular and measure between 0.05 and 0.1 mm. across.

Locality: 26.

RHOMBOPORA LEPIDODENDROIDES Meek

Plate I, Figs. 12a - 12c.

1872. Rhombopora lepidodendroides Meeks U.S. Geol. Surv. Neb., p. 141, pl. 7. figs. 2a-f.

Rhombopora lepidodendroides occurs abundantly in the Morrow collection. Fragments range in diameter from one to three mm. Some specimens range in length up to slightly greater than twenty mm. Four bifurcations are present on some specimens, but the majority branch only once. The zooecia are arranged in a symetrical quincunz pattern developed by three intersecting rows. One row is perpendicular to the length of the zoarium, the other two rows of zooecia form angles at 62° 30' with the first row. A few diaphragms can be seen, but no hemisepta can be located in the specimens at hand. An average aperture is 0.1 mm. across. About twenty zooecia occur within a length of ten mm. No complete zoaria were observed.

Locality: 2, 3, 9, 13, 14, 15, 16, 17, 18, 19, 20, 21, 23, 24, 26, 27, 28, 29, 32.

PINNIRETOPORA CONFERTA Ulrich

Plate I, Figs. 14a-14d.

1890. Pinnatopora conferta Ulrich. Geol. Surv. III., VIII, p. 618, pl. LVI, fig. 6.

Pinniretopora conferta is limited to a thin local bed in the Morrowan

rocks. It is abundant, however, within this unit. The zoaria have a pinnate form with a midrib that averages approximately one half mm. wide and contains two rows of alternating zooecia. These are separated by a high rounded median keel. The branches average 0.2 mm. wide and are evenly spaced with five or six branches occuring within five mm. The branches also contain a double row of alternating zooecia separated by a high rounded median keel. The apertures average 0.1 mm. in diameter and are circular to kidney shaped, with three or four occuring within a space of one mm.

Locality: 25.

BRACHIOPODA

DERBYIA CRASSA (Meek and Hayden)

Plate I, Figs. 14a-14b.

1858. Orthisina crassa Meek and Hayden, Proc. Acad. Nat. Sci. Phila., vol. 10, p. 261.

1884. Derbyia crassa, Waagen, India Geol. Surv. Mem., Palaeontologia Indica, ser. 13, vol. 1, p. 592.

This common species in the Morrow collection shows wide variation in length, width, and thickness. Many individuals were weathered free, but seldom perfectly preserved. The collected specimens vary from fifteen mm. to forty mm. long and twenty mm. to fifty mm. wide. The brachial valve is slightly convex with the greatest convexity about two-thirds the distance from the anterior margin to the umbo. The pedicle valve is relatively flat but may be slightly convex or slightly concave, occasionally forming a resupinate outline. The surfaces of both valves are marked by narrow, ele-

vated lirae whose tops are sharply rounded, and whose sides are sometimes concave. These lirae are separated by wide flat bottomed striae. The coarseness of the lirae vary, one strong lirae being separated by one, two, or three fine lirae. At a distance of thirty-five mm. from the beak from fifteen to twenty lirae are found within a space of ten mm. Fine concentric growth lines which give the shell a crenulate appearance are present on each valve.

Locality: 1, 2, 10, 24.

DERBYIA ROBUSTA (Hall)

Plate I, Figs. 15a, 15b.

1858. Orthis robusta Hall, Geol. Iowa, vol. 1, pt. 2, p. 713, pl. 28, figs. 5a-d.

1892. Derbya robusta, Hall and Clarke, Pal. N. Y. , vol. 8, pt. 1, pl. X, figs. 14-15.

Derbyia robusta is one of the most abundant species in the Morrow collection. Most of the collected specimens are quite uniform in size, being about forty mm. long and fifty-five or sixty mm. wide. Convexity of the shell is variable. The brachial valve is quite convex with the greatest convexity about two-thirds the distance from the anterior margin to the umbo. The pedicle valve is almost flat, displaying only a slight convexity. The surfaces of both valves are marked by narrow elevated lirae which originate near the beak and radiate to the anterior and lateral margins. The lirae are separated by wide flat-bottomed striae. At thirty-five mm. from the beak about sixteen lirae are found within a width of ten mm. Occasionally

concentric growth lines are present.

Locality: 1, 2, 9, 10, 11, 12, 28, 19, 29, 30, 32.

HUSTEDIA MISERI Mather

Plate II, Figs. 1a-1c.

1915. Hustedia miseri Mather, Bull Sci. Lab. Denison Univ., p. 196, pl. XIII, figs 4-6c.

A few well preserved speciments of Hustedis miseri were found in the Morrow collection. The shell is subtriangular in outline. The valves are evenly convex with the greatest convexity occuring near the umbo. The brachial beak is low and rounded and rises little above the hinge line. The pedicle beak is high and rounded and rises well above the hinge line. The surface of each valve is characterized by about twenty-four strong costae which begin at the umbo and radiate to the anterior margins. Some individuals display a faint mesial sinus which causes a faint emargination of the anterior margin. The Utah specimens are consistently larger than the specimens listed by Mather (1915, p. 196), but the length-width ratios compare favorably.

Locality: 1.

length	width	l:w ratio	thickness
10.5 mm.	9.2 mm.	1:1.11	7.0 mm.
9.0 mm.	7.0 mm.	1:1.29	5.0 mm.
10.2 mm.	8.5 mm.	1:1.20	-------
9.0 mm.	8.0 mm.	1:1.12	5.0 mm.

LISSOCHONETES GEINITZIANUS (Waagen)

Plate II, fig. 2.

1884. Chonetes geinitzianus Waagen, Pal. Indica, ser. 13, I, p. 621.

1932. Lissochonetes geinitzianus, Dunbar and Condra. Neb. Geol. Surv. Bull. 5, 2 ser., p. 170, pl. XX, figs. 53-57.

This is an abundant species in the Morrow fauna although its vertical range is limited. Its length-width ratio is variable, with the hinge line representing the widest point on the shell. The surface of the shell is smooth, although fine growth lines are sometimes visible. Weathered mature individuals frequently show no growth lines. Evidence of spines is lacking, although the genus is known to posses them. A broad brachial fold and pedicle sinus are present but they are indistinct on most specimens. Many individuals of this species were collected, but only one was completely weathered free of matrix and it is deformed. Therefore, the correct thickness of the Morrow specimens is unknown.

Locality: 6, 10, 13, 29.

length	width	l:w ratio
8.5 mm.	11.4 mm.	1:1.34
8.1 mm.	13.0 mm.	1:1.60
6.6 mm.	10.0 mm.	1:1.51
8.1 mm.	14.2 mm.	1:1.75
8.2 mm.	13.0 mm.	1:1.58

PUSTULA GLOBOSA Mather

Plate II, figs. 3a-3e.

1915. Pustula globosa Mather, Bull. Sci. Lab. Denison Univ., vol. XVIII, p. 167, pl. X, figs. 7-9.

Although this species is never found weathered free of matrix, it is abundant in the Morrow collection. The shell is subhemispherical in shape. The hinge line is slightly narrower than the greatest width of the shell. The pedicle beak is small and incurved over the hinge line. The strongly convex pedicle valve contains a few scattered spine bases. The brachial valve is concave with the anterior extremities being abruptly deflected.

Locality: 7.

length	width	l:w ratio	thickness
8.0 mm.	8.0 mm.	1:1	4.0 mm.
8.0 mm.	8.0 mm.	1:1	4.2 mm.
8.0 mm.	8.5 mm.	1:1.06	4.0 mm.
8.4 mm.	8.4 mm.	1:1	4.1 mm.
8.7 mm.	8.6 mm.	1:0.99	4.4 mm.
7.8 mm.	8.0 mm.	1:1.03	3.7 mm.
7.2 mm.	7.8 mm.	1:1.08	5.0 mm.
8.2 mm.	8.6 mm.	1:1.05	5.8 mm.
9.0 mm.	9.0 mm.	1:1	5.5 mm.
9.8 mm.	10.2 mm.	1:1.04	5.8 mm.

