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Vertical Range of Fossils at Louisiana

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VERTICAL RANGE OF FOSSILS AT LOUISIANA.

BY CHARLES R. KEYES AND R. R. ROWLEY.

Owing to peculiar phases in the erosion of the Mississippi river in northeast Missouri the basal portion of the Lower Carboniferous rocks is exposed to better advantage than perhaps anywhere else in the whole interior basin. In Pike county, Missouri, and in the contiguous parts of Illinois, not only does the lower part of the Carboniferous crop out along the streams, but vertical sections from the Hudson shales up to the Upper Burlington are obtainable in single exposures. In this locality the bluffs are high and the outcrops of the rocks under consideration are practically continuous along the great river for a distance of more than seventy-five miles.

The section at Louisiana, which may be regarded as typical, is given below, essentially as when first published several years ago,* except that for the present purpose, smaller zones are recognized.

SECTION OF ROCKS EXPOSED AT LOUISIANA, MISSOURI.

TERRANES.	Number	FORMATIONS.	Feet.
Pleistocene.	21	Soil, and red residuary clay, with abundant chert fragments	4
Upper Burlington limestone.	20	Limestone, brown, rather thinly bedded and cherty.	28
	19	Limestone, compact, thin-bedded, encrinital, with much gray chert in bands and nodules.	18
	18	Limestone, yellowish-brown, rather soft, encrinital.	4
Lower Burlington limestone.	17	Limestone, bluish, fine-grained, siliceous.	4
	16	Limestone, massive, white, encrinital, coarse-grained (upper white ledge).	12
	15	Limestone, brown, encrinital, with irregular chert bands and nodules, and occasional thin clay partings.	20
	14	Limestone, white, very heavily bedded, encrinital, some white chert (lower white ledge).	9
	13	Limestone, brown, encrinital, heavily bedded.	6
Chouteau(?) limestone.	12	Limestone, yellow, massive, or heavily bedded, rather soft, fine-grained.	9
Hannibal shales.	11	Shale, brown, very sandy, passing into soft sandstone locally.	12
	10	Shale, green, sandy above.	60

*Am. Jour. Sci., (3) vol. XLIV, p. 448, 1892.

SECTION OF ROCKS EXPOSED AT LOUISIANA—CONTINUED.

TERRANES.	Number.	FORMATIONS.	Feet.
Louisiana limestone.	9	Limestone, buff to gray, compact, very fine-grained, in layers four to six inches thick, similar to lithographic stone in texture.....	34
	8	Limestone, similar to above.....	8
	7	Limestone, similar to above, layers thicker and separated by buff sandy partings	6
	6	Shale, buff, sandy, two to six inches	½
Western Hamilton.	5	Shale, green or dark blue.....	2
	4	Shale, black, fissile	4
Niagara?	3	Limestone, magnesian, buff, massive.....	2
	2	Oolite, white, massive.....	8
Hudson.	1	Shale, blue, with thin bands of limestone, near Louisiana	40

The basal member of the section is the Hudson shale. When fully exposed in the neighborhood it attains a thickness of about seventy feet. It rests on a heavy magnesian limestone carrying characteristic Trenton fossils.

The next two higher members, Nos. 2 and 3, are provisionally referred to the Niagara. The oolite appears to be somewhat of a local phase, but is present not only in the vicinity of the town but all the way to Paynesville, a distance of eighteen miles. The formation appears to be represented elsewhere in the vicinity by fossiliferous limestones which are not oolitic. The organic remains contained are rather abundant. The buff massive layer is very thin at Louisiana, being only two feet in thickness in the river bluff in front of the town. Two miles southward, at the mouth of Buffalo creek, it increases to nine feet, and still further southward, on both sides of the Mississippi river, and southwestward toward Bowling Green, it attains a measurement of twenty-five to thirty feet in a distance of fifteen to twenty miles. It is almost destitute of fossils.

The next two, Nos. 4 and 5, belong to the Devonian. The lower black shale contains a characteristic fish fauna.

Numbers 6 to 9 form the Louisiana division of the Kinderhook. It is the lithographic limestone of the older stage reports. For a long time the lithographic limestone has been regarded as the basal member of the Lower Carboniferous in the Mississippi valley. Recently* some doubt has been thrown upon the interpretation of the age of the formation. Regarding this question the following statements were made:

*American Geologist, vol. X, pp. 380-384, 1892; also Missouri Geol. Sur., vol. IV, pp. 54-55, 1894.

