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THE FAUNA OF THE PHOSPHATE BEDS OF THE PARK CITY FORMATION IN IDAHO, WYOMING, AND UTAH

BY

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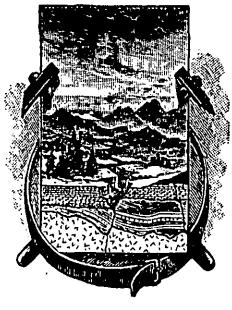

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THE FAUNA OF THE PHOSPHATE BEDS OF THE PARK CITY FORMATION IN IDAHO, WYOMING, AND UTAH.

By GEORGE H. GIRTY.

INTRODUCTION.

The following report deals with the fauna of a series of upper Carboniferous phosphate-bearing shales, about 100 feet thick, in the States of Utah, Wyoming, and Idaho. At the time the report was written I had no immediate knowledge of the geology of this region except that gained by observations made during a few days in Weber Canyon many years ago. I am indebted to F. B. Weeks and W. F. Ferrier for practically all the collections on which this report is based, and also for the geologic sections and such other facts bearing on the stratigraphic relations of the beds as have been necessary to show the geologic relations of the fauna.

During the time, now nearly two years, which has elapsed since the report was completed many additional stratigraphic and paleontologic data concerning the region considered have been collected by me and by others. Although the later collections made have increased slightly the list of species furnished by the original collections and have afforded further information concerning the distribution of the species, it has not seemed desirable to include the new matter in the present report, the body of which remains in this respect as originally prepared. The stratigraphic data, however, in so far as they are essential to a proper understanding of the stratigraphic relations of the phosphate fauna, have been brought abreast of present knowledge.

The geologic formations directly connected with the phosphate deposits seem to be a continuation of those of the Wasatch Mountains described by geologists of the Fortieth Parallel Survey. They were discussed by King under the names Weber quartzite, Upper Coal Measures limestone, and Permo-Carboniferous. Subsequently the "Upper Coal Measures limestone" was named by Boutwell the Park City formation, from its occurrence in the Park City quadrangle, in northern Utah. The phosphate beds, then, occupy a position near

the middle of the Park City formation. They lie between two limestones, also belonging to the same formation.

The three members of the Park City formation vary from point to point in lithology and in thickness, as well as in fauna. In the Montpelier district the upper limestone marks an important horizon for determining the position of the phosphate deposits. It is massive, contains here and there much black chert, and is at many places full of fossils, especially of several species of *Productus*, from which fact it is often called the "*Productus* limestone." Not far to the north, in the Swan Lake district, the upper limestone is replaced by siliceous or cherty shale of dark-purplish color. This cherty shale is not as a rule a prominent feature of the stratigraphy nor does it at many places contain fossils.

The lower limestone in the Montpelier region is of a whitish or buff color and at some places appears to be a fine-grained calcareous sandstone rather than a limestone. As a rule its fossils are very few and so ill preserved as to be indeterminable. In the Swan Lake district, on the other hand, this bed is a massive whitish, more or less siliceous limestone containing in abundance poorly preserved silicified fossils, among them species of *Spirifer*, *Squamularia*, and probably *Composita*. In its upper portion a large semireticulate *Productus* is found, and fine, black, earthy limestones that locally appear at its very top contain numerous specimens of *Spirifer*, *Productus*, and *Composita*. In this region the lower limestone serves much better than the upper as a guide for finding the phosphate beds, and for several reasons, more or less obvious, it seems to have been generally inferred that the guide rock was the same in both areas and that the series was overturned in the Swan Lake region. There is, however, hardly room for reasonable doubt that the stratigraphic sequence is normal in both regions and that the beds themselves differ in character in the two areas.

The phosphate beds consist mostly of soft rock, shales, phosphates, and impure limestones, the latter seldom more than a few inches thick. The shales are more or less phosphatic and the phosphate bands are more or less argillaceous. Their prevailing color is black, weathering to brown, but in the Beckwith Hills the color of the phosphate and associated rock is buff or even reddish. The thickness of the phosphate-bearing shales ranges from 60 to 100 feet. The main deposits of phosphate occur, as a rule, at the base of the series, so that in the Montpelier district they lie about that distance below the "upper *Productus* limestone," but in the Swan Lake district they occur immediately above the "lower *Productus* limestone."

The remaining formations concern the present report less closely. The beds below the Park City formation in southern Idaho have been identified with the Weber quartzite, which holds a similar position in

the Wasatch Range. The equivalence of the strata in the two sections, especially in detail, is not entirely clear. In Idaho the "lower *Productus* limestone" abruptly grades below into white sandstones and quartzites, and the Mississippian limestones are succeeded above by light-colored limestones that include more or less interbedded quartzitic sandstones, these being probably of Pennsylvanian age. Between these two quartzite-bearing groups comes in a series of soft beds approximately 1,000 feet thick. They are poorly exposed but seem to comprise soft sandstones and soft earthy limestones of reddish or yellowish tints. If the upper quartzitic beds are called the Weber, the division between the Weber and the Park City is not easy to determine. It may prove desirable to draw the line at the base of the phosphate shales and to include the siliceous limestones and calcareous sandstones of the "lower *Productus* limestone" in the Weber. If so, the thin stratum of black limestone which at some places occurs at the base of the phosphate beds and has here been spoken of as part of the "lower *Productus* limestone" may perhaps better be united with the Park City formation, because the fossils obtained in it indicate a certain change from the fauna of the white limestone below and an affinity with the fauna of the phosphate series above. In any event, the Weber quartzite, whose fauna is almost unknown, seems to show considerable modification in the Idaho sections.

In notable contrast to the Weber formation, the beds above the Park City formation show striking persistence in their main lithologic and paleontologic characters. These are the "Permo-Carboniferous" beds of the King Survey and were divided by Boutwell in the Park City district into the Woodside, Thaynes, and Ankareh formations. It seems all but certain that the "Permian" of Walcott's section in Kanab Canyon, in southern Utah; the "Permo-Carboniferous" of the Wasatch Mountains, in northern Utah; and, in part, the "lower Triassic" of southeastern Idaho are one and the same series. The Woodside, Thaynes, and Ankareh do not, perhaps, maintain precise boundaries throughout all this territory, and in Idaho the first occurence of Triassic ammonites (*Meekoceras* beds) is conventionally taken as the base of the Thaynes.

A varied and abundant fauna is also found in the "Permo-Carboniferous," though many of the fossils obtained at that horizon are in a poor state of preservation. The fauna which is largely undescribed is in marked contrast to that of the Park City formation beneath, consisting almost exclusively of pelecypods. Of these the group showing the richest differentiation is doubtless the pectinoids, of which many species can be discriminated. From this formation in the Wasatch Mountains Hall and Whitfield have described and identified *Myalina aviculoides*, *M. permiana*, *Aviculipecten curticardinalis*, *A. weberensis*, *A. parvulus*, and *Sedgwickia concava*.

The Triassic age of at least the major portion of the "Permo-Carboniferous" (Thaynes and Ankareh) seems to be shown by fairly satisfactory evidence—the presence of an extensive ammonite fauna of Triassic type and the practical absence of any distinctive Carboniferous forms. In advance of a detailed study of these faunas, however, it may be pointed out that above the *Meekoceras* beds there are zones which contain great numbers of *Rhynchonella* closely related to the Carboniferous *Pugnax utah* and many specimens of apparently true *Myalina*, not unlike Carboniferous species.

It is much less certain that the Woodside formation is not Palezoic (Permian?). A preliminary study of the fauna of the Woodside shows that, except that it has yielded no ammonitic forms, it does not differ materially from the fauna of the Thaynes and presents a strong contrast to the Carboniferous fauna of the Park City. Lithologically also there is a well-marked division between the Woodside and the Park City formation, and no lithologic boundary can be traced between the Woodside and the Thaynes. That the Woodside, Thaynes, and Ankareh form a natural group is indicated by the classification of these rocks adopted by most geologists. If the Thaynes is Mesozoic, the obvious line between the Mesozoic and the Paleozoic would seem to be the line between the Park City and the Woodside. If, then, as may be tentatively concluded, the Woodside does not represent the Permian, the natural question to follow is, Does not the Park City formation belong in the Permian? A decisive judgment on this point should wait upon a careful study of the faunas obtained from other members of the Park City beds, as well as upon a study of other related faunas less certainly appearing at the same horizon. Because of the close relationship or identity of many species of these faunas with the Gschelian fauna of Russia, I am provisionally holding that the Park City formation is older than the Permian.

Anyone at all familiar with the Carboniferous faunas of the Mississippi Valley will at once recognize the fact that the forms found in the phosphate beds, individually as well as collectively, are quite different from any others found in that area. In fact, but few of the phosphate species have closely related forms in the Pennsylvanian, and a correlation by paleontology with any definite portion of the Pennsylvanian section is at present impossible. Even among western faunas this has an extremely individual and novel facies, one which is known to me as occurring only in a well-defined area.

Some of the peculiarities of the phosphate fauna may well be pointed out. So far as known, the Protozoa (*Fusulina*), corals, and Bryozoa are entirely absent from it, although those groups are fairly well represented in most of our American Carboniferous faunas, both eastern and western. The brachiopods, usually so abundant and highly dif-

ferentiated, are here rather rare and restricted, except for the genus *Chonetes*, which is not ordinarily very plentiful. The scarcity of the genus *Productus* and of the Spiriferidæ, which dominate most faunas of the Carboniferous, is noteworthy. The gastropods, pelecypods, and goniatites, on the other hand, are somewhat unusually well represented. The most common and at the same time the most singular and characteristic types of the phosphate fauna are undoubtedly *Chonetes ostiolatus* and its varieties, *Pugnax weeksi*, *P. weeksi* var. *nobilis*, *Omphalotrochus ferrieri*, and *O. conoideus*, but perhaps *Nucula montpelierensis*, *Yoldia mcchesneyana*, and *Gastrioceras simulator* also deserve mention in a secondary degree. Although one of the rarer forms, *Grammysia? carbonaria* is a striking and interesting type. There are few species closely related to these among the Carboniferous faunas yet described from North America.

It has already been mentioned that the phosphate beds constitute a part of the strata called by the geologists of the Fortieth Parallel Survey (in the Wasatch Mountains section) the "Upper Coal Measures limestone," and later described by Boutwell and other writers under the name Park City formation. Even from the fauna of the associated rocks that of the phosphate beds presents striking differences, and one is led to infer tentatively that the segregation of the phosphatic material was original, contemporaneous with, and in some way connected with the peculiar differentiation of the fauna accompanying it.

Though the phosphate fauna possesses a remarkable individuality of facies it is not altogether out of relationship with other formational faunas, for with the aid of the fossils from the associated rocks it can be recognized as belonging to a fauna widely dispersed over the West and traceable, it is believed, even into Alaska, Asia, and eastern Europe. The other western faunas of about the same geologic age are largely composed of representatives of the Brachiopoda and Bryozoa, especially of the Productidæ and Spiriferidæ. Thus there is little common ground for comparison, but though the abundant and characteristic features of the phosphate fauna are peculiar to it, where a common ground for comparison does exist an agreement can be found to a considerable extent, and some of the less abundant forms have a wider distribution. These western faunas have not been studied in detail and in many localities the rocks in which they occur have not been discriminated into formations and named, so that it is possible to speak of them only in a general way. If, however, we eliminate the beds of recognized lower Carboniferous age, such as the "Wasatch limestone" of Utah (lower part), the Redwall limestone of the Grand Canyon section, and the Baird shale of California, and also certain younger divisions such as the "Permo-Carboniferous" of the Wasatch Mountains and surrounding region, the Permian

of the Grand Canyon section, the Guadalupian series of Texas, and, perhaps, a few others, we have left a group of rocks, as already remarked, which is widely distributed throughout the West (including Alaska) and which constitutes the major portion of the Carboniferous representation in that extensive area. The fauna of these formations thus tentatively grouped together, though presenting many local modifications, can, in a general way, be correlated with the Gschelian fauna of the Ural Mountains, some of the American assemblages presenting truly remarkable resemblances to those of Russia.

In the phosphate fauna the resemblance is, perhaps, rather distant, for of the Gschelian fauna we know little aside from its brachiopods, which have been described by Tschernyschew and others. Nevertheless, it is a notable fact that the four species of *Productus* which the phosphate fauna has furnished have closely related types in the Gschelian, and although, lacking material for comparison, I have provisionally given new names to the American forms, it may well be that they will prove to be identically the same. A similar correspondence may be noted in one or two other Brachiopoda also.

The fauna of the phosphate beds, as it occurs in our collection, is shown in the accompanying table, from which the species found at each station, as well as the composite faunas of the different horizons and sections, can readily be determined.

Distribution of the fauna of the phosphate beds of the Park City formation of Idaho, Wyoming, and Utah.[a]

	965.	969.	978.	980.	981.	981a.	981b.	982.	988.	988a.	988b.	988c.
Conularia sp												
Lingula carbonaria (?)												
Lingula carbonaria var. exporrecta												
Lingulidiscina missouriensis									×	×		
Lingulidiscina utahensis												
Chonetes ostiolatus			×									
Chonetes ostiolatus var. impressus												
Chonetes ostiolatus var. minusculus						×				×		
Productus geniculatus												
Productus eucharis												
Productus montpelierensis												
Productus phosphaticus												
Pugnax weeksi						(?)						
Pugnax weeksi var. nobilis			×					×		×		
Pugnax osagensis var. occidentalis												
Rhynchopora taylori												
Dielasma (?) sp												
Amboccelia arcuata										×		
Grammysia (?) carbonaria				×								
Edmondia (?) phosphatica												×
Cardiomorpha (?) sp				×								
Nucula montpelierensis				×								×
Nucula sp												
Yoldia mechesneyana				×								
Leda obesa				×								×
Schizodus ferrieri				×					×			
Aviculipecten (?) montpelierensis	×	×		×				×		×		
Aviculipecten phosphaticus												×
Plagioglypta canna												
Pleurotomaria idahoensis												
Pleurotomaria aff. nevadensis				×						×	×	×
Euphemus subpapillosus												
Omphalotrochus ferrieri												
Omphalotrochus ferrieri var												
Omphalotrochus conoideus			×									
Naticopsis tayloriana				×								
Soleniscus aff. altonensis												
Pseudomelania (?) sp												
Gastrioceras simulator					×		×					
Gastrioceras (?) sp					×							
Goniatites (?) sp											×	
Popanoceras (?) sp												
Hollina emaciata var. occidentalis						×				×		
Jonesina carbonifera						×				×		
Cytherella benniei						×				×		

[a] The numbers at the head of the columns in the table are those given to the collections examined. The localities at which these collections were obtained are described in the register of localities on pages 59–61.

Distribution of the fauna of the phosphate beds of the Park City formation of Idaho, Wyoming, and Utah—Continued.

	988d.	988e.	988f.	988g	988h.	988i.	989.	990e.	991.	992.	993.	993a.
Conularia sp												
Lingula carbonaria (?)	×							×				
Lingula carbonaria var. exporrecta	×											
Lingulidiscina missouriensis		×	×							×		
Lingulidiscina utahensis								×				
Chonetes ostiolatus				×								
Chonetes ostiolatus var. impressus												
Chonetes ostiolatus var. minusculus												
Productus geniculatus												
Productus eucharis												
Productus montpelierensis												
Productus phosphaticus												
Pugnax weeksi												×
Pugnax weeksi var. nobilis												
Pugnax osagensis var. occidentalis												
Rhynchopora taylori												
Dielasma (?) sp												
Ambocœlia arcuata												
Grammysia (?) carbonaria												
Edmondia (?) phosphatica												×
Cardiomorpha (?) sp												
Nucula montpelierensis		×										
Nucula sp												
Yoldia mechesneyana						×						
Leda obesa		×							×		×	
Schizodus ferrieri		×										
Aviculipecten (?) montpelierensis												
Aviculipecten phosphaticus												
Plagioglypta canna												
Pleurotomaria idahoensis		×										
Pleurotomaria aff. nevadensis												×
Euphemus subpapillosus												
Omphalotrochus ferrieri												
Omphalotrochus ferrieri var.												
Omphalotrochus conoideus												
Naticopsis tayloriana												
Soleniscus aff. altonensis							×					
Pseudomelania (?) sp		×										
Gastrioceras simulator					×	×	×					
Gastrioceras (?) sp												
Goniatites (?) sp												
Popanoceras (?) sp						×						
Hollina emaciata var. occidentalis												
Jonesina carbonifera		×										
Cytherella benniei		×										

Distribution of the fauna of the phosphate beds of the Park City formation of Idaho, Wyoming, and Utah—Continued.

	3511.[a]	5067.	5068.	5069.	5069a.	5069c.	5069g.	5069h.	5069t.	5070.	5071.	5071a.	5072.	5074.
Conularia sp	X													
Lingula carbonaria (?)	X										X	X		
Lingula carbonaria var. exporrecta														
Lingulidiscina missouriensis	X		X										X	X
Lingulidiscina utahensis														
Chonetes ostiolatus	X													
Chonetes ostiolatus var. impressus													X	
Chonetes ostiolatus var. minusculus		X												
Productus geniculatus	X													
Productus eucharis	X													
Productus montpelierensis	X													
Productus phosphaticus	X													
Pugnax weeksi	X		(?)					X						
Pugnax weeksi var. nobilis	X						X	X						
Pugnax osagensis var. occidentalis	X													
Rhynchopora taylori	X													
Dielasma (?) sp	X													
Amboccelia arcuata	X	X												
Grammysia (?) carbonaria														
Edmondia (?) phosphatica														
Cardiomorpha (?) sp	X						X							
Nucula montpelierensis	X				X									
Nucula sp	X												X	
Yoldia mcchesneyana					X					X				
Leda obesa	X				X									
Schizodus ferrieri	X		X		X		X						X	
Aviculipecten (?) montpelierensis	X			X	X	X	X		X					
Aviculipecten phosphaticus														
Plagioglypta canna	X													
Pleurotomaria idahoensis	X												X	
Pleurotomaria aff. nevadensis	X	X								X			X	X
Euphemus subpapillosus		X												
Omphalotrochus ferrieri	X													
Omphalotrochus ferrieri var	X													
Omphalotrochus conoideus	X													
Naticopsis tayloriana					X									
Soleniscus aff. altonensis														
Pseudomelania (?) sp														
Gastrioceras simulator										X				
Gastrioceras (?) sp														
Goniatites (?) sp														
Popanoceras (?) sp														
Hollina emaciata var. occidentalis														
Jonesina carbonifera														
Cytherella bennieI														

[a] "Cap lime."

Distribution of the fauna of the phosphate beds of the Park City formation of Idaho, Wyoming, and Utah—Continued.

	Weber Canyon.	Woodruff Creek.	Crawford Mountains.	Sublette Range.	Thomas Fork.	Bear Lake.	Montpelier	Preuss Range.
Conularia sp							×	
Lingula carbonaria (?)	×			×	×		×	
Lingula carbonaria var. exporrecta					×			
Lingulidiscina missouriensis		×	×	×	×		×	
Lingulidiscina utahensis	×							
Chonetes ostiolatus					×		×	×
Chonetes ostiolatus var. impressus				×				
Chonetes ostiolatus var. minusculus				×	×			
Productus geniculatus							×	
Productus eucharis							×	
Productus montpelierensis							×	
Productus phosphaticus							×	
Pugnax weeksi					(?)		×	×
Pugnax weeksi var. nobilis					×	×	×	×
Pugnax osagensis var. occidentalis							×	
Rhynchopora taylori							×	
Dielasma (?) sp							×	
Ambocœlia arcuata				×	×		×	
Grammysia (?) carbonaria							×	
Edmondia (?) phosphatica					×			×
Cardiomorpha (?) sp							×	
Nucula montpelierensis					×		×	
Nucula sp				×			×	
Yoldia mcchesneyana					×		×	
Leda obesa					×		×	×
Schizodus ferrieri				×	×		×	
Aviculipecten (?) montpelierensis			×		×	×	×	
Aviculipecten phosphaticus					×			
Plagioglypta canna							×	
Pleurotomaria idahoensis				×	×		×	
Pleurotomaria aff. nevadensis		×		×	×		×	×
Euphemus subpapillosus				×				
Omphalotrochus ferrieri							×	
Omphalotrochus ferrieri var							×	
Omphalotrochus conoideus							×	×
Naticopsis tayloriana							×	
Soleniscus aff. altonensis					×			
Pseudomelania (?) sp					×			
Gastrioceras simulator					×			
Gastrioceras (?) sp					×			
Goniatites (?) sp					×			
Popanoceras (?) sp					×			
Hollina emaciata var. occidentalis					×			
Jonesina carbonifera					×			
Cytherella benniei					×			

The present report includes collections from the phosphate beds from eight districts—Weber Canyon, Woodruff Creek, the Crawford Mountains, the Sublette Range, Thomas Fork, Bear Lake, Montpelier, and the Preuss Range (exclusive of Montpelier). By far the most numerous and complete are the collections from Montpelier. From this area we have more than 30 lots, most of which were obtained from the limestone above the main phosphate bed, which, in local parlance, is known as the "Cap lime." As these lots all came from the same horizon and from a small area near Montpelier, in some cases even from the same locality, it has seemed best for purposes of tabulation to group the fossils from the "Cap lime" at Montpelier under a single number, 3511. The fauna of the "Cap lime," therefore, can be ascertained by consulting the column in the foregoing table headed by that number.