JURESANIA NEBRASCENSIS (Owen)

Plate II, figs. 4a-4d

1852. Productus nebrascensis Owen, Geol. Rept. Wis., Iowa, and Minn., p. 584, pl. 5, fig. 3.

1932. Juresania nebrascensis, Dunbar and Condra, Neb. Geol. Surv., Bull. 5, 2 ser., p. 195, pl. XXII, figs. 1-9, 13.

Juresania nebrascensis is found in association with other productidae, but is relatively rare. The dimensions of the collected specimens are quite consistant, averaging about twenty-five mm. wide, with the length about equal to the width. The hinge line is commonly about two thirds the greatest width of the shell. A broad, very shallow sinus is present along the medial

portion of the pedicle valve. The surface of the pedicle valve is marked by a series of even costae, about ten occupying a space of ten mm. at a distance of forty-five mm. from the beak. Wide concentric growth lines cross the costae and characteristically form a series of spine bases. These spine bases give the surface of some specimens a rough spinose appearance. Large extended ears appear on some individuals and when present are marked by heavy growth lines. The brachial valve, when preserved, is slightly concave. Its' appearance is much smoother than the pedicle valve, but it does have a series of spine bases which outline the concentric growth lines.

Locality: 12.

DICTYOCLOSTUS PORTLOCKIANUS (Norwood and Pratten)

Plate II, figs. 5a-5c.

1854. Productus portlockianus Norwood and Pratten, Jour. Acad. Nat. Sci. Phila., vol. III, p. 15, pl. I, figs. 9a-c.

1932. Dictyoclostus portlockianus, Dunbar and Condra, Neb. Geol. Surv., Bull. 5, 2 ser. p. 215, pl. XXXIII, figs. 1-3.

This species is found in association with other productidae and is quite abundant in the Morrow collection. The pedicle valve is extremely convex, one well preserved specimen forming an angle of nearly 360° from the end of the umbo at the hinge line, to the anterior margin. The brachial valve is seldom preserved, but is slightly concave. The greatest width of the shell is represented by the hinge line in well preserved specimens and extends up to thirty-five mm. The length of the shell is about equal to the width. The pedicle valve is coarsely costate, and at fifty mm. from the beak seven or eight uneven costae occur within a width of ten mm. These

uneven costae give a rough and irregular appearance to the surface of the shell. A few heavy spine bases are scattered over the shell, most of them being about four mm. apart. A narrow fairly deep sinus is developed on the median portion of the pedicle valve. It begins near the end of the umbo and extends to the anterior margin. Fairly large ears which are marked by concentric lines of growth are found on well preserved specimens. These growth lines may extend over the visceral portion of the shell giving it a reticulate appearance.

Locality: 1, 2, 4, 5, 13, 14, 18, 19, 20, 21, 22, 23, 27, 29.

DICTYOCLOSTUS MORROWENSIS (Mather)

Plate II, figs. 6a-6c.

1915. Productus morrowensis Mather. Bull. Sci. Lab. Denison Univ., vol. XVIII, p. 152, pl. X, figs. 1-4a.

This is one of the more abundant species in the Morrow fauna and has a wide geographic but limited stratigraphic extent. Several specimens were cut along the midsagittal plane. All lacked the diaphragm which characterizes Productus (Dunbar and Condra, 1932, p. 191). For this reason Productus morrowensis of Mather (1915, p. 152) is now placed in the genus Dictyoclostus. This is a medium sized Dictyoclostus having a width of not greater than 35 mm., with the hinge line being equal or almost equal to the greatest width. The length is about equal to the width. Costae on the pedicle valve average about 15 in a space of ten mm. This is a greater number than any other known species of this genus. The exterior of the visceral region is characterized by numerous concentric

growth lines which extend for ten to twenty mm. from the beak. The concentric growth lines crossing the costae form a reticulate pattern and is a consistent character of this species. A few spine bases are found on the convex pedicle valve and are usually spaced between five and ten mm. apart. Near the anterior margin these spine bases cause bifurcation of the costae. Productus inflatus of Girty (1903, p. 359), and Productus coloradoensis of Girty (1927, pl. 27) may be the same species.

Locality: 2, 7, 12, 22, 23, 28, 29.

LINOPRODUCTUS OVATUS (Hall)

Plate II, figs. 7a-7c.

1858. Productus ovatus Hall, Geol. Iowa, vol. I, pt. 2, p. 674, pl. 24, fig. 1.

1927. Linoproductus cora, Chao, Productidae of China, pt. 1, pal. Sinica, ser. B, vol. 5, fas. 2, pp. 132-134, pl. 13, figs. 17-18, pl. 14, figs. 1-4.

Linoproductus ovatus occurs abundantly in the Morrowan rocks of Central Utah in association with other productids. It varies in size up to a maximum width of thirty-five mm. Its length is unknown from the specimens on hand, but in all cases the length appears to be greater than the width. The hinge line is narrow for a productid; being one-half to two-thirds the total width of the shell. The ears are small and contain wrinkles which extend onto the cardinal extremities and lateral slopes. No wrinkles or concentric growth lines are found on the median portion of the pedicle valve, making the shell non-reticulate. The fine plications which characterize the genus are evenly spaced, consistent in size, and number between fifteen and twenty in

a space of ten mm. A few scattered spine bases are found on the shell.

Locality: 2, 3, 7, 8.

PUGNAX WEEKSI Girty

Plate III, figs. 1a-1d.

1908. Pugnax weeksi Girty, U. S. Mus., Proc., vol. 34, p. 296.

One well preserved specimen of this species was collected from the Morrowan rocks. Although no dimensions are listed by Girty (1910, p. 31) it is assumed that the individual at hand is a juvenile. The specimen is 5.4 mm. long, 5 mm. wide, and 2.8 mm. thick with a length-width ratio of 1:0.93. The shell has a subtriangular outline with the brachial valve being moderately convex and the pedicle valve being slightly convex. The brachial valve contains a low broad fold which is divided into two heavy plications by a broad sulcus. Two heavy plications also appear on each lateral slope, with a third rudimentary plication beginning to appear on the extreme lateral margin. The sulci adjacent to the medial fold are extremely accentuated and penetrate to the maximum convexity of the pedicle valve. The fold, plications, and sulci are well defined along the lateral and anterior margins but become indistinct toward the umbonal region. The pedicle valve contains a corresponding sinus which is divided by a median plication. This results in two sulci within the sinus. Each lateral slope contains three plications and three sulci.

Locality: 1.

PUGNOIDES TRIANGULARIS Mather

Plate III, figs. 2a-2e.

1915. Pugnoides triangularis Mather, Bull. Sci. Lab. Denison Univ., vol. XVIII, p. 175, pl. XII, figs. 12-12c.

Several well preserved specimens of Pugnoides triangularia were collected from the Morrowan rocks. The shell is subtriangular in outline. The brachial valve is greatly convex with the greatest convexity being toward the umbo. The brachial valve contains a low beak which rises little above the hinge line. The pedicle valve is slightly convex and contains a high narrow beak. This species is characterized by ten broad prominent plications. The two medial plications on the pedicle valve are slightly deflected giving a false appearance of a sinus. The Utah specimens differ slightly in size and proportions with the specimens listed by Mather (1915, p. 175), but in general the specimens from the two localities are identical.

Locality: 1.

length	width	l:w ratio	thickness
7.9 mm.	6.3 mm.	1:0.80	4.0 mm.
8.0 mm.	6.6 mm.	1:0.82	4.0 mm.
6.6 mm.	6.0 mm.	1:0.91	3.9 mm.
5.6 mm.	5.3 mm.	1:0.95	2.9 mm.
5.4 mm.	5.0 mm.	1:0.96	2.5 mm.
8.5 mm.	7.6 mm.	1:0.90	4.7 mm.

DIELASMA SP.

Plate III, figs. 3a-3d.

Three individuals belonging to the genus Dielasma were found in the Morrow collection which cannot be included in any of the following species of Dielasma. Specific identification is difficult due to poor preservation. The

shell is subtriangular in outline, having a narrow beak and a wide anterior margin. The greatest width of the shell occurs just behind the anterior margin. The pedicle valve is greatly convex, while the brachial valve is medially convex. A very small pedicle sinus and brachial fold is present, but does not affect the convexity of the valves. One specimen is 9.8 mm. long, 6.6 mm. wide, 6.5 mm. thick, and has a length-width ratio of 1:0.67.

Locality: 1.

WELLERELLA OSAGENSIS (Swallow)

Plate III, figs. 4a-4e.