Marion and Pike counties, Missouri, at Hannibal, Louisiana and Clarksville principally, were the leading localities for a large proportion of the "Kinderhook" fossils originally described by Shumard, Hall, White, and Winchell. Most of these forms have a very decided Devonian aspect which gives a peculiar and characteristic physiognomy to the faunas of the three beds. Heretofore little mention has been made concerning the exact horizon of the fossils in question, mere reference to the "Lithographic" limestone, or Kinderhook beds, being considered sufficient. Latey, however, extensive collections of fossils have been made at all three places just mentioned, as well as many intervening and neighboring exposures. Everywhere the Lithographic, or Louisiana limestone has been found to be essentially devoid of organic remains, except an occasional form in the thin sandy partings above the bottommost layer, which is less than one foot in thickness. At the very base of the limestone is a thin seam of buff, sandy shale, seldom over three or four inches in thickness. This seam is highly fossiliferous. It contains the *Productella pyxidata* (Hall), *Cyrtina aetirostris* (Shumard), *Chonetes ornata* (Shumard), *Spirifera hannibalensis* (Shumard), and a host of other forms, many indistinguishable from species occurring in undoubted beds of the western Hamilton.

Lithologically, the thin sandy layer is more closely related to the underlying shales than with the overlying limestone. Faunally, it has very much nearer affinities with the western Hamilton (Devonian) than with the Kinderhook (Lower Carboniferous). In Iowa the "Devonian aspect" of the Kinderhook faunas has disappeared largely, since Calvin's recent discovery that the "Chemung" sandstones of Pine creek, in Muscatine county, Iowa, are in reality true Devonian. In Missouri the same Devonian facies of the fauna contained in the lowest member of the Carboniferous is lost from view, almost completely, by eliminating the species found in the thin sandy seam at the base of the Louisiana or lithographic limestone. The faunas of the Devonian and Carboniferous of the upper Mississippi valley thus become more sharply contrasted than ever. The apparent mingling of faunas from the two geological sections, manifestly was based upon erroneous assumptions rather than upon the detailed field evidence.

Depriving the "Lithographic" limestone, almost entirely of the extensive fauna commonly ascribed to it, and which, as has been seen, comes from a thin seam lying below the calcareous layers its geological age becomes a problem yet to be solved. The few fossils known from the limestone itself have been heretofore rarely met with. It is not at all unlikely that the lower limestone of the Kinderhook eventually may prove to be of Devonian age. But until abundant evidence to this effect is found, it seems advisable to still consider the Louisiana (Lithographic) limestone as the basal member of the Carboniferous.

Since these remarks were made the organic remains which were found only in the thin basal shale (No. 6) have been obtained from higher levels, as is clearly brought out in the accompanying table. The whole formation is thus more closely related to the strata below than those above.

The Hannibal shales (Nos. 10 and 11) are almost wholly devoid of fossils in Missouri, but farther north, at Burlington,

where the beds have always been regarded as non-fossiliferous, an extensive fauna has been lately disclosed.* Its facies is very decidedly Devonian.

The thin, soft, earthy limestone (No. 12), which is nine feet in thickness at Louisiana, is believed to be the attenuated portion of the Chouteau limestone, though it is so closely associated with the lower beds of the Burlington, that it might be termed the Chouteau-Burlington. Toward the southwest the undoubted Chouteau limestone, before leaving Pike county, has a thickness of thirty feet, and still farther in the same direction in central Missouri the thickness increases to over 100 feet.

The lower Burlington limestone is separated upon lithological and faunal grounds into five zones, and the upper Burlington, as represented in the section, into three zones.

Nearly all of the strata are highly fossiliferous. The vertical section and the exposures are so extensive for a single locality that the facilities for determining the exact range of the various faunas stand unrivalled in the whole region. Moreover, a key to the stratigraphy of the entire province is furnished. Owing to unusually favorable opportunities for forming extensive collections of the fossils which are representative of the different horizons, the results are very complete. The determination of the faunal zones and their most important relationships as bearing upon the stratigraphy of the region are therefore of great interest. The subjoined tabular arrangement displays the more salient features in the distribution of the faunas.

TABLE SHOWING VERTICAL RANGE OF FOSSILS.

