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CONTENTS

PALEONTOLOGY AND STRATIGRAPHY OF THE PHOSPHORIA FORMATION

by

CARL C. BRANSON, PH. D.

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INTRODUCTION

The Phosphoria is a marine formation of Upper Pennsylvanian and Lower Permian age which occurs in western Wyoming and adjacent parts of Colorado, Utah, Idaho, and Montana. The purpose of this study is to describe in detail the paleontology and correlation of this formation, and to give minor emphasis to its distribution, lithology, and paleography.

The distribution of the formation is well known from the extensive investigations of the phosphate beds by the United States Geological Survey. Except for fossil lists, the fauna is known only from a paper by E. B. Branson on the fauna of one of its members[13], and from a bulletin by G. H. Girty on the fauna of the phosphate beds of an area in the vicinity of Montpelier, Idaho[32]. The bibliography accompanying the present study cites every previous reference to the Phosphoria formation and its close correlatives known to the writer. The raised numbers given in the text refer to the items listed in the bibliography.

The material given in the following pages is based upon field work of the writer during the greater part of four summers and upon the study over a period of three years of the fossils collected by him, by E. B. Branson, and by students of the University of Missouri field parties. The investigation has been carried out at the University of Missouri and at the University of Chicago.

This investigation was suggested and supervised by the writer's father, E. B. Branson. The final stages of preparation were directed by Carey Croneis, to whom the writer is deeply indebted. Thanks are due to A. W. Slocum of Walker Museum for his kind instruction and assistance in photographing the fossils. A. S. Price worked with the writer in the field and described many of the fossils in a Master's thesis at the University of Missouri. The use of his results, and personal communications from him, have been of great aid in this work. Many of the fossils were lent by the University of Missouri and some by I. A. Keyte and A. E. Brainerd.

DISTRIBUTION OF THE FORMATION

The Phosphoria formation is known definitely in Wyoming, Colorado, Utah, Idaho, and Montana. That its sea extended into Nevada seems probable, for fossils have been found there which indicate Phosphoria age. Some outcrops in Alberta, Canada, are referred to the Phosphoria on the evidence of a doubtfully identified shark and from the presence of phosphate beds[30,31].

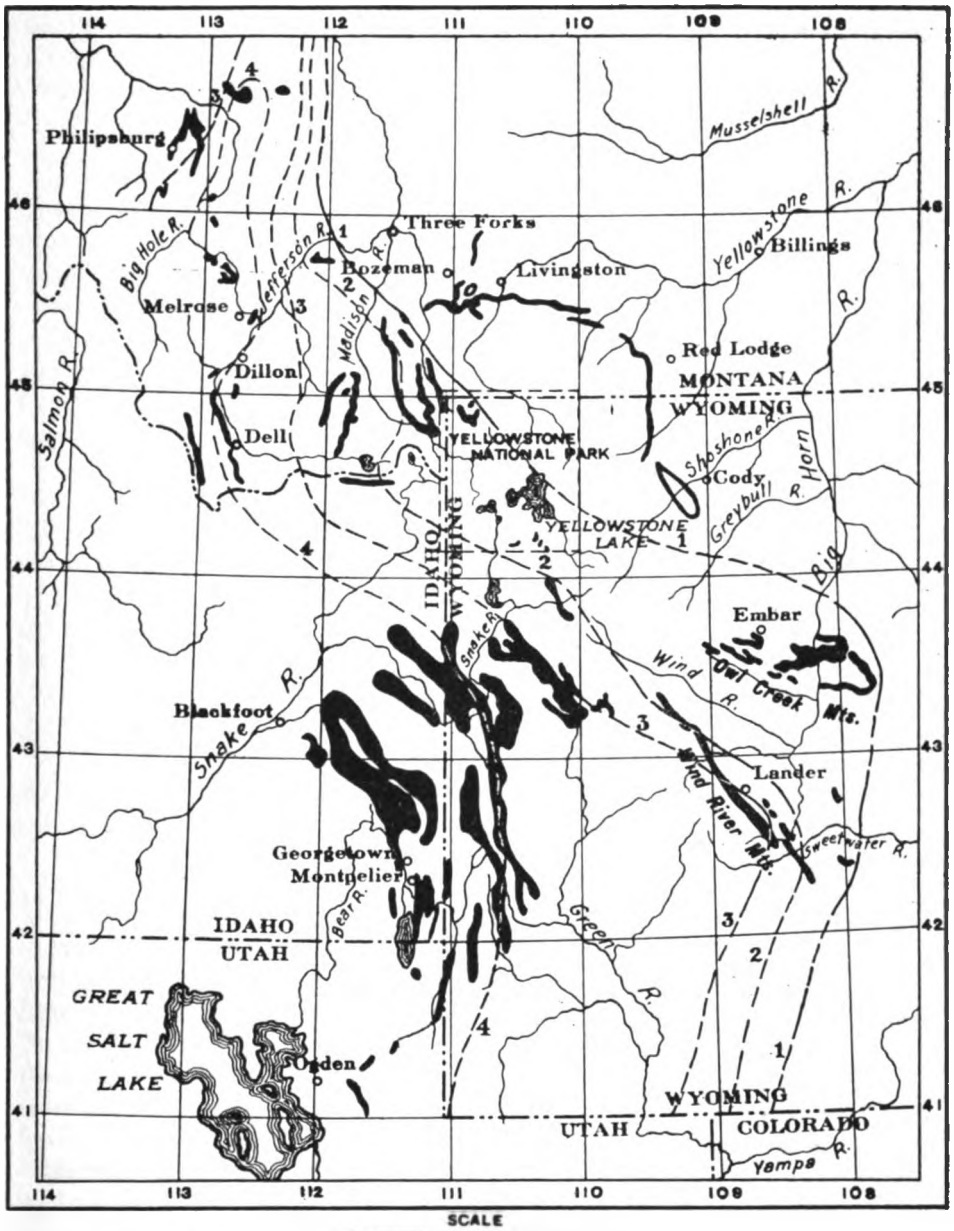
The easternmost outcrop of positively identified Phosphoria is at the east end of the Owl Creek Mountains, Wyoming. The Phosphoria forms long dip slopes along the north side of the range and outcrops irregularly on the south side. Several writers have stated that the Phosphoria and the overlying formation, the Dinwoody, grade from the dominantly limestone phase in the Owl Creek Mountains into a "red beds" phase in the Bighorn Mountains[19,20,52]. The writer has examined the outcrops in the area near the saddle between the two ranges. East from Thermopolis on the north side of the Owl Creek Mountains the Phosphoria and Dinwoody thin rapidly. Fifteen miles east of Thermopolis, near the east end of the Owl Creek Mountains, the Phosphoria is

less than one hundred feet thick, half of its normal thickness, but it is still typical lithologically. The normal chert and limestone phases are well developed, and it shows no gradation toward a "red beds" condition. A few miles to the east of this locality, within three miles of the saddle which separates the Owl Creek and Bighorn Mountains, the Phosphoria is apparently absent. At this place some thin-bedded, buff, sandy limestone represents the Dinwoody, but the formation is not red in color. On No Wood Creek, near No Wood post office, which is in the southern end of the Bighorn Mountains, there is nothing which, in the writer's opinion, could be called Phosphoria or Dinwoody. A great thickness of gypsiferous red beds, the lower part of which has been referred to by some writers as Phosphoria or Dinwoody, is continuous with and entirely similar to the overlying Chugwater and is lithologically like the Chugwater with which the writer is familiar in many localities. There are other evidences of the lack of Phosphoria and Dinwoody in this locality and of the Chugwater age of the lower portion of the red rocks. The basal bed of the red series is a dark-red, massive, sandy shale which exhibits rough columnar jointing and weathers into forms of spherical shape. Beds of this type in other Chugwater localities have been found to belong to the top-set delta beds of the Popo Agie member. Such beds are not found in the Phosphoria or Dinwoody.

Below the red rocks, and directly above the Tensleep sandstone, is a conglomerate composed of detrital sandstone and of rounded pebbles, some two inches in diameter. These pebbles are in large part siliceous and highly colored in red, green, purple, and black shades. Such material, so far as the writer knows, occurs nowhere in the Tensleep sandstone, but is found in great abundance in the Amsden formation. If this evidence is conclusive, it shows a period of erosion following Tensleep time sufficient to remove five hundred feet of Tensleep and to expose the Amsden. The writer believes that the area now occupied by the Bighorn Mountains was above the sea and was being eroded while the Phosphoria and Dinwoody sediments were being deposited to the west. In the canyon east of Tensleep, Wyoming, which is near the middle of the west side of the Bighorn Mountains, the Phosphoria and Dinwoody are clearly absent.

In Colorado, the Phosphoria formation is represented only by two small patches of outcrop near the east end of the Uinta uplift. In Utah, the Phosphoria is extensively developed in scattered localities, chief among which are those around the Uintas and in the Wasatch Mountains. Outcrops are found over large areas in the southeastern part of Idaho as far west as the Fort Hall Indian Reservation. In Montana, outcrops are recorded in small areas scattered over the southwestern portion of the state. The northernmost exposure is near Philipsburg, north of which the rock mass of the Lewis overthrust covers the outcrops. To the east and northeast in Montana, the Phosphoria has been found to thin and disappear, but the exact limits are unknown because it has been mapped with the Quadrant quartzite, which lies beneath.