1858. Rhynchonella osagensis Swallow, Trans. St. Louis Acad. Sci., vol. 1, p. 219.

1932. Wellerella osagensis, Dunbar and Condra, Neb. Geol. Surv., Bull. 5, 2 ser., p. 288, pl. XXXVII, figs. 1-4.

Several well preserved specimens of Wellerella osagensis were collected from the Morrowan rocks. The shell is subtriangular in outline. The brachial valve is greatly convex with the greatest convexity occuring toward the umbo. The brachial valve contains a low, broad beak which rises little above the hinge line. The pedicle valve is somewhat flat, displaying convexity at the umbo and deflection at the anterior margin. The pedicle valve contains a high beak which is incurved over the brachial beak. The brachial valve is characterized by nine plications which begin between four and five mm. from the beak. The medial three plications form a fold on the brachial valve with a corresponding pedicle sinus. The Utah specimens are a little smaller than the individual listed by Dunbar and Condra (1932, p. 288), and their length-width ratios average a little smaller.. The difference

is consistent, but it is not considered of sufficient magnitude to erect a new species of Wellerella or variety of Wellerella osagensis.

Locality: 1, 5.

length	width	l:w ratio	thickness
8.2 mm.	8.3 mm.	1:1.01	4.5 mm.
9.4 mm.	9.4 mm.	1:1.00	5.1 mm.
7.7 mm.	8.6 mm.	1:0.90	5.6 mm.
8.4 mm.	7.8 mm.	1:1.08	4.8 mm.
8.2 mm.	8.6 mm.	1:1.10	5.7 mm.

DIELASMA BOVIDENS (Morton)

Plate III, figs. 5a-5e.

1836. Terebratula bovidens Morton, Am. Jour. Sci., vol. 29, p. 150.

1932. Dielasma bovidens, Dunbar and Condra. Neb. Geol. Surv., Bull. 5, 2 ser., p. 304, pl. XXXVII, figs. 33-34.

Two small specimens of Dielasma bovidens are included in the Morrow collection. The shell is elongate-suboval in outline. A characteristic brachial valve is evenly convex and contains an indistinct symmetrical medial fold. The brachial beak is low and rises little above the hinge line. Concentric growth lines are dominant on this valve. The pedicle valve contains a shallow narrow sinus which begins about one half the distance from the anterior margin to the beak. This fold causes a slight emargination of the anterior commissure which is evident upon both the brachial and pedicle valves. The pedicle beak is high and narrow and incurved over the brachial beak. The pedicle valve also contains distinct concentric growth lines.

Locality: 1.

length	width	l:w ratio	thickness
8.6 mm.	6.1 mm.	1:0.71	5.0 mm.
7.7 mm.	5.0 mm.	1:0.65	4.4 mm.

DIELASMA BILOBATUM Mather

Plate III, figs. 6a-6e.

1915. Dielasma bilobatum Mather. Bull. Sci. Lab. Denison Univ. vol. XVIII, p. 179, pl. XI, figs. 14-15b.

A few specimens of Dielasma bilobatum were found in the Morrow collection. The shell is elongate-suboval in outline. The pedicle valve contains a characteristic sinus which begins a little behind the mid-length of the valve. It is ill-defined for about two mm., then rapidly becomes a heavy deflection which produces an emargination of the anterior margin. The pedicle valve is greatly convex and possesses a high, wide beak which is incurved over the brachial beak. The brachial valve maintains an indistinct fold which is symmetrical across the entire shell. This valve is slightly convex and possesses a beak which rises little above the hinge line. The length-width ratios, which vary between 1:0.80 to 1:0.94, correspond with 1:0.86 of Mather's type (1915, p. 179).

Locality: 1.

length	width	l:w ratio	thickness
8.0 mm.	7.5 mm.	1:0.94	5.5 mm.
11.5 mm.	9.5 mm.	1:0.83	7.0 mm.
10.0 mm.	8.0 mm.	1:0.80	6.4 mm.

DIELASMA? SUBSPATULATUM Weller

1914. Dielasma subspatulatum Weller. Ill. Geol. Surv., Mon. I, p. 270, pl. 33, figs. 6-11.

One juvenile individual has been identified as Dielasma subspatulatum. It is spatuloid in outline and measures 5 mm. long, 3.7 mm. wide, and 2.2 mm. thick, and has a length-width ratio of 1:0.74. Both valves are slightly convex with the greatest convexity along the margins and the medial areas being quite flat. Neither valve contains a sinus or fold, and the anterior margin is straight. Pronounced concentric growth lines are present on each valve.

Locality: 1.

PUNCTOSPIRIFER KENTUCKYENSIS (Shumard)

Plate III, figs. 7a-7e.

1855. Spirifer kentuckyensis Shumard, Geol. Surv. Missouri, Ann. Rept. II, p. 203.

1932. Punctospirifer kentuckyensis, Dunbar and Condra, Nebr. Geol. Sur. Bull. 5, 2 ser. p. 334, pl XXXCIII, figs. 1-5.

A single complete specimen of Punctospirifer kentuckyensis was found in the Morrow collection. Five heavy plications occur on each lateral slope of the specimen, with a large medial plication forming a brachial fold. Sulci are found on the pedicle valve corresponding to the brachial plications. The punctae are located 0.1 to 0.2 mm. apart. They are arranged in a symmetrical pattern developed by alignment in four rows. One row is perpendicular to the length of the plications. Two of the other three rows form at angles of 66°, and one row is perpendicular to the first. The pedicle beak is pronounced but the brachial beak is low and rises little above the hinge line. The pedicle beak forms an angle of 150° with the commissure.

The single adult specimen in the writer's collection measures 13 mm. long, 21 mm. wide, and 10 mm. thick. This results in a length-width ratio of 1:1.61. From measurements by Dunbar and Condra (1932, p. 352) a ratio of 1:1.78 for this species can be calculated.

Locality: 1, 2, 5, 8, 19.

SPIRIFER ROCKYMONTANUS Marcou

Plate III, figs. 8a-8d.

1858. Spirifer rocky-montani Marcou, Geology of North America, p. 50, pl. VII, figs. 4c, d, e.

1903. Spirifer rockymontanus, Girty, U.S.G.S. Prof. Paper 16, p. 383, pl. VI, figs. 5-7c.

A single adult specimen of Spirifer rockymontanus was collected, but several juveniles are believed to be associated with it. The pedicle valve contains a broad shallow sinus which contains six costae. The brachial valve contains a broad fold which contains at least six costae, although the exact number is difficult to determine due to weathering. Each lateral slope on both the brachial and pedicle valve contains twelve costae. Superimposed upon the costae is a network of fine lirae which is crossed by another network of concentric lirae. Heavy concentric growth lines also are present. At a distance of 15 mm. from the beak the costae measure 0.5 to 1.5 mm. from the top of one costae to the top of the next costae. The pedicle beak is high and the interarea forms an angle of 160° with the commissure. The brachial beak is low and rises little above the hinge line. The specimen measures 16.6 mm. long, 22 mm. wide, and 12 mm. thick, and

has a length-width ratio of 1:1.32. Spirifer rockymontanus is often misidentified as Spirifer opimus. But, the ornamentation on Spirifer rockymontanus is finer than that found on Spirifer opimus. Also, Spirifer rockymontanus contains at least five costae in the pedicle sinus and six costae on the brachial fold. Spirifer opimus contains three costae in the sinus and four on the fold, these numbers being constant.

Locality: 1, 8.

SPIRIFER OPIMUS Hall

Plate III, figs. 9a-9d.

1858. Spirifer opimus Hall, Geol. of Iowa, vol. I, pt. II, p. 711, pl. XXVIII. figs. 1a-b.

Spirifer opimus is found abundantly in the Morrowan rocks of Central Utah. The brachial valve contains a large mesial fold which begins near the beak as a single costae. This costae bifurcates twice before reaching the anterior margin of the shell and results in four costae on the fold, the constant for this species. The two central costae are always larger. The pedicle valve contains a mesial sinus which bears three small costae. It originates near the apex of the beak between two large costae which continue anteriorly along the sinus and defines its lateral extent. There are ten costae present on each lateral slope of both the pedicle and brachial valves. At a distance of 15 mm. from the beak the costae measure 1.5 to 2.5 mm. from the top of one costae to the top of the next costae. The pedicle beak is high with the interarea being curved. The brachial beak is low and rises little above the hinge line. Spirifer opimus is commonly misidentified as Spirifer

rockymontanus. But, the ornamentation on Spirifer opimus is coarser than that found on Spirifer rockymontanus. Also, Spirifer opimus contains four costae on the brachial fold with three costae in the pedicle sinus, while Spirifer rocky-montanus contains six or more costae on the fold and five or more costae in the sinus.