SPECIES.	Hudson.		Niagara.		Hamilton.		Louisiana.			Hannibal.		Chouteau.		Lower Burlington.			Upper Burlington.			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
PLANTS:																				
Plumulina gracilis (Shumard).....									x											
Taonurus crassus? (Hall).....											x									
SPONGES:																				
Stromatopora sp?.....		x	x																	
Palæacis enormis (Meek & Worthen).....						x	x	x												
Conopterium effusum, Winchell.....						x	x													
CORALS:																				
Amplexus blairi, Miller.....														x	x					
Amplexus sp?.....														x	x	x				

*Iowa Geol. Sur., vol. III, p. 80, 1893.

TABLE SHOWING VERTICAL RANGE OF FOSSILS—CONTINUED.

SPECIES.	Hudson.		Niagara.		Hamilton.		Louisiana.			Hannibal.		Chouteau.	Lower Burlington.				Upper Burlington.			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	Amplexus fragilis, White & St. John.																		X	X
Aulopora gracilis, Keyes																		X	X	X
Chetetes sp?																		X	X	X
Cyathophyllum sp?			X																	
Cyathophyllum sp?			X	X																
Cyathophyllum sp?			X																	
Favosites sp?				X																
Favosites favosa? (Goldfuss)				X																
Favosites forbesi, Edw. & Haine.			X	X																
Halysites catenulatus (Linnaeus).				X																
Olestopora typa? (Winchell)												X								
Michelinia sp?													X	X	X			X		
Monticulipora sp?	X																			
Monticulipora sp?	X	X																		
Monticulipora sp?	X	X	X																	
Monticulipora lycoperdon? (Say)	X																			
Stenopora sp?																			X	
Streptelasma sp?				X																
Striatopora carbonaria, White																		X	X	
Syringopora sp?																X				
Zaphrentis acuta, White & Whitfield.					X	X	X	X												
Zaphrentis calceola, White & Whitfield.												X	X	X	X	X	X			
Zaphrentis centralis, Edw. & Haine.													X	X	X	X	X	X	X	X
Zaphrentis elliptica, White													X	X	X	X	X			
Zaphrentis sp?												X	X							
Zaphrentis tantilla, Miller													X	X	X	X				
Zaphrentis sp?												X								
Zaphrentis sp?													X	X	X	X				
Hadrophyllum glans, White.																	X			
ECHINODERMS:																				
Archaeocidaris agassizi, Hall														X	X	X				
Actinocrinus coelatus, Hall														X	X					
Actinocrinus clarus, Hall														X	X					
Actinocrinus glans, Hall.																		X	X	X
Actinocrinus proboscidiatis, Hall.														X	X					
Actinocrinus scitulus, Meek & Worthen															X	X				
Actinocrinus verrucosus, Hall															X	X				
Actinocrinus obesus, Keyes.																				X
Actinocrinus puteatus, Rowley																			X	X
Actinocrinus tenuisculptus, McChes-												X	X							
ney.													X							
Actinocrinus sp?												X								
Actinocrinus sp?													X	X						
Actinocrinus sp?														X	X					
Actinocrinus sp?															X					
Actinocrinus sp?																X			X	X
Actinocrinus sp?																	X		X	X
Actinocrinus sp?																		X		
Agaricocrinus sp?												X	X							
Agaricocrinus brevis (Hall)													X	X						
Agaricocrinus sp?														X	X					
Agaricocrinus bellatrema (Hall)															X	X				
Agaricocrinus americanus (Romer)																			X	X
Agaricocrinus gracilis (Hall)																			X	X
Agaricocrinus inflatus, Hall.																			X	X
Agaricocrinus pentagonus, Hall.																			X	X
Agaricocrinus planocovexus, Hall.																			X	X
Agaricocrinus pyramidatus, Hall.																			X	X
Agaricocrinus stellatus, Hall.														X	X					
Agaricocrinus bullatus, Hall.																			X	X
Agaricocrinus sp?																			X	X
Agaricocrinus sp?																			X	X
Allagecrinus americanus, Rowley																X	X			
Amphocrinus divergens (Hall)							X													
Amphocrinus spinobrachiatus														X	X					
(Hall)														X	X					

TABLE SHOWING VERTICAL RANGE OF FOSSILS—CONTINUED.