Outcrops occur over a larger area in Wyoming than in any of the other states. Along the western border the Phosphoria outcrops along the Sublette and Salt River Ranges, near the Teton Range, and in several places in Yellowstone Park. The best exposures known to the writer are found along the east



MAP SHOWING OUTCROPS OF PHOSPHORIA FORMATION

(Based on map in U. S. Geol. Survey Bull. 735)

side of the Wind River Mountains in Fremont County, Wyoming. Here, as in the Owl Creek Mountains, the formation forms a long dip slope on the front of the range, and complete sections are exposed in many of the canyons which cut through it. The best collecting and the most varied faunas occur in these canyons, especially in that of Bull Lake Creek.

STRATIGRAPHIC RELATIONSHIPS

In the Wind River and Owl Creek Mountains, Wyoming, the Phosphoria lies unconformably on the Tensleep sandstone, which is Pennsylvanian in age. Near Bull Lake, the top of the Tensleep is irregular; in one place a hill about twenty feet high stands on the Tensleep surface and the overlying Phosphoria beds show initial dips around it. The erosional surface is overlain by a variable thickness of detrital sandstone in the base of the Phosphoria. The unconformity is often not apparent, but it has been noticed in many places. The top member of the Phosphoria in the Wind River and Owl Creek Mountains is a massive limestone bed. This member is succeeded by a sandy limestone of quite different aspect, and above it are other sandy limestones, sandtones, and sandy shales. This sandy series is known as the Dinwoody formation, of Permian or Triassic age. The few fossils that have been found in it do not serve to distinguish between the two periods, and there is no sign of an unconformity below.

In Utah and in Colorado, the Phosphoria lies with probable unconformity upon the lower member of the Park City formation, which in turn rests upon the Weber quartzite. The upper two members of the Park City formation are now called "Phosphoria", and as yet no name has been applied to the lower member of the Park City. Above the Phosphoria, without apparent unconformity, is the Woodside shale, a formation which may be a correlative of the Dinwoody. At present, most of the evidence points to Lower Triassic as the age of the Woodside.

According to Mansfield, the Phosphoria formation in Idaho lies with slight unconformity upon the Wells formation, which he correlates with the Morgan formation, Weber quartzite, and the lower member of the Park City formation in Utah[69]. As in Utah, the Woodside shale is the overlying formation. In Montana, the Phosphoria lies with apparent conformity upon the Quadrant quartzite, a Pennsylvanian formation. The Quadrant consists of massive beds of quartzite and dolomitic limestone. The Phosphoria is a variable sequence of sandstone, chert, shale, phosphate rock, and quartzite. In places, the two formations are hard to distinguish. Northeast of the Beartooth Mountains, Montana, the Quadrant pinches out and the Phosphoria lies unconformably upon the Madison limestone, a Mississippian formation. A few miles farther to the north and to the east, the Phosphoria thins out and disappears.

The beds which lie above the Phosphoria in most of the Montana localities are shaly limestones, shales, or sandstones of a brown color. These beds have not been correlated with rocks in other localities, and their Triassic age is uncertainly established. In some places, the Ellis formation (Jurassic) lies directly upon the Phosphoria.

LITHOLOGY

The lithology of the Phosphoria formation is highly variable vertically, but the beds are nearly constant in character horizontally. In general, the Phosphoria may be said to vary from east to west from a basal shale series containing thick beds of phosphate rock, and an overlying cherty limestone, to a basal chert and limestone series with progressively poorer and thinner phosphate beds overlain by cherty shales and a massive bed of limestone. The first type is found in Colorado, Utah, Idaho, Montana, and the Sublette and Salt River Ranges of Wyoming. The second type is typically developed in the Wind River and Owl Creek Mountains of Wyoming. There is almost no variation from this regular eastward gradation.

The type locality of the formation is Phosphoria Gulch, near Meade Peake, Idaho. The section there consists of 175 feet of phosphatic shales with a few limestone beds, and 240 feet of chert, cherty limestone, and cherty shale, known as the Rex chert member. The following is a condensed copy of the section as given by Richards and Mansfield in their original paper[67]:

SECTION IN PHOSPHORIA GULCH, IDAHO

	Ft.	In.
Iron-stained calcareous shale (Woodside shale)		
Shale, black, cherty	80	
Chert, in heavily iron-stained ledges	60	
Limestone, gray, banded with dark chert	100	
(Thickness of Rex chert member 240 feet)		
Shale, brown, in thin beds alternating with beds of oolitic phosphate rock	15	
Limestone, lenticular		10
Phosphate rock, dark-brown, oolitic	9	8
Shale, brown to black, phosphatic	89	11
Limestone, purplish-drab, lenticular		8
Shales, black, phosphatic	48	
Limestone, dark-gray, dense (Cap Lime fossils)	3	
Phosphate rock, dark-brown, oolitic	7	
Shale, brown, contorted, soft	1	
Sandstone, white, calcareous. Top of Wells formation		
Thickness of phosphate shales	175	1
Thickness of Phosphoria formation	415	1

The extreme northwestern outcrops of Phosphoria are near Garrison and Philipsburg, Montana. A measured section in the Philipsburg phosphate field is as follows[61]:

SECTION NEAR PHILIPSBURG, MONTANA

	Feet
Limestone and shale of Ellis formation (Jurassic)	
Sandstone, yellowish-brown, and quartzite	130
Shale, red to brown	20
Sandstone and shale, yellowish-brown, phosphatic, with several thin beds of rock phosphate at bottom	30
Cherty limestone and pure quartzite (Quadrant?)	—
	180

In the Garrison phosphate field, the Phosphoria formation is only 53 feet thick, mostly chert, but with one important phosphate bed. In the western part of the field, the phosphate occurs only as scattered nodules.

The Phosphoria formation near the eastern border of its outcrops in Montana is less than 100 feet thick. The following section is fairly typical[23]:

SECTION WEST OF BOZEMAN, MONTANA

	Ft.	In.
Shale, arenaceous and calcareous, ocherous yellow (Ellis formation)		
Quartzite, dark, with cherty nodules	56	
Chert with irregular columns of sandstone	14	
Quartzite, dark, with irregular columns of gray chert	8	
Chert, dark-gray, in thin layers	10	
Phosphate rock, gray, oolitic	1	2
Cherty nodules		3
Sandstone, phosphatic, cherty in lower part	11	
Quartzite, gray, with a few layers of dolomitic limestone (Quadrant quartzite)		
Thickness of Phosphoria formation	100	5

The type locality of the Park City formation described by Boutwell[11] is Big Cottonwood Canyon, Utah. The section is not completely exposed, but in general it is as follows[10,11,67]:

SECTION IN BIG COTTONWOOD CANYON, UTAH

	Feet
Shale, red, thinly bedded, fine grained (Woodside shale)	
Limestone, shaly and cherty (upper member of Phosphoria formation)	129
Shale, phosphatic, with beds of rock phosphate (lower member of Phosphoria formation)	112
Quartzite, with prominent limestone beds (lower member of Park City formation)	194
Quartzite, gray, massively bedded, homogeneous, dense (Weber quartzite)	1350

COMPOSITE SECTION IN THE OWL CREEK MOUNTAINS

	Feet
Conglomerate, overlain by yellow calcareous sandstone (Dinwoody formation)	
14. Limestone, gray, compact, fossiliferous, with calcite geodes, petroliferous	13
13. Limestone, gray, fine-grained, phosphatic	11
12. Limestone, gray, compact, cherty	6
11. Limestone, gray to buff, glauconitic, with scattered calcite geodes and chert nodules, fossiliferous; weathers to a porous, greenish, granular material	17
10. Limestone, gray to buff, cherty, crowded with large calcite geodes; weathers into caves	3
9. Limestone, gray, glauconitic, cherty, fine-grained, compact, fossiliferous	14
8. Chert, nodular, in green shale matrix	15
7. Shale, green, thin-bedded	22
6. Rock phosphate, dark-gray, fossiliferous	1
5. Limestone, shaly, cherty, with geodes, very fossiliferous	15
4. Limestone, shaly, yellow, fossiliferous	4
3. Sandstone, yellow, shaly, calcareous	16
2. Sandstone, red, calcareous	4
1. Limestone, gray, dolomitic, resting unconformably on the Tensleep sandstone	6
Sandstone, gray, fine-grained, cross-bedded (Tensleep sandstone)	
Thickness of Phosphoria formation	147

The phosphate beds of the formation are the most distinctive feature. Usually they are oolitic tricalcium phosphate, but beds of solid tricalcium phosphate and brecciated beds of the same material are found. There are nearly always two main beds, although there are often numerous thin beds. The beds are thickest in southeastern Idaho and in southwestern Montana and the phosphate is purer than that in other localities, in some places containing eighty per cent tricalcium phosphate. The beds become thinner and the quality of the phosphate poorer toward the east. In the Wind River Mountains, Wyoming, the lower bed is less than two feet thick, and the upper bed is rarely more than six inches thick. There are several beds of poor quality in the shales of the upper part of the formation. In the Owl Creek Mountains, only the upper bed is present, and it is thin and of poor quality.