The following section, which was furnished me by Messrs. Weeks and Ferrier, shows the constituent members of the phosphate beds in the Montpelier district. It was taken from cut 4A, at the north end of the Waterloo claim:

Section at north end of Waterloo claim, Montpelier, Idaho.

Soil.	Ft.	in.
Phosphatic shale	10	
Limestone No. 3		6
Phosphate No. 4	1	
Shaly limestone	1	6
Phosphate No 3		11
Limestone No. 2	1	3
Phosphate No. 2	2	2
Limestone No. 1 or "Cap lime"	2	
Phosphate No. 1, main bed	6	
Basal limestone, undetermined.		

The fauna of the "Cap lime," or limestone No. 1, consists as at present known of 26 species about equally divided between the mollusks and the brachiopods, and it includes most of the important species of the phosphate fauna.

Nine lots were obtained above the "Cap lime" in the phosphate series. The lowest of these is perhaps lot 5069h, from limestone 2 or 3 and it contains only *Pugnax weeksi* and *P. weeksi* var. *nobilis*, both characteristic species of the "Cap lime."

From nodules in phosphates 3 and 4 was obtained lot 5069, furnishing only *Aviculipecten? montpelierensis.*

Lot 5068 was collected in limestone No. 3. It comprises only three species—*Lingulidiscina missouriensis, Pugnax weeksi?* and *Schizodus ferrieri.*

A more extensive fauna was obtained from the base of the first shale above limestone No. 3. (5069a), the species obtained being *Nucula montpelierensis, Yoldia mcchesneyana, Leda obesa, Schizodus ferrieri, Aviculipecten? montpelierensis,* and *Naticopsis tayloriana.*

From the second shale above limestone No. 3 our collection contains only *Aviculipecten? montpelierensis* (station 5069c).

From about the same horizon, the upper beds above limestones Nos. 2 and 3 (5069g), we have *Pugnax weeksi* var. *nobilis, Cardiomorpha?* sp., *Schizodus ferrieri,* and *Aviculipecten? montpelierensis.* At about this horizon also occurs lot 5069t, in which only *Aviculipecten? montpelierensis* has been identified.

A single fauna, rather extensive compared with those cited above, has been obtained from limestone No. 4 (not shown in the detailed section above). It comprises the following species (station 980): *Grammysia? carbonaria, Grammysia?* sp., *Nucula montpelierensis, Yoldia mcchesneyana, Leda obesa, Schizodus ferrieri, Aviculipecten? montpelierensis, Pleurotomaria* aff. *nevadensis, Naticopsis tayloriana.*

From a higher horizon, though one still in the phosphate series, our collection contains a single lot (965) consisting of a single species, *Aviculipecten? montpelierensis.*

As represented in our collections the Montpelier area has furnished 29 out of the 49 species recognized as belonging to the phosphate fauna, the most significant omissions being the groups of cephalopods and ostracods which were obtained from the Thomas Fork section. Of the 29 species known to occur in the Montpelier district 26, or all but 3, are found in the "Cap lime." The forms not yet found in the "Cap lime" are *Grammysia? carbonaria, Yoldia mcchesneyana,* and *Naticopsis tayloriana.* The "Cap lime" appears to be by all means the most abundantly fossiliferous zone of the phosphate series in this area and most of the brachiopods as well as most of the peculiar and characteristic types of the fauna are restricted to it, or at least to the lower portion of the series. The upper faunas comprise a not large number of pelecypods and a few gastropods.

From the phosphate beds in the rest of the Preuss Range, we have three collections, 993, 993a, and 978, comprising seven species, *Chonetes ostiolatus, Pugnax weeksi, P. weeksi* var. *nobilis, Edmondia phosphatica, Leda obesa, Pleurotomaria* aff. *nevadensis,* and *Omphalotrochus conoideus.* These collections are referred to the "Cap lime" of the Montpelier section and all the species except *Edmondia phosphatica* are common to the "Cap lime" and include some of its characteristic forms.

Our collections from the Weber Canyon district are very meager, as the beds are not well exposed there. They consist in fact of but a single lot (990e), containing two species, *Lingula carbonaria?* and *Lingulidiscina utahensis.*

From the Woodruff Creek district also we have only two species, *Lingulidiscina missouriensis* and *Pleurotomaria* aff. *nevadensis* (from station 5074), both of which occur also at Montpelier.

Two collections (969 and 992) from the Crawford Mountains contain but a single species each. These are *Lingulidiscina missouriensis* and *Aviculipecten? montpelierensis,* both of which occur at Montpelier.

From the Sublette Range our collections contain four lots (5067, 5071, 5071a, and 5072), with an aggregate of ten species. These are *Lingula carbonaria?, Lingulidiscina missouriensis, Chonetes ostiolatus* var. *impressus, Chonetes ostiolatus* var. *minusculus, Ambocœlia arcuata, Nucula* sp., *Schizodus ferrieri, Pleurotomaria idahoensis, Pleurotomaria* aff. *nevadensis,* and *Euphemus subpapillosus.* All these are found also in the Montpelier district except three, *Chonetes ostiolatus* var. *minusculus, Chonetes ostiolatus* var. *impressus,* and *Euphemus subpapillosus.* The phosphate fauna has here lost much of its peculiar facies, most of the individual and striking species not having been

found. From what has been said it will follow that the characteristic facies of the "Cap lime" also does not appear in this region.

In number our collections from the Thomas Fork district are second only to those from Montpelier and the fauna is correspondingly varied. There are 16 lots (981, 981a, 981b, 988, 988a, 988b, 988c, 988d, 988e, 988f, 988g, 988h, 988i, 989, 991, 5070) and 26 species. The species are *Lingula carbonaria?*, *Lingula carbonaria* var. *exporrecta*, *Lingulidiscina missouriensis*, *Chonetes ostiolatus*, *Chonetes ostiolatus* var. *minusculus*, *Pugnax weeksi?*, *Pugnax weeksi* var. *nobilis*, *Ambocœlia arcuata*, *Edmondia? phosphatica*, *Nucula montpelierensis*, *Yoldia mcchesneyana*, *Leda obesa*, *Schizodus ferrieri*, *Aviculipecten? montpelierensis*, *Aviculipecten phosphaticus*, *Pleurotomaria idahoensis*, *Pleurotomaria* aff. *nevadensis*, *Soleniscus* aff. *altonensis*, *Pseudomelania?* sp., *Gastrioceras simulator*, *Gastrioceras?* sp., *Goniatites?* sp., *Popanoceras?* sp., *Hollina emaciata* var. *occidentalis*, *Jonesina carbonifera*, *Cytherella benniei*. Of these, 13 are common to the Montpelier district and 13 are not. Nine of the latter are in fact restricted to this particular district and consist mainly of the groups of goniatites and ostracods which are not elsewhere represented in the phosphate fauna, with two species of gastropods. The four other species which occur in this area, but not at Montpelier, are *Lingula carbonaria* var. *exporrecta*, *Chonetes ostiolatus* var. *minusculus*, *Edmondia phosphatica*, and *Aviculipecten phosphaticus*. Here again, in the Thomas Fork district many of the characteristic and abundant types of the "Cap lime" are absent. From this fact one would necessarily infer either that the horizon of the "Cap lime" and possibly the lower or main phosphate of the Montpelier district was absent at Thomas Fork (unless merely undiscovered), or that the faunal peculiarities of the "Cap lime," strong as they are, are a local development and possibly not to be looked for outside of the Montpelier district. The latter inference is doubtless correct.

The stratigraphic occurrence of these collections as determined by Messrs. Weeks and Ferrier may be seen from the accompanying section, which has been kindly furnished me.

The top of the section is the massive, cherty limestone reef in which *Productus* is very abundant.

Section of phosphate beds exposed in Coal Canyon, a few miles south of Raymond Canyon, on the west side of the Sublette Range, Wyoming.

	Ft.	in.
1. Shaly and shattered limestone	1	9
2. Hard blocky limestone	3	2
3. Crushed and shaly oolitic limestone	1	10
4. Hard black shattered limestone containing *Chonetes ostiolatus* (988g)	9	8
5. Impure oolitic shaly phosphate		5
6. Coarse black limestone and shale, in part sandy	7	8

	Ft.	in.
7. Hard black limestone, including 3 inches of crushed shale, containing *Lingula carbonaria?* and *L. carbonaria* var. *exporrecta* (988d)	1	8
8. Oolitic phosphate	5	10
9. Hard dark-gray blocky limestone, 6 inches shattered at top; contains *Edmondia phosphatica*, *Nucula montpelierensis*, *Leda obesa*, *Aviculipecten phosphaticus?*, *Pleurotomaria* aff. *nevadensis* (988c)	2	1
10. Black oolitic phosphate with 4-inch band of brown shale 10 inches above base	4	9
11. Hard gray limestone containing *Lingulidiscina missouriensis* (988f)	1	4
12. Shattered and weathered limestone, with streak of 3-inch phosphate	2	1
13. Thin shaly and oolitic limestone	6	6
14. Hard dark-gray limestone containing *Lingulidiscina missouriensis*, *Chonetes ostiolatus* var. *minusculus*, *Pugnax weeksi* var. *nobilis*, *Ambocœlia arcuata*, *Leda obesa*, *Aviculipecten? montpelierensis*, *Pleurotomaria* aff. *nevadensis*, *Hollina emaciata* var. *occidentalis*, *Jonesina carbonifera*, *Cytherella benniei* (988c, 991)	2	2
15. Thin and shattered brown shale with oolitic and nodular limestone layers	3	3
16. Hard, gray sandy limestone, 8 inches shattered at base; contains *Lingulidiscina missouriensis*, *Nucula montpelierensis*, *Leda obesa*, *Schizodus ferrieri*, *Goniatites* sp., *Pleurotomaria idahoensis*, *Pseudomelania?* sp., *Jonesina carbonifera*, *Cytherella benniei* (988, 988e)	1	9
17. Black, impure phosphatic shale		4
18. Massive gray limestone with shattered zone in center and at top; contains *Pleurotomaria* aff. *nevadensis*, *Goniatites?* sp. (988b)	4	8
19. Black and brown thin-bedded phosphatic shale, with limestone layers and large nodules at top; *Gastrioceras simulator* (988h)	8	6
20. Gray limestone much shattered, 2 to 3 inches at base oolitic	3	2
21. Black phosphate, much shattered, dirty and with thin shaly layers	3	3
22. Light-brown sandy phosphatic shale		9
23. Black phosphate, much shattered and crushed	1	5
24. Light-brown sandy phosphatic shale, shattered transverse to bedding	1	3
25. Impure black phosphate		10
26. Similar to No. 24	2	2
27. Phosphate, much shattered and contorted	4	9
28. Brown shaly material, somewhat pebbly, shattered transverse to bedding		6
29. Black oolitic phosphate		6
30. Black shale, only slightly oolitic	1	8
31. Coarse impure oolitic phosphate, with fine limy bands	2	
32. Dirty phosphate, coarsely oolitic at top	2	4
33. Brown nodular shale	4	5
	98	5

The remainder of the section is covered to and beyond the yellow sandstone which forms the base of the phosphate series.

From the Bear Lake district we have but one collection (982), containing two species, *Pugnax weeksi* var. *nobilis* and *Aviculipecten? montpelierensis*. The horizon is given as the "Cap lime," and as both species occur in the "Cap lime" of the Montpelier district, the faunal evidence, so far as it goes, is in agreement with the stratigraphic identification.

A general consideration of the phosphate fauna, so far as it is known, in connection with the stratigraphic and geographic occurrence, indicates several facts with considerable clearness. The phosphate fauna has peculiarities of facies not yet known in any other area. Its peculiarities are especially found in the lower portion, chiefly in the limestone overlying the lower or main phosphate of the Montpelier district. These peculiarities are suggested in the faunas of the Preuss Range and of the Bear Lake district, although the evidence is too meager to indicate to what extent this facies extends into those areas. On the other hand, this facies is not known in any of the other districts from which we have fossils, even when the fauna as a whole occurs there. Our collections from the Weber Canyon, Woodruff Creek, and Crawford Mountain districts are too incomplete to stand as evidence of any conclusiveness on this or almost any other point, but those from the Sublette Range and Thomas Fork districts are more complete and conclusive. It seems necessary to believe either that the lower beds of the Montpelier district are not represented faunally in the districts named (or at all events not in the collections from those districts) or more probably that the peculiarities of the Montpelier districts and probably of the remainder of the Preuss Range and of the Bear Lake district are local and not characteristic of the fauna as a whole. On the other hand, the Thomas Fork fauna itself has rather strongly individual features in the presence of certain species of Ostracoda and Cephalopoda, groups otherwise absent from the phosphate fauna in toto, together with a few species of gastropods also peculiar to it.

Acknowledgments are due to Messrs. W. F. Ferrier, F. B. Weeks, J. J. Taylor, and C. C. Jones, by whom the collections forming the subject-matter of this report were made; far the larger part was obtained by Mr. Ferrier and Mr. Weeks, and to Mr. Ferrier am I especially obliged for much of the best and rarest material, which was generously donated by him. To Mr. Weeks I am also indebted for stratigraphic data and other assistance in the preparation of this report.

DESCRIPTION OF SPECIES.

ANNELIDA?

CONULARIIDÆ.

CONULARIA Miller.

CONULARIA sp.

Plate VI, figure 8.

Only two species of *Conularia* have been described from our upper Carboniferous rocks, *C. roeperi* and *C. crustula*, and the present form is much more similar to the latter than to the former species. It is represented in our collections by but a single specimen, which, when complete, may have had a length of about 25 mm. The cross section is square and the diameter at the larger end about 9 mm. The costæ occur 11 in 5 mm.

This species differs from *C. crustula* in being more gradually expanding and in having somewhat more closely arranged costæ. It is therefore probably new, but the introduction of a new name seems hardly justified at present, because some important characters, such as the sculpture or crenulations on the costæ are unknown, not being shown in our specimen.

Horizon and locality.—Phosphate beds of the Park City formation; Montpelier, Idaho (station 3511).

BRACHIOPODA.

LINGULIDÆ.

LINGULA Bruguière.

LINGULA CARBONARIA Shumard?

Plate I, figures 2–5.

1858. *Lingula carbonaria.* Shumard, St. Louis Acad. Sci. Trans., vol. 1, p. 215.
Coal Measures: Clark County, Mo.

1873. *Lingula mytiloides?* Meek and Worthen, Geol. Survey Illinois, Rept., vol. 5, p. 572, pl. 25, figs. 2a, 2b, 2c.
Coal Measures: Illinois.

1899. *Lingula mytiloides?* Girty, U. S. Geol. Survey, Nineteenth Ann. Rept., pt. 3, p. 575.
Upper Coal Measures: Atoka quadrangle, Hartshorne, Ind. T. [Okla.]; roof shale of the Grady or Hartshorne coal.

1903. *Lingula carbonaria.* Girty, U. S. Geol. Survey, Prof. Paper 16, p. 342.
Weber formation: Leadville district, Colorado.

I am loath to identify these western shells with Shumard's species, because, since they come from so distant an area and are associated with so different a fauna, it seems intrinsically somewhat unlikely that they are specifically the same. At least, however, they are very similar so far as their characters can now be determined.

Shumard did not figure *Lingula carbonaria*, and his brief description applies very well to the form under consideration, the chief discrepancy being in point of size. The typical form is somewhat smaller.

Under the title "*Lingula mytiloides* Sowerby?" Meek has figured a species from Illinois which is probably best regarded as distinct from the English form and as identical with that described by Shumard. Two of Meek's figures represent small shells, smaller than typical *L. carbonaria;* a third figure is considerably larger. It is, in fact, almost exactly twice the size of one of the smaller figures, and as it also has almost exactly the same shape, it probably represents a mere enlargement of the same. The junction of the lateral outline with the cardinal slopes is angular, and in this respect it fails to agree with Shumard's description. In this respect also it is unlike the form under consideration, but if it is not an enlargement and is not distinct specifically from the smaller variety, it is probable that typical *L. carbonaria* does attain even a greater size than the form from the phosphate beds. Furthermore, I have identified *L. carbonaria* as far west as Colorado, but from a lower horizon and from an association of species like that of the typical Pennsylvanian and quite different from the phosphate fauna. Under the circumstances I would hardly feel justified in describing this as a new species, and a provisional identification with *L. carbonaria* seems the least objectionable course.

The National Museum contains six specimens from Springfield, Ill., which have been identified by Worthen as *Lingula mytiloides* Sowerby. They clearly belong to the same species which Meek and Worthen figured under that name and possibly were part of the original material. Some specimens are narrower than others, and some have the anterior outline more rectilinear. The largest is 12.5 mm. long. The surface appears to be smooth but under a lens is seen to be marked by extremely fine, sharp, regular, wavy liræ. These specimens, while of a smaller size, have very much the shape of those from the phosphate beds. The latter do not show the fine liræ seen on the others, and, indeed, this delicate sculpture would hardly appear in the present preservation even if originally a character. They do show fairly strong concentric undulations of growth which seem to be absent from the Illinois material.

As found in the phosphate beds *L. carbonaria?* attains but probably does not exceed a length of 19 mm., while the average is distinctly under this measurement. The length is one and one-half times the

width, or even more in narrow specimens. The sides are subparallel, rounding into the anterior and posterior outlines. The anterior outline is slightly straightened or truncated in some specimens but more rounded in others. The posterior outline is broadly angular in ventral valves, bluntly rounded in dorsals. The convexity is rather high for the genus; the shell is thick and marked by rather fine and indistinct concentric striæ.

This form occurs abundantly at a certain horizon at Thomas Fork, and perhaps at a corresponding one at Cokeville. It has not been found at Montpelier, except in a single specimen, which agrees very well with one of Meek's figures of *L. mytiloides* and with the younger stages of the Thomas Fork specimens as indicated by growth lines.

Horizon and locality.—Phosphate beds of the Park City formation; Weber Canyon, Utah (station 990e); Sublette Range, Wyoming (stations 5071, 5071a); Thomas Fork, Wyoming (station 988d); Montpelier, Idaho (station 3511).

LINGULA CARBONARIA var. EXPORRECTA n. var.

Plate I, figure 1.

Associated with the foregoing are a few specimens which are distinguished by being much wider in proportion to their length. At the same time the outline contracts posteriorly more strongly than has been noted in any of the specimens referred to *L. carbonaria?* I believe that this peculiarity is not the result of distortion, though possibly it may be extrinsic to some extent. To comprise these specimens with the others under the same specific name would, from present evidence, make a grouping rather incongruous and it seems preferable to distinguish them as a separate variety.

Horizon and locality.—Phosphate beds of the Park City formation; Thomas Fork, Wyoming (station 988d).

DISCINIDÆ.

LINGULIDISCINA Whitfield.

LINGULIDISCINA MISSOURIENSIS Shumard.

Plate I, figures 6–10.

1858. *Discina Missouriensis.* Shumard, St. Louis Acad. Sci., Trans., vol. 1, p. 221.
Middle Coal Measures: Lexington and Charbonnier, Missouri.

1873. *Discina nitida?* Meek and Worthen (non Phillips), Geol. Survey Illinois, Rept., vol. 5, p. 572, pl. 25, fig. 1.
Coal Measures: Illinois.

1882. *Discina Meekana.* Whitfield, New York Acad. Sci., Annals, vol. 2, p. 228.
Coal Measures: Carbon Hill and Flint Ridge, Ohio; Illinois; Iowa.

1884. *Discina nitida.* White, Geol. Survey Indiana, Thirteenth Rept., pt. 2, p. 121, pl. 25, fig. 10.
Coal Measures: Indiana; Illinois; Iowa; Missouri; abundant at Cannelton and Horse Shoe of Little Vermilion.