SPECIES.	Hudson.		Niagara		Hamilton.		Louisiana.			Hannibal.		Chouteau.		Lower Burlington.				Upper Burlington.																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20																
<i>Barycrinus rhombiferus</i> (Owen & Shumard)																				x	x															
<i>Batocrinus æqualis</i> (Hall)															x						x	x														
<i>Batocrinus æquibrachiatus</i> (McClesney)																					x	x														
<i>Batocrinus calvini</i> , Rowley												x										x	x													
<i>Batocrinus christyi</i> (Shumard)													x									x	x													
<i>Batocrinus clypeatus</i> (Hall)														x	x	x																				
<i>Batocrinus discoides</i> (Hall)														x	x	x																				
<i>Batocrinus lepidus</i> (Hall)														x	x	x																				
<i>Batocrinus longirostris</i> (Hall)												x	x	x	x																					
<i>Batocrinus quasillus</i> , Meek & Worthen														x	x	x																				
<i>Batocrinus subæqualis</i> (Hall)														x	x	x																				
<i>Batocrinus turbinatus</i> (Hall)												x	x																							
<i>Batocrinus inflatus</i> , Rowley													x																							
<i>Batocrinus rotadentatus</i> , Rowley															x	x																				
<i>Batocrinus pyriformis</i> (Shumard)																					x	x	x													
<i>Batocrinus</i> sp?															x	x																				
<i>Batocrinus</i> sp?																																				
<i>Eretmocrinus carica</i> (Hall)																	x	x																		
<i>Eretmocrinus calyculoides</i> (Hall)																							x													
<i>Eretmocrinus coronatus</i> (Hall)															x	x																				
<i>Eretmocrinus konincki</i> (Shumard)																							x	x												
<i>Eretmocrinus leucosia</i> (Hall)															x	x																				
<i>Eretmocrinus verneuillanus</i> (Shumard)																								x												
<i>Eretmocrinus</i> sp?																x																				
<i>Eretmocrinus</i> sp?															x																					
<i>Eretmocrinus</i> sp?																x																				
<i>Eretmocrinus</i> sp?													x	x	x	x																				
<i>Eretmocrinus</i> sp?													x																							
<i>Eretmocrinus</i> sp?																								x	x											
<i>Eretmocrinus</i> sp?																									x	x										
<i>Belemno-erinus</i> sp?																										x	x									
<i>Calceocrinus ventricosus</i> (Hall)																	x	x	x								x	x								
<i>Catillernus wachsmuthi</i> , (Meek & Worthen)																												x	x							
<i>Codaster kentuckiensis</i> , Shumard																													x	x						
<i>Codaster gracillimus</i> , Rowley																x	x													x	x					
<i>Codaster grandis</i> , Rowley																														x	x					
<i>Codaster</i> sp?													x	x																x	x					
<i>Orophocrinus stelliformis</i> (Shumard)																															x	x				
<i>Orophocrinus inopinatus</i> , Rowley														x	x	x															x	x				
<i>Cyathocrinus</i> sp?																																x	x			
<i>Cyathocrinus</i> sp?																																	x	x		
<i>Cyathocrinus iowensis</i> (Owen & Shumard)																																	x	x		
<i>Cyathocrinus</i> sp?																																		x	x	
<i>Cyathocrinus</i> sp?																																		x	x	
<i>Dichocrinus lineatus</i> Meek & Worthen																																		x	x	
<i>Dichocrinus pisum</i> , Meek & Worthen																																		x	x	
<i>Dichocrinus plicatus</i> , Hall																																		x	x	
<i>Dichocrinus striatus</i> , Owen & Shumard																																			x	x
<i>Dichocrinus</i> sp?																																			x	x
<i>Dichocrinus</i> sp.																																			x	x
<i>Dorycrinus parvus</i> (Shumard)																																			x	x
<i>Dorycrinus intermedius</i> , Meek & Worthen																																			x	x
<i>Dorycrinus romeri</i> , Meek & Worthen																																			x	x
<i>Dorycrinus cornigerus</i> (Hall)																																			x	x
<i>Dorycrinus subaculeatus</i> (Hall)																																			x	x
<i>Dorycrinus unicornis</i> (Owen & Shumard)																																			x	x
<i>Dorycrinus missouriensis</i> (Shumard)																																			x	x
<i>Dorycrinus inflatus</i> , Rowley																																			x	x
<i>Dorycrinus</i> sp?																																			x	x
<i>Glyptocrinus forasheffi</i> , Miller																																			x	x
<i>Glyptocrinus</i> sp?	x																																		x	x

TABLE SHOWING VERTICAL RANGE OF FOSSILS—CONTINUED.