The Phosphoria may be the source of the black oil which is produced in Wyoming, particularly near Lander. The original oil sand was probably one of the Dinwoody sands, and later production has been from the top of the Tensleep. The consensus of opinion is that the source of the petroleum is in the

Phosphoria. In parts of Idaho and Montana, especially in the Dillon and Dell regions, the phosphatic shales contain considerable amounts of petroleum. On Bull Lake, in the Wind River Mountains, Wyoming, there is a chert member near the base of the formation which is highly petroliferous and contains many fossil pelecypods. The top limestone bed of the Phosphoria in the Owl Creek Mountains is nearly saturated with petroleum.

The section of the Phosphoria formation exposed near Bull Lake in the Wind River Mountains, Wyoming, is unusually complete, and most of the members are fossiliferous. Since most of the fossils described in this paper were collected there, the section is given in some detail:

SECTION NEAR BULL LAKE

		Ft.	In.
	Limestone, buff, sandy (bottom of Dinwoody)		
33.	Limestone, gray, carbonaceous	18	
32.	Limestone, gray, massive	1	6
31.	Limestone, gray, massive, very cherty, with many calcite concretions; contains *Aulosteges* fauna	15	6
30.	Limestone, gray, cherty; contains *Hustedia* fauna	7	6
29.	Chert, nodular in green shale matrix; top 1 foot thin-bedded green shale containing *Hustedia* fauna	10	
28.	Shale, brown at base to green at top, cherty near top, limestone beds	67	
27.	Phosphate rock, dark-gray; contains *Pustula nevadensis*, *Leda bellistriata*, *Nucula poposiensis*	1	
26.	Limestone, light-gray, crowded with fragments of *Spiriferina*, *Pugnoides*, and *Chonetes*	2	
25.	Limestone, light-gray, massive, siliceous; contains *Pustula* fauna	3	
24.	Phosphate rock, dark-gray, shaly, thin-bedded, very fossiliferous at base	5	
23.	Shale, blue-gray, thin-bedded, with nodular chert, very fossiliferous	4	
22.	Limestone, gray, dense, siliceous; contains *Pustula* fauna	2	
21.	Limestone, gray, siliceous; contains bryozoa	1	6
20.	Limestone, gray, slightly carbonaceous; contains fossil fragments	7	
19.	Limestone, gray, sandy, cherty, massive	23	6
18.	Limestone, light-yellow, coarse-grained, highly carbonaceous	1	6
17.	Limestone, gray sandy, thin-bedded	15	
16.	Limestone, gray, sandy, compact	10	
15.	Chert, in thin-bedded shale matrix	5	
14.	Shale, sage-gray, sandy, thin-bedded	19	

13.	Limestone, gray, arenaceous	10	
12.	Sandstone, gray, calcareous, carbonaceous	2	
11.	Shale, with limestone and flint layers	9	6
10.	Phosphate, gray, impure, nonfossiliferous	2	3
9.	Shale, sage-gray, cherty, thin-bedded	9	3
8.	Phosphate rock, dense; contains *Orbiculoidea*		7
7.	Limestone, gray, dense, cherty, crystalline	2	2
6.	Phosphate rock, dark, oolitic; contains a bed composed of shells of *Orbiculoidea utahensis*	3	8
5.	Limestone, gray, dense, cherty; contains many bryozoa	17	6
4.	Sandstone, dark-gray, with fossiliferous chert concretions	6	
3.	Sandstone, light-gray, massive	3	2
2.	Limestone, gray, very cherty, massive, stands in vertical cliffs, petroliferous; contains abundant pelecypods	28	4
1.	Sandstone, light-gray, consists of detritus from the Tensleep	2	6
	Sandstone, light-gray, cross-bedded (Tensleep)		
	Thickness of Phosphoria formation	315	11

STRATIGRAPHIC PALEONTOLOGY

The Phosphoria formation exhibits an extensive vertical faunal variation within itself. The variation is attributable in large part to faunal facies, rather than to development with age. The faunas of the phosphate beds are unlike those of the other members because of the peculiar chemical condition of the waters in which the animals lived. The oolitic phosphate beds are of syngenetic origin, for their faunas are typically depauperate. One bed is almost entirely composed of shells of *Orbiculoidea utahensis*, which in life contained a high percentage of phosphorus. In spite of the thinness of the formation, it is certain that the sedimentation occurred over a long period of time. Limestone, chert, and phosphate rock are deposited slowly, and these form the major part of the section. The length of time represented by the formation is also shown by its life, for the base of the formation contains a typically Pennsylvanian life assemblage, which is succeeded by one containing both Pennsylvanian and Permian elements, and then by a true Permian fauna.

The fauna of the phosphatic shales in the western part of the area where the Phosphoria outcrops has been well described by Girty[42]. The following species have been identified by him from this member:

Conularia sp.
Lingula carbonaria (?)
Lingula carbonaria var. exporrecta
Lingulidiscina missouriensis
Lingulidiscina utahensis
Chonetes ostiolatus
Chonetes ostiolatus var. impressus
Chonetes ostiolatus var. minisculus
Productus geniculatus
Productus eucharis

Productus montpelierensis
Productus phosphaticus
Pugnax weeksi
Pugnax weeksi var. nobilis
Pugnax osagensis var. occidentalis
Dielasma (?) sp.
Ambocoelia 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 ferriere
Omphalotrochus conoideus
Naticopsis tayloriana
Soleniscus aff. altonensis
Pseudomelania (?) sp.
Gastrioceras simulator
Gastrioceras (?) sp.
Goniatites (?) sp.
Popanoceras (?) sp.
Hollina emaciata var. occidentalis
Jonesina carbonifera
Cytherella bennei

All of these species were found in the region near the junction of the state lines of Idaho, Utah, and Wyoming. A thin black limestone at the base of the Phosphoria in this region contains the following faunule:

Lingulidiscina sp.
Chonetes ostiolatus
Productus phosphaticus
Pustula aff. P. porrecta
Rhynchopora taylori
Spirifer aff. triplicatus
Composita subtilita

In giving this list, Girty states that *Rhynchopora taylori*, which he formerly included in the fauna of the phosphatic shales, belongs only in this faunule.

The second persistent fauna of the Phosphoria in the western part of its outcrop area is that of the Rex chert member, from which the following species have been identified by Girty[58]:

Amphiporella laminaria
Productus nevadensis
Productus eucharis
Productus multistriatus
Productus subhorridus
Camarophoria n. sp.
Spirifer aff. cameratus
Spiriferina pulchra
Composita subtilitavar.

The writer has collected some additional species from the Rex chert member in the Fort Hall Indian Reservation, Idaho. These species are:

Leda bellistriata
Nucula pulchella
Worthenopsis bicarinata
Naticopsis gracilis

Several collections have been made from the Phosphoria formation in Wyoming, but none of them have been differentiated as to the member of the formation from which they came. The earliest list is that of St. John[71], but the identifications are uncertain. The identifications of the fossils listed by Jamison[47] at a much later date are equally uncertain. His collection came from the Wind River Mountains and his list follows:

Spiriferina pulchra
Spiriferina opimus
Spiriferina cameratus
Productus multistriatus
Productus costatus
Productus semireticulatus
Pleurotomaria sp.
Bellerophon sp.
Aviculipecten occidentalis
Aviculipecten utahensis
Sedgwickia concava
Allorisma ventricosa
Myalina permiana
Seminula argentia
Lingula sp.

Hares collected the following fauna from rocks which Girty calls Phosphoria in the Rattlesnake Mountains[68]:

Phyllopora? sp.
Leioclema n. sp.
Lingulidiscina convexa?
Derbya n. sp.
Dielasma? sp.
Spiriferina pulchra
Composita mexicana
Pinna peracuta
Leda obesa?
Pseudomonotis sublaevis?
Pseudomonotis aff. P. hawni
Myalina deltaidea
Myalina aff. M. perattenuata
Chaenomya? sp.
Schizodus n. sp. aff. S. compressus
Pleurophorus sp.
Bellerophon sp.
Euphemus n. sp. aff. E. subpapillosus

A large collection of Phosphoria fossils from the northern part of the Wind River Mountains, Wyoming, was examined by Girty, who lists the following species[4]:

Foraminifera undet.
Crinoids
Septopora? sp.
Phyllopora n. sp.
Stenopora sp.
Rhombopora sp.
Fenestella sp.
Batostomella sp.
Batostomella n. sp.
Batostomella? sp.
Leioclema n. sp.
Polypora sp.
Lingula aff. carbonaria
Lingulidiscina utahensis
Derbya sp.
Derbya n. sp.
Meekella sp.
Chonetes aff. geinitzianus
Productus nevadensis
Productus subhorridus
Productus cora
Productus multistriatus
Aulosteges n. sp.
Heterelasma? sp.
Pugnax utah
Dielasma? sp.
Dielasmina n. sp.
Spirifer aff. cameratus
Spirifer cameratus var.
Spiriferina pulchra
Spiriferina pulchra?
Composita mexicana
Composita subtilita
Hustedia meekana
Acanthopecten coloradoensis
Aviculopecten coreyanus
Aviculopecten aff. whitei
Aviculopecten sp.
Pseudomonotis n. sp.
Pseudomonotis aff. hawni

Pseudomonotis sp.
Myalina aff. wyomingensis
Myalina sp.
Euchondria neglecta
Solenomya sp.
Pteria sp.
Allerisma terminale?
Allerisma n. sp.
Pleurophorus subcostatus
Pleurophorus? 3 species
Parallelodon sp.
Schizodus? sp.
Astartella sp.
Leda obesa
Plagioglypta canna
Bellerophon aff. crassus
Bellerophon sp.
Bellerophon? sp.
Euphemus? sp.
Patella n. sp.
Patella sp.
Patellostium? sp.
Pleurotomaria sp.
Pleurotomaria sp.
Pseudomelania? sp.
Enchostoma sp.
Nautilus? sp.
Fish remains

No attempt was made to assign these various forms to members.