Locality: 1, 8, 10, 12, 17, 24.

length	width	l:w ratio	thickness
18.0 mm.	25 mm.	1:1.39	12 mm.
19.0 mm.	26 mm.	1:1.37	13 mm.
23.0 mm.	24 mm.	1:1.04	16 mm.
20.5 mm.	21 mm.	1:1.02	15 mm.
16.0 mm.	21 mm.	1:1.31	12 mm.
17.5 mm.	24 mm.	1:1.37	12 mm.

NEOSPIRIFER CAMERATUS (Morton)

Plate III, figs. 10a-10d.

1836. Spirifer cameratus Morton, Amer. Jour. Sci., vol. XXIX, p. 150, pl. 2, fig. 3.

1932. Neospirifer cameratus, Dunbar and Condra, Neb. Geol. Surv., Bull. 5, 2 ser. p. 334, pl. XXXIX, figs. 4, 6-9a.

Neospirifer cameratus occurs abundantly in the Morrowan rocks. All the collected specimens are imperfect, with the lateral extremities and the umbo commonly being broken. On one nearly perfect specimen the hinge line is equal to the greatest width of the shell. The interareas also are incomplete on all the specimens, but three specimens have interarea angles of 142°, 146°, and 159°. An average specimen has a length of 28.5 mm., a width of 46.5 mm., and a thickness of 20.5 mm. This results in a length-width ratio of 1:1.62. From measurements by Dunbar and Condra (1932, p.

334) a ratio of 1:1.43 can be calculated for this species from their type description. Plications are low and rounded and the characteristic fasiculate bundling of the plications is obscure. The fold and sinus of the specimens in the authors collection varies from low and broadly rounded to greatly pronounced. The fold contains six plications while the sinus contains five. Twelve to fourteen plications occur upon each lateral slope.

Locality: 1, 8.

CLEIOTHYRIDINA ORBICULARIS (McChesney)

Plate IV, figs. 1a-1d.

1859. Athyris orbicularis McChesney, Descr. New Species Pal. Fossils, p. 47.

1915. Cleiothyridina orbicularis, Girty, U.S.G.S. Bull. 544, p. 101, pl. XII, figs. 1-3b.

Cleiothyridina orbicularis is represented in the Morrow collection by a few rather small specimens. A characteristic of these specimens is the almost complete lack of a fold or sinus, although in some specimens a rudimentary sinus has developed. Both valves are evenly convex with the greatest convexity being near the umbo. The brachial beak is low and rises little above the hinge line. The pedicle beak is broad and rises slightly above the hinge line. The shell is sub-oval in outline with the greatest width being near the midlength. Measurements show a wide range in length-width ratios. Three of the ten measured specimens have ratios less than 1:1.06 while seven have ratios of 1:1.11 or greater. This species is often misidentified as Composita wasatchensis or juveniles of Composita subtilita

and Composita ovata. Cleiothyridina orbicularis can be distinguished from the compositas by the sulcus which is often present in Composita, and by the greater antero-latero angle of Cleiothyridina orbicularis. This species has an antero-latero angle of 123° while Composita wasatchensis has an antero-latero angle of 102°.

Locality: 1.

length	width	l:w ratio	thickness
9.2 mm.	10.2 mm.	1:1.13	4.8 mm.
11.7 mm.	13.0 mm.	1:1.11	6.7 mm.
12.0 mm.	14.0 mm.	1:1.17	6.4 mm.
11.8 mm.	13.4 mm.	1:1.13	6.2 mm.
10.0 mm.	10.3 mm.	1:1.03	5.8 mm.
9.0 mm.	9.0 mm.	1:1.00	5.4 mm.
8.3 mm.	10.0 mm.	1:1.20	6.2 mm.
9.8 mm.	10.2 mm.	1:1.06	5.8 mm.
9.0 mm.	11.0 mm.	1:1.22	5.2 mm.
8.4 mm.	9.6 mm.	1:1.14	5.7 mm.

COMPOSITA GIBBOSA Mather

Plate IV, figs. 2a-2d.

1915. Composita gibbosa Mather, Bull. Sci. Lab. Denison Univ., vol. XVIII p. 204, Plate XIII, figs. 16-18c.

A few specimens of Composita gibbosa were found in the Morrow collection. The shell is sub-oval with the greatest width near the midlength or anterior to it. The pedicle valve is convex with the greatest convexity occuring at the umbo. A shallow pedicle sinus is present which contains a medial sulcus. The posterior-lateral margin of the pedicle valve is sometimes concave causing the umbo to be high, deep, and well defined. The brachial valve is convex with the posterior-medial portion being high and pronounced. A small brachial fold is present. Composita parva of Branson

(1930, p. 40) may be the same species.

Locality: 1.

length	width	l:w ratio	thickness
12.8 mm.	10.9 mm.	1:0.85	7.0 mm.
11.0 mm.	9.4 mm.	1:0.85	5.9 mm.
9.5 mm.	8.2 mm.	1:0.86	5.5 mm.
8.4 mm.	8.0 mm.	1:0.95	4.9 mm.
8.2 mm.	7.8 mm.	1:0.95	4.6 mm.

SQUAMULARIA? PERPLEXA (McChesney)

Plate IV, figs. 3a-3d.

1859. Spirifer perplexa McChesney, Descr. New Pal. Fossils, p. 43.

1903. Squamularia perplexa, Girty, U.S.G.S. Prof. Paper 16, pl. VI, figs. 8-10a.

One specimen of Squamularia perplexa is inclueded in the Morrow collection. Surface features were destroyed by weathering, thus identification is made only on the shape of the individual. The specimen is small being 13.6 mm. long, 13.8 mm. wide and 7.8 mm. thick. The length-width ratio of 1:1.01 compares favorably with the two specimens listed by Dunbar and Condra (1932, p. 314). The brachial valve is greatly convex with the greatest convexity being four mm. from the beak. The brachial valve is relatively flat, but contains a broad flat median fold.

Locality: 1.

COMPOSITA WASATCHENSIS (White)

Plate IV, figs. 4a-4d.

1877. Rhynchonella wasatchensis White, U.S.G.S., w. 100th. Merid., vol. 4, p. 130, pl. 9, figs, 3a-d.

1915. Composita wasatchensis, Mather, Bull. Sci. Lab. Denison Univ. vol. XVIII, p. 200, pl. XIV, figs. 7-10b.

Composita wasatchensis is abundant in the Morrow collection and is believed by Dunbar and Condra (1932, p. 371) to be juveniles of Composita subtilita and Composita ovata. But, Mather (1915, p. 201) points out that the similarities between these species are constant only with inmature individuals under 5 mm. in length. The shell is sub-oval with the greatest width near the midlength. The fold and sinus of Composita wasatchensis is entirely lacking or slightly accentuated in mature individuals. This contrasts with Composita ovata and Composita subtilita which have sinuses well developed within 5 mm. of the beak. When a sinus is present it contains a narrow sulcus which extends within 3 mm. of the beak. Both valves are convex, the pedicle valve showing the greater convexity and also containing a high umbo with a beak which is closly incurved over the brachial beak. The length-width ratio of Composita wasatchensis is reliably constant and averages 1:1.03 which varies from the average of 1:1.17 for the collected specimens of Composita subtilita and for Composita ovata according to Dunbar and Condra (1932, p. 371).

Locality: 1, 3, 8, 12, 17, 24, 28, 29.

length	width	l:w ratio	thickness
15.4 mm.	15.4 mm.	1:1.00	7.2 mm.
13.8 mm.	13.8 mm.	1:1.00	7.5 mm.
12.8 mm.	13.0 mm.	1:1.02	7.2 mm.
13.5 mm.	13.5 mm.	1:1.00	6.9 mm.
11.8 mm.	12.4 mm.	1:1.05	6.7 mm.
12.1 mm.	12.7 mm.	1:1.05	5.8 mm.
10.8 mm.	11.0 mm.	1:1.02	6.2 mm.
13.2 mm.	13.0 mm.	1:1.09	6.5 mm.
10.6 mm.	11.2 mm.	1:1.06	6.0 mm.
9.8 mm.	10.8 mm.	1:1.10	5.0 mm.

COMPOSITA SUBTILITA (Hall)

Plate IV, figs. 5a-5d.