SPECIES.	Hudson.		Niagara.		Hamilton.		Louisiana.			Hannibal.		Chouveau.	Lower Burlington.				Upper Burlington.			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
<i>Steganocrinus pentagonus</i> (Hall).....																X	X			
<i>Steganocrinus sculptus</i> (Hall).....																X	X	X		
<i>Strotocrinus glyptus</i> (Hall).....																			X	X
<i>Strotocrinus regalis</i> (Hall).....																			X	X
<i>Symbathocrinus brevis</i> . Meek & Worthen.....																X				
<i>Symbathocrinus dentatus</i> , Owen & Shumard.....																			X	X
<i>Symbathocrinus papillatus</i> , Owen & Shumard.....																			X	X
<i>Symbathocrinus wortheni</i> , Hall.....																			X	X
<i>Symbathocrinus</i> sp?.....																			X	
<i>Symbathocrinus</i> sp?.....															X					
<i>Taxocrinus themii</i> (Hall).....														X						
<i>Teleocrinus agllops</i> (Hall).....																			X	X
<i>Teleocrinus liratus</i> (Hall).....																			X	X
<i>Teleocrinus umbrosus</i> (Hall).....																				X
<i>Teleocrinus</i> sp?.....																	X			
<i>Metablastus wortheni</i> (Hall)?.....																				X
<i>Metablastus lineatus</i> (Shumard).....														X	X					
<i>Metablastus</i> sp?.....																				X
<i>Woodocrinus elegans</i> (Hall).....																				X
<i>Woodocrinus troostanus</i> , Meek & Worthen.....																	X	X		
<i>Woodocrinus</i> sp?.....																	X	X		
BRYOZOANS:																				
<i>Coscium latum</i> , Ulrich.....																X				
<i>Evactinopora grandis</i> , Meek & Worthen.....															X	X				
<i>Evactinopora radiata</i> , Meek & Worthen.....																X				
<i>Evactinopora sexradiata</i> , Meek & Worthen.....																				X
<i>Fenestella burlingtonensis</i> , Ulrich.....																		X	X	X
<i>Fenestella filistriata</i> , Ulrich.....																X	X			
<i>Leioclema</i> sp?.....					X	X														
<i>Lyropora retrorsa</i> , Meek & Worthen.....																X				
<i>Polypora burlingtonensis</i> , Ulrich.....																X	X			
<i>Rhombopora</i> sp?.....																X				
<i>Tentodictya ramulosa</i> , Ulrich.....																				X
BRACHIOPODS:																				
<i>Ambocoelia minuta</i> , White.....						X	X	X												
<i>Ambocoelia</i> sp?.....														X	X					
<i>Athyris incrassata</i> , Hall.....																X	X			
<i>Athyris lamellosa</i> , Hall.....											X	X	X	X	X	X				
<i>Athyris</i> sp?.....																X	X			
<i>Athyris hannibalensis</i> , Swallow.....					X	X	X			X	X									X
<i>Athyris</i> sp?.....														X	X					
<i>Athyris</i> sp?.....														X	X					
<i>Atrypa nodostriata</i> , Hall.....				X																
<i>Atrypa</i> sp?.....		X																		
<i>Camarophoria</i> sp?.....																X	X			
<i>Centronella rowleyi</i> (Worthen).....																X	X			
<i>Centronella</i> sp?.....																X	X			
<i>Chonetes geniculatus</i> , White.....						X	X													
<i>Chonetes logani</i> , Norwood & Pratten.....																X	X			
<i>Chonetes oratus</i> , Shumard.....				X	X	X				X										
<i>Chonetes</i> sp?.....																X				
<i>Crania rowleyi</i> , Gurley.....						X	X													
<i>Crania</i> sp?.....						X														
<i>Crania</i> sp?.....						X														
<i>Crania</i> sp?.....						X										X				
<i>Cyrtina acutirostris</i> , Shumard.....				X	X	X	X													
<i>Cyrtina burlingtonensis</i> , Rowley.....															X	X				
<i>Discina</i> sp?.....				X	X															
<i>Discina melle</i> , Hall.....															X					

TABLE SHOWING VERTICAL RANGE OF FOSSILS—CONTINUED.