The writer has found that the fossils of the Phosphoria formation in the Wind River and Owl Creek Mountains can be referred consistently to members of the formation. Some of these faunules are persistent throughout the two ranges; others are generally imbedded in rock from which they can not be collected. All of the various faunules are represented by fossiliferous rocks on Bull Lake, in the Wind River Mountains.

The lowest member which bears a considerable faunule is Bed Number 2 of the section at that locality. The rock is dense limestone, almost entirely replaced by chert. It is crowded with casts of the interior of shells of large pelecypods. This member is referred to for convenience as the Lower Chert member. It is rarely well exposed, and at no other locality is it so fossiliferous. The following forms have been identified from it:

Orbiculoidea utahensis
Plagioglypta canna
Euphemus carbonarius
Edmondia gibbosa
Schizodus concinnus
Schizodus canalis
Deltopecten occidentalis
Allerisma sp.
Pleurophorus pinnaformis

This faunule is evidently a facies which was peculiar to a portion of the sea favorable to large pelecypods. The single brachiopod is very rare, and *Euphemus carbonarius* is not common in this member.

The second faunule is that of Bed Number 6 of the section. It is characterized by great numbers of *Orbiculoidea utahensis* and by an extensive fish fauna. Shells of *Orbiculoidea* form almost the entire mass of some of the beds in this member. The faunule was described by E. B. Branson[13], who lists the following species:

Orbiculoidea utahensis
Plagioglypta canna
Nucula perumbonata
Nucula pulchella
Nucula sp. (N. poposiensis of this paper)
Leda bellistriata
Euphemus carbonarius
Bellerophon bellus
Helodus subpolitus
Helodus rugosus

Pseudomonotis sp.
Myalina aff. wyomingensis
Myalina sp.
Euchondria neglecta
Solenomya sp.
Pteria sp.
Allerisma terminale?
Allerisma n. sp.
Pleurophorus subcostatus
Pleurophorus? 3 species
Parallelodon sp.
Schizodus? sp.
Astartella sp.
Leda obesa
Plagioglypta canna
Bellerophon aff. crassus
Bellerophon sp.
Bellerophon? sp.
Euphemus? sp.
Patella n. sp.
Patella sp.
Patellostium? sp.
Pleurotomaria sp.
Pleurotomaria sp.
Pseudomelania? sp.
Enchostoma sp.
Nautilus? sp.
Fish remains

No attempt was made to assign these various forms to members.

The writer has found that the fossils of the Phosphoria formation in the Wind River and Owl Creek Mountains can be referred consistently to members of the formation. Some of these faunules are persistent throughout the two ranges; others are generally imbedded in rock from which they can not be collected. All of the various faunules are represented by fossiliferous rocks on Bull Lake, in the Wind River Mountains.

The lowest member which bears a considerable faunule is Bed Number 2 of the section at that locality. The rock is dense limestone, almost entirely replaced by chert. It is crowded with casts of the interior of shells of large pelecypods. This member is referred to for convenience as the Lower Chert member. It is rarely well exposed, and at no other locality is it so fossiliferous. The following forms have been identified from it:

Orbiculoidea utahensis
Plagioglypta canna
Euphemus carbonarius
Edmondia gibbosa
Schizodus concinnus
Schizodus canalis
Deltopecten occidentalis
Allerisma sp.
Pleurophorus pinnaformis

This faunule is evidently a facies which was peculiar to a portion of the sea favorable to large pelecypods. The single brachiopod is very rare, and *Euphemus carbonarius* is not common in this member.

The second faunule is that of Bed Number 6 of the section. It is characterized by great numbers of *Orbiculoidea utahensis* and by an extensive fish fauna. Shells of *Orbiculoidea* form almost the entire mass of some of the beds in this member. The faunule was described by E. B. Branson[13], who lists the following species:

Orbiculoidea utahensis
Plagioglypta canna
Nucula perumbonata
Nucula pulchella
Nucula sp. (N. poposiensis of this paper)
Leda bellistriata
Euphemus carbonarius
Bellerophon bellus
Helodus subpolitus
Helodus rugosus

Campodus corrugatus
Ctenacanthus browni
Ctenacanthus obscuracostatus
Ctenacanthus amblyxiphias
Eunemacanthus keytei
Batacanthus gigas
Janassa unguiformis
Janassa unguicula
Janassa angularis
Deltodus mercurii
Cladodus occidentalis

Of these forms, *Orbiculoidea utahensis*, *Plagioglypta canna*, and *Euphemus carbonarius* are found below in the Lower Chert member. *Plagioglypta canna*, *Nucula pulchella*, *Nucula poposiensis*, *Leda bellistriata*, *Helodus subpolitus*, *Janassa unguicula* occur in higher beds. The other species are confined to the Lower Phosphate member, as Bed Number 6 is called.

The rocks between the Lower Phosphate member and Bed Number 25 are generally fossiliferous, but the fossils can rarely be determined. In some of the limestone beds, a large pelecypod, *Allerisma wyomingensis*, is common. Beds Number 22 to 27 inclusive bear an extensive and distinctive faunal assemblage, many of whose species are as wide-spread as the outcrops of Phosphoria. The surface of Bed Number 25 is so crowded with specimens of large Producti that have partially weathered out, that from a distance the rock resembles conglomerate. Specimens of *Pustula nevadensis* predominate, and specimens of *Pustula subhorrida* are second in number. From this fact, the member is named here the "Pustula member", and its faunule is named the "Pustula faunule". The following forms have been identified from the member.

Orthotetes sulcus
Chonetes phosphoriensis
Productus multistriatus
Productus semireticulatus
Productus phosphaticus
Pustula nevadensis
Pustula subhorrida
Pustula montpelierensis
Aulosteges hispidus
Rhynchopora taylori
Pugnoides osagensis
Spirifer pseudocameratus
Squamularia perplexa?
Ambocoelia arcuata
Spiriferina pulchra
Spiriferina kentuckyensis
Hustedia phosphoriensis
Composita subtilita
Composita plana
Composita gigantea
Nucula poposiensis
Nucula pulchella
Nucula montpelierensis
Leda bellistriata
Leda obesa
Plagioglypta canna
Bellerophon depauperata
Pleurotomaria phosphatica
Strophostylus sp.
Helodus subpolitus
Janassa unguicula
Hamatus phosphoriensis

Of these species, *Spiriferina kentuckyensis*, *Hustedia phosphoriensis*, *Nucula poposiensis*, *N. pulchella*, *N. montpelierensis*, *Leda bellistriata*, *Pustula nevadensis*, *Plagioglypta canna*, *Bellerophon depauperata*, *Pleurotomaria phosphatica*, and *Strophostylus* sp. comprise the depauperate fauna of Bed Number 27, an oolitic phosphate. The fish species *Helodus subpolitus*, *Janassa unguicula*, and *Hamatus phosphoriensis* occur with them. In respect to the presence of

fish and the depauperate condition of the fauna, the fauna of this bed is like that of the Lower Phosphate member, but most of the species are different.