1852. Terebratula subtilita Hall, Stansbury's Expl. and Surv., Great Salt Lake, p. 409, pl. IV, figs. 1a-2c.

1909. Composita subtilita, Girty. U.S.G.S. Bull. 389, p. 68.

Individuals of Composita subtilita are rare in the Morrow collection as compared to Composita ozarkana. The shell is subelongate-oval in outline. Individuals of Morrowan Composita subtilita have a broad brachial fold and pedicle sinus which begins to appear between one-third and one-half the distance between the beak and the anterior margin. This fold and sinus is usually not distinct until one-half to two-thirds the distance between the beak and anterior margin. Both valves are evenly convex, the pedicle valve having a high umbo with a beak closly incurved over the brachial beak. The length-width ratio of 1:1.15 to 1:1.19 for this species is distinct and contrasts with the subequal 1:0.9 to 1:1.0 ratio of the more abundant Composita ozarkana. The length-width ratio of the specimens in the writer's collection compares favorably with the individual listed by Dunbar and Condra (1932, p. 365) and will help to distinguish Composita subtilita from Composita argentea with which it is often confused.

Locality: 1, 2, 5, 12, 17, 24, 28, 29.

length	width	l:w ratio	thickness
21.2 mm.	18.2 mm.	1:1.15	11.8 mm.
19.5 mm.	16.7 mm.	1:1.17	11.6 mm.
25.0 mm.	21.0 mm.	1:1.19	13.0 mm.
18.6 mm.	16.0 mm.	1:1.16	11.2 mm.
16.3 mm.	14.0 mm.	1:1.16	9.6 mm.
19.6 mm.	16.8 mm.	1:1.17	11.2 mm.
17.4 mm.	15.4 mm.	1:1.13	9.0 mm.

COMPOSITA ELONGATA Dunbar and Condra

Plate IV, figs. 6a-6d

1932. Composita elongata Dunbar and Condra, Neb. Geol. Surv., Bull. 5, 2 ser., p. 371, pl. XLIII, figs. 20-24.

A few specimens of Composita elongata were found in the Morrow collection. The shell is elongate-oval. The brachial valve is greatly convex with the medial portion being very high due to a brachial fold which is defined almost to the beak. The pedicle valve is convex and becomes flattened about 7 mm. from the beak, then develops a shallow sinus. A sulcus is present on some individuals. The greatest width of the shell occurs about one-third the distance from the anterior to the posterior margin. The pedicle beak is high and curved over the brachial beak. The specimens in the writer's collection vary slightly from the original specimens of Dunbar and Condra (1932, p. 371) in having slightly greater widths.

Locality: 12, 17.

length	width	l:w ratio	thickness
17.0 mm.	12.0 mm.	1:0.71	9.2 mm.
15.4 mm.	10.7 mm.	1:0.69	9.8 mm.
13.8 mm.	10.8 mm.	1:0.78	8.0 mm.
19.0 mm.	14.5 mm.	1:0.76	11.2 mm.

COMPOSITA TRILOBATA Dunbar and Condra

Plate IV, figs. 7a-7e.

1932. Composita trilobata Dunbar and Condra, Neb. Geol. Surv., Bull. 5, 2 ser., p. 372, pl. XLIII, figs. 25-31.

Composita trilobata is found in the Morrow collection in association with other species of Compositas. A pair of broadly rounded sinuses occur

on either side of the brachial fold. These sinuses begin to develop about one-third the distance from the anterior margin and separate the brachial fold from the lateral slopes of the shell. This feature is distinctive and is not found on any other Pennsylvanian Composita. The pedicle valve contains a sinus and two pedicle folds. This sinus contains a narrow V-shaped sulcus which begins about five mm. from the beak. This sulcus is very prominent in some individuals while only poorly developed in others. The brachial valve is markedly convex near the beak, but only slightly convex near the anterior margin. The pedicle valve is evenly convex medially, but the pedicle folds diminish the convexity laterally. The pedicle umbo is high and its beak is closly incurved over the brachial beak. The greatest thickness of the shell occurs about one-third the distance from the anterior margin giving the shell a subtriangular outline. The length-width ratios vary slightly, but the dimensions of the specimens in the Morrow collection compare favorably with that listed by Dunbar and Condra (1932, p. 373). Coarse concentric growth lines occur on the surface of the shell and are crossed by fine lirae which radiate from the beak area.

Locality: 1, 24, 28, 29.

length	width	l:w ratio	thickness
24.3 mm.	22.0 mm.	1:0.91	15.4 mm.
21.6 mm.	18.4 mm.	1:0.85	14.8 mm.
14.6 mm.	13.6 mm.	1:0.93	10.2 mm.

COMPOSITA OZARKANA Mather

Plate IV, figs. 8a-8e.

1915. Composita ozarkana Mather, Bull. Sci. Lab. Denison Univ., vol.

XVIII p. 198, pl. XIII, figs. 11-15c.

Composita ozarkana is one of the most abundant species in the Morrow collection and is represented by individuals which vary in length from 17 to 27 mm. Both valves are evenly convex, the pedicle valve having a high umbo with a beak closly incurved over the brachial beak. The fold and sinus varies from poorly defined in some of the smaller individuals to well developed in some of the larger individuals. A median sulcus is always present within the sinus and may extend within two or three mm. from the beak. The shells are sub-oval in outline. Tabulations of lengths and widths show that forty percent of the specimens are slightly longer than wide, thirty percent are as long as they are wide, and thirty percent are slightly wider than long. The length-width ratios range from 1:0.88 to 1:1.08. The measurements are more variable than the three individuals which are listed by Mather (1915, p. 187), his ratios range from 1:0.99 to 1:1.01.

Locality: 1, 2, 8, 12.

length	width	l:w ratio	thickness
25.7 mm.	24.5 mm.	1:0.95	13.0 mm.
23.0 mm.	23.5 mm.	1:1.02	15.0 mm.
23.7 mm.	24.0 mm.	1:1.01	14.0 mm.
23.5 mm	21.0 mm.	1:0.89	13.5 mm.
23.5 mm.	21.5 mm.	1:0.92	13.0 mm.
21.5 mm.	22.5 mm.	1:1.04	11.0 mm.
20.5 mm.	21.0 mm.	1:1.02	12.0 mm.
20.0 mm.	18.5 mm.	1:0.92	10.5 mm.
21.0 mm.	18.5 mm.	1:0.88	12.0 mm.
18.5 mm.	17.0 mm.	1:0.92	11.0 mm.
18.5 mm.	17.5 mm.	1:0.95	11.0 mm.
17.5 mm.	19.0 mm.	1:1.07	10.0 mm.
18.0 mm.	18.0 mm.	1:1.00	9.0 mm.
18.0 mm.	16.0 mm.	1:0.89	9.5 mm.
17.0 mm.	17.0 mm.	1:1.00	10.5 mm.
16.5 mm.	16.5 mm.	1:1.00	9.0 mm.
19.0 mm.	20.0 mm.	1:1.05	10.5 mm.
20.0 mm.	20.0 mm.	1:1.00	10.7 mm.
18.5 mm.	18.5 mm.	1:1.00	10.0 mm.
17.2 mm.	17.2 mm.	1:1.00	9.0 mm.

SCHIZOPHORIA TEXANA Girty

Plate IV, figs. 9a-9f.

1927. Schizophoria texana Girty, U. S. G. S. Prof. Paper 152, p. 432, pl. 27 figs. 1-8.

Adults of this species are restricted to two horizons in the writer's sections, but are extremely abundant there. Schizophoria texana can be identified by the deep pedicle sinus which has its beginning on an average sized individual between five and ten mm. from the beak. The pedicle valve is slightly convex, while the brachial valve is greatly convex. Both umbos are of equal height. The pedicle interarea is slightly curved and forms an obtuse angle with the commissure. The brachial interarea forms a reflex angle with the commissure. The length-width ratios vary from 1:1. 0 to 1:1. 33. This ratio compares favorably with the two specimens listed by Newell (1934, p. 425) which show ratios of 1:1. 06 and 1:1. 08. The Utah specimens are larger than those listed from Kansas and Oklahoma (Newell, 1934, p. 425) in respect to lengths and widths. The Utah specimens show considerable variation in thickness indicating that the shells are deformed. This species is found in association with Schizophoria altirostris which it closly resembles.

Locality: 12, 26.

length	width	l:w ratio	thickness
30. 0 mm.	35. 0 mm.	1: 1. 17	12. 5 mm.
24. 5 mm.	30. 0 mm.	1: 1. 23	9. 5 mm.
24. 5 mm.	27. 5 mm.	1: 1. 15	8. 0 mm.
24. 5 mm.	27. 0 mm.	1: 1. 14	7. 0 mm.
25. 0 mm.	27. 0 mm.	1: 1. 08	8. 0 mm.
18. 8 mm.	23. 0 mm.	1: 1. 22	13. 6 mm.
24. 5 mm.	24. 5 mm.	1: 1. 00	16. 0 mm.
18. 0 mm.	19. 0 mm.	1: 1. 05	9. 5 mm.
22. 0 mm.	25. 0 mm.	1: 1. 14	14. 0 mm.

