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THE PALEONTOLOGY AND STRATIGRAPHY OF THE UPPER CARBONIFEROUS OF IOWA.

GEO. L. SMITH.

The object of this paper is to give the results of field observation and paleontologic study of the Upper Carboniferous of southwestern Iowa, extending over several years, as opportunity offered. It has been necessary that portions of the adjacent states of Missouri and Nebraska be included in this investigation, to complete and confirm the results obtained by studies of the stratigraphy of Iowa. Good exposures of outcrops in Iowa are infrequent and widely scattered; correlations are therefore difficult to make without the information to be derived from the examination of outcrops in adjacent territory.

As the result of his investigation of the stratigraphy in this geological field, the writer has been convinced of the accuracy of the "General Section of the Strata Exposed on the Missouri River," by J. E. Todd in his paper "Some Variet Conclusions in Iowa Geology," published in "Proceedings of the Iowa Academy of Science," Vol. XIII, page 183. All the outcrops examined by the writer can be easily correlated with this general section. Todd's long familiarity with the geology in this field enables him to interpret correctly the stratigraphy of this portion of Iowa. This section is the type section with which all other sections will be compared.

As far as possible sections of natural outcrops will be given, correlated and combined with each other and the type section. These sections are selected from many others as the most adapted to give the true sequence of strata. They will be given, commencing with the lowest strata and following each other in order until the highest strata east of the Missouri river are included.

"GENERAL SECTION OF THE UPPER CARBONIFEROUS ROCKS OF IOWA."

J. E. TODD.

No.		FEET
16.	Blue, red and ash-colored clays with two layers of limestone, two and four feet thick.....	19
15.	Yellow micaceous sandstone.....	10
14.	Drab, ash, lead and chocolate-colored clays or shales with a thin limestone layer.....	39

18

13. Limestone in thin layers, light yellow and gray..	12
12. Shales, mostly gray, some red and blue, with five thin layers of limestone and four of sandstone	185
11. Bluish limestone, interstratified with black shales and one foot of coal near center.....	12
10. Drab clays enclosing three strata of limestone, two to four feet thick	30
9. Compact limestone, mostly thin bedded, and some layers stylonitic	20
8. Blue clays, carbonaceous at two levels, and with two thin limestones	12
7. Soft, fine-grained, yellow sandstone.....	12
6. Clays and shales, bluish and gray, with three or four limestones, one much the thickest, sometimes seven feet thick.....	45
5. Limestone, yellow and gray, with many Fusulina	20
4. Clays, ash and red, with black shale in middle....	5
3. Yellowish, soft sandstone	4
2. Limestone, very fossiliferous	10
1. Greenish and chocolate clays above, and shales below to level of Missouri river at Plattsmouth	25
Total	460

Number eleven of the above includes the cap and bottom rocks of the Nodaway coal, and the limestone in number fourteen is the cap rock of the Nyman coal.

This series of strata has been divided into different formations by the Iowa Geological Survey as follows, commencing with the uppermost:

- | | |
|---------------------------|------------------------|
| McKissick's Grove shales. | Forbes limestone. |
| Tarkio limestone. | Platte shales. |
| City Bluffs shale. | Plattsmouth limestone. |
| Braddyville beds. | Andrew shales. |

COMPOSITE SECTION OF THE OUTCROPS RECORDED IN THIS REPORT.

	FEET	Nos. of Todd's SECTION
McKissick's Grove shales.....	80	14, 15, 16
Tarkio limestones	12	13
City Bluffs shale.....	200	12
Nodaway coal	1½	*11
Braddyville beds	45	10
Forbes limestone	20	9
Platte shales	70	6, 7, 8
Plattsmouth limestone	20	5
Total	448½	

*Includes cap and bottom rocks.

All the following outcrops have been examined by the writer, and most of them in company with the late Doctor Calvin. They

will be given in the order most favorable for explaining the relations of the different outcrops.

OUTCROP EXPOSURE AT ROCK BLUFF, NEBRASKA.