The shales overlying the Pustula member are entirely barren of fossils. The thin-bedded shale at the top of Bed Number 29 and the rocks of Bed Number 30 are abundantly fossiliferous. The commonest species is *Hustedia phosphoriensis*, and the member and its faunule are named here the "Hustedia member" and the "Hustedia fanule" respectively. The member is especially rich in bryozoa, which often comprise an important part of the rock. The fossils themselves are preserved in colored chalcedony, and they weather out in abundance. The Hustedia faunule consists of the following species:

?Eocidaris hallianus
Erisocrinus?
Delocrinus?
Stenopora sp.
Leioclema sp.
Batostomella sp. A
Batostomella sp. B
Bryozoan A
Bryozoan B
Fenestella sp.
Orthotetes magnus
Aulosteges hispidus
Dielasma phosphoriensis
Spiriferina pulchra
Spiriferina kentuckyensis
Hustedia phosphoriensis
Composita parva
Myalina sinuata
Aviculipecten alatus
Aviculipecten alternatus

The specimens are difficult to find because they occur in such a restricted thickness of rock and because the amount of chert in the member is often so great that the fossils become completely embedded in it. When the faunule is found, it is distinctive in the extreme. Girty identified the following species from the member in the Owl Creek Mountains[52]:

Stenopora aff. S. carbonaria
Leioclema n. sp.
Leioclema n. sp.
Phyllopora sp.
Derbya multistriata?
Spiriferina pulchra
Deltopecten aff. D. coreyanus
Pseudomonotis? sp.
Schizodus sp.
Plagioglypta canna

Immediately above the Hustedia member is a heavy ledge of gray limestone. This member is omnipresent and forms the dip slopes of many ranges. It is fossiliferous wherever it is found, though the fossils are generally hard to collect. The member is referred to as the "Top Limestone" member and its fauna is called here the "Aulosteges faunule" because of the abundance of *Aulosteges hispidus* in these rocks. The faunule is extremely varied, and many fragments of fossils which are different from those determined show that there are still many forms to be found. The specimens which were identified consist of:

Polypora sp.
Fenestella sp.
Lingulidiscina missouriensis?
Orbiculoidea sp.
Meekella rotunda
Aulosteges hispidus
Dielasma phosphoriensis
Spiriferina pulchra
Composita quadricostata
Solenomya radiata?
Schizodus phosphoriensis
Monopteria sp.
Cyrtorostra varicostata
Cyrtorostra sexradiata

Myalina sinuata?	Pleurotomaria reticulata
Aviculipecten landerensis	Pleurotomaria robusta
Deltopecten vanvleeti	Pleurotomaria sp.
Deltopecten sexradiata	Orthonema sp.
Pleurophorus pricei	Conularia crustula?
Plagioglypta monolineata	Coloceras sp.
Euphemus subpapillosus	Asymptoceras phosphoriensis

Of these species, *Aulosteges hispidus*, *Meekella rotunda*, *Dielasma phosphoriensis*, and *Euphemus subpapillosus* are especially abundant.

AGE AND CORRELATION

In the Wind River and Owl Creek Mountains, Wyoming, the Phosphoria formation lies unconformably upon the Tensleep sandstone, which is Pennsylvanian in age. The time interval represented by the unconformity is of unknown duration, but was of sufficient length to allow disintegration of some feet of the top of the sandstone and to permit erosion of the surface into a topography which at least had reached maturity. The Phosphoria is conformably overlain by the Dinwoody formation. Such fossils as have been found in the Dinwoody are not diagnostic as to age. The Chugwater formation overlies the Dinwoody with possible unconformity. A bed 800 feet above its base establishes the age of that part as Middle or Upper Triassic. Thus, from its stratigraphic position, the Phosphoria formation is limited to a period from late Pennsylvanian to early Triassic.

The fauna of the Lower Chert member is one that is entirely composed of species which occur in the Upper Pennsylvanian of the Mississippi Valley. The faunule of the Lower Phosphate member is established in age by E. B. Branson[13], who says, "The abundance of cochliodont sharks, which have never been reported from strata younger than the Pennsylvanian, indicates an age older than the Permian."

The Pustula faunule of the middle portion of the formation contains *Spiriferina pulchra*, which Girty regards as diagnostically Permian. The Pustula faunule and the faunules of higher members contain *Aulosteges hispidus*. *Aulosteges* is not known from beds older than Permian. The faunule of the Top Limestone member shows a distinct tendency toward the Mesozoic type in the abundance of pelecypods, but no ammonoids occur in it. However, the Pennsylvanian aspect of the lower faunules is missing, for there is no species in the Aulosteges faunule which is of the Pennsylvanian type. In the Pustula member, many common Pennsylvanian forms appear, such as *Spiriferina kentuckyensis*, *Pugnoides osagensis*, *Composita subtilita*, and *Helodus subpolitus*. The Hustedia faunule is also Pennsylvanian in aspect, for its dominant forms are *Composita parva*, which resembles some varieties of *C. subtilita*, *Spiriferina kentuckiensis*, and *Hustedia phosphoriensis*, which is not very different from *H. mormoni*. It seems from the above evidence that the formation through the Lower Phosphate member is late Pennsylvanian in age, and that there is a gradation into beds of Permo-Carboniferous age somewhere between the Lower Phosphate and the Pustula member. There is no indication of a stratigraphic break in the lithology. The Pustula and Hustedia

faunules are Permo-Carboniferous with Pennsylvanian hold-overs, and the Aulosteges faunule is a very different one of distinctly Permian age. From the complete absence of ammonites, however, it must be concluded that the faunule belongs to the lowermost part of the Permian. Here, as in Kansas and Nebraska, is a gradation without a break from Pennsylvanian to Permian.

Boutwell named the Park City formation from a locality in Utah[11]. When the Phosphoria formation was named by Richards and Mansfield, they defined it as equivalent to the upper two of the three main members of the Park City. This correlation is borne out by the following fossils which the two have in common:

Orbiculoidea utahensis	Productus phosphaticus
Pustula montpelierensis	Rhynchopora taylori
Spiriferina pulchra	Composita subtilita
Nucula montpelierensis	Leda obesa
Plagioglypta canna	Euphemus carbonarius
Euphemus subpapillosus	Conularia crustula?

The base of the Phosphoria formation is a more logical division line than that which was defined as the base of the Park City, and the recent tendency is to substitute the name "Phosphoria" for the upper two members of the Park City in all localities. In naming the Phosphoria, Richards and Mansfield placed the lower member of the Park City in the Wells formation[67]. The Wells is not represented in the Wind River and Owl Creek Mountains, Wyoming, but is probably of the age represented by the unconformity on the Tensleep sandstone.

In the Laramie Basin, Wyoming, is a limestone ledge in the midst of red sediments which are usually presumed to be Triassic. This ledge contains the following Permian fauna[28]:

Solenomya n. sp.	Schizodus compressus
Schizodus meekanus	Myalina perattenuata
Deltopecten manzanicus	Deltopecten occidentalis
Deltopecten coreyanus?	Allerisma terminale
Pleurophorus aff. taffi	Plagioglypta canna
Orthonema? sp.	

Nearly all of these forms have closely related species in the Aulosteges faunule of the Phosphoria in the Wind River Mountains. It seems probable that the two limestones are very nearly of the same age. The above limestone is the Forelle limestone, and below it is a red shale, the Satanka, which is non-fossiliferous, but which should be a correlative of the Phosphoria, for the top of the underlying Casper formation bears a fauna which may be as young as Lower Permian. The upper part of the Casper is probably equivalent to the lower and middle parts of the Phosporia.

N. H. Darton named the Embar formation from a section on the South Fork of Owl Creek in the Owl Creek Mountains, Wyoming. The Embar is divisible into the Phosphoria and Dinwoody formations, and these names have superseded the name "Embar". Where the Phosphoria and Dinwoody can not be differentiated, the name "Embar" still is used. This is usually the case when the rocks are encountered in the drilling of oil wells.

The "Teton formation" of Yellowstone Park is a group which includes

sediments equivalent to the Phosphoria and Dinwoody, and to the Chugwater in part[6,20].

The fauna of the Manzano group of New Mexico is very similar to that of the Phosphoria. The two formations have the following species in common.

Squamularia perplexa	Composita subtilita
Edmondia gibbosa	Leda obesa
Deltopecten vanvleeti	Plagioglypta canna
Euphemus subpapillosus	Cytherella bennei

Besides these species, the Manzano has a variety of *Pugnoides osagensis*, a *Coloceras* similar to one in the Phosphoria, a distorted *Meekella*, and a species of *Orthonema*. The general appearance of the two faunas is strikingly similar. The correlation of the two formations seems to be well founded.

The Phosphoria has a correlative in eastern Nevada whose presence is indicated by the following fossils, all of which occur in the Phosphoria:

Pustula nevadensis	Pustula subhorrida
Productus multistriatus	Composita mira
Spiriferina pulchra	Spiriferina kentuckiensis

These fossils were collected by the geologists of the United States Geological Exploration of the Fortieth Parallel, and their locality is known to be in White Pine County, Nevada.

The Guadalupian rocks of Texas and New Mexico have a fauna which is similar to that of the Phosphoria in its general aspect. Only two species are common to both faunas, however, and it is probable that the two formations are of about the same age, but that the Guadalupian had a southern connection with the sea and the Phosphoria a northern one.

The Lyons and Lykins formations of Colorado lie between the Fountain sandstone (Pennsylvanian) and the "red beds" which are continuous with the Chugwater of Wyoming. A correlation of the Phosphoria with these will be established later, in all probability. Correlations have been suggested with the Upper Aubrey and with the Kaibab of the Grand Canyon region, but have little evidence to support them.

The relationships of the Phosphoria to foreign rocks are well established in some instances. The faunule of the Lower Phosphate member is tied up with the Moscovian of Russia by the occurrence of *Crassidonta stuckenbergi* and *Cladodus occidentalis*[13]. Girty is convinced that the fauna of the phosphatic shales of the Phosphoria formation is closely related to the highest Pennsylvanian beds of Alaska, which he believed to be Gschelian in age. However, on the authority of Holtedahl, he now refers these beds to the Artinskian, or basal Permian[58].