1887. *Discina nitida.* Herrick, Sci. Lab. Denison Univ., Bull., vol. 2, p. 145, pl. 2, figs. 8, 9 (*Discina Meekana* on description of plate, p. 65).
Coal Measures: Flint Ridge, Ohio.

1888. *Discina nitida.* Keyes, Acad. Nat. Sci. Philadelphia, Proc., p. 226.
Lower Coal Measures: Des Moines, Iowa.

1891. *Discina Meekana.* Whitfield, New York Acad. Sci., Annals, vol. 5, p. 598, pl. 15, figs. 1–3, also p. 603.
Coal Measures: Carbon Hill and Flint Ridge, Ohio.

1892. *Orbiculoidea nitida.* Hall and Clarke, New York State Geologist, Eleventh Ann. Rept. for 1891, pl. 5, fig. 16.
Lower Coal Measures: Springfield, Ill.

1892. *Orbiculoidea nitida.* Hall and Clarke (pars), Geol. Survey New York, Pal., vol. 8, pt. 1, p. 131, pl. 4F, figs. 23–28 (non fig. 29).
Coal Measures: Springfield, Ill.; Grover, Mo.

1895. *Discina nitida.* Keyes, Missouri Geol. Survey, Rept., vol. 5, p. 39, pl. 35, fig. 6 (date of imprint, 1894).
Coal Measures: Clinton, Lexington, and Richmond, Mo.

1895. *Discina meekana.* Whitfield, Geol. Survey Ohio, Rept., vol. 7, p. 483, pl. 11, figs. 1–3, also p. 488.
Coal Measures: Carbon Hill, Hocking County, Ohio.

1897. *Orbiculoidea missouriensis.* Schuchert, U. S. Geol. Survey, Bull. 87, p. 280.

1900. *Orbiculoidea missouriensis.* Beede, Univ. Geol. Survey Kansas, Rept., vol. 6, p. 55, pl. 8, figs. 1–1c.
Upper and Lower Coal Measures: Fort Scott; Rosedale, Wyandotte County; Lansing, Leavenworth County; Topeka.

Shumard's specimens were obtained from a limestone. In the black shales of Missouri associated with coals a small discinoid occurs in great abundance, which agrees in most respects with Shumard's description and which I have often seen identified as his species. It usually is found completely flattened down, but here and there specimens occur in concretions and retain their normal convexity. I would say that in these shells the apex of the dorsal valve is nearer one-fourth of a diameter from the posterior margin than one-third, as described by Shumard, and it is distinctly curved downward, so that the highest point is a little anterior to the apex. This seems to be contrary to Shumard's description, and the elevation also seems to be in disagreement, since it is less than one-third of the diameter.

In the collections of the United States National Museum there is a block of black limestone from Pittsburg, Ill., containing a similar species in great profusion. This differs from the other form, however, in having the apex erect and the convexity somewhat greater. The elevation varies more or less in different specimens and the position of the apex also varies from about one-third to one-fourth of a diameter from the margin. In the ventral valve the pedicel slit is more depressed. This form seems to be rather nearer typical *L. missouriensis* than any of the specimens which I have seen from Missouri.

The phosphate beds of Idaho and Wyoming furnish a similar small species of *Lingulidiscina*, which I am unable to distinguish satisfactorily from those of the Mississippi Valley, especially the form from

Illinois. The size is in some shells larger, a few specimens attaining a diameter of 15 mm., while the Illinois and Missouri specimens do not go above 10 mm., but there is little difference in the average. In a few specimens the apex is somewhat curved, but in the greater number it is erect. The elevation, though in the majority of specimens comparable to that of the Illinois form, is in a few somewhat greater, though this relation is rather difficult to determine, as many of the specimens have been compressed more or less laterally. For the same reason the position of the apex is sometimes not determinable in its relation to the margin, but it seems to be as in the form from the Mississippi Valley; similarly with the characters of the ventral valve and with the sculpture, which consists of strongly elevated, closely arranged liræ, about 15 to 19 in 3 mm.

Horizon and locality.—Phosphate beds of the Park City formation; Woodruff Creek, Utah (station 5074); Crawford Mountains, Wyoming (station 992); Sublette Range, Wyoming (station 5072); Thomas Fork, Wyoming (stations 988, 988a, 988e, 988f); Montpelier, Idaho (stations 3511, 5068).

LINGULIDISCINA UTAHENSIS Meek.

Plate I, figure 11.

1877. *Discina* sp. undet. Meek, U. S. Geol. Expl. 40th Par., Rept., vol. 4, p. 99, pl. 10, fig. 3.
Upper Carboniferous: Weber Canyon, Wasatch Range, Utah.
1877. *Discina utahensis.* Meek, U. S. Geol. Expl. 40th Par., Rept., vol. 4, p. 99, (See also footnote, p. 9.)

This species was originally founded on two ventral valves from Weber Canyon, Utah, and it is a little surprising that the four specimens in the present collections from practically the same locality and horizon are likewise all ventrals. The shape of the present specimens is, like the original ones, more or less elongate or oval, the largest having a length of 19 mm. The peculiarity mentioned by Meek seems to be a normal feature, viz, the shape is neither regularly convex nor regularly concave, but the posterior portion is convex (upon the inner side) and the anterior portion concave. The center of growth and the inner end of the fissure are eccentric, but the inner end of the fissure hardly lies midway between the center of the valve and the posterior margin, as stated by Meek. The fissure is rather short with extraverted sides.

It is impossible to tell certainly from the material in hand whether this is the same form which I have identified as *L. missouriensis* or a different one, but I rather think that it is different. The ventral valves referred to *L. missouriensis* seem to have a more circular shape and a simple instead of a compound curvature, besides being considerably smaller.

In describing this form I have employed the orientation used by Meek, but I suspect that the inner and outer sides are really reversed in his description, because the edges of the fissure are normally introverted rather than turned outward in this group. In well-preserved specimens or in molds the presence of sharply defined sculpture sufficiently identifies the outer side, but as the present specimens are exfoliated this test can not be applied.

If my orientation of this shell is correct, these ventral valves show, though in a less marked degree, the configuration upon which Hall and Clarke distinguished their genus *Roemerella*. I have, however, felt somewhat doubtful about assigning them to that genus, both because *Roemerella* is, so far as known, restricted to a single species in the mid-Devonian, and because these upper Carboniferous shells possess the distinguishing character in so subordinate a degree. In any event, the character seems to afford a distinction between this and the form referred to *Lingulidiscina missouriensis*.

Horizon and locality.—Phosphate beds of the Park City formation; Weber Canyon, Utah (station 990e).

PRODUCTIDÆ.

CHONETES Fischer-de-Waldheim.

CHONETES OSTIOLATUS n. sp

Plate I, figures 12–14.

Shell large, subquadrate, often unusually long for the width, but sometimes, especially in young specimens, more transverse. As a rule the cardinal angles are quadrate and the sides parallel, but occasionally the sides converge toward the front and the hinge line is slightly extended. On the other hand, the hinge is sometimes slightly shorter than the width in front.

In the ventral valve the beak is rather small, depressed, and inconspicuous. On either side five or six cardinal spines are found, with perhaps two or three small ones near the center which are not usually preserved. The convexity ranges from high to moderate, the small, ill-defined ears being depressed.

The shape of the dorsal valve is that of the ventral, save that as usual the convexity is lower and the beak less projecting. A sinus is as a rule entirely absent from both valves, but occasional traces of a faint one can be made out.

The surface is without true radiating striæ, but is marked by fine concentric striæ or wrinkles, which are often rather strong, especially on the ears, and very irregular in direction. The shell is also pierced by numerous relatively large pores which are finer and more scattered over the younger portion of the shell and vary somewhat in size and abundance in different specimens. Narrow, sharp, but very fine

discontinuous channels proceed forward from the pores—a character apparently confined more or less to the more marginal portion of the shell.

The interior of the valves is covered with little spinules in closely arranged rows. When exfoliated, a condition in which to a greater or less degree most of the specimens occur, these spinules appear as punctæ, not to be confused, however, with the larger and less numerous pores, and this arrangement gives the surface an appearance of being marked by rather faint liræ—an appearance, however, which is, according to the best evidence at hand, misleading.

This species is related to *C. geinitzianus* of the Pennsylvanian, but it is believed to be distinct on the following considerations. It is a much larger shell than typical *C. geinitzianus*, less transverse, normally without a sinus, not usually extended at the hinge, with stronger concentric striæ, and with larger pores. Indeed, I am not satisfied that *C. geinitzianus* possesses any structure corresponding to the pores in the present species, for the fine openings in the shell of the Pennsylvanian form resemble the fine punctæ among which the larger pores in *C. ostiolatus* are distributed.

Horizon and locality.—Phosphate beds of the Park City formation; Thomas Fork, Wyoming (station 988g); Montpelier, Idaho (station 3511); Preuss Range, Idaho (station 978).

CHONETES OSTIOLATUS var. IMPRESSUS n. var.

Plate I, figures 15–17.

This form has been found only at Cokeville (station 5072), but all the specimens obtained from that station can be referred to it.

The size is small, reaching 13 mm. in width. The shape is as a rule broadly subquadrate, with nearly rectilinear front and sides. The sides are subparallel, so that the hinge is as wide as or a little wider than the shell in front. The convexity is low with a broad, ill-defined sinus in the ventral valve, which causes a deflection of the whole anterior border. The sinus is confined to the anterior half of the shell.

The surface is smooth with numerous large pores.

This form is closely related to *C. ostiolatus*, from which it is distinguished by its smaller size, lower convexity, more transverse shape, and the possession of a definite and constant sinus. It resembles *C. geinitzianus* much more closely than does *C. ostiolatus* itself. There is only one character by which they are surely distinguishable, and that is the presence of macroscopic pores in the western form. It is doubtful whether *C. geinitzianus* has anything comparable to these, the little punctæ to which Meek calls attention being much smaller and much more numerous. Indeed, I think they are homolo-

gous, rather, with the numerous fine pores which occur in *C. ostiolatus* and its varieties and tend in some conditions of preservation to lend an appearance of fine, indistinct radial striation.

Horizon and locality.—Phosphate bed of the Park City formation; Sublette Range, Wyoming (station 5072).

CHONETES OSTIOLATUS var. MINUSCULUS n. var.

Plate I, figures 18–20.

At several localities a form of *Chonetes* has been obtained differing from *Chonetes ostiolatus* in being very much smaller but in little else. These shells rarely attain a size of 13 mm. in diameter, the average being smaller and thus only about one-half that of the typical form. They can hardly be regarded as young examples, for the thickness of the shell and the relatively high convexity indicate that they are mature. They do not occur associated with typical *C. ostiolatus*, and they are very abundant.

I am in some uncertainty as to how best to treat this form. It seems hardly advisable to refer the specimens without qualification to *C. ostiolatus*, while, on the other hand, I dislike to discriminate them even as a variety without some more important difference than mere size. This, however, is so great in degree and so constant that a separation on account of that character seems preferable to a union in spite of it. If anything the pores in these small shells are as large or larger than in the large ones. The shape varies considerably, some specimens having nearly parallel sides and subquadrate cardinal angles, while others have converging sides, acute cardinal angles, and a hinge distinctly longer than the width below. A discrimination of the long-hinged and short-hinged types has not seemed practical to me.

Horizon and locality.—Phosphate beds of the Park City formation; Sublette Range, Wyoming (station 5067); Thomas Fork, Wyoming (stations 981a, 988a).

PRODUCTUS Sowerby.

PRODUCTUS GENICULATUS n. sp.

Plate II, figures 1–2.

Shell rather small, about 25 mm. in width, transverse, subquadrate. Cardinal angles not extended. Ventral valve shaped much like the dorsal valve of most *Producti*, with nearly flat visceral area and abruptly deflected margins. The beak is small, slightly elevated, and incurved. The ears are small and inconspicuous. A rather strong, narrow sinus is developed along the middle of the anterior part of the shell, extending backward for a short distance onto the visceral area but dying out before reaching the beak.

The surface is marked by fine, regular, radiating liræ, which occur about 14 in 5 mm. They are faint, especially toward the beak. Concentric wrinkles are absent, but the posterior portion at least is crossed by obscure, somewhat irregular incremental striæ. Spines are developed sparingly and are of several sizes, some being relatively very stout and some rather slender. Two or three of the latter sort occur on each side along the hinge, while otherwise the spines, and especially the large ones, are chiefly developed upon the geniculated portion.

The dorsal valve is not known, and no evidence of *Marginifera* structure has been observed.

There is no Pennsylvanian form which *P. geniculatus* closely resembles, and but few described species in the West. *P. multistriatus* is perhaps as close as any but is clearly distinct. Some similar forms occur in the lower beds of the Guadalupian series, of which, in fact, this type of shell, with flattened posterior portion, geniculated margin, and strong sinus, is rather characteristic. No American species known to me, however, bears so close a resemblance to the one in hand as the Russian *Productus mammatus* Keyserling, but without specimens for comparison I do not like to identify it with the Russian form.

Horizon and locality.—Phosphate beds of the Park City formation; Montpelier, Idaho (station 3511).

Productus eucharis n. sp.

Plate II, figures 3–4.

Shell small, very transverse. Cardinal line extended. Ears pointed. Ventral valve rapidly enlarging, strongly convex. The surface of this valve is marked by fine, even, radiating liræ, 13 to 15 in 5 mm. Where well preserved these are sharply elevated and rather widely separated from one another. They are often more or less wavy in direction. New ones are introduced by intercalation. A few large wrinkles are developed upon the sides, to which they are confined, never crossing the body of the shell. A few spines spring from the surface of this valve, some of them large enough to occasion the deflections of the liræ above mentioned, others smaller and less conspicuous. Three or four rather small spines are developed along the hinge.

The dorsal valve is gently concave over the visceral portion, but rather abruptly bent along the margins. In marked contrast to the opposite valve the visceral area is crossed by strong, sharp, sublamellose wrinkles, making steplike rugosities. There are also fine, wavy, concentric, incremental striæ. The radiating liræ of this valve are similar to those of the ventral, but the strong wrinkles give

them a disconnected appearance. No evidence of spines has been seen. The shell is thick and strong. As in most species of the genus, the dorsal valve appears to have been convex in its early stages.

This form may have attained a width of 25 mm., but seldom if ever exceeded that dimension. The majority of the specimens are probably nearer 18 mm. across.

P. eucharis is very closely related to *P. aagardi* Toula, but, as in the other cases and for the same reason, I feel that an identification without material for comparison would be inadvisable. It is related in a general way to *P. cora*, from which, however, it is evidently distinct, but with no other Pennsylvanian species does it hold relationship demanding especial consideration.

Horizon and locality.—Phosphate beds of the Park City formation; Montpelier, Idaho (station 3511).

PRODUCTUS PHOSPHATICUS n. sp.

Plate II, figures 7–9.

Shell of the *cora* type, broad, slightly transverse or slightly elongate in different specimens. Hinge line about as wide as the width below. The cardinal angles subquadrate. Ventral valve strongly convex, with small depressed ears. Beak inflated and much incurved. Dorsal valve similar to the ventral, but with lower convexity and smaller and less projecting beak.

Surface marked by fine radiating liræ, as in *P. cora*, eight to ten in 5 mm. The whole surface of both valves is crossed by moderately strong, subequal but more or less irregular transverse wrinkles, which are stronger and coarser on the ears. There are also small spines, which appear to be rather numerous and regularly distributed. Sometimes the development of a spine is accompanied by an elevation of the rib from which it springs, beginning some distance above the point of appearance. In such cases the presence of spines is a conspicuous feature, but otherwise not, since they are of about the same size as the costæ and do not produce very considerable enlargements.

This species is of the same general type as our common Pennsylvanian form *P. cora*, but it is clearly distinct. The costæ are probably finer and the wrinkles are finer and are distributed over the entire surface, whereas in *P. cora* they occur only on the ears and do not cross the shell, and the spines are more numerous and smaller, since in *P. cora* they interrupt two or three of the ribs and cause large nodes on the shell. I know of no described species in the Pennsylvanian that is really closely related to the present one, except *Productus pertenuis*, which is similar, though I believe distinct. My specimens are much smaller, with finer costæ and stronger wrinkles.

P. phosphaticus is closely related to *P. cancriniformis* Tschernyschew,[a] and may prove identical when it is possible to compare specimens. It does not seem very probable, a priori, that an American species is exactly the same as a Russian one, but the probability is enhanced in this case by the fact that other associated *Producti* show a similar agreement to Russian forms and that *P. cancriniformis* is already credited with a wide distribution, having been found also in the Carnic Alps and in India.

Horizon and locality.—Phosphate beds of the Park City formation; Montpelier, Idaho, (station 3511).

PRODUCTUS MONTPELIERENSIS n. sp.

Plate II, figures 5–6.

Shell of medium size, transverse, subcircular in outline. Hinge shorter than the greatest width, cardinal angles rounded. Anterior outline subrectilinear or slightly concave.

Convexity of ventral valve rather low. Beak small, strongly incurved, rapidly expanding. Ears small, undefined, depressed. A rather narrow, shallow sinus occurs in the ventral valve and a corresponding fold in the dorsal.

The dorsal valve is nearly flat. The ears are slightly recurved, and a low, narrow, undefined fold passes down the median portion. There are thus three elevated and four depressed areas on the dorsal valve, the depressed areas consisting of the two ears and the two radiating divisions on either side of the fold.

The surface is covered by great numbers of small spines mounted on slightly elongate bases and more or less regularly arranged in quincunx. The bases are larger and more elongated toward the front and sides, where, consequently, the rasplike surface appears to be coarser. There are also fine, equal, but irregular wrinkles which cover the entire surface.

There is no Pennsylvanian species with which this needs to be compared. In South America [b] and in Russia [c] we have kindred forms, both of which have been called *Productus humboldti*. The present form is certainly closely related to both of those referred to, but is considerably smaller, and the sculpture appears to be on a finer scale. A satisfactory conclusion as to the relationship of these types can not be reached, however, without the comparison of actual specimens, but in view of the wide geographic separation I would hardly expect to find them quite the same.

Horizon and locality.—Phosphate beds of the Park City formation; Montpelier, Idaho (station 3511).

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[a] Mém. Com. géol. [Russia], vol. 16, no. 2, 1902, pl. 52, figs. 5 and 6.

[b] D'Orbigny, Voyage dans l'Amérique méridionale, Pal., 1842, pl. 5, figs. 4–7.

[c] Tschernyschew, Mém. Com. géol. [Russia], vol. 16, no. 2, 1902, pl. 53, figs. 1–3.

RHYNCHONELLIDÆ.

PUGNAX Hall and Clarke.

PUGNAX WEEKSI Girty.

Plate III, figures 1–4.

1908. *Pugnax weeksi* Girty, U. S. Nat. Mus., Proc., vol. 34, p. 296.
Phosphate beds: Montpelier, Idaho.

Shell large, varying in shape from subtriangular or subovate to subpentagonal, and from elongate to transverse. As a rule, highly gibbous, but sometimes of lower convexity, probably as a persistence of an immature character, young shells being usually discoidal. Ventral beak large, pointed, suberect, flattened, and spreading at the sides. Foramen apparently triangular and open. Dorsal beak rather inconspicuous and strongly incurved. Fold and sinus very strong, usually broad and subquadrate; but sometimes narrow and sometimes rounded; typically divided by a medium sulcus so that it bears two plications, but occasionally the sulcus is so faint that the fold appears to be simple. Much more rarely three plications are found upon specimens referred to this species. There is always one rather distinct lateral plication on each side of the fold, with usually a second, which is also sometimes distinct, but may be obscure. All the plications are confined to the marginal portions of the shell, and they vary in different specimens not only as to distinctness but also as to being angular or rounded. In young specimens the shell is broadly oval and discoidal. The fold develops first, and later its median sulcus and the lateral plications.

Upon the interior the ventral valve is provided with dental lamellæ and the dorsal valve apparently with strongly diverging socket plates, connecting with a hinge plate, which is also joined to a fairly long, high, median septum.

The posterior portion, especially of the ventral valve, is rather thick shelled and moderately strong, though not well-defined muscular imprints are retained in many specimens.