No.		FEET
14.	Yellow limestone; Forbes.....	15
13.	Yellow shale	1½
12.	Gray limestone	1
11.	Shale, carbonaceous	2
10.	Gray limestone	2
9.	Concealed	30
8.	Limestone, gray	3
7.	Concealed	10
6.	Limestone, disintegrated	5
5.	Limestone, gray	1
4.	Shale, blue, weathered	8
3.	Limestone, chips, weathered	5
2.	Shale with bands of limestone, weathered.....	10
1.	Limestone, yellow and gray; Plattsmouth.....	20
	Total	113½

This is the only known outcrop showing the full thickness of Platte shales. It is not in good condition at the present time, as much of it is concealed by slides and talus.

WILSON SECTION, TWO MILES NORTH OF THURMAN, IOWA.

No.		FEET
26.	Shale, black	1
25.	Limestone, with a shale.....	2½
24.	Shale, yellow	1½
23.	Shale, black	1¾
22.	Shale, gray, calcareous.....	1½
21.	Shale, black	1
20.	Shale, gray, calcareous.....	1½
19.	Coal, Nodaway	1
18.	Shale, blue	2
17.	Limestone, blue	4
16.	Shale, gray, calcareous.....	6
15.	Limestone, gray	4
14.	Shale, gray	6
13.	Limestone, blue	1½
12.	Shale, gray, calcareous	4
11.	Limestone, yellow, cherty	2½
10.	Shale, gray	3
9.	Limestone, gray	1
8.	Shale, yellow	2
7.	Limestone, gray, in four benches; Forbes.....	21
6.	Shale, carbonaceous	2½
5.	Limestone	¾
4.	Shale, carbonaceous	2½
3.	Limestone, blue	2
2.	Shale, blue	4
1.	Sandstone, micaceous	1
	Total	83½

This is the only known locality in the state of Iowa, where a complete section of the Braddyville beds is shown in outcrop. It includes numbers eight to eighteen, inclusive, in this section.

At the present time the base of the outcrop is concealed by talus, and the section given above is that described by Chas. A. White in Iowa Geological Survey Report of 1870, slightly modified.

COMPOSITE SECTION OF OUTCROPS IN THE VICINITY OF STENNETT, IOWA.

No.	FEET
12. Limestone, residual	5½
11. Shale, gray, calcareous	½
10. Limestone, gray	1¾
9. Shale, gray, argillaceous	3½
8. Limestone, variable	5
7. Shale, yellow	1
6. Limestone, blue, cherty	6
5. Shale, parting	
4. Limestone, variable	5
3. Shale, argillaceous	1½
2. Shale, carbonaceous	3
1. Limestone, shaly	2
Total	34¾

The Forbes limestone is represented by numbers four to eight, inclusive. The carbonaceous shale number two is universally present, underlying this limestone, and has been prospected for coal both at Wilson section and near Stennett.

The Missouri Geological Survey has correlated the Forbes limestone with the Deer Creek limestone of Kansas, and uses this term for the Forbes limestone. As the Iowa outcrops of this limestone are upwards of one hundred miles distant from the type section of the Forbes limestone, it is by no means certain they represent the same horizon. Under these circumstances, the Missouri Geological Survey having abandoned the use of the term Forbes, it is proposed that this limestone be named the Stennett limestone. Until the different formations of Iowa have been actually traced in the field to those of Kansas, it is preferable that they be designated by local names rather than by those of formations several hundred miles distant.

The City Bluffs beds of Broadhead are situated two miles northwest of Burlington Junction, Missouri.

SECTION AT WEST END OF BRIDGE OVER NODAWAY RIVER.

No.		FEET
16.	Sandstone, ferruginous	1
15.	Shale, blue	10
14.	Shale, yellow, concretionary	2
13.	Shale, blue	3
12.	Shale, yellow, concretionary	1½
11.	Shale, blue	1
10.	Sandstone, ferruginous	½
9.	Shale, arenaceous, septaria	10
8.	Sandstone, ferruginous	2
7.	Limestone and sandy shale in alternate layers....	5
6.	Shale, gray, many septaria	30
5.	Shale, dark blue	25
4.	Shale, below level of water in river	30
3.	Limestone, cap rock	2
2.	Shale	4
1.	Coal, Nodaway	1½
	Total	128½

The forty-seven feet of strata in numbers six to nine, inclusive, comprise the septarian zone of the City Bluffs shales. Some of these septaria reach a diameter of two feet. This outcrop is the City Bluffs beds described and named by Garland C. Broadhead in the Missouri Geological Report of 1872.