It is believed that the Phosphoria sedimentation occurred at about the same time as that of the Productus limestone of the Salt Range, India. Although no comparison of species was made, both faunas are made up of about the same types. Both contain a fauna largely composed of pelecypods and brachiopods, and the pelecypods of both are in large part of the same genera; the most prominent are *Pleurophorus*, *Schizodus*, *Aviculipecten*, and *Deltopecten*. Among the brachiopods, the two faunas are similar in their abundant species of *Productus*, *Orthotetes*, and *Spiriferina*. Bellerophon type gastro-

pods and Bradyodont sharks are common in each. In a broad way, the two formations can be correlated.

The Permian of Timor is quite different from the Phosphoria. Beyond resemblances between *Productus* (*Pustula*) *waageni* and *Retzia* (*Hustedia*) *radialis* of that fauna and *Pustula nevadensis* and *Hustedia phosphoriensis* of the Phosphoria, the two are very unlike.

Correlations that seem to be well established are with the Manzano of New Mexico and with the Forelle of the Laramie Basin in southeastern Wyoming. The sharks of the Lower Phosphate faunule are like those of the Moscovian of Russia, and the higher faunules of the Phosphoria are related to the Artinskian of Alaska and of Russia. The Phosphoria apparently is a correlative with at least part of the Productus limestone of the Salt Range, India.

PALEOGEOGRAPHY

The Phosphoria sea certainly covered all of western Wyoming, southwestern Montana, southeastern Idaho, northeastern Utah, and part of Moffat County, Colorado. Deposits in White Pine County, Nevada, were probably laid down in the same sea, as the fossils from those beds are Phosphoria species. An arm of the sea evidently reached to the Laramie Basin, Wyoming, where the Forelle limestone was laid down. The connection with the area of the Manzano group in New Mexico is uncertain, but the faunas are different enough to have been deposited in different arms of the sea.

The thickest deposits of Phosphoria time are in northeastern Utah and southeastern Idaho, and there the sea was probably deepest and remained longest. The sea covered that area continuously from Mississippian time into the Triassic, except for minor possible breaks between the Wells and the Phosphoria, and between the Phosphoria and the Woodside. In central Wyoming, however, there is a distinct unconformity at the top of the Tensleep sandstone. This break probably represents Upper Wells time. Such a hypothesis agrees well with the greater thickness of the Phosphoria in the western area.

The manner in which the sediments thin to the west is obscured by a covering of later beds. The formation pinches out to the east and to the northeast, and the source of sediments for at least part of the sea is believed to be in those directions. The land was evidently low-lying, for there are no coarse sediments, but the phosphate beds contain much more foreign material near these shores. The area now occupied by the southern end of the Bighorn Mountains has no Phosphoria or Dinwoody, and the writer interprets the facts to mean that this area began to rise slowly after Tensleep time. The area was low during the time of the deposition of the Phosphoria, but after the deposition of the Top Limestone member of that formation, it attained sufficient elevation to furnish the sands of the Dinwoody formation in the Owl Creek and Bighorn Mountains.

The connection of the Phosphoria sea with the main ocean seems to have been to the northwest. If the phosphate-bearing rocks of Alberta are Phosphoria in age, they were evidently deposited in the connecting trough. The alliance of the Phosphoria fauna with the Artinskian fauna of Alaska indicates

an outlet in that direction. The further connection with Russia seems to have been direct.

SYSTEMATIC PALEONTOLOGY

Phylum ECHINODERMATA
Sub-phylum ELEUTHEROZOA
Class ECHINOIDEA
Family ARCHEOCIDARIDAE

Eocidaris hallianus ? Geinitz

A spine and a plate bearing a spine base are the only representatives of this type found. The spine is evenly striated longitudinally and the plate is of a shape and size that is like *E. hallianus*. The imperfection of the material prevents positive identification.

Horizon and *locality*:—Hustedia member: Wind River Mountains, Wyoming.

Sub-phylum PELMATOZOA
Class CRINOIDEA

Plate I, figures 1-5

Crinoid stems are abundant in the Pustula and Hustedia members of the Phosphoria formation. The only calyx found consists of the basal and radial plates of an individual from the Hustedia member near Bull Lake, Wyoming. It seems to be covered by a calcareous secretion so that the sutures between the plates are not visible. The specimen is 4 mm. in diameter across the top of the radials, and 2 mm. across the stem socket. It is possibly an *Erisocrinus*.

Some plates in the collection are very like the radials of *Ceriocrinus*. They are slotted on each of their five sides, and on the upper side bear knobs at each end of a transverse slit.

One of the columnals is pentagonal; it is about 3 mm. in diameter. All of the other ossicles are about 6mm. in diameter and are marked by thirty or forty ridges radiating from the center. The ridges are notched in the central part of the ossicle and divide near the edge.

Horizon and locality:—Pustula and Hustedia members: Wind River and Owl Creek Mountains, Wyoming.

Phylum MOLLUSCOIDEA
Class BRYOZOA

Plate I, figures 6-13.

On account of the difficulcies arising from lack of literature, no attempt is made to describe the Bryozoa in detail. Most of the forms are probably new species.

A large, ramose *Stenopora* is common in the Hustedia member in the Owl Creek Mountains. Associated with it is a smaller ramose bryozoan which may be a *Batostomella*.

The Hustedia member near Bull Lake in the Wind River Mountains contains the following forms:

Bryozoan A: a moderately large, ramose type with slight amalgamation of the zoecial walls, numerous large mesopores, and no diaphragms or acanthopores.

Bryozoan B: a very small ramose form with amalgamating zoecial walls, polygonal zoecial apertures, and small mesopores.

Leioclema sp.: an incrusting form on crinoid ossicles and brachiopods; has a very irregular surface.

Batostomella sp.: a very large, massive, ramose type.

The Hustedia and Top Limestone members of the Wind River and Owl Creek Mountains contain a *Fenestella*, and the Top Limestone member of the Wind River Mountains contains a species of *Polypora*.

Class BRACHIOPODA
Order NEOTREMATA
Superfamily DISCINACEA
Family TREMATIDAE
Genus LINGULIDISCINA Whitfield

Lingulidiscina missouriensis ? Shumard

Plate II, figures 2-3

Only two specimens of this type were found by the writer. The general shape of the shell approaches that of a right cone, and the surface is covered with fine concentric markings. Girty has described *L. missouriensis* from the phosphate beds in the Crawford Mountains, the Sublette Range, and at Thoma Fork, Wyoming, at Montpelier, Idaho, and on Woodruff Creek, Utah.

Horizon and locality:—Top Limestone member: Wind River and Owl Creek Mountains, Wyoming.

Family DISCINIDAE
Genus ORBICULOIDEA D'Orbigny

Orbiculoidea utahensis (Meek)

Plate II, figures 8-11.

1877. *Discina* sp. undet. Meek, U. S. Geol. Expl. 40th Par., 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., vol. 4, p. 9 (footnote), p. 99.

1910. *Lingulidiscina utahensis* Girty, U. S. Geol. Survey Bull. 436, pp. 24-25, pl. 1, fig. 11.
Phosphate beds of the Park City formation: Weber Canyon, Utah.

1911. *Lingulidiscina utahensis?* Woodruff, U. S. Geol. Survey Bull. 452, p. 13.
Embar formation: near Lander, Wyoming.

1913. *Lingulidiscina utahensis* Blackwelder, Am. Jour. Sci., 4th ser., vol. 36, p. 178.
Embar formation: Wind River Mountains, Wyoming.

1916. *Orbiculoidea utahensis* Branson, Jour. Geol., vol. 24, p. 657, pl. 3, figs. 22-25.
Embar formation: Wind River Mountains, Wyoming.

This species is very abundant in the Lower Phosphate member and also occurs in the Lower Chert member. Shells of this species alone make up practically the entire mass of some of the beds of the Lower Phosphate member. Nearly all of the specimens preserved are pedicle valves, but two brachial valves were found. The brachial valve is shaped like a low cone, and its surface is marked by fine concentric striae and growth lines. Its characteristics are those of *Orbiculoidea* and not those of *Lingulidiscina*, to which genus the species has been often referred[42].

Horizon and Locality:—Lower Chert and Lower Phosphate members: Wind River Mountains, Wyoming; phosphate beds: Weber Canyon, Utah.

Orbiculoidea sp.

Plate II, figures 6-7.

Two specimens of an *Orbiculoidea* seem to be distinct from previously described species. They are about 6 mm. in diameter and appear to be opposite valves. The apex is close to the edge of the shell and is quite prominent. The surface of the shell is marked by fine concentric striae, about nine or ten in number. From the specimens at hand, the shells seem to be different from *O. utahensis* (Meek), but until more specimens are obtained this can not be told with certainty.

Horizon and locality:—Top Limestone member: Wind River and Owl Creek Mountains, Wyoming.

Order PROTREMATA
Superfamily STROPHOMENACEA
Family STROPHOMENIDAE
Subfamily ORTHOTETINAE
Genus ORTHOTETES Fischer de Waldheim

Orthotetes magnus C. Branson, n. sp.

Plate IV, figures 1-5.