In general appearance certain variants of this form are very suggestive of some species of athyroids, as, for instance, *Composita trinuclea*, but more especially the forms grouped by Abich under the title *Spirigera protea*,[a] some of which, unlike *C. trinuclea*, have lateral plications. Aside, however, from the fact that these shells appear to be without spiralea, the configuration of the beak of the ventral valve indicates almost to a certainty that we have not to do here with an athyroid. In fact, there can be but little doubt that this form is one of the Rhynchonellidæ. I have, however, been in some doubt

[a] Geologische Forschungen in den Kaukasischen Ländern, 1. Theil, Eine Bergkalkfaune aus der Araxesenge bei Djoulfa in Armenien, Wien, 1878, pp. 52, et seq.

as to what genus it may best be cited under. The choice seems to lie between *Rhynchonella* s. s. and *Pugnax*. The type species of *Rhynchonella* and *Pugnax* are very similar in external form, but *Rhynchonella loxia* has a septum in the dorsal valve, while *Pugnax pugnus* is without that structure. In general appearance, therefore, *P. weeksi* could be referred to either genus with almost equal propriety, but it possesses a pretty well developed dorsal septum. On that account it might best, perhaps, be referred to *Rhynchonella*, although internally and externally it appears to be generically related to certain Carboniferous shells which Hall and Clarke have placed with *Pugnax*.

This species is so dissimilar to any of our American rhynchonelloids that a comparison with them is scarcely necessary. Tschernyschew has figured a similar species from the Gschelstufe of Russia as *Pugnax connivens*.[a] Some enlarged figures of *Pugnax dawsoniana* given by Davidson[b] resemble the present species in a remarkable degree. I have not had specimens of *P. dawsoniana* for comparison, but in view of the great difference in size of the two species, their wide geographic separation, and their probable great difference in geologic age and faunal association, such a comparison would, I believe, show them to be distinct. Hall and Clarke[c] have figured and referred to Davidson's species a form from Windsor, Nova Scotia, which, if correctly identified, clearly shows that *P. dawsoniana* is distinct from *P. weeksi*.

Type specimens.—Cat. No. 53466, U.S.N.M.

Horizon and locality.—Phosphate beds of the Park City formation; Thomas Fork, Wyoming (station 981a?); Montpelier, Idaho (stations 3511, 5069h, 5068?); Preuss Range, Idaho (station 988a).

PUGNAX WEEKSI var. NOBILIS n. var.

Plate III, figures 5–7.

Associated in many cases with typical *P. weeksi* occurs another form which can hardly be included under the same title without making the assemblage appear heterogeneous, but which can not be satisfactorily discriminated because of intermediate specimens. The shells in question are considerably larger than the typical variety, more transverse, less convex, and with a correspondingly lower fold and sinus. There are three instead of two plications on the fold and three or four lateral ones. The plications themselves are apt to be stronger than in *P. weeksi* and to extend farther toward the beaks. To this variety I have doubtfully assigned a few specimens with two plications on the fold, while four sometimes occur there.

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[a] Mém. Com. géol. [Russia], vol. 16, No. 2, 1902, p. 483, Pl. L, figs. 12, 13, 19, 20.
[b] Quart. Jour. Geol. Soc. London, vol. 19, 1863, p. 172, Pl. IX, figs. 13, 14.
[c] Geol. Survey New York, Pal., vol. 8, pt. 2, Pl. LXII, figs. 30–33.

These large spreading shells graduate into others of smaller size and higher convexity. As a rule shells of this group having three plications on the fold are broader than those with two, yet there are individuals with three plications which are as narrow as the average of those having two, and individuals with two plications which are as broad as the average of those having three. It often seems inexpedient to separate the broad forms with two plications from the narrow ones (typical *P. weeksi*), which differ in little else. The propriety seems likewise doubtful of discriminating the broad shells having two plications from the ordinary thrice-plicated ones having the same configuration otherwise, while no sharp demarcation is apparent between the latter and the larger, broader, flatter shells which typify the present variety.

Horizon and locality.—Phosphate beds of the Park City formation; Thomas Fork, Wyoming (station 988a); Bear Lake, Idaho (station 982); Montpelier, Idaho (stations 3511, 5069g, 5069h); Preuss Range, Idaho (station 978).

PUGNAX OSAGENSIS var. OCCIDENTALIS n. var.

Plate I, figures 21-22.

A few fossils from the phosphate beds appear to be rather closely related to our common Pennsylvanian form *P. osagensis*, and yet they may also be regarded as an extreme modification of the robust species so characteristic of the phosphate fauna, which is widely different from *P. osagensis*. They have a subtriangular or subpentagonal shape, and are broad and spreading. On the fold they have two or three plications and on each side four additional ones. In some specimens as many as six can be counted on the dorsal valve on each side of the fold, the last two appearing rather as denticulations in the line of junction of the two valves than as plications of the shell. The plications are rather high and sharp and extend halfway to the beak or farther.

On the interior the ventral valve has the usual pair of dental plates and the dorsal valve a distinct but probably not very high septum.

So far as observed this species has two plications on the fold as often as three, and in this respect it differs from *P. osagensis*, which has usually three or more. The lateral plications are more numerous and a larger number of them are well marked. The shell as a whole is more robust than that of typical *P. osagensis*, and the plications are more angular. In view of these facts and the widely different faunal association it seems hardly justifiable to identify this form directly with *P. osagensis*.

In just what degree it is related to *P. utah*, which is usually regarded as identical with *P. osagensis*, I am unable to say, because the typical

P. utah is known only from Marcou's not very complete first description. It seems to differ in being more robust and in having more numerous lateral plications.

Horizon and locality.—Phosphate beds of the Park City formation; Montpelier, Idaho (station 3511).

RHYNCHOPORA King.

RHYNCHOPORA TAYLORI n. sp.

Plate III, figure 8.

Shell rather large, subpentagonal. Width greater than length, greatest a little above the middle. Convexity moderate. Fold wide, not very high, well defined, marked by six regular, rounded plications. Sides surmounted by about eleven costæ, of which the three final ones are indistinct. Length about 12 mm., width 14.5 mm., thickness 8.5 mm.

This species appears to be rare in the phosphate beds, only one specimen having come to hand; but it is, fortunately, in a good state of preservation. *R. taylori* is closely related to *R. illinoisensis*, but unless that species shows rather wide limits of variation it apparently should not be regarded as the same. The type specimen of *R. illinoisensis* has eight plications on the fold and eight lateral ones on each side, while *R. taylori* has six plications on the fold and ten or eleven on each side. The total number does not vary materially in the two species, but they are differently arranged with reference to the fold and to the lateral areas. Furthermore, although this is probably of minor importance, the present form is less convex, the dorsal valve is nearly flat instead of arched across the median portion, and the fold is well defined, without costæ upon its sides, as is the case with the type specimen of *R. illinoisensis*.

Horizon and locality.—Phosphate beds of the Park City formation; Montpelier, Idaho (station 3511).

TEREBRATULIDÆ.

DIELASMA King.

DIELASMA? sp.

This type is represented by a single specimen, which is so imperfect that it scarcely deserves mention save that it is the only terebratuloid which is known in this fauna and that it has a somewhat unusual shape. The specimen is, with but little question, the posterior portion of a ventral valve and is characterized by being broad and tumid, so that it has the appearance of a dorsal valve of a small *Schizophoria*. The absence of all striation clearly shows that it is not an

orthoid. The fragment has a length of 18 mm. and a width of about the same. From its shape and convexity the perfect shell could hardly have been one of the elongate types, like *Dielasma bovidens*, but must have represented a broader, more circular one.

Horizon and locality.—Phosphate beds of the Park City formation; Montpelier, Idaho (station 3511).

SPIRIFERIDÆ.

AMBOCŒLIA Hall.

AMBOCŒLIA ARCUATA n. sp.

Plate VI, figures 15–17.

Shell large, elongate, attaining in the type specimen a length of 15 mm. and a width of 13 mm.; hinge line shorter than the width below, so that the greatest transverse dimension occurs about midway in the entire shell. Ventral valve inflated, especially in the umbonal region, with an erect, strongly projecting and incurved beak; no trace of a sinus. Area well defined, rather narrow, about one-third occupied by the delthyrium, which is wider than high.

The dorsal valve is gently convex and in the type specimen seems to have a narrow, indistinct median sinus, best observed as a flexure in the line of junction of the valves.

The surface appears now to be smooth, but doubtless it was originally covered by hairlike spines. In the interior the ventral valve seems to be without either dental or septal plates, but the dorsal has the two little socket plates characteristic of the genus.

I feel little doubt that this is a distinct species from our common *A. planiconvexa*. It is more robust, elongate instead of transverse, with a more convex dorsal valve. The ventral valve has a broader delthyrium and is without a sinus. Probably all these differences are not equally constant or equally important. In younger specimens, apparently, the shape is apt to be more transverse, as in *A. planiconvexa*, while the shape of the area and delthyrium probably differ considerably in different individuals. The original description of *A. planiconvexa* mentions an indistinct sinus as one of the specific characters, and with but few exceptions the specimens examined show this feature, to which Meek in his description hardly seems to do justice. The entire absence of a sinus in the present species is reckoned one of its distinguishing characters, together with the greater convexity of the dorsal valve, to which the other differences named are auxiliary.

Horizon and locality.—Phosphate beds of the Park City formation; Sublette Range, Wyoming (station 5067); Thomas Fork, Wyoming (station 988a); Montpelier, Idaho (station 3511).

PELECYPODA.

GRAMMYSIIDÆ.

GRAMMYSIA Verneuil.

GRAMMYSIA? CARBONARIA n. sp.

Plate VI, figures 11–13.

Shell rather small for the genus, transverse, subelliptical; width about 1⅓ times the height; convexity high. Beaks rather small, strongly projecting, and incurved. Hinge line posterior to the beaks straight. Inferior outline gently convex, more or less parallel to the hinge, though converging slightly toward the front. Posterior outline nearly rectilinear above, broadly rounded below, and merging into the inferior outline. Superior posterior angle slightly obtuse. Anterior outline strongly and regularly rounded to the beaks, which are about one-fourth the width back from the anterior border. A narrow and very distinct constriction, curved, but generally perpendicular to the upper and lower margins, marks off the anterior one-fourth of the shell.

The sculpture consists of rather coarse, strong, concentric corrugations, regularly increasing in size from beak to ventral border, and becoming evanescent posteriorly. They also die out suddenly at the constriction and are arranged in such manner that, generally speaking, those on the front portion alternate with those on the back portion, the ridges on the one side standing opposite to the grooves on the other. Over other portions of the shell also the corrugations seem to be not quite regular, new ones being sometimes intercalated and those above and below being flexed to accommodate them. Shell thin; dentition not known.

This singular form is unlike anything which is known to me in the Pennsylvanian and strikingly suggests the Devonian genus *Grammysia*. Although Grammysias occur in the lower Mississippian, none is known, on this continent at least, above that horizon, and in spite of an appearance so strongly resembling that genus it seems improbable that if its dentition were known this species would be found to agree with *Grammysia*. I suspect that it will prove to belong to a genus, possibly a new one, of the relationship of *Allerisma* and *Sedgwickia*.

Horizon and locality.—Phosphate beds of the Park City formation; Montpelier, Idaho (station 980).

EDMONDIA De Koninck.

EDMONDIA? PHOSPHATICA n. sp.

Plate VI, figure 9.

Shell rather small, transversely subelliptical, strongly convex. Width somewhat less than twice the length. Hinge line slightly convex, about half as long as the greatest width. Lower margin nearly

straight or slightly sinuous, rounding upward strongly at either end. Posterior outline rather regularly rounded but somewhat straightened above and tending to make a distinct angle with the hinge; anterior extremity strongly rounded, curving inward some distance below the level of the posterior hinge line and sometimes slightly angular above. Beaks rather large and strongly incurved, situated about one-fourth of the width back from the front end. Umbonal ridge high and rounded, descending rapidly to the posterior and superior margins but dying down below. A very faint but perceptible sinus passes obliquely backward across the anterior third of the shell, causing a slight emargination of the outline. Internal structure not known.

Sculpture consisting of very fine crowded concentric striæ with a few larger striæ of growth.

I have been much perplexed as to the proper generic disposition of this species, finally referring it to *Edmondia*, but with considerable doubt. In some respects it suggests the genus *Sedgwickia*, but it is without the concentric corrugations which appear to be one of the characters of that genus. Among the American species of *Sedgwickia*, *S. concava* is somewhat suggestive of the present form but is more transverse, with a concave instead of the convex hinge line. Of the American species of *Edmondia*, *E. glabra* is the most and indeed a closely similar species. *E.? phosphatica* seems to be distinct by reason of its higher convexity, more distinct umbonal ridge, and straight or sinuate instead of convex inferior outline.

Horizon and locality.—Phosphate beds of the Park City formation; Thomas Fork, Wyoming (station 988c); Preuss Range, Idaho (station 993a).

CARDIOMORPHA De Koninck.

CARDIOMORPHA? sp.

Plate VI, figure 10.

Under this title I am including four specimens, each from a different collection. As all are more or less fragmentary, it is not certain that more than a single species is not represented among them. The shape is transversely subelliptical, with a not very prominent beak which is nearly terminal. The extremities appear to be symmetrically rounded. The surface is marked by fine faint crowded striæ. The most perfect specimen is represented by my figure. It is 16 mm. wide and 11 mm. high.

In its general appearance this form suggests a *Cardiomorpha*, but it is distinct from our common *C. missouriensis* of the Pennsylvanian of the Mississippi Valley by reason of several differences. The posterior extremity appears to be regularly rounded instead of having a distinct cardinal angle; the anterior extremity is less projecting, and there is no distinct umbonal ridge.

This form also suggests some species of *Nucula*. It seems, however, to lack the dentition of that genus.

Horizon and locality.—Phosphate beds of the Park City formation; Montpelier, Idaho (stations 980, 3511, 5069g).

NUCULIDÆ.

NUCULA Lamarck.

NUCULA MONTPELIERENSIS n. sp.

Plate IV, figures 1–3.

Shell rather large. Width somewhat greater than the length. Convexity low. Inferior border gently and symmetrically rounded; anterior-superior and posterior-superior outlines also gently convex, merging gradually with the inferior outline, but more abruptly behind (on the shorter side) than before. Where these margins are rather strongly convex the shape is subelliptical, but where they are straighter it is more subtriangular. The beaks are small, rather narrow, and not strongly incurved.

In some specimens a rather angular but not very distinct ridge can be seen well up toward the anterior border, while an abrupt descent to the posterior-superior margin also produces an obscure angulation, the two lines, when they can be distinguished at all, making an angle with one another of slightly less than 90°.

The surface is marked by fine indistinct concentric striæ, with stronger ones at irregular intervals.

This species resembles in some respects *N. illinoisensis*, from which, however, it may be distinguished by its less transverse shape. Another related species and one coming from what is probably the same general horizon is *N. levatiformis*, a species which I have recently identified in the Manzano group of New Mexico. If the Idaho specimens be compared with the specimens from New Mexico, the most obvious difference, one which immediately strikes the eye, is that the form here under consideration is much less convex—is, in fact, unusually flat and discoidal. This difference is maintained by a large series of specimens. It is accompanied, also, by some minor differences dependent on it, as, for instance, the greater incurvature of the beaks in the tumid shells, though the beaks are at the same time less slender and pointed. Perhaps another attendant variation is that the outline, especially the anterior outline, is more apt to be bowed, the shell in the flatter form spreading out instead of being directed vertically to compensate for the convexity of the rest of the valve. The concentric striæ in *N. montpelierensis* are finer, fainter, and more closely and irregularly arranged than in *N. levatiformis*. The two species are nevertheless closely related, and it may seem best

to regard the Montpelier form as only a variety, especially since typical *N. levatiformis* occurs possibly in the same beds.

Horizon and locality.—Phosphate beds of the Park City formation; Thomas Fork, Wyoming (stations 988c, 988e); Montpelier, Idaho (stations 980, 3511, 5069a).

NUCULA sp.

Under this title are included two specimens, each from a different locality, where they are not associated with *N. montpelierensis*, although they occur in the same beds. They are distinguished from the latter species primarily by their size, the larger being 14 mm. wide, or nearly twice the average size of *N. montpelierensis*, and they are also much more gibbous. As to sculpture, they are somewhat more like *N. levatiformis*, having regular strong striæ separated by rather wide intervals, but on the more umbonal portions this character is not so marked. The specimens are imperfect and do not show the shape satisfactorily, but in that respect they appear not to differ materially from either *N. levatiformis* or *N. montpelierensis*. Just what relation they bear taxonomically to these species can not be determined. It is possible that they are merely large specimens of *N. montpelierensis* which show old-age characters. If of a larger size than *N. montpelierensis* they are still more out of comparison with the smaller *N. levatiformis*.

Horizon and locality.—Phosphate beds of the Park City formation; Sublette Range, Wyoming (station 5072); Montpelier, Idaho (station 3511).

LEDIDÆ.

YOLDIA Moller.

YOLDIA MCCHESNEYANA n. sp.

Plate IV, figures 4–6.

Shell small, transversely subelliptical, contracting slightly toward the posterior end, somewhat less than twice as wide as long. Convexity rather high. Beak anterior to the posterior margin by about one-third the width or less, moderately prominent. Inferior outline gently convex; posterior outline regularly curved; anterior superior outline more or less rectilinear. Anterior end regularly rounded; rarely somewhat truncated. Surface marked by regular, faint, fine, rather widely spaced, concentric striæ.

This species is distinguished from most of those described from the American Carboniferous by the less central position of the umbones. One only is comparable to it in this particular, *Y. knoxensis* of McChesney. So far as the relationship between two forms can be satisfactorily determined when the comparison on one side is based

on descriptions and figures, the western species is distinct by reason of its much smaller size and the regular shape of the posterior end. McChesney also states that the beaks point toward the shorter end in *Y. knoxensis*, but that is probably an error.

Y. mcchesneyana occurs associated with *Nucula montpelierensis* and one can almost imagine intermediate forms between them. It is not absolutely certain that *Y. mcchesneyana* is a *Yoldia*, and several specimens show clearly that they do not gap at the anterior end.

Horizon and locality.—Phosphate beds of the Park City formation; Thomas Fork, Wyoming (stations 988i, 5070); Montpelier, Idaho (station 3511).

LEDA Schumacher.

LEDA OBESA White.

Plate IV, figures 7–8.

1879. *Nuculana obesa.* White, U. S. Geol. and Geog. Survey Terr. [Hayden], Bull., vol. 5, p. 216.
Carboniferous: Wild Band Pockets, northern Arizona, 15 miles south of Pipe Spring.

1880. *Nuculana obesa.* White, Contr. Inv. Pal., Nos. 2–8, p. 136, pl. 34, figs. 2*a–c*. (Extracted from U. S. Geol. and Geog. Survey Terr. [Hayden], Twelfth Ann. Rept., for 1878, pt. 1.)
Upper Carboniferous: Wild Band Pockets, northern Arizona, 15 miles south of Pipe Spring.

1883. *Nuculana obesa.* White, U. S. Geol. and Geog. Survey Terr. [Hayden], Twelfth Ann. Rept., for 1878, pt. 1, p. 136, pl. 34, figs. 2*a–c*.
Top of the Carboniferous: Wild Band Pockets, northern Arizona, 15 miles south of Pipe Spring.

1909. *Leda obesa.* Girty, U. S. Geol. Survey, Bull. 389, pp. 76–77.
Manzano group: Yeso sandstone, Mesa del Yeso; Abo sandstone, Abo Canyon, New Mexico.

This species is fairly abundant in the phosphate beds, but is usually in an unsatisfactory state of preservation. The specimens occur chiefly as internal molds, some of them with part of the shell attached, but in a few specimens where the matrix is more shaly the shell has been macerated so that the external and internal impressions are in contact and combine more or less the characters of both surfaces. These specimens are apt to be distorted by compression and very much of the material is fragmentary. In size the specimens vary greatly, ranging from small ones up to some as large as the examples figured by White. There is considerable variation in shape also, both in the convexity of the sides and in the extension of the elongate anterior portion. The smaller shells appear to be more inflated and less extended. These facts might be regarded as evidence for considering them a distinct species from *Leda obesa* rather than a younger stage of that form, but viewed in another light they really appear to point the other way.

In some and probably all of the Ledas additions to the shell are greater at the ends, especially the anterior end, than below, so that the shape changes from more or less equilateral and not especially transverse in its youthful condition to very transverse and much produced on the anterior side at maturity. Furthermore, *L. obesa*, while characterized in one particular by its flattened sides, is also characterized by having the umbonal ridges very close to the upper outline, with a very broad escutcheon. Such a shape would result from a convex youthful stage which was later followed by a gradual change to one in which the sides were flattened.