Schizophoria texana (continued)

length	width	l:w ratio	thickness
23.0 mm.	25.5 mm.	1:1.11	13.5 mm.
17.3 mm.	23.0 mm.	1:1.33	15.0 mm.
19.0 mm.	21.2 mm.	1:1.12	13.5 mm.
18.5 mm.	20.6 mm.	1:1.11	15.0 mm.
21.5 mm.	24.0 mm.	1:1.11	19.0 mm.
21.5 mm.	27.5 mm.	1:1.26	18.5 mm.

SCHIZOPHORIA ALTIROSTRI (Mather)

Plate IV, figs. 10a, 10b.

1915. Rhipidomella altirostris Mather, Bull. Sci. Lab. Denison Univ., vol. XVIII, p. 143, pl. VIII, figs. 5-5c.

1922. Schizophoria altirostris, Morningstar, Geol. Surv. Ohio, 4th ser., Bull. 25, p. 176.

Schizophoria altirostris is restricted to a single horizon in the writer's sections and is found in association with Schizophoria texana, but it is not as abundant as the latter. Both valves are convex with the brachial valve showing the greater convexity. Both beaks are even in height, and the interareas slope away from each other forming obtuse angles with the commissure. The length-width ratios of the Utah specimens compare favorably with the individual listed by Morningstar (1922, p. 176), although the thicknesses are continually smaller. Crushing of the specimens has taken place which accounts for this discrepancy. This species is often misidentified as Schizophoria resupinoides which it resembles closly, the chief difference being the larger size of Schizophoria resupinoides (Morningstar, 1922, p. 176). Schizophoria altirostris can be distinguished from Schizophoria texana by its pedicle sinus which is entirely lacking or only slightly present.

Locality: 26

length	width	l:w ratio	thickness
26.6 mm.	28.5 mm.	1:1.07	12.6 mm.
22.5 mm.	26.5 mm.	1:1.18	12.8 mm.
22.6 mm.	25.3 mm.	1:1.12	13.0 mm.
20.6 mm.	23.5 mm.	1:1.14	10.4 mm.
17.0 mm.	19.5 mm.	1:1.15	9.0 mm.

REGISTER OF LOCALITIES

1. Five-Mile Pass Quadrangle: "Fossil Hill" 0.2 mile north of center of sec. 10. T. 7 S., R. 3 W.

2. Five-Mile Pass Quadrangle: 5-mile pass sec. S. E. 1/4, sec. 10, T. 7 S, R. 3 W. 144' Stratigraphically above bottom of Morrow.

3. Five-Mile Pass Quadrangle: 5-mile pass sec. S. E. 1/4, sec. 10, T. 7 S, R. 3 W. 145' stratigraphically above bottom of Morrow.

4. Five-Mile Pass Quadrangle: 5-mile pass sec. S. E. 1/4, sec. 10, T. 7 S, R. 3 W. 155' stratigraphically above bottom of Morrow.

5. Five-Mile Pass Quadrangle: 5-mile pass sec. S. E. 1/4, sec. 10, T. 7 S, R. 3 W. 190' stratigraphically above bottom of Morrow.

6. Five-Mile Pass Quadrangle: 5-mile pass sec. S. E. 1/4, sec. 10, T. 7 S, R. 3 W. 150' stratigraphically below top of Morrow.

7. Five-Mile Pass Quadrangle: Flat-iron mt. sec. N. E. 1/4, sec. 28, T. 7 S, R. 3 W. base of Morrow.

8. Five-Mile Pass Quadrangle: Flat-iron mt. sec. N. E. 1/4, sec. 28, T. 7 S, R. 3 W. 12' stratigraphically above bottom of Morrow.

9. Five-Mile Pass Quadrangle: Flat-iron mt. sec. N. E. 1/4, sec. 28, T. 7 S R. 3 W. 15' stratigraphically above bottom of Morrow.

10. Five-Mile Pass Quadrangle: Flat-iron mt. sec. N. E. 1/4, sec. 28, T. 7 S, R. 3 W. 136' stratigraphically above bottom of Morrow.

11. Five-Mile Pass Quadrangle: Flat-iron mt. sec. N. E. 1/4, sec. 28, T. 7 S, R. 3 W. 164' stratigraphically above bottom of Morrow.

12. Five-Mile Pass Quadrangle: Flat-iron mt. sec. N. E. 1/4, sec. 28, T. 7 S, R. 3, W. 183' stratigraphically above bottom of Morrow.

13. Five-Mile Pass Quadrangle: Flat-iron mt. sec. N. E. 1/4, sec. 28, T. 7 S, R. 3 W. 211' stratigraphically above bottom of Morrow.

14. Five-Mile Pass Quadrangle: Flat-iron mt. sec. N. E. 1/4, sec. 28, T. 7 S, R. 3 W. 238' stratigraphically above bottom of Morrow.

15. Five-Mile Pass Quadrangle: Flat-iron mt. sec. N. E. 1/4, sec. 28, T. 7 S, R. 3 W. 255' stratigraphically above bottom of Morrow.

16. Five-Mile Pass Quadrangle: Flat-iron mt. sec. N. E. 1/4, sec. 28, T. 7 S R. 3 W. 265' stratigraphically above bottom of Morrow.

17. Five-Mile Pass Quadrangle: Flat-iron mt. sec. N.E. 1/4, sec. 28, T. 7 S, R. 3 W. 330' stratigraphically above bottom of Morrow.

18. Five-Mile Pass Quadrangle: Flat-iron mt. sec. N. E. 1/4, sec. 28, T. 7 S, R. 3 W. 377' stratigraphically above bottom of Morrow.

19. Five-Mile Pass Quadrangle: Flat- iron mt. sec. N. E. 1/4, sec. 28, T. 7 S, R. 3 W. 419' stratigraphically above bottom of Morrow.

20. Five-Mile Pass Quadrangle: Flat-iron mt. sec. N. E. 1/4, sec. 28, T. 7 S, R. 3 W. 461' stratigraphically above bottom of Morrow.

21. Five-Mile Pass Quadrangle: Flat-iron mt. sec. N. E. 1/4, sec. 28, T. 7 S, R. 3 W. 471' stratigraphically above bottom of Morrow.

22. Five-Mile Pass Quadrangle: Flat-iron mt. sec. N. E. 1/4, sec. 28, T. 7 S, R. 3 W. 565' stratigraphically above bottom of Morrow.

23. Five-Mile Pass Quadrangle: Flat-iron mt. sec. N. E. 1/4, sec. 28, T. 7 S, R. 3 W. 648' stratigraphically above bottom of Morrow.

24. Five-Mile Pass Quadrangle: Flat-iron mt. sec. N. E. 1/4, sec. 28, T. 7 S, R. 3 W. 693' stratigraphically above bottom of Morrow.

25. Five-Mile Pass Quadrangle: Flat-iron mt. sec. N. E. 1/4, sec. 28, T. 7 S, R. 3 W. 947' stratigraphically above bottom of Morrow.

26. Five-Mile Pass Quadrangle: Flat-iron mt. sec. N. E. 1/4, sec. 28, T. 7 S, R. 3 W. 960' stratigraphically above bottom of Morrow.

27. Bridal Veil Falls Quadrangle: Rotary Park sec. N 1/2, sec. 33, T. 5 S, R. 3 E. 70' stratigraphically above bottom of Morrow.

28. Bridal Veil Falls Quadrangle: Rotary Park sec. N 1/2, sec. 33, T. 5 S, R. 3 E. 104' stratigraphically above bottom of Morrow.

29. Bridal Veil Falls Quadrangle: Rotary Park sec. N 1/2, sec. 33, T. 5 S, R. 3 E. 132' stratigraphically above bottom of Morrow.

30. Bridal Veil Falls Quadrangle: Rotary Park sec. N 1/2, sec. 33, T. 5 S, R. 3 E. 150' stratigraphically above bottom of Morrow.

31. Bridal Veil Falls Quadrangle: Rotary Park sec. N 1/2, sec. 33, T. 5 S, R. 3 E. 154' stratigraphically above bottom of Morrow.

32. Bridal Veil Falls Quadrangle: Rotary Park sec. N 1/2, sec. 33. T. 5 S, R. 3 E. 205' stratigraphically above bottom of Morrow.