Shell very large, asymmetrical, moderately convex, outline roughly circular. Pedicle valve pointed at the beak, which is strongly curved over the area; margin irregular, broadly rounded; surface marked by sharp, wavy striae three to the millimeter, which increase in number by intercalation, and by heavy, irregular costae. The latter join where crossed by growth lines and separate between them, giving the shell a pitted appearance. There are twelve or more costae near the front margin and fewer posteriorly, the umbo being almost free of them. The beak in one specimen stands above the plane of the valve, and the cardinal area rises perpendicularly, interrupting the shape of the valve like the chord of a circle.

The cardinal area is very large, being 20 mm. high and at least 40 mm. wide in a specimen not much over 50 mm. long. The deltidium is narrow at the beak and widens to the hinge, where it is over 15 mm. wide. The area is marked by fine striae parallel to the deltidium, and by a few less distinct lines in the opposite direction.

The pedicle valve has a median septum which occupies two-thirds of the length of the shell. It is pointed at the beak, but attains height rapidly, so that 20 mm. in front of the hinge it is almost 20 mm. high, and it is rising at an angle of about sixty-five degrees. On each side of the deltidium is a strong dental plate bearing a tooth 5 mm. long, which fits into a socket on the brachial valve.

The brachial valve is sub-circular in outline, and is marked by essentially the same type of striae and costae as the pedicle valve. In one specimen, however, the costae are not so continuous as those of the pedicle valve, and are made very knobby where crossed by the growth lines. The beak turns well over to the hinge-line, which is 80 mm. long in a large specimen. The shell at the umbo is thick and supports a broad platform from which the crura extend in a wide curve a distance of 15 mm. to the middle of the umbo of the pedicle valve. The crura are 5 mm. wide from front to back, and are 4 mm. thick. They diverge gradually on the platform, leaving a deep median groove, and then extend upward and separate until they are 10 mm. apart at their extremities. They pass on either side of the median septum where it is 8 mm. high. Each of the crura bears a deep slot on its posterior side. The platform on which the crura rest is 45 mm. wide and 17 mm. long. On the platform, and parallel to the crura on each side, are ridges which extend from opposite the place of origin of the crura to pointed extensions of the platform opposite the points where the crura turn toward the pedicle valve. The hinge bears a socket on each side of the beak to receive the teeth of the opposite valve.

The length of the largest pedicle valve is 120 mm., the width 80 mm., and the height 50 mm. The smallest pedicle valve is 60 mm. long and 50 mm. wide. The best specimen of a brachial valve is 90 mm. long, 90 mm. wide, and 50 mm. high.

All of the specimens are preserved as chert concretions, and the internal structures were brought out by removing the matrix with acid. The irregular costae, the arrangement of the striae, and the size of the shell distinguish this species. There is no similar member of the genus.

Horizon and locality:—Hustedia member: near Cody, Wyoming, and Owl Creek Mountains, Wyoming.

Orthotetes sulcus C. Branson, n. sp.

Plate II, figure 20; Plate III, figures 1-4.

Shell large, concavo-convex, sub-circular in outline; surface of both valves marked near the beak by about fifty radial striae, which increase in number by intercalation anteriorly, each new striation originating as a small rib and increasing in size gradually until it is equal in size to the original striae. The intercalation of the new striae gives the middle portion of the shell a pattern of alternating large and small striae, but at the front margin, all the striations, numbering about three hundred, are the same size. The intercalation takes place entirely in the umbonal region. Both valves also bear fine lines of growth and two or three concentric undulations.

The brachial valve is most convex just in front of the umbo; the convexity amounts to about 10 mm. A well-developed sinus lies near the beak and ex-

tends to the front margin. The sinus is bounded by broad, rounded, but rather high undulations. The hinge-line is nearly as long as the valve is wide, but the greatest width of the valve is slightly farther forward. The posterior part of the valve is sharply bent over to meet the pedicle valve.

The pedicle valve is distinctly concave. A low fold divides the concavity into two shallow, cup-like depressions. A shallow groove leads from each depression to the anterior margin. The concavity of the valve in one specimen amounts to 5 mm. The umbo turns up sharply posteriorly, so that the posterior part of the valve resembles half of a low cone. The cardinal area is rather low and extends the length of the hinge. It slopes slightly posteriad near its tip. The concavity of the pedicle valve affects the shape so that the plane of the valves is seen as a flat surface in lateral view, and the umbo, umbonal slope, and cardinal area stand above this plane. The deltidium is prominent, triangular, higher than wide; the only well preserved specimen is 7 mm. high and 6 mm. wide at the base. The pedicle valve bears a strong median septum which extends nearly half way to the front margin.

The specimens vary in length from 20 mm. to 80 mm. An average specimen is about 60 mm. long, 70 mm. wide, and 25 mm. thick.

The species is distinguished by the concavity of the pedicle valve, by the prominent sinus of the brachial valve, and by its rather large size. *O. crassa* (Meek and Hayden), a somewhat similar form, possesses neither a concave pedicle valve nor a sinus. The specific name refers to the sinus and to the concave condition of the pedicle valve.

Horizon and locality:—Pustula member: Wind River Mountains, Wyoming.

Genus MEEKELLA White and St. John

Meekella rotunda C. Branson, n. sp.

Plate V, figures 1-6; Plate VII, figures 1-7.

Shell rather large, distorted, gibbous. Ventral valve sharply pointed at the beak, expanding to an evenly rounded anterior margin; hinge about two-thirds as long as the greatest width of the shell, which is near the anterior margin. Cardinal area usually not much more than half as high as the width. In an average specimen the width of the area is about 23 mm., the height 14 mm. The deltidium is narrow at the beak, wide at the hinge, occupying about one-fourth to one-third the width of the area. The area on either side of the deltidium is marked by about ten fine, wavy lines parallel to the deltidium. The area and beak are often greatly twisted, and the shape of the shell, usually knob-like, is sometimes spatulate and the area lies almost in the plane of the valve. The pedicle valve has a strong median septum, which extends two-thirds of the distance to the front margin. A pair of dental plates originate on either side of the septum near its origin and diverge at right angles. They extend nearly to the lateral margins of the shell about a third of the way to the front of the shell.

The dorsal valve is nearly circular in outline, strongly convex in the umbonal region, truncated across the posterior one-fourth by the hinge. The margin is regular except where it curves up to meet the ends of the hinge. A weak median septum extends about a third of the way to the front margin of the brachial valve. The crural plates are strong and support the brachidia upon shoulders on their sides.

The surface of both valves is irregular, and is marked by fine, rounded plications and by concentric growth lines. The plications alternate in size and increase in number by intercalation at each growth line. Bifurcation occurs in rare instances. The plications are two to the millimeter on the umbo, three to the millimeter near the front margin. They are closely spaced and separated only by narrow grooves.

The smallest specimen in the collection is 27 mm. long, 25 mm. wide, and 12 mm. thick. The average size is 45 mm. long, 42 mm. wide, and 27 mm. thick. No specimen greatly exceeds the average in size.

M. rotunda is easily distinguishable from other *Meekellas* because of its lack of the large costae which all other American species possess. It closely resembles *M. amsdenensis* Branson of the Amsden Mississippian, but has more plications, a wider deltidium, and is much larger.

Horizon and locality:—Top Limestone member: Wind River and Owl Creek Mountains and Cody, Wyoming.

Family PRODUCTIDAE
Subfamily CHONETINAE
Genus CHONETES Fischer

Chonetes phosphoriensis C. Branson, n. sp.

Plate V, figures 8-11.

Just below the phosphate bed which forms the top of the Pustula member in the Wind River Mountains, is a thin bed of limestone crowded with shell fragments of a *Chonetes*. A few fairly good specimens were obtained. They are quite variable in several characteristics, notably in the shape of the sinus and ears.

Shell small, semicircular, only slightly convex, widest near the hinge, wider than long; hinge with six or seven spines directed posteriorly; sinus shallow, with flat bottom, bounded by broad, low ridges; beak low, distinct, extending a short distance past the hinge; surface of valve marked by fine radial striae, few posteriorly, but many introduced by intercalation near the front, so that there are about seventy-five at the front margin. The slope to the front margin is moderate to abrupt. Growth lines are few. The ears are small; often not apparent. The interior of the pedicle valve bears a strong median septum, and is marked by fine radial striae. The brachial valve is nearly flat. Its interior is spinose; the spines flat and radially arranged.

From the specimens at hand, it seems apparent that the type is new. *C. verneuilianus* is similar, but has a V-shaped sinus, fewer striae, and a more prominent beak. *C. mucronatus* differs in the greater extension of its ears and in the greater depth of its sinus.

Horizon and locality:—Pustula member: Wind River Mountains, Wyoming.

Subfamily PRODUCTINAE

Genus PRODUCTUS Sowerby

Productus multistriatus Meek

Plate VII, figures 11-12

1860. *Productus multistriatus* Meek, Proc. Acad. Nat. Sci. Phil., p. 309.
Upper Carboniferous: Long Valley, Nevada.

1876. *Productus multistriatus* Meek, Simpson's Expl. Gt. Basin, Utah, p. 350, pl. 1, figs. 8a-b.
Yellow L. S. (U. Carb.?): Long Valley, Nevada.

1876. *Productus multistriatus* White, Powell's Rept. Geol. Uinta Mts., p. 90.
Lower Aubrey Group: Grand and Green Rivers, Utah.