There can be but little question that the large shells belong to the species which White described as *L. obesa*. As to the smaller ones, they are so imperfect that it is not practicable to separate them into a different species, even should such prove to be their proper disposition, while at present it seems probable to me that they are for the most part at least immature individuals.

Horizon and locality.—Phosphate beds of the Park City formation; Thomas Fork, Wyoming (stations 988c, 988e, 991); Montpelier, Idaho (stations 980, 3511, 5069a); Preuss Range, Idaho (station 993).

TRIGONIIDÆ.

SCHIZODUS King.

SCHIZODUS FERRIERI n. sp.

Plate IV, figures 12–13.

Shell rather large, subquadrate, somewhat wider than long. Hinge line nearly as long as the greatest width. Inferior outline parallel to the hinge, nearly straight behind, rounding upward into a broad curve which defines the anterior portion of the shell and meets the hinge in a more or less obscure angle a little in front of the beaks. Posterior outline truncating the shell abruptly, nearly perpendicular to the upper and lower borders or slightly inclined to them. Beaks large, strongly projecting and incurved, about one-fourth of the width back from the anterior margin. Convexity high; umbonal ridge well marked. A more or less distinct constriction occurs in some specimens a little in front of the umbonal ridge, making a slight emargination in the lower border. A certain amount of variation is shown in the length of the shell back of the umbones and also in the angle which the posterior truncation makes with the upper and lower margins.

Surface more or less smooth. Toward the front and up near the beaks fine, regular, concentric striæ are developed at relatively wide intervals, but these soon appear to die out in passing backward across the shell. Rather fine obscure, concentric striæ sometimes occur toward the margin.

This species is especially characterized by the fact that the outline does not contract posteriorly and that the truncation is but slightly oblique. But few species in the American Carboniferous are at all comparable to it in this particular. The Waverly form *S. equalis* resembles it in some degree, but is much less transverse and has the lower margin more strongly curved. The same is true of the Pennsylvanian species *Schizodus curtus*, which is much like a diminutive variety of *S. equalis*. The Chemung species *quadrangularis* appears to belong to this group, but is less transverse, rounder below, with more angular umbonal ridge and smaller, less projecting beaks. Perhaps no American species so closely resembles *S. ferrieri* as that which Meek and Worthen identify as *S. rossicus*, but this also is less transverse, with a more strongly convex inferior outline, more central beaks, and a correspondingly longer portion of the shell anterior to them, and it is also a much smaller species.

S. ferrieri has been identified at a number of points, but most of the material is so poor that no more than general reference to the genus *Schizodus* can be made with any degree of assurance. With regard to the generic identification of these shells with *Schizodus* I may say that the dentition has in no instance been observed, but the shape and general expression make the reference reasonably satisfactory. I must confess, however, that an occasional specimen suggests quite another type of shell, a *Sedgwickia* or a *Chænomya*. This is especially true of such specimens as have an unusually produced posterior portion and a slightly oblique truncation.

Horizon and locality.—Phosphate beds of the Park City formation; Sublette Range, Wyoming (station 5072); Thomas Fork, Wyoming (stations 988, 988e); Montpelier, Idaho (stations 980, 3511, 5068, 5069a, 5069g).

PECTINIDÆ.

AVICULIPECTEN McCoy.

AVICULIPECTEN? MONTPELIERENSIS n. sp.

Plate IV, figures 9–10.

Shell sometimes attaining a medium or rather large size, subcircular, somewhat longer than wide; axis perpendicular to the hinge, which is somewhat shorter than the width below. The convexity of both valves is about the same and rather high for the genus. In the right valve the anterior wing is depressed, sharply defined, auricular, with a deep byssal sinus. The posterior wing is small, narrowly triangular, and much depressed below the body of the shell, which rises abruptly from it. The outline rounds out strongly on the anterior side beneath the ear and to a less degree on the posterior side.

The shape of the left valve is somewhat similar to that of the right, though the anterior wing is not auricular and it has no sinus beneath

it. It is more sharply defined than the posterior wing, though both are rather abruptly depressed.

In most specimens the surface of both valves appears to be smooth, with no markings except very obscure growth lines. In a few, however, there are traces of regular, closely arranged, concentric liræ. These probably are a constant character of the shell and would be seen on all specimens if well preserved. Whether they are confined to the left valve or are common to both valves, however, has not been determined.

The largest specimen referred to here has a length of 33 mm., but the average is much smaller. In some examples the anterior side projects considerably more than the posterior, but usually the axis is about perpendicular to the cardinal line and the two sides are approximately symmetrical. Always, however, the anterior wing is larger and more sharply defined than the posterior. In the left valve the anterior wing often descends abruptly from the general convexity. The depression of the posterior wing is more gradual, but depends on the convexity of the mesial portion, which varies in different individuals. The size of the wing is also subject to variation.

No cardinal structures have been ascertained, but it is improbable that this form properly belongs either with *Aviculipecten* s. s. or *Deltopecten*. This opinion is based on the fact that in the present species the two valves are equal in convexity and ornamentation, whereas in both the genera mentioned the left valve is highly sculptured, while the right is apt to be much flatter and almost without sculpture. The general appearance is very suggestive of *Plagiostoma*, but the presence of a well-marked byssal sinus in the right valve bars the Limidæ from consideration in this connection.

Horizon and locality.—Phosphate beds of the Park City formation; Crawford Mountains, Wyoming (station 969); Thomas Fork, Wyoming (station 988a); Bear Lake, Idaho (station 982); Montpelier, Idaho (stations 965, 980, 3511, 5069, 5069a, 5069c, 5069g, 5069t).

AVICULIPECTEN PHOSPHATICUS n. sp.

Plate IV, figure 11.

Shell small, subquadrate, slightly wider than high and somewhat oblique. Hinge line longer than the greatest width.

Left valve rather strongly convex. The ears are triangular, depressed. Anterior ear oblique, more depressed than the posterior, defined in outline by a deep sinus. The posterior ear is defined from the rest of the shell by an angulation and in outline by a moderately strong sinus.

The sculpture consists of rather thin, high, abruptly elevated, subequal costæ, separated by relatively very broad, flat striæ. On the body of the shell the costæ are 21 in number. Toward the anterior

side they become more closely arranged or rather, perhaps, one or two alternating ones are introduced. The anterior ear has seven or eight fine, rather closely arranged radiating costæ, but there is a space between the ear and the body of the shell which is not thus ornamented. The same is true of the posterior ear, only the space is broader and the ear is sharply defined on the body of the shell by the angulation above mentioned. The posterior ear bears six costæ not so closely arranged as those on the anterior. There is also a concentric ornamentation of fine liræ much more crowded than the costæ. These are conspicuous on the noncostate strip which defines or forms part of the posterior ear. They are present on the latter as well, and also on the anterior ear, but only traces of them can be seen crossing the body of the shell in the only specimen examined.

Right valve unknown.

This form in a general way suggests Walcott's *Pterinopecten spio* of the Eureka district, but it is much smaller and the sculpture differs obviously in its detail. The Warsaw species *A. oblongus*, as well as *A. orestes* of the Keokuk limestone, are comparable in a general way, but they obviously can not be mistaken for the form here described.

Horizon and locality.—Phosphate beds of the Park City formation; Thomas Fork, Wyoming (station 988c).

SCAPHOPODA.

DENTALIIDÆ.

PLAGIOGLYPTA Pilsbry and Sharp.

PLAGIOGLYPTA CANNA White.

Plate VI, figure 14.

1874. *Dentalium canna.* White, U. S. Geog. Surveys W. 100th Mer. [Wheeler], Prelim. Rept. Invert. Foss., p. 23.
Carboniferous (Coal Measures): Near Salt Lake, New Mexico, and near Relief Spring, Arizona.
1877. *Dentalium canna.* White, U. S. Geog. Surveys W. 100th Mer. [Wheeler], vol. 4, p. 156, pl. 12, figs. 6*a*, *b*.
Carboniferous: Near Salt Lake, New Mexico, and near Relief Spring, Arizona.
1903. *Plagioglypta canna.* Girty, U. S. Geol. Survey, Prof. Paper 16, p. 452.
1908. *Plagioglypta canna.* Girty, U. S. Geol. Survey, Bull. 389, pp. 95–96, pl. 11, fig. 11.
Manzano group: Abo sandstone, Sandia Mountains, and Mesa del Yeso; San Andreas formation, Mesa del Yeso, Nogal Creek, and Engle; Yeso formation, Alamillo and Mesa del Yeso, New Mexico.

This species is fairly abundant in the phosphate beds but is always fragmentary and usually preserved as interval molds, for the shell itself mostly adheres to the surrounding rock.

The shape is subcylindrical, very gradually tapering. The largest diameter noted is 9 mm. The shell is rather thick and made up of

oblique plates. The surface where preserved is entirely without traces of longitudinal striæ and either appears to be smooth or is marked with irregular transverse striæ. The latter are in some instances at least due to a certain extent to an exfoliation of the shell around the edges of the oblique layers.

There is only one straight Pennsylvanian *Dentalium* having a smooth or nearly smooth surface, *P. canna*, and at present there seems to be no reason for not identifying the present form with that species.

Horizon and locality.—Phosphate beds of the Park City formation; Montpelier, Idaho (station 3511).

GASTROPODA.

PLEUROTOMARIIDÆ.

PLEUROTOMARIA Defrance.

PLEUROTOMARIA IDAHOENSIS n. sp.

Plate VI, figure 3.

The shape of this form is in a general way globose, with a rather low, broad spire which occupies about two-fifths of the entire height. The volutions number five or six and are rather rapidly enlarging. The peritreme is subcircular in section, perhaps a little wider than high, and regularly rounded on the outer side. A distinct and rather broad slit band occupies a median position on the periphery, defined above and below by narrow, sharp grooves but only slightly elevated above the regular convexity. The surface above and below the band is crossed by numerous fine, indistinct, revolving liræ. Their number can not be ascertained because of their small size and poor definition. Three or four of the liræ near the suture are more distinct than the others. A few obscure liræ seem to be developed upon the slit band. The surface is also crossed in a transverse direction by fine, more or less indistinct, irregular, somewhat fasciculated growth lines which bend backward at the slit band and have a sinuous direction below it. Near the suture they tend somewhat to be raised into low costæ. The volutions are embracing to a point just below the slit band.

In the senile condition the peritreme seems to lose its revolving liræ, becoming nearly smooth. A few specimens have been provisionally placed with this species which have the characteristic configuration but appear to be without revolving liræ, so far as can be determined.

In general appearance this form resembles *Pleurotomaria subglobosa*, from which it is distinguished readily by being less globose and by having the slit band on the median line instead of above it. There is

no American species known to me which more resembles the present form than the one just mentioned.

Horizon and locality.—Phosphate beds of the Park City formation; Sublette Range, Wyoming (station 5072); Thomas Fork, Wyoming (station 988e); Montpelier, Idaho (station 3511).

PLEUROTOMARIA aff. NEVADENSIS Walcott.[a]

Plate VI, figures 4–5.

The specimens included under this caption are both variant and badly preserved. Many are mere fragments and most are reduced to molds of the interior. Only here and there are portions of the shell retained, and it is doubful how completely the sculpture is preserved upon them.

The specimen figured is an extreme example of this group. It has a moderately high spire with a rapidly enlarging peritreme, which toward the aperture is strongly angulated a little above the middle. The surface above and below the carina is obliquely flattened. This example does not show the sculpture, which seems to consist only of fine growth lines that bend backward at the carina, indicating a reentrant angle in the aperture at this point. Few specimens exceed 11 mm. in diameter, and the greatest height is generally less than the greatest width.

Among the forms to which, so far as the characters can be ascertained, this description applies, there are found many variations. One line of variation consists in the height of the spire, which is sometimes distinctly lower than in the figured example; another in the shape of the peritreme, which is angular at a much younger stage instead of showing this character distinctly only near the aperture; a third in the sculpture, one specimen showing traces of revolving liræ above the carina and another below.

Lack of uniformity in the height of the spire must probably be attributed to intrinsic variation. The varying shape of the peritreme, as seen in molds, is possibly due to difference in age, mature shells being thickened on the inside to a circular shape except near the aperture, where the test is thin and the shape about the same on the inside as on the outside. The difference in sculpture may be due to real variation or to preservation, one or both.

We may have among these specimens more than a single species, but it is impossible to determine this fact or make a subdivision with the fossils in their present condition.

On the assumption that we are dealing with a single species, it resembles, of American forms, *P. minima* of the Louisiana limestone and *P. nevadensis* of the Eureka district more than any others. It is

[a] Walcott, C. D., Mon. U. S. Geol. Survey, vol. 8, 1884, p. 259, pl. 24, figs. 2, 2a.

a much smaller species than *P. nevadensis*, though of about the same shape. Revolving striæ which are well developed on the Nevada form are either absent or very obscure on most of the specimens seen. Though typically this form is considerably different from *P. idahoensis*, having a higher spire, a more angular peritreme, and a sculpture without revolving liræ (?), specimens occur which are difficult to refer satisfactorily to one species or the other. For instance, there are examples with the low spire of *P. idahoensis*, which at the same time have a strong angulation where the slit band is developed. The sculpture in these specimens not being preserved, it seemed best to place them with *P.* aff. *nevadensis*. There is also a form having a low spire and general configuration of *P. idahoensis*, but so far as can be determined no sculpture of revolving liræ. A few shells with this peculiarity have been provisionally placed with *P. idahoensis*.

At several stations occurs what is probably a dwarfed variety of this form (stations 5067, 988b, and 988c), specimens having a diameter of 7 mm. or less.

Horizon and locality.—Phosphate beds of the Park City formation; Woodruff Creek, Utah (station 5074); Sublette Range, Wyoming (stations 5067, 5072); Thomas Fork, Wyoming (stations 988a, 988b, 988c, 5070); Montpelier, Idaho (stations 980, 3511); Preuss Range, Idaho (station 993a).

BELLEROPHONTIDÆ.

EUPHEMUS McCoy.

EUPHEMUS SUBPAPILLOSUS White.

1876. *Bellerophon carbonarius* var. *subpapillosus*. White, Powell's Rept. Geol. Uinta Mountains, p. 92.
Upper Aubrey Group: Beehive Point, near Echo Canyon, and near Echo Park, Utah.

1879. *Bellerophon subpapillosus*. White, U. S. Geol. and Geog. Survey Terr. [Hayden], Bull., vol. 5, p. 218.
Carboniferous: Wild Band Pockets, northern Arizona, 15 miles south of Pipe Spring.

1880. *Bellerophon subpapillosus*. White, Contrib. Pal., Nos. 2–8, p. 138, pl. 34, fig. 3*a* (extracted from U. S. Geol. and Geog. Survey Terr. [Hayden], Twelfth Ann. Rept., for 1878, pt. 1).
Upper Carboniferous: Northwestern Colorado and northern Arizona.

1883. *Bellerophon subpapillosus*. White, U. S. Geol. and Geog. Survey Terr. [Hayden], Twelfth Ann. Rept., for 1878, pt. 1, p. 138, pl. 34, fig. 3*a*.
Upper Carboniferous: Northwestern Colorado and northern Arizona.

1899. *Euphemus subpapillosus*. Girty, U. S. Geol. Survey, Nineteenth Ann. Rept., pt. 3, p. 592.

1903. *Euphemus subpapillosus*? Girty, U. S. Geol. Survey, Prof. Paper 16, p. 476.
Bellerophon limestone: Diamond Peak, Uinta Mountains, Colorado.

1908. *Euphemus subpapillosus*. Girty, U. S. Geol. Survey, Bull. 389, pp. 99–100.
Manzano group: San Andreas formation, Engle; Yeso formation, San Andreas and Fra Cristobal; Abo sandstone, Sandia Mountains, New Mexico.

This species is represented by a single specimen in a poor state of preservation. It is distinguished by being rather large and broad and by having a few strong, widely spaced, revolving liræ. There is only one American species which possesses these characters, and as this specimen agrees with *E. subpapillosus* in all points in which comparisons can be made the identification is probably to be relied upon.

Horizon and locality.—Phosphate beds of the Park City formation; Sublette Range, Wyoming (station 5067).

TURBINIDÆ.

OMPHALOTROCHUS Meek.

OMPHALOTROCHUS FERRIERI Girty.

Plate V, figures 4–9; Plate VI, figure 1.

1908. *Omphalotrochus ferrieri.* Girty, U. S. Nat. Mus., Proc., vol. 34, p. 297. Phosphate beds: Montpelier, Idaho.

Shell rather small, consisting of six or seven volutions. Diameter rarely, if ever, in excess of 30 mm. and usually 25 mm. or less. Height about half the diameter, varying. Spire low, with flattish top and rounded sides. Suture more or less strongly indented. Umbilicus deep and broad. Peritreme section from subcircular to transversely subelliptical, sometimes more or less quadrangular, with a distinct peripheral carina. The horizontal axis of the peritreme section is almost perpendicular to the axis of revolution. The upper external portion of the peritreme between the carina and the suture is gently convex. It is marked by a revolving ridge, which is sometimes very indistinct, situated rather nearer to the carina than to the suture. Both above and below the revolving ridge the shell is depressed, but it rounds out again at the suture. The lower sulcus, that between the carina and the revolving ridge, is narrower and stronger than the one above. In proportion as these two sulci are evanescent the revolving ridge is distinct or obscure, and to some extent the carina is affected in the same manner. Usually the upper part of one volution projects somewhat above the preceding one, so that the suture is well marked. The junction of the two volutions is sometimes more precise, in which case the suture is less depressed. When this occurs, and when the sides are unusually flat, without a distinct revolving ridge, the shells have a rather individual expression, and they may possibly deserve to be discriminated as a variety. On the lower side the shell is gently convex, and regularly so, except for a shallow groove, more distinct in some specimens than in others, which occurs a little below the carina and helps to define it. The upper internal side is gently concave by reason of conforming its shape to the preceding volution.

This description refers to the later or mature volutions, the earlier ones showing considerable variation. The earliest whorls, one or two in number, appear to have been nearly circular in section and complanate, so that the spire was really depressed. Then the peritreme became flattened on top, with a relatively deep median depression. The upper surface of the volutions at this stage lay in the same plane, which was perpendicular to the axis of revolution. Then the upper or exposed surface became considerably broader, oblique, and much less strongly and sharply depressed. Finally, an elevation of its median or submedian portion into a revolving ridge gave it in the main a gently convex instead of a concave outline. It is due to the character of the early development that the spire is truncated on top, as if broken off, and owing to the same cause young shells are more discoidal than mature ones.

The growth lines in some specimens extend forward from the suture for a short distance, bending backward with a sharp turn on the little shoulder which occurs just below the suture. In others their course appears to be backward from the start. About midway on the outer side, or just above the revolving ridge, they again assume a forward direction, which is reversed at the carina or immediately above it. On the under side the lines are gently sigmoid, but more or less backward in general direction. Thus the aperture would have had a projecting outline at the carina, with a strong sinus above and a shallow one on the under side. The growth lines are fine and regular, becoming strongly fasciculate and more or less sublamellose in older volutions.

Omphalotrochus ferrieri is extremely variable in all its characters, passing into types which approach *O. conoideus* more or less closely.

Type specimens.—Cat. No. 53465, U.S.N.M.

Horizon and locality.—Phosphate beds of the Park City formation: Montpelier, Idaho (station 3511).

OMPHALOTROCHUS FERRIERI var.

Plate VI, figure 2.

Under this title I have discriminated a few specimens differing from typical *O. ferrieri*, with which they are associated, chiefly in the height of the spire, the typical form being somewhat more depressed and discoidal. The volutions are also likely to be somewhat inflated, owing perhaps to an extra development of the revolving ridge. These forms are, however, intimately connected with typical *O. ferrieri*, and probably no one would make exactly the same identification of a good suite of specimens twice. On the other hand, while they are to some extent intermediate between *O. ferrieri* and *O. conoideus*, the latter is reasonably distinct from them. Specimens of *O. conoideus* having

a spire lower than normal, a slightly convex instead of concave lateral surface to the peritreme, and a suture in which the volutions are flush, instead of having the lower overlap upon the upper, are most liable to be confused with this variety, but this combination of characters is extremely rare.

Horizon and locality.—Phosphate beds of the Park City formation; Montpelier, Idaho (station 3511).

OMPHALOTROCHUS CONOIDEUS Girty.

Plate V, figures 1–3.

1908. *Omphalotrochus conoideus.* Girty, U. S. Nat. Mus., Proc., vol. 34, p. 299. Phosphate beds: Montpelier, Idaho.