COMPOSITE SECTION OF DIFFERENT OUTCROPS SOUTH OF THE I. O. O. F. CEMETERY, NEAR ELMO, MISSOURI.

No.		FEET
8.	Shale, gray, weathered yellow	25
7.	Limestone, blue, weathered yellow, cap rock	1
6.	Shale	½
5.	Coal, Elmo	1
4.	Underclay	½
3.	Shale, weathered yellow	13
2.	Shale, yellow, with nodules of impure limestone..	2
1.	Shale, weathered yellow, with many large septaria	15
	Total	58

Number one is the upper member of the septarian zone of the City Bluffs shale. The coal, number five, has been named the Elmo coal by the Missouri Geological Survey. It is an irregular coal, only rarely present, and has long been known in Iowa, being first described by E. H. Lonsdale in the Montgomery County Report of 1894.

COMPOSITE SECTION OF DIFFERENT OUTCROPS ON TARKIO CREEK, PAGE COUNTY, IOWA.

No.		FEET
11.	Limestone, yellow, cap rock	3
10.	Coal, Nyman	1
9.	Shale, variable	30
8.	Limestone, yellow	1

7. Shale, gray, calcareous	3
6. Limestone, blue, weathered yellow and brown....	2
5. Shale, blue	12
4. Limestone, gray	2
3. Shale, gray, calcareous	3½
2. Limestone, gray	2
1. Shale, blue, with thin layers of sandstone.....	35
<hr/>	
Total	94

The lower limestones, numbers two and four, are not constant as they often grade into a very calcareous shale. Numbers six to eight, inclusive, are the Tarkio limestone. The lower limestones with the interbedded shale should be included in the City Bluffs shale. This section does not reach down to the upper shale, exposed in the outcrop on the wagon road south of the cemetery near Elmo, leaving a hiatus of probably not to exceed twenty feet, not known in outcrop in Iowa or Missouri. As shown by outcrops and drillings the thickness of the City Bluffs shale is one hundred and eighty to two hundred feet.

SECTION AT WEST END OF RAILROAD BRIDGE OVER THE MISSOURI RIVER AT NEBRASKA CITY, NEBRASKA.

No.		FEET
12.	Thin bedded limestone with shale partings.....	4
11.	Sandstone, yellow, micaceous	4
10.	Shale, blue	5
9.	Limestone, gray, single layer, thickens to the south, Nyman coal cap rock.....	2
8.	Shale, coaly, black, Nyman	¼
7.	Shale, blue, arenaceous, and micaceous in places..	40
6.	Limestone, yellow	2
5.	Shale, weathered	6
4.	Limestone, yellow	1
3.	Shale, weathered	1
2.	Limestone, yellow, in two layers.....	1
1.	Shale	5
<hr/>		
Total		71¼

This outcrop is one mile below the Nebraska City landing section described by Fielding B. Meek over forty years ago. Numbers two to six, inclusive, are the Tarkio limestone. This section is nearly the same as that on Tarkio creek, but in addition it reaches higher in the General Section of Todd.

SECTION IN FIRST RAVINE SOUTH OF ROSE BRANCH, NORTHWEST OF ROCKPORT, MISSOURI.

No.		FEET
11.	Shale, red	5
10.	Sandstone, brown, micaceous, irregularly bedded..	10
9.	Shales and sandstone with one foot of limestone in upper part	35

8. Limestone, yellow	1
7. Limestone, shaly	3
6. Limestone, blue	1¼
5. Coal, shaly; Nyman	¼
4. Shale, arenaceous	24
3. Limestone, gray	1½
2. Shale, calcareous	1½
1. Limestone, brown	4
Total	86½

This outcrop includes in its higher members the latest strata found in the Carboniferous in the states of Iowa and Missouri.

The Tarkio limestone includes one to three, and the McKis-sicks Grove shale comprises all the section above this limestone. The different outcrops, sections of which have been given, are the best and most extensive known and show a nearly complete succession of strata from the Plattsmouth limestones to the uppermost of the Carboniferous east of the Missouri river.

PALEONTOLOGY.