33. Bridal Veil Falls Quadrangle: Rotary Park sec. N 1/2, sec. 33, T. 5 S, R. 3 E. 152' stratigraphically below top of Morrow.

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PLATE I


1


2


3a


3b


3c


4


5

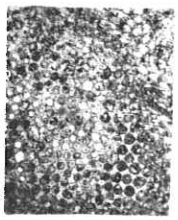

8a


6a


6b


7a


7b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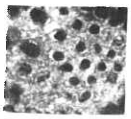
9a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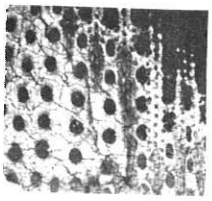
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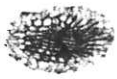
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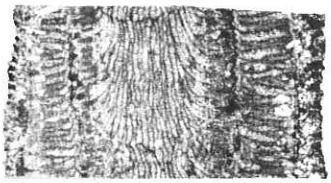
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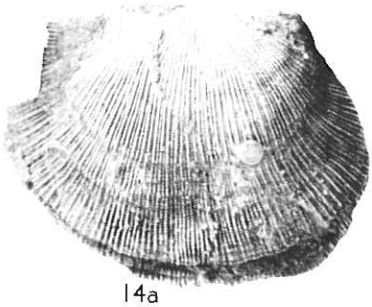
12b


13b


13a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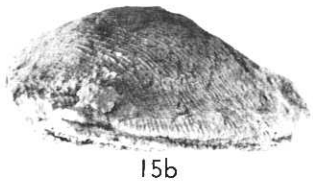
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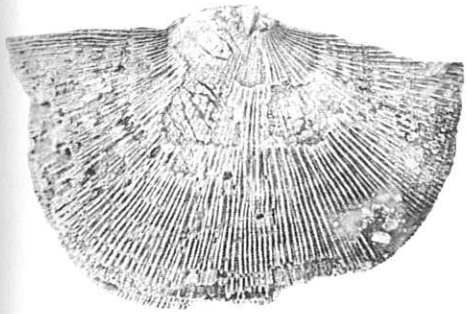
14b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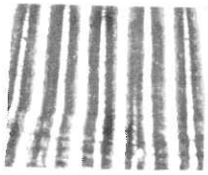
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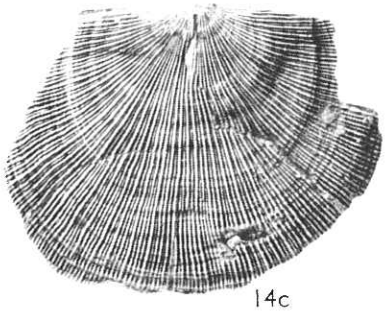

14c

Morrowan Fossils

PLATE I-continued

Figs. 14a-14d. Derbyia crassa — p. 23, 24
14a. a brachial valve
14b. posterior view
14c. a pedicle valve
14d. a pedicle valve, X5

Figs. 15a, 15b. Derbyia robusta — p. 25
15a. a pedicle valve
15b. lateral view

PLATE II

Figs. 1a-1e Hustedia miseri — p. 26
- 1a. brachial view
- 1b. brachial view, X2
- 1c. pedicle view, X2
- 1d. lateral view, X2
- 1e. anterior view, X2

Fig. 2 Lissochonetes geinitzianus, pedicle valve. — p. 27

Figs. 3a-3e. Pustula globosa — p. 27
- 3a. pedicle valve
- 3b. pedicle valve, X2
- 3c. brachial valve, X2
- 3d. lateral view, X2
- 3e. posterior view, X2

Figs. 4a-4d. Juresania nebrascensis — p. 28
- 4a. pedicle valve
- 4b. brachial valve
- 4c. lateral view
- 4d. posterior view

Figs. 5a-5c. Dictyoclostus portlockianus — p. 29
- 5a. pedicle valve
- 5b. lateral view
- 5c. posterior view

Figs. 6a-6c. Dictyoclostus morrowensis — p. 30
- 6a. pedicle valve
- 6b. lateral view
- 6c. posterior view

Figs. 7a-7c. Linoproductus ovatus — p. 31
- 7a. pedicle valve
- 7b. lateral view
- 7c. posterior view

PLATE II

1a

1b

1c

1d

1e

2

3a

3b

3c

3d

3e

4a

4b

4c

4d

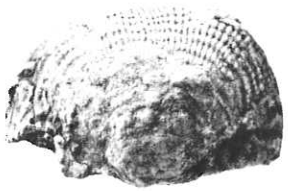
5a

5b

5c

6a

6b



6c

7a

7b

7c

Morrowan Brachiopods

PLATE III

Figs. 1a-1d. Pugnax weeksi — p. 32
- 1a. brachial valve
- 1b. brachial valve, X2
- 1c. pedicle valve, X2
- 1d. anterior view, X2

Figs. 2a-2e. Pugnoides triangularis — p. 33
- 2a. brachial valve
- 2b. brachial valve, X2
- 2c. pedicle valve, X2
- 2d. lateral view, X2
- 2e. anterior view, X2

Figs. 3a-3d. Dielasma sp. — p. 33
- 3a. brachial valve
- 3b. lateral view
- 3c. pedicle valve
- 3d. anterior view

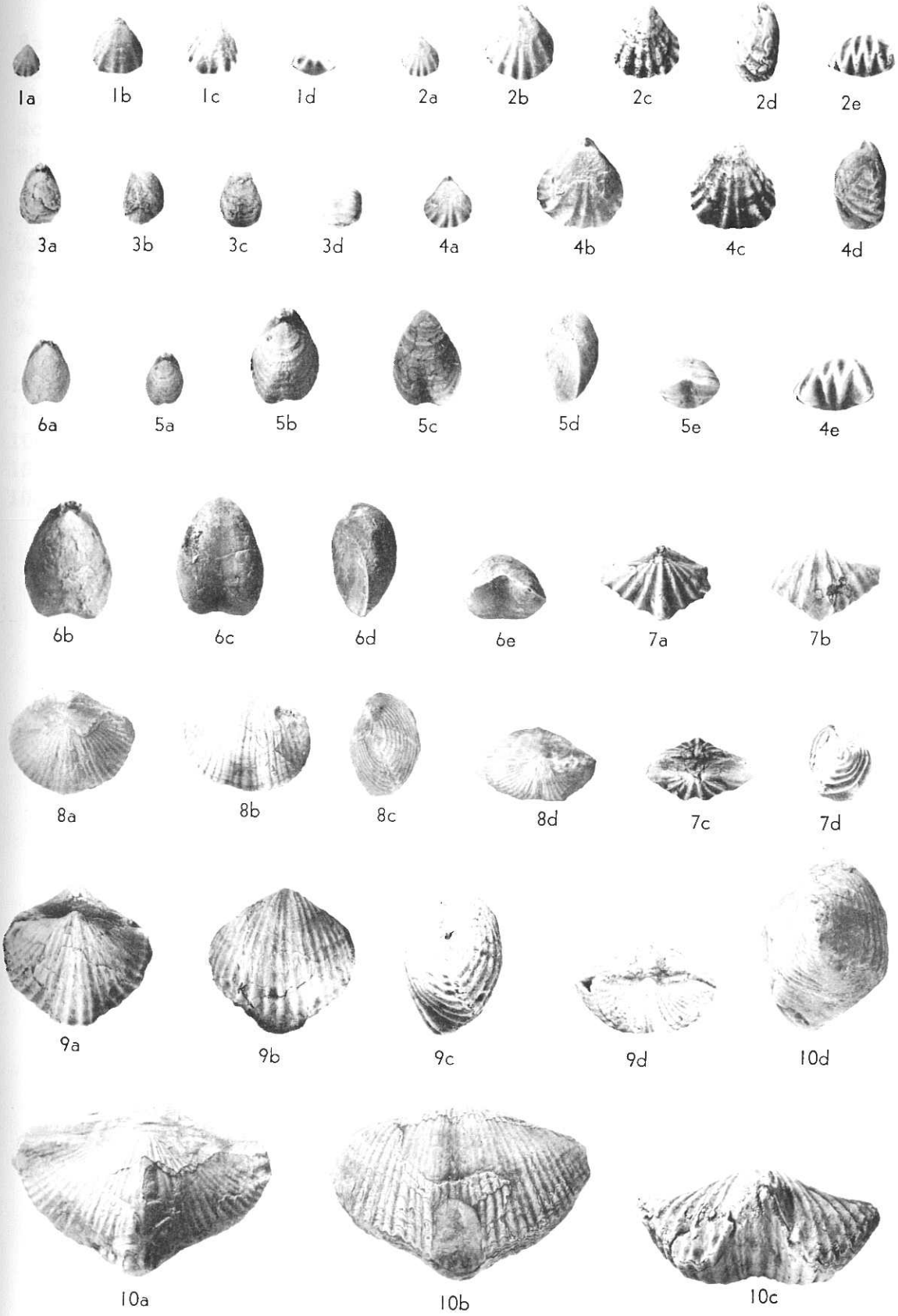
Figs. 4a-4e. Wellerella osagensis — p. 34
- 4a. brachial valve
- 4b. brachial valve, X2
- 4c. pedicle valve, X2
- 4d. lateral view, X2
- 4e. anterior view, X2