Shell rather small, seldom exceeding 25 mm. in diameter, consisting of seven or eight volutions. Spire high, 19 mm. in one large specimen but about 15 mm. as a rule. Umbilicus large, open. General outline conical, with sides nearly flat from apex to base. The peritreme section is approximately tetragonal, the upper and lower surfaces being more or less flat and subparallel, the inner surface nearly flat and perpendicular to them, and the outer also nearly flat, making an angle of about 60° with the base. The junction of the external and lower surfaces forms a sharp, somewhat projecting carina, emphasized above and below by shallow indistinct grooves. A low ridge is usually developed on the external side of the peritreme slightly below the middle. Each of the mature volutions projects at its base a little beyond the upper edge of that which follows it. In but few specimens is the upper edge of one volution flush with that which preceded, and in none has it been observed to extend beyond. The internal outline is circular, the shell being thickened to form the carina and at the three other angles made by the surfaces of the peritreme.

The growth lines indicate that the aperture had a sinus above and below the carina, with a projection along it.

In most of the characters enumerated there is more or less variation. The lateral surface of the peritreme is as a rule slightly concave, but sometimes flat or convex. The lower surface also is in some shells more strongly rounded than in others, thus affecting the prominence and sharpness of the carina. The revolving ridge of the lateral surface is sometimes obscure, though usually distinguishable.

In all other characters, as well as some of those enumerated, this species is closely allied to *O. ferrieri*, so that the description of the former may be used for *O. conoideus*, with the following modifications. As in *O. ferrieri*, the spire of the present form is truncated, and owing to the same cause. The height of the peritreme is considerably greater than in *O. ferrieri*, because of the fact that the lateral surface is considerably oblique to the axis. It is, at the same time, slightly concave or flat, instead of being convex, although a slightly convex

condition has sometimes been observed in shells referred to this species. The height of the shell is relatively considerably greater than in *O. ferrieri* for these reasons. The lower surface is flatter than in *O. ferrieri*, which fact, joined with the flatter lateral surface, makes the carina sharper and more prominent.

Although the relationship of this form to *O. ferrieri* is very obvious, and although both forms vary so much that the extremes approach each other in some particulars, *O. conoideus* is a fairly well-marked form, deserving, it seems to me, specific distinction.

Type specimens.—Cat. No. 53464, U. S. N. M.

Horizon and locality.—Phosphate beds of the Park City formation; Montpelier, Idaho (station 3511); Preuss Range, Idaho (station 978).

NERITOPSIDÆ.

NATICOPSIS McCoy.

NATICOPSIS TAYLORIANA n. sp.

Plate VI, figure 6.

Shell very small, consisting of four and one-half volutions, rapidly enlarging, the last comprising most of the visible portion of the shell. Above it the spire rises to about one-fourth the height of the whole, with strongly rounded whorls. Final volution inflated, slightly flattened above, so that the peripheral line is situated well toward the top of the peritreme. Surface smooth or with only obscure growth lines.

But few species to which the present form is closely related have been described from the American Carboniferous, and those which seem most similar are two Canadian species from the other margin of the continent. I refer to *Naticopsis dispassa* and *N. howei*. The latter species is more similar than the former, but it seems to differ in having a more elevated spire and less inflated body whorl. I am, however, without specimens with which to make comparisons.

In many respects this form suggests a diminutive example of *Sphærodoma texana*, and the reference to the genus *Naticopsis* is not made unreservedly.

Horizon and locality.—Phosphate beds of the Park City formation; Montpelier, Idaho (stations 980, 5069a).

PYRAMIDELLIDÆ.

SOLENISCUS Meek and Worthen.

SOLENISCUS aff. ALTONENSIS Worthen.[a]

Plate VI, figure 7.

Of this species our collection contains only one specimen, which is preserved as an internal mold. Though much smaller than the types of either species, it closely resembles *S. altonensis* and *S. hallanus*, the

[a] Worthen, A. H., Rept. Geol. Survey Illinois, vol. 5, p. 593, pl. 28, fig. 8.

former perhaps a little more than the latter. It shows a slight difference from *S. altonensis* in having the volutions more rounded and the sutures more depressed, but this difference would be found to exist between the testiferous condition (in which the type of *S. altonensis* occurs) and the internal mold (which is the condition of the present specimen) even in the same individual. It seems inadvisable to identify this form definitely with *S. altonensis* without having testiferous specimens for comparison, and the introduction of a new name would, under present conditions, be still more inadvisable.

In the fauna of the Manzano group of New Mexico, which I have recently described, occurs a species similar to and perhaps identical with this one. It, too, is preserved in the condition of internal molds. A large specimen agrees with the present form in all points available for comparison save that it is nearly twice as large, while a small specimen of practically the same size presents no substantial differences at all.

Horizon and locality.—Phosphate beds of the Park City formation; Thomas Fork, Wyoming (station 989).

PSEUDOMELANIA Pictet.

PSEUDOMELANIA sp.

Under this title are included three specimens from station 988e. They are largely reduced by exfoliation to the condition of internal molds, and the surface characters and to some extent even the shape of the peritreme have been obscured. They are small and slender and have a high spire. The diameter is about 2 mm. and the height about 7 mm. The volutions must have numbered seven or eight. They are rather strongly oblique, with somewhat flattened, gently rounded sides and not very deeply depressed sutures. So far as can now be told, these shells are without sculpture or slit band.

Horizon and locality.—Phosphate beds of the Park City formation; Thomas Fork, Wyoming (station 988e).

CEPHALOPODA.

GLYPHIOCERATIDÆ.

GASTRIOCERAS Hyatt.

GASTRIOCERAS SIMULATOR n. sp.

Plate VII, figures 11–13.

Shell rather small, the largest specimen examined having a diameter of 24 mm. Shape subdiscoidal. Whorl section lunate, somewhat broader than high when mature, considerably broader proportionally in the younger stages. Ventral surface strongly and regularly arched; sides flattened, slightly diverging toward the umbilicus. The latter

is rather broad, somewhat less than one-third the entire diameter. Volutions deeply embracing with a strong distinct umbilical shoulder, which is not quite concealed by the following volution.

Sculpture consisting of sharp angular liræ separated by rounded striæ, the striæ much the wider. The liræ are somewhat more closely arranged over the ventral surface than toward the umbilicus. There are also fine, transverse growth lines, very indistinct in the specimens seen, but which in a perfect state of preservation may have been fine, regular, closely arranged liræ. They follow the shape of the aperture and have a sinuous course with a rather deep sinus over the ventral surface, a low, broad saddle where the latter merges into the sides, and a broad, indistinct lobe on the side itself.

The suture is known not from the mature but from the half-grown stage, and the following description is based on a specimen having a diameter of 12 mm. and at very nearly the youngest portion visible. There is a low, narrow ventral saddle with a median notch. The first lateral lobe is somewhat narrower than the ventral saddle and is regularly rounded. The first lateral saddle is broadly and regularly rounded; it rises high above the ventral saddle and is about as broad as the ventral saddle and the first lateral lobes combined. The second lateral lobe is regularly rounded, about as broad as the first saddle, but somewhat shallower. The second lateral saddle is broader and shallower than the second lobe, rounded but not quite symmetrically so. A third saddle, probably broad, low, and not symmetrical, occurs on the umbilical shoulder.

The ontogeny of this species is only imperfectly known. In tracing its development backward the whorl section is seen to have been increasingly broader and lower and the volutions less embracing in proportion to their height, while the umbilicus is relatively broader. The sculpture also undergoes a noteworthy change, for when rather young (about 4 mm. in diameter) it is marked by very fine, regular, transverse, lamellose liræ, the revolving striæ appearing only as very fine crenulations. In the young condition also (at a diameter of about 6 mm.) the sides are marked by large, distinct nodes, which are much better developed in some specimens than in others. So far as the sutures have been observed in the early stages the lobes and saddles were regularly shallower and more uniform in size and shape.

This species in many respects closely resembles one from the Caney shale of Oklahoma, which I described as *G. caneyanum*, but a careful comparison reveals many differences. The present form has a wider umbilicus. It is a little more finely lirate, with less difference in arrangement between the ventral and umbilical liræ. The transverse liræ are probably finer and less distinct. The saddles are more regularly rounded and the second lateral lobe is rounded instead of pointed (a difference which seems to be only in part due to differ-

ence in age of the specimens compared). The present form also passes through a stage in which the sides are nodose, a condition not observed in the Caney species.

The distinctive characters between *Gastrioceras* and *Glyphioceras* (*Goniatites*) have not been worked out very satisfactorily, and for the same reason which influenced me to refer *G. caneyanum* to *Gastrioceras* I have assigned to the same genus the present species, which agrees in a general way with *G. caneyanum* in its development and mature characters. At the same time it much resembles several species which J. P. Smith has placed in the genus *Goniatites* s. s. I have no authentic specimens of the forms in question, so that a comparison would needs be more or less unsatisfactory, besides being altogether unnecessary if the two types belong to different genera; but as I am not sure that my discrimination of *Gastrioceras* is based on the same characters as that of Professor Smith, these forms should be carefully compared when the facilities for doing so are at hand.

Horizon and locality.—Phosphate beds of the Park City formation; Thomas Fork, Wyoming (stations 981, 981b, 988h, 988i, 989, 5070).

GASTRIOCERAS? SP.

Plate VII, figure 14.

Under this title is included a single specimen which occurs in association with *G. simulator* and which resembles it in general appearance. The only well-marked difference consists in the absence of revolving liræ. Obscure transverse striæ of growth are distinctly shown, and it is fairly certain that if revolving liræ comparable to those of *G. simulator* had ever been present they would have been sharply retained. The growth lines have a sinuous direction, very much as in the other species, but somewhat different in their detail. Slight differences exist in the shape also.

The sutures are not shown by the specimen.

Horizon and locality.—Phosphate beds of the Park City formation; Thomas Fork, Wyoming (station 981).

GONIATITES De Haan.

GONIATITES? sp.

This term is employed for a single specimen which, though indeterminate, is probably deserving of mention. It is very small and discoidal, with a diameter of about 1.5 mm. and a thickness of perhaps 0.25 mm. The volutions are six in number, scarcely enlarging at all, complanate, and barely in contact. The initial point is a bulbous enlargement having a greater diameter than the whorl beyond.

In its present condition no sutures are shown, but it must be presumed to have possessed them if, as I suppose, it is a larval goniatite. The genus can not, of course, at this time be fixed. Professor Smith has figured a similar form as *Goniatites calyx*,[a] and the young stages of *G. caneyanus* present a similar appearance.

Horizon and locality.—Phosphate beds of the Park City formation; Thomas Fork, Wyoming (station 988b).

POPANOCERATIDÆ.

POPANOCERAS Hyatt.

POPANOCERAS? sp.

Plate VII, figure 15.

This form is represented in our collection by a single specimen, which is not very well preserved. The size is rather small and the shape discoidal, the diameter being 15 mm. and the thickness about 8 mm. The volutions are deeply embracing, so that the umbilicus is nearly closed. The volutions are perhaps a little higher than wide, strongly curved over the ventral surface, gently curved or somewhat flattened on the sides. The sculpture is unknown.

The suture is known only in a general way. It is certainly rather complicated with an undetermined number of lobes and saddles, probably more than in *Gastrioceras* and about as in *Popanoceras*. The detail is not well shown, but appears to consist of simple, rounded saddles contracting toward the aperture and of lobes of which some are three-forked and some probably two-forked.

Although a definite determination of the genus can not be made, it seems highly probable that this form is a *Popanoceras*, while in its specific relations it is probably new.

Horizon and locality.—Phosphate beds of the Park City formation; Thomas Fork, Wyoming (station 988i).

OSTRACODA.

BEYRICHIIDÆ.

HOLLINA Ulrich and Bassler.

HOLLINA EMACIATA var. OCCIDENTALIS n. var.

Plate VII, figures 8–10.

Shell rather small, transverse. Width about 1.5 mm. or a little less. Shape higher and less convex at the posterior end. Anterior end regularly rounded. Posterior end subtruncate with a distinct obtuse angle above and a regularly rounded, projecting lower portion. Toward the margin the shell is marked by a narrow flange or lamella parallel to the plane of the shell margin and slightly raised above it.

[a] Smith, J. P., Mon. U. S. Geol. Survey, vol. 42, 1903, pl. 18, figs. 6,9, etc.

The anterior tubercle is large and inflated and situated rather close to the margin. The posterior tubercle is also inflated but much smaller and the two are separated by a deep subcentral sulcus. The remaining portion of the shell, which has more or less of a U shape, is variously modified in different specimens. In a few it is merely a highly convex, regularly rounded ridge, which passes around the tubercles and dies out at the anterior end in front of the larger one. In most of the specimens this ventral ridge is partly divided into two portions, the sulcus which bounds the smaller tubercle on its posterior side obscurely passing upon or across it. The smaller tubercle thus sometimes appears in some degree connected with the anterior half of the ventral ridge. In a few shells the posterior portion is depressed and the ventral ridge very obviously terminates at the posterior tubercle. It is apt to be relatively thin in such cases and the resulting arrangement is suggestive of *Bollia*.

This form is closely related to *Hollina herrickana* of the Manzano group of New Mexico. It is distinguished, however, by having a relatively larger anterior tubercle, while the ventral ridge is not so narrow and shows a marked tendency to be subdivided or to die out entirely at the posterior tubercle.

Compared with *Hollina emaciata* this is often, though not always, a more slender form with a greater proportional width, and the larger tubercle is situated nearer to the anterior border. I have not noted the short vertical curved ridge in the postdorsal angle nor the rimlike border along the straight back and anterior end. On the other hand, *Hollina emaciata* is not described as having the modification of the ventral ridge found in the present form.

Horizon and locality.—Phosphate beds of the Park City formation; Thomas Fork, Wyoming (stations 981a, 988a).

JONESINA Ulrich and Bassler.

JONESINA CARBONIFERA n. sp.

Plate VII, figures 1–4.

Shell rather large, subquadrate, somewhat inequivalve, nearly equilateral. The hinge line is distinct, long, and straight, about two-thirds as long as the greatest width. The inferior border is gently and regularly convex, subparallel to the hinge and regularly rounded upward at the ends. The outline of the two ends is nearly the same. A more or less distinct angle is formed by junction of the terminal outlines and the hinge, these angles being sometimes prolonged upward as slightly projecting points. The convexity of mature shells is usually high, with somewhat flattened sides, more strongly incurved around the ventral border. In smaller specimens the convexity is likely to be lower and more regular, the final additions to the shell being so directed as to increase the convexity rather

than the height. When viewed either dorsally or ventrally the anterior portion is seen to be considerably more convex than the posterior. Furthermore, in the side view, when the two valves have not been displaced—that is, when the two hinge lines are in contact—the right valve is seen to be slightly smaller than the left and to be slightly enveloped by it. The same feature is shown in an interesting manner in the dorsal view, the hinge line of the smaller valve being slightly shorter than the hinge line of the other. There is a distinct deflection of the line of junction at the two cardinal angles (further distinguished by the projecting points above referred to), which thus seem to produce an elementary though probably more or less functional cardinal tooth at each end of the hinge.

The surface is smooth but marked by a narrow deep sulcus directed perpendicularly to the hinge and situated well posterior to the median line. It does not extend halfway across the valve and its lower end is more deeply sunk than the upper. A second sulcus, much less distinct than the first, though having about the same direction, occurs a short distance anterior to it. The two sulci are connected by a depressed line along the cardinal border, and the lower ends also in a few cases can be seen to be connected, thus defining a circular or somewhat elongated tubercle.

The shells referred to this species differ rather widely in many particulars. A considerable range in point of size can probably be referred to difference in age. More important is a difference in shape, some examples having the outlines of the two ends very nearly equal, whereas others are more distinctly oblique, with the posterior end projecting more strongly beyond the end of the hinge than the anterior. Some specimens are also narrow and others broad, while in some the primary sulcus is more nearly central than in others.

This species is one of the simpler types of the genus, represented in the American section by *J. gregaria*, from which it is clearly distinct, being more transverse, lacking the spine, and showing other differences. It more closely resembles the English species *J. arcuata*, but is more equilateral, less oblique, and with a much narrower sulcus.

Horizon and locality.—Phosphate beds of the Park City formation; Thomas Fork, Wyoming (stations 981a, 988a, 988e).

CYTHERELLIDÆ.

CYTHERELLA Jones.

CYTHERELLA BENNIEI Jones, Kirkby, and Brady.

Plate VII, figures 5–7.

1884. *Cytherella benniei.* Jones, Kirkby, and Brady, Pal. Soc., Mon. British Fossil Entomostraca Carb. Form., pt. 1, no. 2, p. 70, pl. 6, figs. 3a, b, 4a, b, 5a, b, 7a, b; pl. 7, figs. 12a–d.

1908. *Cytherella benniei.* Girty, U. S. Geol. Survey, Bull. 389, p. 116, pl. 8, figs. 7–9. Manzano group: Yeso formation, San Andreas, N. Mex.

The form here under consideration occurs in abundance at station 988a, but owing to maceration, by which the shell has been reduced to a soft chalky substance, the preservation is seldom good. At station 988e, although other ostracods are abundant, this species seems to be rare and the specimens thus far obtained are small. They are, however, well preserved and both valves occur in juxtaposition.

As they occur in the phosphate beds these shells are rather small, seldom attaining a size much over 1 mm. in width. They are strongly transverse, the width being very nearly twice the height, though this proportion varies in different specimens. The shape is generally elliptical, often narrowing somewhat toward one end, which is also distinctly thinner than the other. Seldom can any straight margin be distinguished as a cardinal line. When the two valves are in place they are conspicuously unequal.

The surface is smooth, without sculpture or muscle spots. The curvature is not altogether regular, but there are no definite sulci or tubercles. In so far as I am able to determine, this small, poorly characterized form is the same which I identified as *C. benniei* in the Manzano group of New Mexico.

Horizon and locality.—Phosphate beds of the Park City formation; Thomas Fork, Wyoming (stations 981a, 988a, 988e).

REGISTER OF LOCALITIES.

965. *Montpelier district.*
Waterloo claim, Montpelier, Idaho; limestone above 10-foot bed of phosphatic shales above limestone No. 4 in cut 4A. (See section on p. 15.)
F. B. Weeks and W. F. Ferrier, October 4, 1907.

969. *Crawford Mountains.*
Absaroka tunnel, one-half mile east of Emberg's ranch.
F. B. Weeks, September 9, 1907.

978. *Preuss Range.*
Swan Lake, Idaho; "Cap lime" in north tunnel on north side of gulch, Duke claim.
F. B. Weeks and W. F. Ferrier, September 21, 1907.

980. *Montpelier district.*
Waterloo claim, Montpelier, Idaho; limestone No. 4 in cut 4A, 6-inch limestone. (See section on p. 15.)
F. B. Weeks and W. F. Ferrier, October 4, 1907.

981. *Thomas Fork district.*
Goniatite bed on west side of gulch, Layland tunnel, Sublette Range.
F. B. Weeks and W. F. Ferrier, September 17, 1907.

981a. *Thomas Fork district.*
Chonetes-bearing limestone above Layland tunnel.
F. B. Weeks, September 17, 1907.

981b. *Thomas Fork district.*
Layland claim, Thomas Fork, Wyoming.
W. F. Ferrier, 1907.

982. *Bear Lake district, Idaho.*
"Cap lime" above main phosphate bed, south end of Hot Springs ridge.
F. B. Weeks, W. F. Ferrier, and J. J. Taylor, September 26, 1907.

988. *Thomas Fork district.*
Coal Canyon, *Pleurotomaria* bed, bed 16. (See 988e; also, section on p. 18.)
W. F. Ferrier.

988a. *Thomas Fork district.*
Bed 14, *Chonetes*-bearing limestone, Coal Canyon. (See section on p. 18.)
W. F. Ferrier, August 20, 1907.

988b. *Thomas Fork district.*
Bed 18, Coal Canyon. (See section on p. 18.)
W. F. Ferrier, August 20, 1907.

988c. *Thomas Fork district.*
Coal Canyon section, bed 9. (See section on p. 18.)
W. F. Ferrier, August, 1907.

988d. *Thomas Fork district.*
Coal Canyon, bed 7. (See section on p. 18.)
W. F. Ferrier, August 20, 1907.

988e. *Thomas Fork district.*
Bed 16, Coal Canyon. (See section on p. 18.)
W. F. Ferrier, August 20, 1907.

