ART. XI.—*On the Occurrence, in the Rocky Mountains, of an Upper Devonian Fauna with Clymenia;* by PERCY E. RAYMOND.

IT is the purpose of the present paper to announce the discovery in the Three Forks shales, near Three Forks, Madison County, Montana, of an Upper Devonian fauna containing *Clymenia*, *Entomis*, and goniatites.

The Devonian of the Three Forks region has been described by Peale* as consisting of 640 feet of massive limestone, capped by the Three Forks shales 135 feet in thickness. The limestones (Jefferson limestone) are dolomitic in character and nearly barren of fossils. Peale lists the following from a stratum about 30 feet below the top. They were identified by Dr. C. D. Walcott:—

Spirifer disjunctus,
Chonetes macrostriatus,
Smithia sp. ind.,
Orthis sp. ind.

In the vicinity of the Yellowstone National Park, from what appears to be the same formation, a few fossils were obtained by the United States Geological Survey parties. These were listed by Girty† as follows:—

Actinostroma sp.,
Cyathophyllum cæspitosum?
Pachyphyllum sp.,
Cladopora sp.,
Favosites sp.,
Spirifer engelmanni,
Atrypa missouriensis,
Atrypa reticularis,
Athyris vittata, var. *triplicata*,
Pleurotomaria? sp.,
P. isaacsi?
Platyostoma minutum,
Loxonema delicatum.

This fauna was considered by Girty to be Lower or Middle Devonian, while the presence of *Spirifer disjunctus* in the list identified by Dr. Walcott argues a somewhat later age for the fossiliferous stratum at Logan.

The Three Forks shales were divided by Dr. Peale into three portions:—

3. Upper shales, with many fossils. ..... 65 feet.
2. Grayish-brown limestone, without fossils. ..... 15–20 feet.
1. Lower shales, without fossils. ..... 50 feet.

*The Paleozoic Section in the Vicinity of Three Forks, Montana, Bull. U. S. Geol. Surv., No. 110; also Three Forks Folio, Geological Atlas of the United States.

† Geology of the Yellowstone National Park, Mon. xxxii, U. S. Geol. Surv., p. 483.

Division 3 is subdivided as follows:—

D. Yellow sandstone, the lower part calcareous,	25 feet.
C. Coal-black shale,	5 feet.
B. Gray limestone,	10 feet.
A. Green shales with bands of limestone,	30 feet.

Zones A, B, and D were described as fossiliferous, and Dr. Walcott identified 39 species from the collections made by Peale.

In 1895, while Mr. Douglass, now of the Section of Paleontology, Carnegie Museum, was collecting in the Tertiary deposits near Three Forks, he was shown specimens of *Spirifer disjunctus*. The gentleman who had these fossils later conducted Mr. Douglass to the locality from which they were obtained, and on this and succeeding visits Mr. Douglass collected the following fossils, which have been identified by Dr. George H. Girty*:—

Spirifer disjunctus,
Cleiothyris sp. nov.,
Camarotœchia tethys,
Pugnax pugnus,
Goniatites (2 sp.).

In September, 1905, Mr. Douglass and the writer visited this locality and obtained a large collection of fossils from the upper shales. The writer also made a collection from the Devonian ravine opposite Logan. These have been identified only provisionally, as a large number appear to be new and require more study than it has yet been possible to devote to them. It is thought, however, that the novelty of this fauna and its important bearing upon the problems of the distribution of Paleozoic lands and seas will justify this preliminary note.

In the 65 feet of strata constituting the upper shales at Three Forks, there are five zones in which the lithology and faunules differ somewhat. 1, 2, and 3 make up A above; 4 is the same as B; and 5 equals D. From C no fossils were obtained. These zones, beginning with the lowest, are as follows:—

1. *Red shale zone.*—The shales of this zone are hard, reddish, and fissile, the layers weathering into small sharp-pointed fragments. The fossils are preserved in pyrite, which is often partially altered to limonite, and they weather out on the surface in numerous bare spots along the strike of the beds. A set of fossils from this zone was sent to Dr. E. Holzapfel, whose determination of the species is quoted below:—

Orthoceras, 3 species,
Orthoceras, similar to *O. gregarium* Münst.,
Bactrites sp.

*Notes on the Geology of Southwestern Montana, by Earl Douglass. Annals Carnegie Museum, vol. iii, p. 416.

Goniatite, like *G.* (*Prolobites*) *delphinus*,
Cheiloceras, 2 species,
Clymenia,* somewhat like *C. annulata* Münst.,
Clymenia sp.,
Loxopteria, near *L. lævis* Frech,
Loxopteria, near *L. dispar* Sandb.,
Mecynodus, or *Goniophora* sp.,
Leiorhynchus sp.,
Camarotœchia sp.,
Spirifer Verneuili Murch. = *S. disjunctus* Sowerby,
Athyris sp.

In addition to these, the collection contains fragments of another species of *Clymenia*, a small gastropod, a *Nucula* and *Spirifer pinonensis* Meek.