SPECIES.	Hudson.		Niagara.			Hamilton.		Louisiana.			Hannibal.		Chouteau.		Lower Burlington.				Upper Burlington.	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	Eumetria prima? White															x	x			
Leiorhynchus? sp?																x				
Leptæna sericea, Sowerby	x																			
Lingula sp?				x																
Lingula halli? White																				
Meristella sp?		x													x					
Nucleospira barrisi? White								x	x											
Nucleospira sp?															x	x				
Platystrophia acutilirata (Conrad)	x																			
Rhipidomella missouriensis(Swallow)						x	x	x			x									
Orthis elegantula? Dalman			x																	
Orthis flabellium, Sowerby				x																
Orthis sp?				x																
Orthis occidentalis, Hall	x																			
Orthis subquadrata, Hall	x																			
Orthis swallowi, Hall												x	x	x	x	x	x	x	x	x
Orthis testudinaria, Dalman	x	x	x	x																
Orthis sp?															x	x				
Orthis burlingtonensis, Hall															x	x				
Productella pyxidata (Hall)						x	x	x	x	x	x									x
Productella shumardiana, Hall															x					
Productella sp?															x					
Productus arcuatus, Hall															x	x				
Productus cora? a' Orbigmy															x	x				x
Productus burlingtonensis, Hall															x	x				x
Productus punctatus, Martin															x	x				
Productus semireticulatus, Martin																	x	x		
Productus viminalis, White															x	x				
Productus sp?															x	x				
Productus sp?															x	x				
Productus sp?															x	x				
Productus sp?															x	x				
Retzia? sp?																				
Retzia? sp?																				
Retzia? sp?																				
Rhynchonella boonensis, Swallow								x	x											
Rhynchonella capax, Conrad	x																			
Rhynchonella missouriensis, Shumard						x	x	x												
Rhynchonella sp?																				
Rhynchonella sp?																				
Rhynchonella sp?																				
Rhynchonella whitei? Winchell	x																			
Rhynchonella sp?																				
Spirifera forbesi, Norwood & Pratten															x	x				
Spirifera hirtus, White & Whitfield																				
Spirifera imbrex, Hall																				
Spirifera incerta, Hall																				
Spirifera lineatoides, Swallow																				
Spirifera marionensis, Shumard						x	x	x			x									
Spirifera meeki, Swallow																				
Spirifera peculiaris? Shumard																				
Spirifera plena, Hall																				
Spirifera pseudolineata, Hall																				
Spirifera solidorostris, White																				
Spirifera striatiformis, Meek																				
Spirifera subrotundata, Hall																				
Spirifera grimesi, Hall																				
Spirifera temeraria? Miller																				
Spirifera mundula, Rowley																				
Spirifera sp?																				
Spirifera sp?																				
Spiriferina binacuta, Winchell																				
Spiriferina clarksvillensis, Winchell																				
Spiriferina aciculifera, Rowley																				
Spiriferina subtexta, White																				

TABLE SHOWING VERTICAL RANGE OF FOSSILS—CONTINUED.

SPECIES	Hudson.		Niagara.			Hamilton.			Louisiana.			Hannibal.		Chouteau.	Lower Burlington.				Upper Burlington.		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
	Straparollus roberti, White																X				
Straparollus obtusus, Hall																X					
Straparollus sp?																X					
Loxonema delphicola (Hall)																X					
Loxonema proluxa, White & Whitfield																X					
Soleniscus sp?																X					
Soleniacus sp?																X					
Sphaerodoma penguin (Winchell)																X					
Murchisonia pygmaea, Rowley								X	X							X					
Murchisonia sp?																X					
Murchisonia sp?			X													X					
Murchisonia sp?			X													X					
Igoceras quincyense (McChesney)													X	X							
Igoceras capulus (Hall)																X	X				
Capulus latus (Keyes)														X	X						
Capulus parvulus (Keyes)														X	X						
Capulus biserialis (Hall)																				X	
Capulus obliquus (Keyes)														X	X						
Capulus tribulosus (White)																					X
Capulus sp?																X					
Capulus sp?							X	X								X					
Orthonychia formosus (Keyes)																X					
Orthonychia pabuliformis (Owen)																X	X	X	X	X	X
Strophostylus reversus (Hall)																X	X	X	X	X	X
Pleurotomaria sp?			X																		
Pleurotomaria sp?			X																		
Pleurotomaria minima, Rowley							X	X													
Pleurotomaria subcarbonaria, Keyes																X	X				
Pleurotomaria sp?																X	X				
Pleurotomaria sp?																X	X				
Pleurotomaria montezuma, Worthen																	X				
Holopea subconica? Winchell																X					
Porcellia nodosa, Hall																X					
CEPHALOPODS:																					
Cyrtoceras sp?																X					
Goniatites sp?																X	X				
Goniatites sp?																X					
Goniatites osagensis, Swallow																X					
Goniatites sp?																					X
Goniatites sp?																					X
Goniatites louisianensis, Rowley							X	X				X									
Nautilus sp?							X									X					
Orthoceras sp? Hall			X																		
Orthoceras sp?				X																	
Orthoceras sp?																X					
Orthoceras sp?																X	X				
Orthoceras sp?																X					
WORMS:																					
Cornulites carbonarius, Gurley							X	X													
Spirorbis kinderhookensis, Gurley							X	X													
CRUSTACEANS:																					
Asaphus megistos (Locke)			X																		
Calymene callicephalata, Green			X																		
Calymene niagarensis, Hall			X	X																	
Dalmanites sp?			X																		
Lichas sp?				X																	
Phillipsia swallovi? Shumard							X														
Phillipsia insignis, Winchell																X	X				
Phillipsia tuberculata, Meek & Worthen																X	X	X	X	X	X
Phillipsia sp?																X					
VERTEBRATES:																					
Fish teeth																X	X	X			
Fish teeth and bones																X	X	X			
Fish spine																X	X				