Figs. 5a-5e. Dielasma bovidens — p. 35
- 5a. brachial valve
- 5b. brachial valve, X2
- 5c. pedicle valve, X2
- 5d. lateral view, X2
- 5e. anterior view, X2

Figs. 6a-6e. Dielasma bilobatum — p. 36
- 6a. brachial valve
- 6b. brachial valve, X2
- 6c. pedicle valve, X2
- 6d. lateral view, X2
- 6e. anterior view, X2

Figs. 7a-7d. Punctospirifer kentuckyensis — p. 37
- 7a. brachial valve
- 7b. pedicle valve
- 7c. posterior view
- 7d. lateral view

PLATE III



Morrowan Brachiopods

PLATE III-continued

Figs. 8a-8d. Spirifer rockymontanus — p. 38
8a. brachial valve
8b. pedicle valve
8c. lateral view
8d. posterior view

Figs. 9a-9d. Spirifer opimus — p. 39
9a brachial valve
9b. pedicle valve
9c. lateral view
9d. posterior view

Figs. 10a-10d. Neospirifer cameratus — p. 40
10a. brachial valve
10b. pedicle valve
10c. anterior view
10d. lateral view

PLATE IV

Figs. 1a-1d. Cleiothyridina orbicularis — p. 41
- 1a. pedicle valve
- 1b. brachial valve
- 1c. lateral view
- 1d. anterior view

Figs. 2a-2d. Composita gibbosa — p. 42
- 2a. brachial valve
- 2b. pedicle valve
- 2c. lateral view
- 2d. anterior view

Figs 3a-3d. Squamularia perplexa — p. 43
- 3a. brachial valve
- 3b. pedicle valve
- 3c. lateral view
- 3d. anterior view

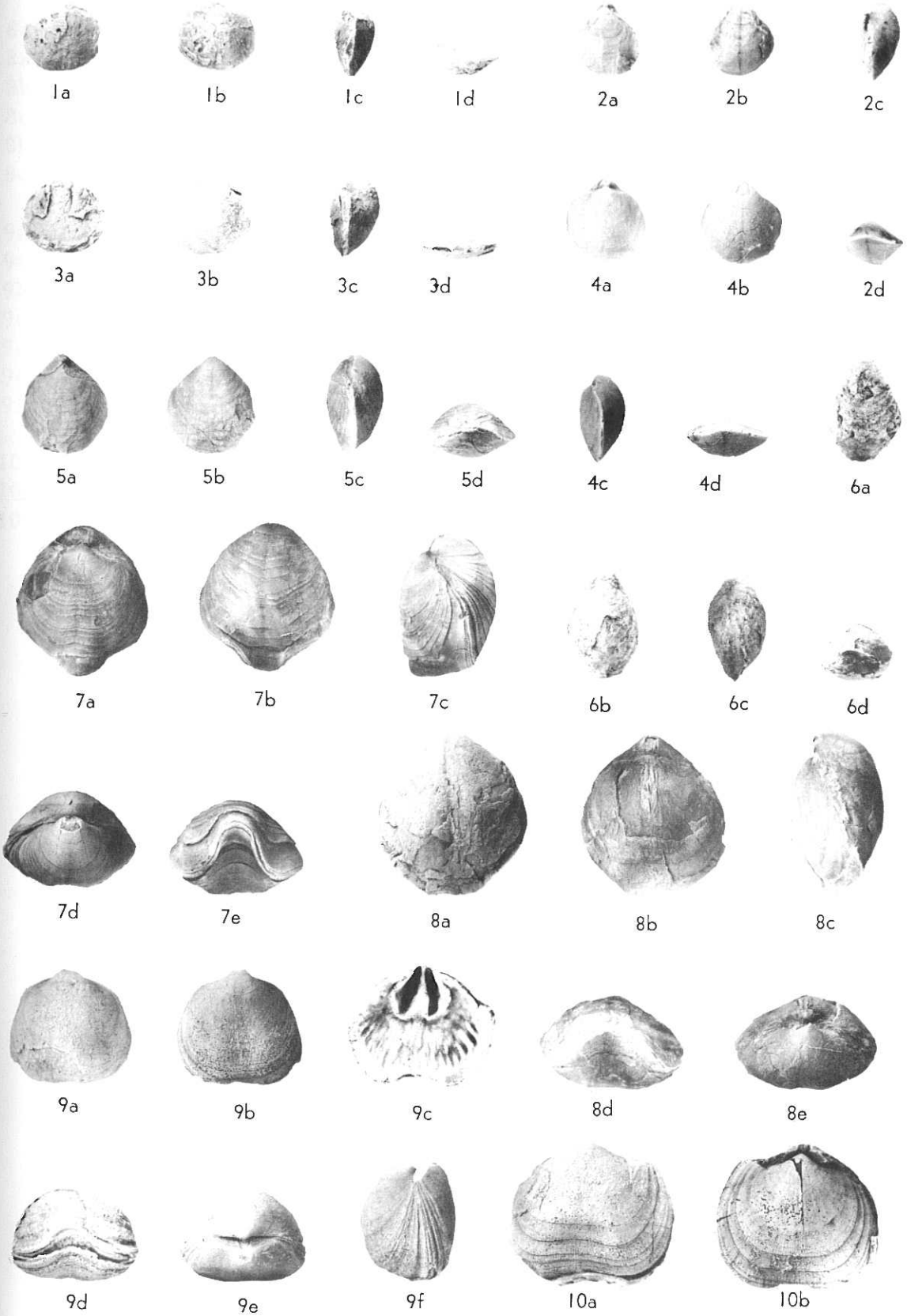
Figs. 4a-4d. Composita wasatchensis — p. 43
- 4a. brachial valve
- 4b. pedicle valve
- 4c. lateral view
- 4d. anterior view

Figs. 5a-5d. Composita subtilita — p. 45
- 5a. brachial valve
- 5b. pedicle valve
- 5c. lateral view
- 5d. anterior view

Figs. ba-bd. Composita elongata — p. 46
- 6a. pedicle valve
- 6b. brachial valve
- 6c. lateral view
- 6d. anterior view

Figs. 7a-7e. Composita trilobata — p. 46
- 7a. brachial valve
- 7b. pedicle valve
- 7c. lateral view
- 7d. posterior view
- 7e. anterior view

PLATE IV



Morrowan Brachiopods

PLATE IV-continued

Figs. 8a-8e. Composita ozarkana — p. 47
8a. pedicle valve
8b. brachial valve
8c. lateral view
8b. anterior view
8e. posterior view

Figs. 9a-9f. Schizophoria texana — p. 49
9a. pedicle valve
9b. brachial valve
9c. brachial valve, interior view
9d. anterior view
9e. posterior view
9f. lateral view

Figs. 10a, 10b. Schizophoria altirostris — p. 50
10a. pedicle valve
10b. brachial valve

ABSTRACT

This report concerns the invertebrate fossils found in the rocks of Morrowan Age in Central Utah. Forty-five species, which are divided into five phyla, are described. A sixth phylum, echinodermata, is present in the form of crinoid stem fragments, but no specific identifications are made. Forty-two species have been photographed and are presented on plates I to IV.

The Central Utah fauna is compared with faunas of known equivalent age in the Rocky Mountains, Great Basin, and Mid-Western United States. When compared with other Rocky Mountain and Great Basin faunas, the brachiopods appear to maintain thegreatest stratigraphic value. When compared with faunas of Morrowan Age in Mid-Western United States a difference in depositional conditions between the Mid-West area and the Rocky-Mountain-Great Basin area is suggested.

A discussion of each measured section is presented with mention made of the characteristic fossil assemblages which occur.

Several biofaces are discussed and it is concluded that several different biocoenoses and thinatocoenoses are responsible for the deposition of the Morrowan rocks.