In commenting on this faunule, Prof. Holzapfel states that the mode of preservation is exactly like that of some fossils

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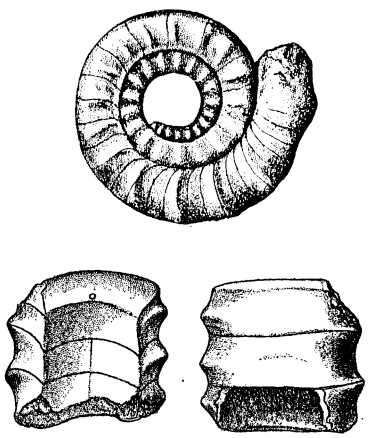

FIGURE 1.—An exfoliated specimen, natural size, of *Clymenia* (*Platyclymenia*) *americana*, in which the inner whorls are not preserved. Two views of a fragment of another specimen, twice natural size, to show position of the siphon and form of the suture line.
Cotypes in the Carnegie Museum.

in the Nehden shales, and that, except for the presence of *Clymenia*, which gives the fauna more the aspect of that of the Clymenia limestone, the composition of the fauna is analogous to that of the Nehden shales.

*This species of *Clymenia* is abundant in zones 1, 2, and 4, and may be readily recognized by its broad-backed, compressed and ribbed whorls. The suture is simple, as is shown by the accompanying figures. The name *Clymenia* (*Platyclymenia*) *americana* is here proposed for this species.

2. *Green shale zone.*—These are the green shales described by Peale (part of A, above). Fossils abound and further collecting should reveal a much larger fauna. *Clymenia* and *Entomis* are abundant, associated with a great number of brachiopods and lamellibranchs. For the complete faunal list, see the table below.

3. *White blocky shale.*—The exact horizon of this zone is not known, as the fossils were obtained at a locality where the layers seemed to be somewhat disturbed. In the field it appeared to be above the green shale, but it could not be located in any place where the beds were undisturbed. The faunal list is short, but the fossils are abundant:—

Fish spines,
Goniatite, either *Cheiloceras* or *Tornoceras*,
Orthoceras sp.,
Bellerophon sp.,
Posidonomya sp., very abundant,
Lingula sp.

4. *Gray limestone zone.*—This limestone weathers readily and produces great quantities of fine fossils, mostly brachiopods. Two species of *Clymenia* occur in this zone, but the goniatites are very rare. This same limestone is well exposed in the Devonian ravine at Logan, but no specimens of *Clymenia* were found at that locality; it has, however, furnished two fragments of cups of crinoids, one of which has been identified as a species of *Mariacrinus*, by Mr. Frank Springer. This is of interest, as it is the first crinoid reported from the Devonian of the Rocky Mountains. The fossils found in the limestone at these two localities are indicated in the table below. This seems to be the upper limit of the range of *Clymenia*.

5. *Yellow sandstone zone.*—This sandstone or sandy limestone forms the capping bed of the Devonian both at Three Forks and at Logan. A few beds are very fossiliferous and the fauna indicates a transition into the Mississippian (Madison limestone).

At Three Forks were found:—

Prorhynchus sp.,
Springothyris carteri,
Spirifer disjunctus,
Pugnax pugnus,
Camarocœtchia contracta,
Leiorhynchus mesicostale?
Ambocœlia gregaria,
Cleiothyris sp.,
Schuchertella inflata,
Productus sp.,
Edriotrypa sp.

The fossils of the various zones are tabulated below to show the range of the species:

Species	Three Forks					Logan	
	1	2	3	4	5	4	5
Fish spines			c				
Proëtus sp.						r	
Ostracoda sp. ind.		c					
Entomis sp.		c					
Platyclymenia americana sp. nov.	c	c		c			
Clymenia sp., smooth form	r	r		r			
Clymenia sp.	r						
Prolobites? sp.	c						
Cheiloceras sp.	c	c	c	r			
Cheiloceras sp.	r						
Bactrites sp.	c						
Orthoceras cf. *O. gregarium* Münst.	r						
Orthoceras, various species	c	c	c	c		r	
Platyostoma sp.				r		r	
Bellerophon sp.		r	r				
Pleurotomaria sp.		r					
Platyceras sp.						r	
Tentaculites sp.		c					
Aviculopecten, various species		c		r		r	
Lyriopecten sp.		r					
Crenipecten cf. *C. obsoletus* Hall		c					
Pteriniopecten sp.		r		r		r	
Actinopteria sp.		r					
Leptodesma sp.						r	
Loxopteria cf. *L. dispar* Sandb.	r			r			
Loxopteria cf. *L. lævis* Frech	c						
Mytilarca chemungensis Conrad		r					
Goniophora sp.	c	c		c			
Goniophora chemungensis Vanuxem				c		r	
Cypricardella sp.		r					
Modiomorpha sp.		c					
Prorhynchus sp.		r			r		
Cypricardinia arcuata? Hall		c		r			
Grammysia minor Walcott						r	
Grammysia sp.		r		c		r	
Paracyclas peroccidens Hall and Whitf.				r			
Paracyclas sp.		r					
Nucula, large form		r					
Nucula, small form	r	r					
Palæoneilo sp.		r					
Leda sp.		r					
Spathella typica Hall				c		c	
Sphenotus sp.		r					
Posidonomya sp.			c				
Syringothyris carteri (Hall)					c	c	
Spirifer disjunctus Sowerby	r	c		c	c	c	