The above table embraces all the evidence thus far obtained at the locality in question.

In considering the faunal features of the succession the interest centers in the characters of the fauna of the Kinderhook and of its several parts. Three problems are presented: (1) the general facies of the fauna as a whole, and the parts giving it its predominant phase; (2) the character and relations of the basal fauna, and (3) the upper limit, if any can be made out, of the fauna most characteristic of the formation.

(1) *General Faunal Facies.*—Heretofore the attempt has been always to treat the organic remains contained in the Kinderhook, "Chouteau" or "Chemung," as belonging to a single fauna. Owing to the heterogeneous beds that have been placed together in the formation it has been the chief mission of later work to take out from time to time various parts which were originally correlated with this terrane. Thus gradually the formation at its typical localities has finally come to be more clearly understood.

Regarding the "Kinderhook" as made up of three subdivisions, the Louisiana limestone, the Hannibal shale and the Chouteau limestone (in its original sense) the fauna contained when deprived of elements which have in reality no relation to it whatever, presents a very different facies from that generally ascribed to it. With the light of definite zonal distribution of the organic forms there appears to be, instead of a single compact and characteristic group of forms, two very distinct faunas, as is nowhere more clearly shown than in the locality which can be regarded as typical and in which the faunal zones have been determined with considerable accuracy and corroborated by evidence from other districts. Owing to indefinite knowledge regarding the exact horizons from which the various genera and species have been found in the past the general faunal facies of the "Kinderhook" has heretofore borne a composite and not a pure physiognomy.

A tabular arrangement of all the species of fossils that are recognized at a typical locality for the Kinderhook, and that range from the Hudson to the Upper Burlington, has disclosed very clearly some important facts which heretofore have been overlooked. The first of these features is the close affinity of the faunas, from the lower two members of the Kinderhook, with the underlying Devonian, and the second is the sharpness with which the lower fauna stops at the base of the Chouteau,

and the abruptness with which an entirely new fauna begins at that level.

(2) *Character and Relations of the Lower Fauna.*—The components of this fauna comprise those forms which, as already noted, occur in the Louisiana limestone and the Hannibal shales. For the present only the species from the former need occupy attention.

As a whole the fauna is clearly closely related to that occurring in the Western Hamilton. Some of the species, though bearing different names, are in reality identical with typical forms from that formation. Heretofore the fossils have been found, with few exceptions, perhaps, only in the basal portion of what is called the Louisiana limestone, in number 6, a thin sandy layer which is lithologically similar to the partings in the limestone itself. The results of the latest investigations show that many of the forms extend upward, some of them passing practically unchanged through the whole Louisiana to the top of the Hannibal. Not a single species of this fauna appears to occur in the overlying layer which has been regarded as the equivalent of the Chouteau. Many of the forms also range downward into the dark colored shale below, which is regarded as of Devonian age and which is here separated into two parts. A short distance away the shale becomes much thicker.