988f. *Thomas Fork district.*
Bed 11, Coal Canyon.
W. F. Ferrier, August 19, 1907. (See section on p. 18.)

988g. *Thomas Fork district.*
Bed 4, Coal Canyon. (See section on p. 17.)
W. F. Ferrier, August 20, 1907.

988h. *Thomas Fork district.*
Goniatite-bearing limestone, bed 19. (See section on p. 18.)
W. F. Ferrier, August 20, 1907.

988i. *Thomas Fork district.*
Raymond claim, Wyoming.
W. F. Ferrier, 1907.

989. *Thomas Fork district.*
Goniatite bed, first gulch north of Raymond Tunnel gulch, Wyoming, in small cut on south side of gulch.
F. B. Weeks and W. F. Ferrier, September 14, 1907.

990e. *Weber Canyon district.*
Phosphate series above main phosphate beds on Weber claim, in east Weber Canyon, between Robinson's ranch and upper tunnel between Croydon and Morgan, Utah.
F. B. Weeks and W. F. Ferrier, October 7, 1906.

991. *Thomas Fork district.*
Bed 14, Coal Canyon. (See section on p. 18.)
F. B. Weeks.

992. *Crawford Mountains.*
South of Emberg's ranch; fossils from Blackfoot dump.
F. B. Weeks, September 9, 1907.

993. *Preuss Range.*
From decomposed limestone over phosphate bed (phosphate No. 1 of Montpelier section), Diamond claim, Swan Lakes, Idaho.
W. F. Ferrier, 1907.

993a. *Preuss Range.*
"Duke" claim, second pit above valley, north end of claim, Swan Lake, Idaho; from weathered "Cap lime."
W. F. Ferrier, October 26, 1907.

3511. *Montpelier district, Idaho.*
About 20 lots gathered at different times by different collectors but all from the limestone above the lower or main phosphate ("Cap lime") and all from points not far apart in the phosphate grounds near Montpelier.
W. F. Ferrier, F. B. Weeks, J. J. Taylor, and C. C. Jones, 1904–1907.

5067. *Sublette Range.*
Cokeville, Wyo. Phosphate beds.
F. B. Weeks, October 11, 1906.

5068. *Montpelier district, Idaho.*
Limestone No. 3, Winter ground, section in cut 2A.
F. B. Weeks, October 13, 1906.

5069. *Montpelier district, Idaho.*
Phosphates Nos. 3 and 4, from nodules, Waterloo ground, cut 4A.
F. B. Weeks, October 13, 1906.

5069a. *Montpelier district, Idaho.*
Base of first shale above limestone No. 3, section in cut 4A, Waterloo claim.
F. B. Weeks, October 13, 1906.

5069c. *Montpelier district, Idaho.*
Waterloo ground, second shale above limestone No. 3, in section of cut 4A.
F. B. Weeks, October 13, 1906.

5069g. *Montpelier district, Idaho.*
Waterloo ground, upper layers just beneath the detritus in section of cut 4A, above limestones Nos. 2 and 3.
F. B. Weeks, October 13, 1906.

5069h. *Montpelier district, Idaho.*
Waterloo ground, cut 21, limestone No. 2 or No. 3 above main phosphate.
F. B. Weeks, October 13, 1906.

5069t. *Montpelier district, Idaho.*
From limestone (nodules) at top of 10-foot upper phosphate bed, Marlow pit, Waterloo claim, a few feet below 5069g.
W. F. Ferrier, August 26, 1907.

5070. *Thomas Fork district.*
Twenty feet above main phosphate bed in phosphate series on Thomas Fork, Wyoming.

5071. *Sublette Range.*
Probably same horizon as 5071a, but from bottom of tunnel near base of hill.
F. B. Weeks, October 11, 1906.

5071a. *Sublette Range.*
Cokeville, Wyo., phosphate section.
F. B. Weeks, October 11, 1906.

5072. *Sublette Range.*
Cokeville, Wyo., blue limestone, base of phosphate beds.
F. B. Weeks, October 11, 1906.

5074. *Bradbury claim, Woodruff Creek, Utah.*
W. F. Ferrier.

PLATE I.

PLATE I.

LINGULA CARBONARIA var. EXPORRECTA (p. 22).

FIGURE 1. A dorsal (?) valve.
Thomas Fork, Wyoming (station 988d).

LINGULA CARBONARIA? (pp. 20–22).

FIGURE 2. A dorsal (?) valve.
3. A ventral (?) valve.
4. A dorsal (?) valve.
Thomas Fork, Wyoming (station 988d).
5. A small dorsal (?) valve referred to the same species.
"Cap lime," Montpelier, Idaho (station 3511).

LINGULIDISCINA MISSOURIENSIS (pp. 22–24).

FIGURE 6. A dorsal valve; seen from above.
6a. Same, side view in outline.
"Cap lime," Montpelier, Idaho (station 3511).
7. A large dorsal valve; seen from above.
7a. Same, side view in outline.
Crawford Mountains, Idaho (station 992).
8. A dorsal valve somewhat deformed by pressure. Seen from above, × 2.
8a. Same, side view in outline.
"Cap lime," Montpelier, Idaho (station 3511).
9. A dorsal valve; seen from above.
9a. Same, side view in outline.
Montpelier, Idaho (station 5068).
10. A ventral valve, preserved as an external mold and deformed by pressure, × 2.
Thomas Fork, Wyoming (station 988e).

LINGULIDISCINA UTAHENSIS (pp. 24–25).

FIGURE 11. A ventral valve showing the characteristic configuration.
Weber Canyon, Utah (station 990e).

CHONETES OSTIOLATUS (pp. 25–26).

FIGURE 12. A large characteristic ventral valve.
13. A young ventral valve; seen from above, × 2.
14. A small transverse specimen with a distinct sinus.
"Cap lime," Montpelier, Idaho (station 3511).

CHONETES OSTIOLATUS var. IMPRESSUS (pp. 26–27).

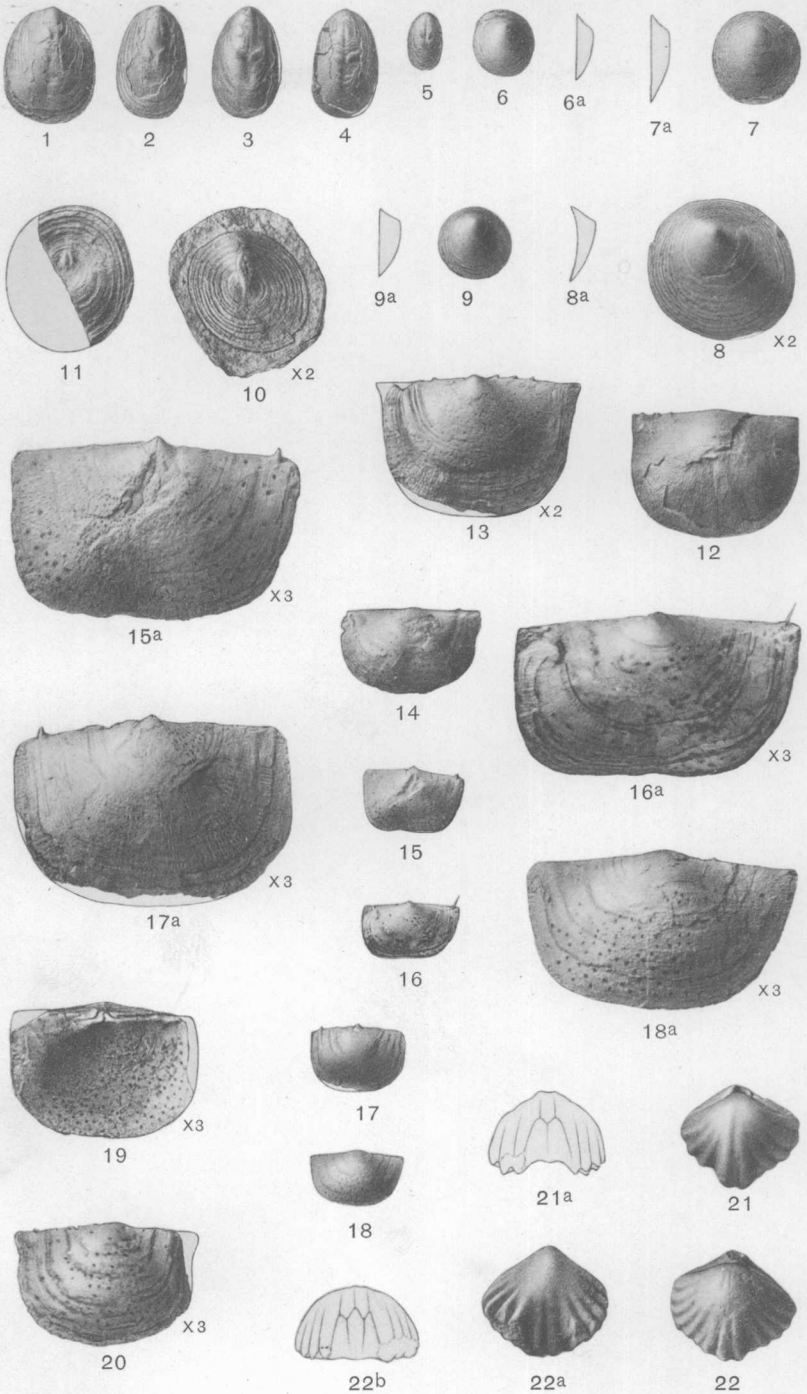
FIGURE 15. A ventral valve; seen from above.
15a. Same, × 3.
16. Another ventral valve; seen from above.
16a. Same, × 3.
17. Another ventral valve; seen from above.
17a. Same, × 3.
Cokeville, Wyoming (station 5072).

CHONETES OSTIOLATUS var. MINUSCULUS (p. 27).

FIGURE 18. A large specimen with large pores around the margin; seen from above.
18a. Same, × 3.
19. A specimen with both valves in conjunction; dorsal view, × 3.
20. A small ventral valve with small pores; seen from above, × 3.
Thomas Fork, Wyoming (station 988a).

PUGNAX OSAGENSIS var. OCCIDENTALIS (pp. 33–34).

FIGURE 21. A specimen with two plications on the fold; dorsal view.
21a. Same, front view in outline.
22. A specimen with three plications on the fold; dorsal view.
22a. Same, ventral view.
22b. Same, anterior view in outline.
"Cap lime," Montpelier, Idaho (station 3511).



FAUNA OF THE PHOSPHATE BEDS OF IDAHO, WYOMING, AND UTAH

PLATE II.

PLATE II.

PRODUCTUS GENICULATUS (pp. 27–28).

FIGURE 1. The typical specimen, a ventral valve; seen from above.
1a. Same, side view in outline.
1b. Same, posterior view.
1c. Same, anterior view.
2. An exfoliated specimen, with large spine scars; anterior view.
2a. Same, seen from above.
2b. Same, side view in outline.
"Cap lime," Montpelier, Idaho (station 3511).

PRODUCTUS EUCHARIS (pp. 28–29).

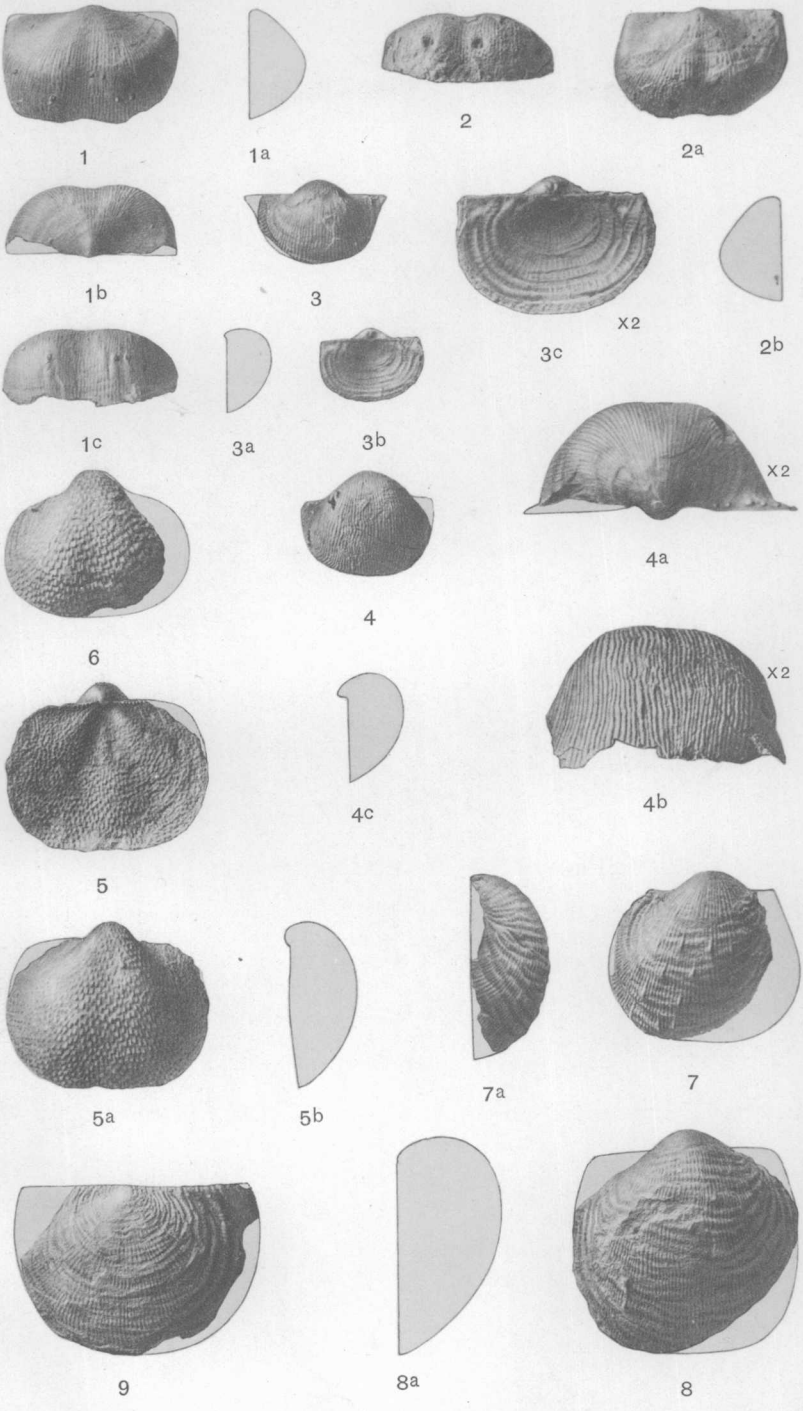
FIGURE 3. A bivalve specimen with part of the ventral valve broken off; seen from above, with the piece on.
3a. Same, side view in outline.
3b. Same, inner side of the broken piece, showing the characters of the plicated dorsal valve.
3c. Same as figure 3b, × 2.
4. A ventral valve; seen from above.
4a. Same, posterior view, × 2.
4b. Same, anterior view, × 2.
4c. Same, side view in outline.
"Cap lime," Montpelier, Idaho (station 3511).

PRODUCTUS MONTPELIERENSIS (p. 30).

FIGURE 5. The typical specimen; dorsal view.
5a. Same, ventral view.
5b. Same, side view in outline.
6. A second specimen, an imperfect ventral valve.
"Cap lime," Montpelier, Idaho (station 3511).

PRODUCTUS PHOSPHATICUS (pp. 29–30).

FIGURE 7. A ventral valve with numerous spines springing from raised costæ; seen from above.
7a. Same, side view.
8. A characteristic ventral valve.
8a. Same, side view in outline.
9. External mold of a dorsal valve.
"Cap lime," Montpelier, Idaho (station 3511).



FAUNA OF THE PHOSPHATE BEDS OF IDAHO, WYOMING, AND UTAH

PLATE III.

PLATE III.

PUGNAX WEEKSI (pp. 31–32).

FIGURE 1. A nearly perfect specimen of the broad type; ventral view, showing the thick shell exfoliated over the umbonal region.

1a. Same, side view in outline.

1b. Same, anterior view.

1c. Same, dorsal view.

2. A narrow specimen with obscure plications; dorsal view.

2a. Same, side view.

2b. Same, anterior view.

Montpelier, Idaho (station 5069h).

3. A specimen with stronger plications of which three instead of two occupy the fold; dorsal view.

3a. Same, side view in outline.

3b. Same, anterior view.

"Cap lime," Montpelier, Idaho (station 3511).

4. A small, narrow, triangular type, perhaps a distinct variety; dorsal view.

4a. Same, side view in outline.

4b. Same, anterior view.

Swan Lakes, Idaho (station 993a).

PUGNAX WEEKSI var. NOBILIS (pp. 32–33).

FIGURE 5. The typical specimen; dorsal view.

5a. Same, side view in outline.

6. A young example referred to this species; dorsal view.

6a. Same, side view in outline.

6b. Same, anterior view in outline.

"Cap lime," Montpelier, Idaho (station 3511).

7. An unusual specimen referred here with doubt; dorsal view.

7a. Same, side view in outline.

7b. Same, ventral view.

"Cap lime," Bear Lake, Idaho (station 982).

RHYNCHOPORA TAYLORI (p. 34).

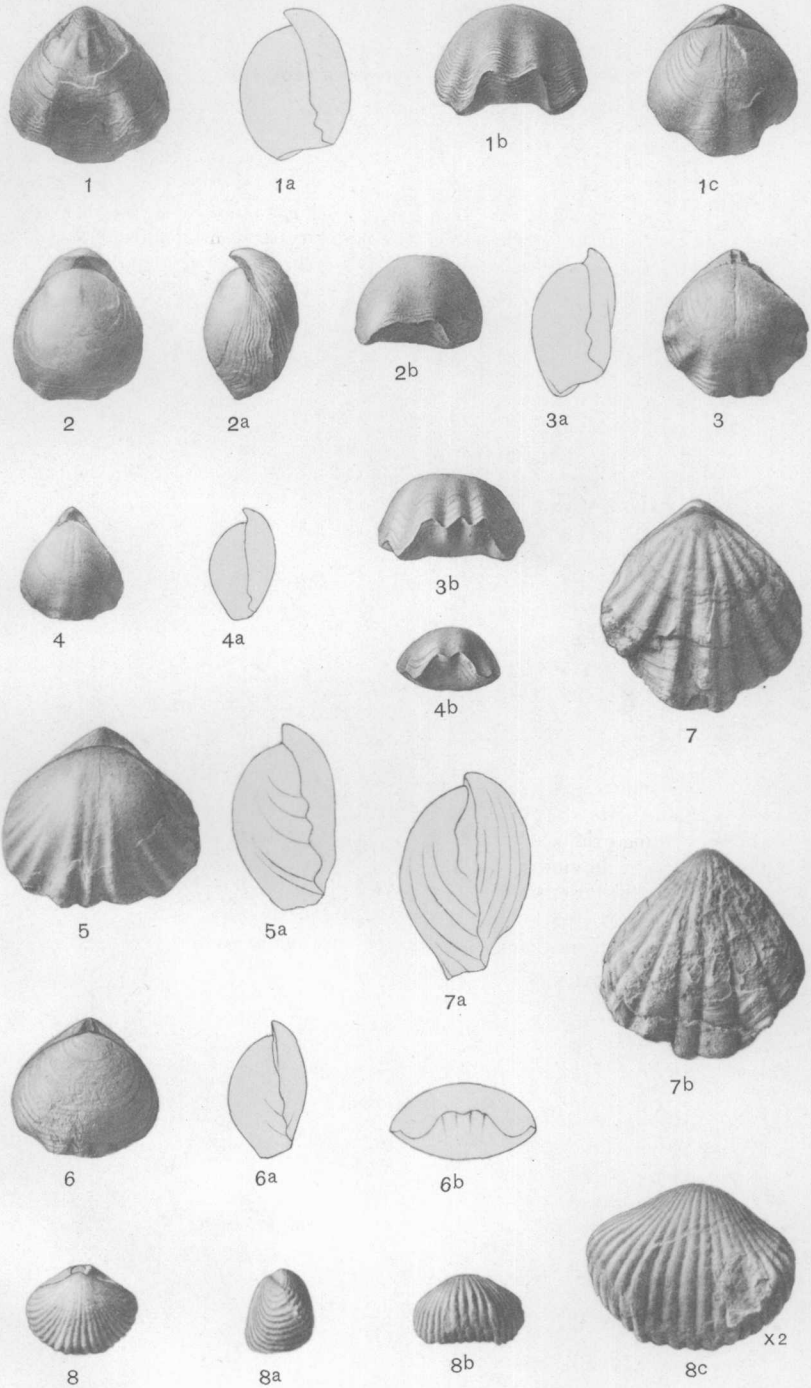
FIGURE 8. The typical specimen; dorsal view.