Species	Three Forks					Logan	
	1	2	3	4	5	4	5
S. disjunctus animasensis Girty				c		c	
S. pinonensis Meek	r	r		c		c	
Spirifer, new type				r			
Athyris sp.		r		r		r	
Cleiothyris sp.	c	c		c	c	c	
Ambocœlia gregaria Hall	r	c		c	c	c	
Pugnax pugnus (Martin)		r		c	c	r	
Camarotœchia contracta? Hall	r	c		r		r	
Camarotœchia sp.		c		c	c	c	
Leiorhynchus, large form				r			
Leiorhynchus mesicostale? Hall	c	c		c	c	c	
Leiorhynchus sp.				c		c	
Productus sp.				r	r	r	
Productella subaculeata Walcott (Not *P. spinulicosta* Hall)		c		c		c	
Productella sp.		c		c		c	
Strophalosia cf. *S. truncata* (Hall)				r		r	
Chonetes filistriatus? Walcott						r	
Chonetes, large striæ						r	
Chonetes sp.		r					
Schuchertella chemungensis (Conrad)				c		r	
S. inflata White and Whitf.					r		
Schizophoria cf. *S. striatula* Schlotheim		c		c		c	
Schizophoria sp.		r		c		c	
Pholidops sp.		r					
Orbiculoidea sp.		r		r		r	
Lingula sp.		r	r	r			
Edriotrypa, large form		c		c		c	
Edriotrypa, small form		c					
Fenestella? sp.		r				r	
Mariacrinus sp.						r	
Crinoid stems		c		c		r	
Streptelasma sp.						r	

Correlation.

Clymenia has been previously represented in America only by *Clymenia* (*Acanthoclymenia*) *neapolitana* (Clarke) from the Cashaqua shales of western New York. With that species occur the numerous goniatites and other fossils of the *Manticoceras intumescens* fauna, so well described by Dr. Clarke. The fauna of the Three Forks shales agrees with that of New York in the presence of *Clymenia*, *Cheiloceras*, *Bactrites*, *Entomis*, and *Loxopteria*, but the species are in all cases distinct; the associated fauna is very different and the guide fossil, *Manticoceras intumescens*, appears to be absent from the Three Forks shales.

The fauna here listed seems to be much more like that of

the Upper Devonian of South Devon, the Rheinland, and other localities in Europe and Asia, where the top of the Devonian is indicated by one containing numerous species of *Clymenia* and goniatites. It is to be noticed, however, that the clymenias and goniatites of this American fauna are accompanied by indigenous forms suggestive of the typical Chemung of the eastern sections.

The Three Forks shale fauna cannot be directly correlated with any of those now known in the Rocky Mountains. It has a few species in common with the Devonian of the Eureka District, but these seem to be forms which have a long range in the Nevada section and are of little diagnostic value. With the fauna of the Devonian along the Mackenzie River this has little in common, as the fauna described by Whiteaves contains an abundance of corals, while these organisms are almost entirely lacking in the Three Forks shales.

The Ouray limestone of Colorado, described by Girty, contains one or two species found in the present fauna. *Spirifer disjunctus animasensis* is rather common in both.

In the uppermost zone of the Three Forks section the presence of *Syringothyris* and *Spirifer disjunctus* may prove to be of considerable interest in the correlation of these beds with Eastern sections. Williams* has noted the presence of *Syringothyris* and *Spirifer disjunctus* in beds overlying the typical Chemung and underlying the Waverly in southwestern New York. On account of the presence of *Syringothyris* these beds have been referred to the Mississippian. Dr. Girty, who has devoted a considerable time to the study of these strata and their enclosed fossils, has shown† that the fauna indicates a separate time interval, which he calls the Bradfordian. In this he includes the Cattaraugus, Oswego, and Knapp formations of the New York section, and considers these beds to represent the latest Devonian deposition in their province.

The fauna of the upper zone of the Three Forks section may, therefore, indicate the occurrence of the Bradfordian in the Rocky Mountains, and serves to confirm the reference of the *Clymenia americana* fauna to a very high Devonian horizon.

It is the intention of the writer to continue the study of this fauna, both in the field and in the laboratory, and further work may make possible more definite correlations.

Acknowledgment is here made to Dr. Holzapfel, of Aachen, in appreciation of his kindness in identifying a suite of fossils from the red shale zone, and to Mr. Douglass, the discoverer of the goniatites, for bringing the locality to the attention of the writer.

Carnegie Museum, Pittsburg, Pa., September 4, 1906.

* Bull. Geol. Soc. America, vol. xiv, p. 184, 1903.

† Science, vol. xix, No. 470, Jan. 1, 1904, pp. 24–25.