Nearly all the fossils listed were obtained at the mine dumps at Coin and New Market, and at different outcrops on Tarkio creek in Page county, Iowa. The under shale of the Nodaway coal is included, its fauna being in fact part of that of the Nodaway coal. In the mines this shale is excavated to a depth of about two feet in constructing the entries. The coal is underlain directly by a gray shale, no under clay being present. All material excavated in sinking shafts and mining operations is promiscuously dumped and it is impossible to discriminate closely between horizons. An attempt is made to give the fauna and flora of the roof and under shales of the Nodaway coal. It is a matter of regret that the cap rock of the Nodaway coal cannot be included, but this is not practicable as this limestone is very seldom seen in outcrop and is inaccessible in the mines. Paleontologic studies of other formations in southwestern Iowa are in progress and the result of such investigation will be given in a future paper. As a whole the characteristic of the fauna is the predominance of the Molluscoida, while the Pelecypoda are but meagerly represented. The limestone and the calcareous shales are usually prolific in fossils, but the blue shales and the sandstones are well nigh barren. While by far the greater part of the different species range throughout the whole series of strata there is a certain expression of the fauna that enables a close approximation to be made of the different horizons.

Although the study of the Bryozoa has been difficult and unsatisfactory it is believed all precise correlation must be done by a close discrimination of the different species of the Bryozoa and their horizons. There has been great difficulty in identifying the smaller Productidae. Although several hundred ventral valves of Marginifera, *Productus longispina* and *P. muricatus*, have been examined, but few detached dorsal valves have been found, and none of these show the submarginal ridge that characterizes the genus Marginifera. A small brachiopod that is especially difficult to identify is found in the City Bluffs shale and the Tarkio limestone. At first sight it appears to be a Strophalosia. However, it is without a cardinal area and has no attachment scar on the ventral valve, which definitely removes it from the genus Strophalosia. It is probably an undescribed species of Productus. The feature most evident in the fauna of the Tarkio limestone is the great abundance of the different species of Myalina to be found in this limestone.

At Coin the outstanding feature of the City Bluffs fauna is the abundance of Bellerophon, Chonetes, and Spiriferina present. At New Market in this same shale the species most frequent are Marginifera, *Productus muricatus*, and *Orthothes crassa*. Bryozoa are far more abundant at Coin than at New Market. The most common fossils of the roof and under shales of the Nodaway coal are *Euomphalus catilloides* and a small variety of *Orthothes crassa*. In the City Bluffs shale are found specimens of the marine plant, *Conostychus ornatus*, identification by Calvin. Moreover a few specimens of *C. broadheadi* have been positively identified. It is a surprise that these algae should be found so high in the Carboniferous when they were originally described as found at the very base of the Coal Measures of Missouri. The gymnosperm *Carpolithes granulosa* is found in great abundance in the City Bluffs shale, both at Coin and at New Market. As this shale is a marine deposit plant remains are rarely found in it. The only plant remains so far found are *Conostychus*, *Carpolithes*, and *Neuropteris*.

The calcareous shales and partings in the limestones carry an abundance of Bryozoa. Detached stem fragments of crinoids are abundant in all the different strata except the sandstones. Several indeterminata have been found which are under further

study. Grabau and Shimer, "North American Index Fossils," has been the principal authority used in the identification of the fauna and in terminology.

TARKIO LIMESTONE.

FAUNA.

Foraminifera—	Pelecypoda—
<i>Fusulina secalica</i> .	<i>Allorisma terminale</i> .
Bryozoa—	<i>Aviculopecten whitei</i> .
<i>Rhombopora lepidodendroides</i> .	<i>Myalina kansasensis</i> .
Brachiopoda—	<i>Myalina subquadrata</i> .
<i>Ambocelia planoconvexa</i> .	<i>Myalina swallovi</i> .
<i>Chonetes glaber</i> .	Gastropoda—
<i>Chonetes granulifer</i> .	<i>Bellerophon pericarinatus</i> .
<i>Chonetes verneuillana</i> .	<i>Bucanopsis montfortiana</i> .
<i>Enteleles hemiplicata</i> .	<i>Naticopsis altonensis</i> .
<i>Meekella striatocostata</i> .	<i>Orthonema subeniatum</i> .
<i>Productus cora</i> .	<i>Phanerotrema grayvillensis</i> .
<i>Productus costatus</i> .	<i>Platyceras parvum</i> .
<i>Productus nebrascensis</i> .	Cephalopoda—
<i>Productus pertenuis</i> .	<i>Orthoceras rushense</i> .
<i>Productus semireticulatus</i> .	Trilobita—
<i>Pugnax utah</i> .	<i>Phillipsia major</i> .
<i>Seminula argentea</i> .	
<i>Spirifer cameratus</i> .	
<i>Spiriferina kentuckiensis</i> .	