The general impression derived from the table is that the zones 5 to 8 inclusive are faunally very closely related, and that the higher ones, 9 to 11, also have close affinities with the lower zones. It may be noted in this connection that no special effort has been made to determine the full faunas of the higher beds, as the critical evidence that was needed was in regard to the fauna of the Louisiana (Lithographic) limestone. The shales have, however, proved to be remarkably barren in organic remains. Towards the top where they become sandy a number of the lower species are found. That the shales do not appear to be fossiliferous is not remarkable. Since they manifestly do not contain abundant remains in a good state of preservation they have not been searched so carefully by fossil collectors as have the other beds. At Burlington, Iowa, where there are excellent exposures and numerous active local collectors, besides a host of transient ones, the same shales remained for half a century without a fauna to be ascribed to them. But of late they have been shown to be abundantly

supplied with fossils. Without exception they appear to be characteristic Devonian forms. As yet, however, the fauna has not been studied sufficiently to be specifically listed, but the brachiopods are mostly very similar to, if not identical with, the species found in undoubted Devonian shales farther northward in the same state. The cephalopods are represented by large forms of *Cyrtoceras*, *Gomphoceras*, and *Phragmoceras*. One belonging to the latter genus may prove to be Winchell's *P. expansus*. Another very characteristic phase of the fauna is the non-trilobitic crustaceans, of which a very considerable number have been found. They have very close affinities to *Tropidocaris* and *Amphipeltis*.

It appears, then, that a well defined Devonian fauna extends up to the top of the Hannibal shales in northeastern Missouri, at Louisiana especially, and that the "Kinderhook" shales of southeastern Iowa, as typically developed at Burlington, and as corresponding in great part to the Hannibal shales, carry no other remains than those of pronounced Devonian types. The upper part of the section usually regarded as Kinderhook at Burlington, in fact all the thin limestone and sandstone bands down to the great body of argillaceous shales may be more properly regarded as the equivalent of the Chouteau limestone, that is, the uppermost member of the so-called Kinderhook in Missouri.

(3) *Upper Limit of the Louisiana Fauna.*—One reason that the fauna of the Chouteau (original) limestone has not been better understood than it has, in its relation to the faunas occurring lower in the so-called Kinderhook, and higher in the Burlington limestone, has been that in the localities where the lower Carboniferous has been most thoroughly and widely studied along the Mississippi river, the Chouteau, as commonly recognized, nowhere crops out along the great stream, except, perhaps, in the vicinity of the town of Louisiana where, under the typical Burlington, there are nine feet of earthy limestone which has been considered a part of the latter, but which is now believed to be the attenuated edge of the Chouteau, or its equivalent. In the same county the Chouteau attains a maximum thickness of twenty-five to thirty feet.

In the table given there is: (1) The species that come up from below to the base of the Chouteau, (2) those starting in the Chouteau and ranging upward, (3) the forms starting in the basal member of the Burlington limestone, and (4) the

species which comprise a lower fauna in the midst of a higher.

The most striking features in the vertical distribution of the fossils shown in the table given are: (1) The upper fauna nowhere extends beneath the base of the Chouteau (No. 12) and the lower fauna nowhere rises above the same line; (2) all the species belonging to the fauna beginning in the Chouteau extend upward into the Burlington; (3) while in the Burlington many new forms appear there is no immediate replacement of the older forms; (4) the many new species which appear in the second bed of the Burlington (No. 14) are largely so-called Kinderhook forms, not altogether from the Chouteau, but from the limestones which occur just beneath the Burlington limestone at the city of Burlington.

From a consideration of both tabular arrangements the following general conclusions are deduced:

1. The most marked change in the succession of faunas in the entire sequence of rocks commonly known as the Lower Carboniferous, or "Subcarboniferous" as represented along the Mississippi river is at the base of the Chouteau limestone (limited). At this horizon there is so great a faunal hiatus that there is scarcely a species that is common to the beds on either side.

2. That instead of the so-called Kinderhook containing in its fauna a mingling of Devonian and Carboniferous types there are really two faunas that are perfectly distinct, well-defined and not merging into each other. The one is characteristically Devonian in character and the other as strikingly Carboniferous in its general facies.

3. That the basal line of the Lower Carboniferous or Mississippian series is the base of the Chouteau limestone and the lower member of the four-fold series contains only one formation instead of the three heretofore commonly ascribed to it.

4. That the early reference of a part of the so-called Kinderhook or "Chemung" to the Devonian was correct in fact, though made through erroneous correlations.

5. That the evidence afforded by the faunas of the region is in close accord with the facts obtained regarding discordant sedimentation, and the stratigraphical and lithological characters of the formations.