8a. Same, side view.

8b. Same, anterior view.

8c. Same, ventral view, × 2.

"Cap lime," Montpelier, Idaho (station 3511).



FAUNA OF THE PHOSPHATE BEDS OF IDAHO, WYOMING, AND UTAH

PLATE IV.

PLATE IV.

NUCULA MONTPELIERENSIS (pp. 38–39).

FIGURE 1. The typical specimen, left valve.
1a. Same, × 3.
1b. Same, posterior view, × 3.
1c. Same, cardinal view, × 3.
2. A right valve, × 3.
Montpelier, Idaho (station 980).
3. A left valve of somewhat different shape, × 3.
3a. Same, cardinal view, in outline, × 3.
Montpelier, Idaho (station 5069a).

YOLDIA MCCHESNEYANA (pp. 39–40).

FIGURE 4. A left valve, not so transverse as the type, × 3.
5. A small but nearly perfect specimen taken as the type, left valve.
5a. Same, × 3.
5b. Same, cardinal view, × 3.
6. A right valve, somewhat larger than the type, × 3.
Montpelier, Idaho (station 980).

LEDA OBESA (pp. 40–41).

FIGURE 7. A specimen with both valves in conjunction, considerably deformed by compression, left valve.
8. A large imperfect specimen in shale.
Swan Lakes, Idaho (station 993).

AVICULIPECTEN? MONTPELIERENSIS (pp. 42–43).

FIGURE 9. A left valve of medium size, × 2.
Montpelier, Idaho (station?).
10. A small right valve, × 2.
"Cap lime," Montpelier, Idaho (station 3511).

AVICULIPECTEN PHOSPHATICUS (pp. 43–44).

FIGURE 11. A squeeze from the typical specimen, the mold of a left valve, × 2.
Thomas Fork, Wyoming (station 988c).

SCHIZODUS FERRIERI (pp. 41–42).

FIGURE 12. The typical specimen, a right valve.
12a. Same, anterior view in outline.
Montpelier, Idaho (station 980).
13. A left valve having a shape suggestive of *Sedgwickia*.
13a. Same, anterior view.
Montpelier, Idaho (station 5069g).


X3
1a

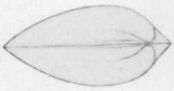

X3
1b


1


X3
2


X3
1c


X3
3


3a

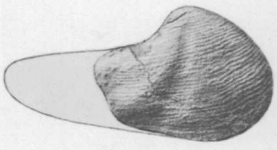

X3
4


5

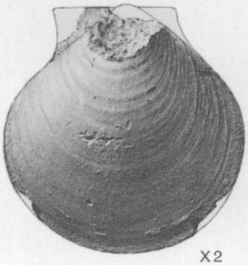

7


X3
5a


X3
6


8


X3
5b


X2
9


X2
10


11 X2


12


12a


13a


13

FAUNA OF THE PHOSPHATE BEDS OF IDAHO, WYOMING, AND UTAH

PLATE V.

PLATE V.

OMPHALOTROCHUS CONOIDEUS (pp. 50–51).

FIGURE 1. A large specimen, the last whorl of which is more or less of the *ferrieri* type; seen from above.

1a. Same, side view.

1b. Same, side view.

2. A characteristic specimen which shows the rare feature of very obscure revolving lines; seen from above.

2a. Same, seen from below.

2b. Same, side view.

3. A specimen more or less intermediate with *O. ferrieri;* seen from above.

3a. Same, side view.

3b. Same, seen from below.

"Cap lime," Montpelier, Idaho (station 3511).

OMPHALOTROCHUS FERRIERI (pp. 48–49).

FIGURE 4. A specimen of medium size; seen from above.

4a. Same, seen from below.

4b. Same, side view in outline.

5. A small specimen with low spire; seen from above.

5a. Same, seen from below.

5b. Same, side view in outline.

6. Another specimen; seen from above.

6a. Same, side view in outline.

7. A specimen showing old-age characters on the last whorl; seen from above.

7a. Same, side view.

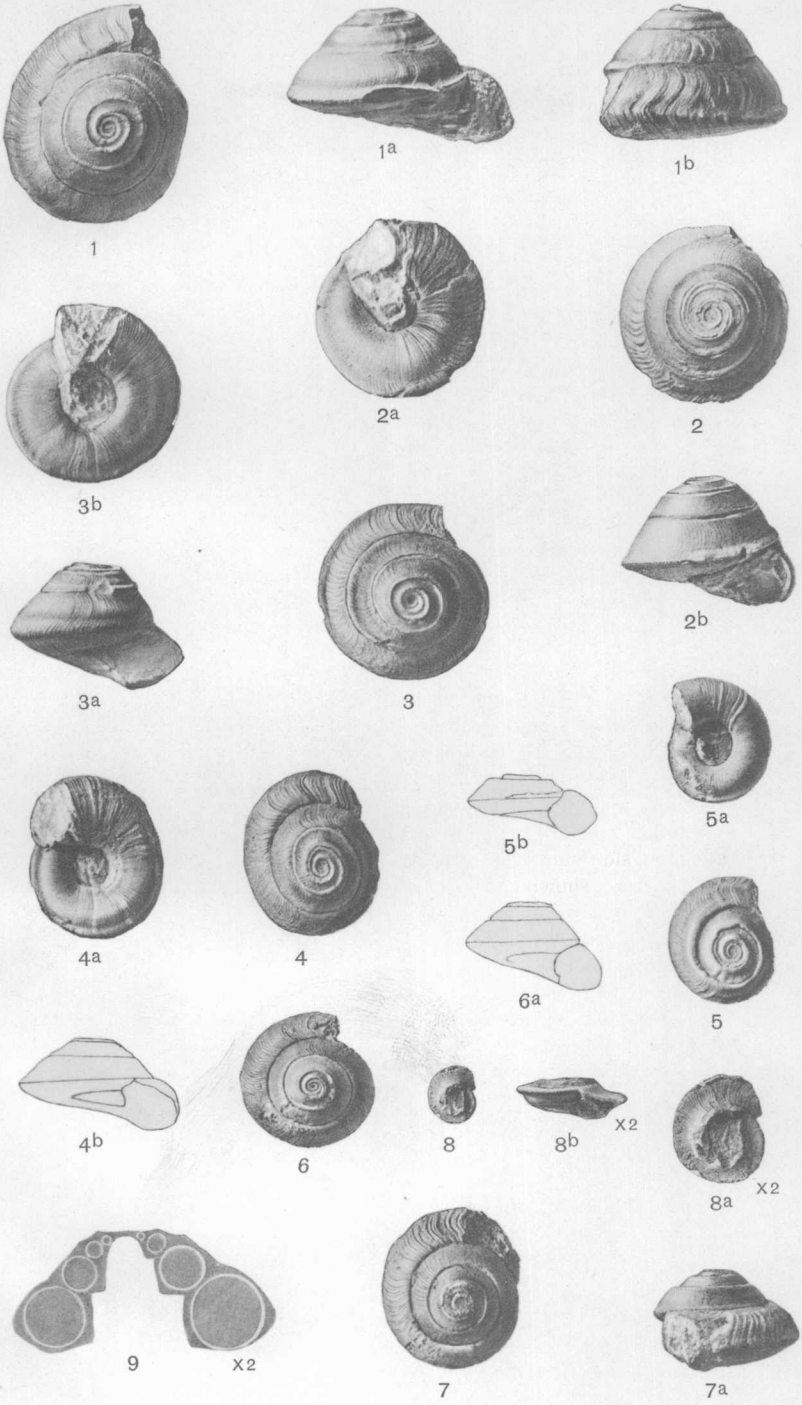
8. A very young specimen; seen from above.

8a. Same, × 2.

8b. Same, side view, × 2.

9. Cross section through a small specimen, × 2. The interior of the whorls is lined with calcite.

"Cap lime," Montpelier, Idaho (station 3511).



FAUNA OF THE PHOSPHATE BEDS OF IDAHO, WYOMING, AND UTAH

PLATE VI.

PLATE VI.

OMPHALOTROCHUS FERRIERI (pp. 48–49).

FIGURE 1. A characteristic specimen; seen from above.
1a. Same, seen from below.
1b. Same, side view in outline.
"Cap lime," Montpelier, Idaho (station 3511).

OMPHALOTROCHUS FERRIERI var. (pp. 49–50).

FIGURE 2. A specimen having an unusually high spire; side view.
"Cap lime," Montpelier, Idaho (station 3511).

PLEUROTOMARIA IDAHOENSIS (pp. 45–46).

FIGURE 3. The typical specimen; side view.
3a. Same, side view, × 2, showing sculpture.
Thomas Fork, Wyoming (station 988e).

PLEUROTOMARIA aff. NEVADENSIS (pp. 46–47).

FIGURE 4. A characteristic specimen of the group for which this title is used; side view.
Cokeville, Wyo. (station 5072).

PLEUROTOMARIA aff. NEVADENSIS? (pp. 46–47).

FIGURE 5. A fragment doubtfully referred to this species; side view, × 2, showing the shape of the slit and the aperture adjacent.
Preuss Range, Idaho (station 993a).

NATICOPSIS TAYLORIANA (p. 51).

FIGURE 6. The typical specimen; side view, × 2.
6a. Same, opposite side, × 2.
Montpelier, Idaho (station 980).

SOLENISCUS aff. ALTONENSIS (pp. 51–52).

FIGURE 7. The only specimen obtained; side view.
7a. Same, opposite side.
Thomas Fork, Wyoming (station 989).

CONULARIA sp. (p. 20).

FIGURE 8. The only specimen found; side view.
"Cap lime," Montpelier, Idaho (station 3511).

EDMONDIA? PHOSPHATICA (pp. 36–37).

FIGURE 9. A somewhat compressed specimen retaining both valves in conjunction, left valve.
9a. Same, cardinal view in outline.
Swan Lakes, Idaho (station 993a).

CARDIOMORPHA? sp. (pp. 37–38).

FIGURE 10. A left valve considerably larger than the three other specimens included under this title.
"Cap lime," Montpelier, Idaho (station 3511).

GRAMMYSIA? CARBONARIA (p. 36).

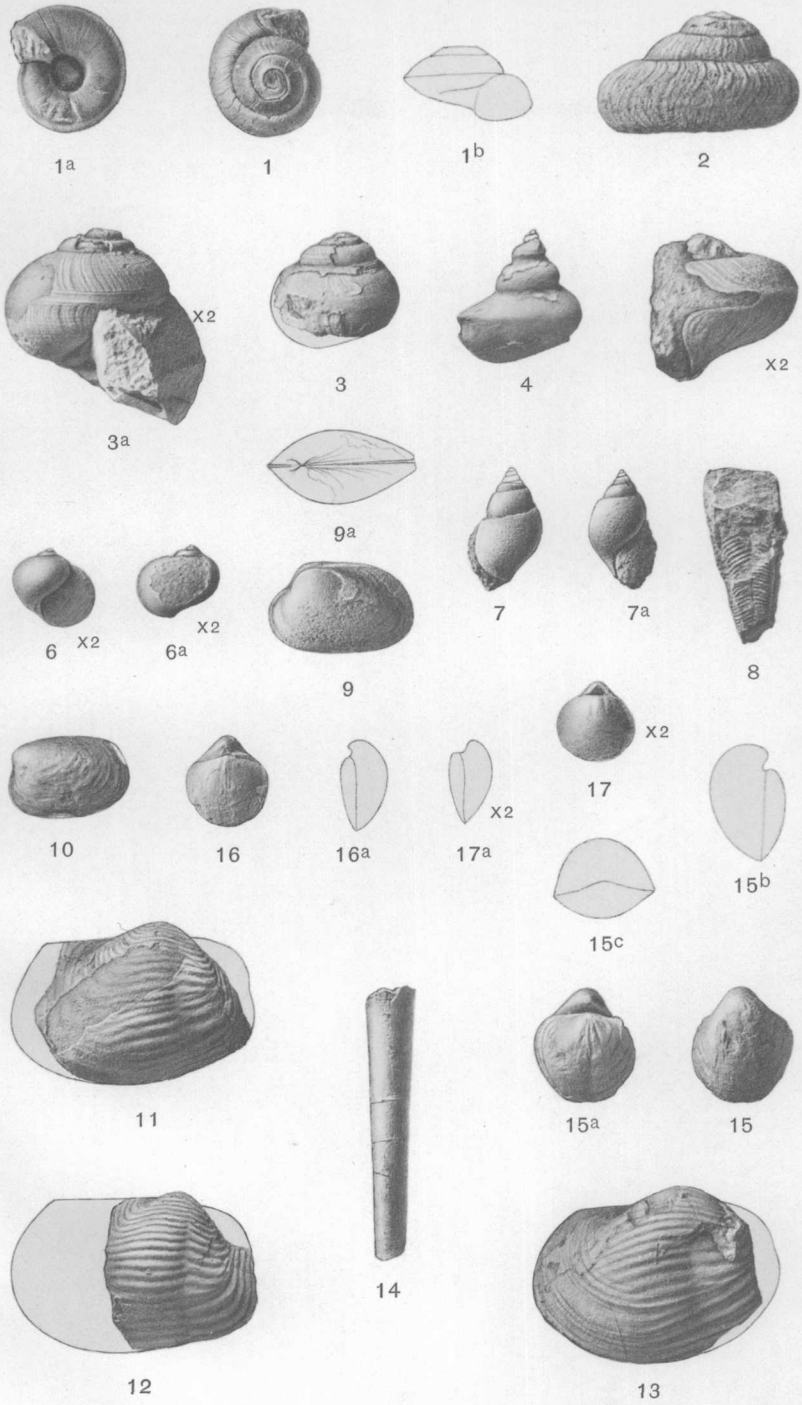
FIGURE 11. An imperfect right valve.
12. The anterior half of another right valve.
13. Another imperfect right valve.
Montpelier, Idaho (station 980).

PLAGIOGLYPTA CANNA (pp. 44–45).

FIGURE 14. Internal mold of the most perfect specimen observed.
Montpelier, Idaho (station 5069).

AMBOCŒLIA ARCUATA (p. 35).

FIGURE 15. The typical specimen; ventral view.
15a. Same, dorsal view.
15b. Same, side view in outline.
15c. Same, anterior view.
"Cap lime," Montpelier, Idaho (station 3511).
16. A medium-sized specimen; dorsal view.
16a. Same, side view in outline.
17. A very young specimen; dorsal view, × 2.
17a. Same, side view in outline, × 2.
Thomas Fork, Wyoming (station 988a).



FAUNA OF THE PHOSPHATE BEDS OF IDAHO, WYOMING, AND UTAH

PLATE VII.

PLATE VII.

JONESINA CARBONIFERA (pp. 56–57).

FIGURE 1. A characteristic left valve; side view, × 15.
2. A large right valve; side view, × 15.
3. A small bivalved specimen; left valve, × 15.
3a. Same, right valve, × 15.
3b. Same, dorsal view, × 15.
4. A large bivalved specimen; dorsal view, showing a sort of articulation along the hinge line, × 15.
Thomas Fork, Wyoming (station 988e).

CYTHERELLA BENNIEI (pp. 57–58).

FIGURE 5. A bivalved specimen, right valve, × 15.
5a. Same, left valve, × 15.
5b. Same, cardinal view, × 15.
Thomas Fork, Wyoming (station 988e).
6. A small specimen, × 15.
7. A large valve, × 15.
Thomas Fork, Wyoming (station 988a).

HOLLINA EMACIATA var. OCCIDENTALIS (pp. 55–56).

FIGURE 8. A left valve, × 15.
9. A right valve, × 15.
10. A right valve with somewhat different configuration.
Thomas Fork, Wyoming (station 988*a*).

GASTRIOCERAS SIMULATOR (pp. 52–54).

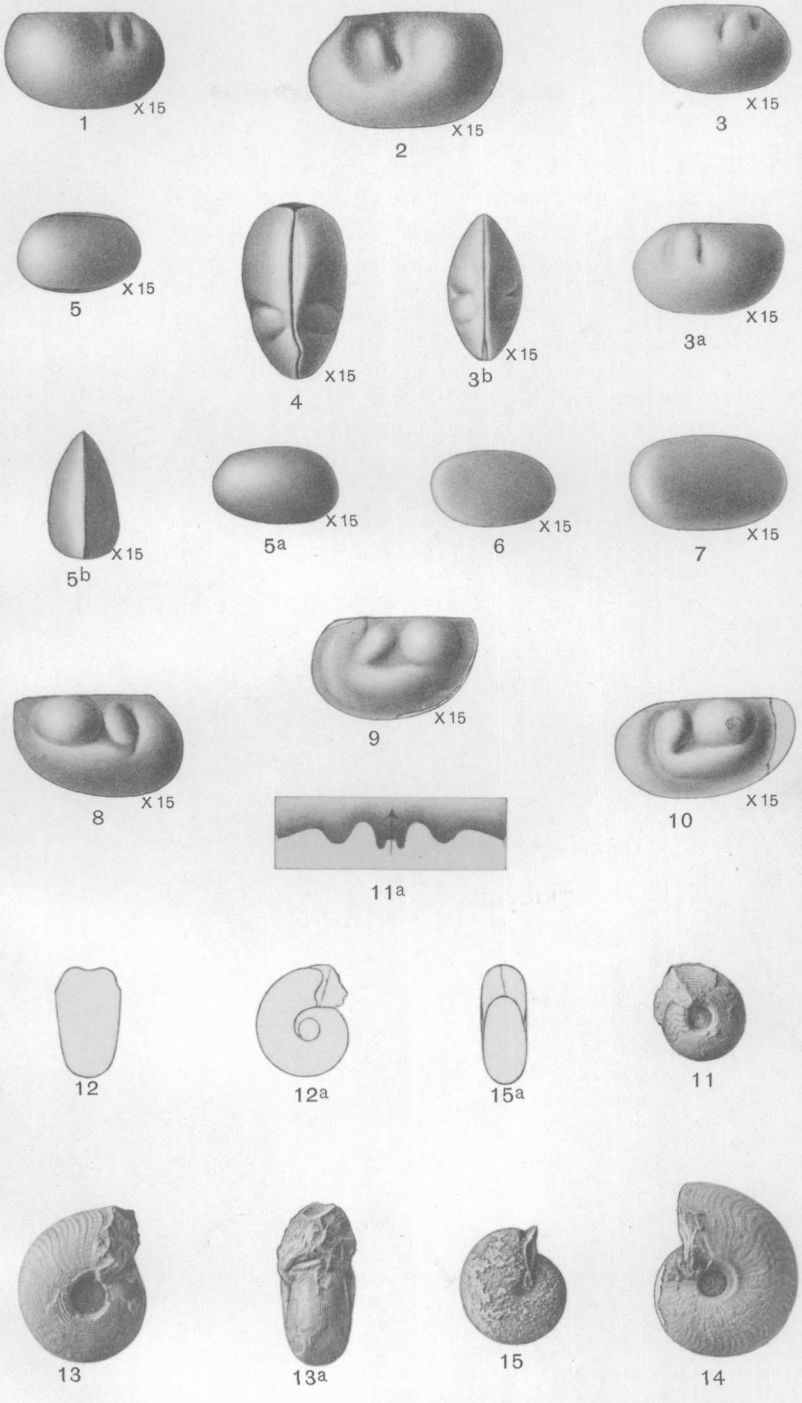
FIGURE 11. A small specimen showing suture; side view.
11a. Suture of same, × 3.
Thomas Fork, Wyoming (station 981).
12. A mold showing the original shape of the aperture; ventral view in outline.
12a. Same, side view in outline.
Thomas Fork, Wyoming (station 988*i*).
13. A rather large specimen showing sculpture; side view.
13a. Same, ventral view.
Thomas Fork, Wyoming (station 981*b*).

GASTRIOCERAS? sp. (p. 54).

FIGURE 14. A large specimen, which seems to be devoid of revolving striæ; side view.
Thomas Fork, Wyoming (station 981).

POPANOCERAS? sp. (p. 55).

FIGURE 15. The only specimen observed, of a rare undetermined form; side view.
15a. Same, ventral view in outline.
Thomas Fork, Wyoming (station 988*i*).



FAUNA OF THE PHOSPHATE BEDS OF IDAHO, WYOMING, AND UTAH

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[Names in *italic* are those of synonyms; figures in **black face** denote descriptions; figures in *italic* show position of illustrations.]

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