CITY BLUFFS SHALE.

FAUNA.

Foraminifera—	<i>Polypora elliptica</i> .
<i>Fusulina secalica</i> .	<i>Polypora submarginata</i> .
Anthozoa—	<i>Rhombopora lepidodendroides</i> .
<i>Lophophyllum profundum</i> .	<i>Septopora biserialis</i> .
<i>Lophophyllum westi</i> .	<i>Stenopora carbonaria</i> .
Crinoidea—	Brachiopoda—
<i>Cerriocrinus hemisphericus</i> .	<i>Ambocelia planoconvexa</i> .
<i>Erisocrinus typus</i> .	<i>Chonetes glaber</i> .
<i>Eupachyercinus tuberculatus</i> .	<i>Chonetes granulifer</i> .
<i>Hydreionocrinus acanthroporus</i> .	<i>Chonetes variolatus</i> .
<i>Hydreionocrinus mucrospinus</i> .	<i>Dielasma bovidens</i> .
Vermes—	<i>Enteleles hemiplicata</i> .
<i>Serpula insista</i> .	<i>Hustedia mormoni</i> .
Bryozoa—	<i>Marginifera (Productus) longispina</i> .
<i>Fenestella perelegans</i> .	<i>Marginifera (Productus) muricatus</i> .
<i>Fistulipora nodulifera</i> .	<i>Meekella striatocostata</i> .
<i>Pinnatopora trilineata</i> .	
<i>Polypora crassa</i> .	

- | | |
|-----------------------------|-----------------------------|
| Orthothes crassa. | Myalina swallowi. |
| Productus cora. | Nucula ventricosa. |
| Productus costatus. | Leda bellistriata. |
| Productus nebrascensis. | Gastropoda— |
| Productus pertenuis. | Bellerophon percarinatus. |
| Productus punctatus. | Bucanopsis montfortiana. |
| Productus semireticulatus. | Euomphalus catilloides. |
| Pugnax utah. | Euphemus carbonarius. |
| Rhipodomella pecosi. | Phanerotrema grayvillensis. |
| Seminula argentea. | Soleniscus brevis. |
| Spirifer cameratus. | Soleniscus paludinæformis. |
| Spiriferina kentuckiensis. | Worthenia tabulata. |
| Pelecypoda— | Cephalopoda— |
| Allorisma terminale. | Orthoceras rushense. |
| Allorisma granosum. | Tainoceras occidentale. |
| Aviculopinna peracuta. | Trilobita— |
| Aviculopecten occidentalis. | Griffithides. scitula. |
| Aviculopecten whitei. | Vertebrata— |
| Edmondia nebrascensis. | Pisces. |
| Myalina peratenuata. | Agassizodus variabilis. |
| Myalina subquadrata. | Peripristis semicircularis. |

FLORA.

- | | |
|-------------------------|-------------------------|
| Algae— | Pteridophyta— |
| Conostychus broadheadi. | Neopteris scheuchzeri. |
| Conostychus ornatus. | Cordaitales— |
| | Carpolithes granularis. |

NODAWAY COAL: ROOF AND UNDER SHALES.

FAUNA.

- | | |
|-------------------------------------|-----------------------------|
| Anthozoa— | Productus pertenuis. |
| Lophophyllum profundum. | Seminula argentea. |
| Bryozoa— | Spiriferina kentuckiensis. |
| Rhombopora lepidodendroides. | Gastropoda— |
| Brachiopoda— | Bellerophon percarinatus. |
| Ambocoelia planoconvexa. | Euomphalus calliloides. |
| Chonetes granullifer. | Euphemus carbonarius. |
| Orthothes crassa. | Phanerotrema grayvillensis. |
| Marginifera (Productus) longispina. | |

FLORA.

- | | |
|---------------------------------|------------------------|
| Pteridophyta— | Calamites suckowii. |
| Alethopteris grandini. | Neopteris ovata. |
| Annularia sphenophylloides. | Neopteris scheuchzeri. |
| Asterophyllites equisetiformis. | Pecopteris cyathea. |

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SHENANDOAH.