1877. *Productus multistriatus* Meek, U. S. Geol. Expl. 40th Par., vol. 4, p. 76, pl. 8, figs. 3-3e.
Carboniferous: East-central Nevada.

1920. *Productus multistriatus* Girty, U. S. Geol. Survey Prof. Paper 111, pl. 56, figs. 7-7a.
Carboniferous: Nevada.

This species is common in the Pustula member. It is distinguished by its width and by its vaulted ears. The surface of the shell is marked by radial striae, about two to the millimeter. An average specimen is 40 mm. long, 40 mm. wide, and 20 mm. high.

Horizon and locality:—Pustula member: Wind River and Owl Creek Mountains, Wyoming.

Productus phosphaticus Girty

Plate VII, figures 8-9.

1910. *Productus phosphaticus* Girty, U. S. Geol. Survey Bull. 436, pp. 29-30, pl. 2, figs. 7-9.
Phosphate beds of the Park City formation: Montpelier, Idaho.

Several specimens were found and described by Girty from a locality at Montpelier, Idaho. A single specimen was found in the Wind River Mountains. It is typical in all respects.

Horizon and locality:—Pustula member: Wind River Mountains, Wyoming.

Productus semireticulatus (Martin)

Plate VII, figures 13-14.

1900. *Productus semireticulatus* Beede, Kansas Geol. Survey, vol. 6, pp. 78-79, pl. 10, figs. 2-2d. Synonomy.
Upper Carboniferous: Kansas.

The single specimen found undoubtedly belongs to the *P. semireticulatus* group, although its plications are finer and its hinge-line shorter than the average.

Horizon and locality:—Pustula member: Owl Creek Mountains, Wyoming.

Genus PUSTULA Thomas

Pustula nevadensis (Meek)

Plate VIII, figures 1-8.

1877. *Productus nevadensis* Meek, U. S. Geol. Expl. 40th Par., vol 4, p. 64, pl. 8, figs. 2-2a.
Carboniferous: Nevada.

1920. *Pustula nevadensis* Girty, U. S. Geol. Survey Prof. 111, pl. 56, fig. 3.
Carboniferous: Nevada.

Pustula nevadensis is the most common fossil in the Pustula member of the Phosphoria formation in the Wind River and Owl Creek Mountains. The species is characterized by an essentially flat brachial valve, and a pedicle valve with a deep sinus and strong concentric markings.

The shell is very thick in the middle portion of the pedicle valve; the outline approaches circularity; the beak turns over sharply and extends 5 mm. past the hinge-line. The valve bears well developed ears, 9 mm. long in a shell 35 mm. long. An average specimen is 60 mm. long, 55 mm. wide, and 30 mm. thick.

The surface of the shell is very spinose. The spines on the ears and near them are longer and slenderer than those on the umbo. The former are about 0.2 mm. thick and are well over 4 mm. long. The spines on the umbo are short and thick.

The hinge of the pedicle valve bears sixteen knoblike projections, unevenly spaced and irregular in size and shape. These fit into sockets along the hinge of the brachial valve.

The species most nearly resembling *P. nevadensis* is *P. punctata* (Martin), but the deep sinus, the more irregular and larger concentric markings, and the cardinal process of *P. nevadensis* serve to distinguish them. The cardinal process of *P. nevadensis* presents a bifid appearance from the dorsal side, the three terminal lobes are close together, there is a very short and shallow median groove on the ventral side, and there is very little sign of a spatulate appearance of the posterior portion of the median lobe. The cardinal process of *P. punctata* is distinctly trifid from both aspects, the three terminal lobes diverge at right angles, the median groove on the ventral side is long and deep, and the posterior termination of the median lobe is spoon-shaped. The muscle scars of the brachial valve are similar in the two species, but those of *P. nevadensis* are more nearly circular and are less prominent.

Horizon and locality:—Pustula member: Wind River and Owl Creek Mountains, Wyoming.

Pustula montpelierensis Girty

Plate VII, figures 15-17.

1910. *Productus montpelierensis* Girty, U. S. Geol. Survey Bull. 436, p. 30, pl. 2, figs. 5-6.
Phosphate beds of the Park City formation: Montpelier, Idaho.

1927. *Pustula montpelierensis* Girty, U. S. Geol. Survey Prof. Paper 152, pl. 28, figs. 12-23.
Phosphate beds of the Park City formation: Montpelier, Idaho.

This species is rare; except for Girty's locality, it is found only in the Wind River Mountains, Wyoming. The specimens found are all perfectly typical.

Horizon and locality:—Pustula member: Wind River Mountains, Wyoming; phosphate beds: Montpelier, Idaho.

Pustula subhorrida (Meek)

Plate VIII, figures 9-11.

1877. *Productus subhorridus* Meek, U. S. Geol. Expl. 40th Par., vol. 4, p. 75, pl. 7, figs. 3-3b.
Carboniferous: Wasatch Mountains.

1920. *Pustula subhorrida* Girty, U. S. Geol. Survey Prof. Paper 111, pl. 56, figs. 1-2.
Undesignated locality in the Great Basin.

This species is one of the more common types in the Pustula member. The shells, however, depart slightly from Meek's type; the sinus is variable, deep in some specimens, shallow or absent in others. The cardinal process is short and trilobate. It bears a node at the base of the apophysis.

Horizon and locality:—Pustula member: Wind River and Owl Creek Mountains, Wyoming.

Subfamily STROPHOLOSINAE
Genus AULOSTEGES Helmerson

Aulosteges hispidus Girty

Plate IV, figures 6-8; Plate VI, figures 1-5.

1920. *Aulosteges hispidus* Girty, U. S. Geol. Survey Prof. Paper 111, p. 644, pl. 56, figs. 8-8b.
Permian: Weber Canyon, Wasatch Range, Utah.

A. hispidus is the most common species in the Top Limestone member of the Phosphoria formation in central Wyoming. Since the specific description is based upon rather scanty material, it is emended here where it seems necessary.

"Shell rather large, ovate, expanding from an almost pointed posterior to a broadly rounded anterior, the outline but little interrupted by the projection of the small depressed ears. The largest specimens observed are about 40 mm. long. The width is variable, but always distinctly less than the length. The convexity of the ventral valve is moderate." In some of the writer's specimens, the convexity is great, often as much as half the length. The specimens from the Wind River Mountains show a tendency for one side of the shell to be longer than the other, thus giving it an asymmetrical outline.

"The convexity is rather high transversely, and more shallow lengthwise. The sides and front are apt to descend strongly, but the slope backward to the umbo is apt to be gradual. The auricles are small and indistinct. The cardinal area is low; it lies about in the plane of the shell edges."

The area is 6 to 8 mm. wide and not quite 4 mm. high. Some of the specimens show wrinkles on the cardinal area, six or eight of them parallel to the hinge-line and three on each side of the deltidium perpendicular to the hinge-line. One of the specimens exhibits very fine striae on the area parallel to the hinge-line. These were probably present on all shells, but are usually not preserved. The striae number twenty-five to the millimeter. The deltidium is narrow at the hinge, but widens toward the middle of the area.

"The dorsal valve is nearly flat, of an ovate shape with a small terminal beak." One specimen at hand is heartshaped and is 30 mm. long and 30 mm. wide. Another is 30 mm. long, but is only 20 mm. wide. The exterior of the valve is marked by fine radiating striae, and by heavy concentric growth lines which are crossed by the striae. The interior is similarly marked. The brachial valve conforms to the shape of the pedicle valve rather closely and leaves only a small living chamber. Some of the specimens show a distinct median septum, which extends about two-thirds of the way to the front margin. Paralleling the border of the shell and reaching about half way to the front margin are a pair of dental ridges.

"The surface of the ventral valve is marked by very fine, wavy, radia[1] lirae, as in some varieties of *Productus cora*. There are also numerous stout spines which appear to be differently arranged in different specimens. Commonly there appears to be a broad spinose belt passing around the shell well to the front, in which the spines are large and closely-set. In several of the specimens the shell in front of this belt is almost without spines and is marked only by the fine, sharp, wavy lirae." In our specimens the spines extend to the front. The spines are hardly to be called stout, but are slender and long, some of those measured attaining a length of 3 mm. "In several specimens again the surface back of the spinose band appears to be almost without spines, or to have the spines smaller than on the band itself." This is true of all the Wyoming specimens.

Aulosteges is a typical Permian genus, but the use of the name is somewhat confused. *Aulosteges* has no standing as a generic name, for the genotype, *A. wangenheimi*, is a *Strophalosia*. The name *Aulosteges* has come to be since used for a different type of shell, the productiform type with a high cardinal area, which is typical of the Permian. The name *Strophalosia* has been used as a synonym for *Aulosteges* in some cases, but the typical *Strophalosia* is an attached parasitic form closely related to *Productella*. The genus *Strophalosia* should be redefined and a new name should be given to the *Aulosteges* type as now used.

Horizon and locality:—Top Limestone member: Wind River and Owl Creek Mountains, Cody, Wyoming.

Order TELOTREMATA
Superfamily RHYNCHONELLACEA
Family RHYNCHONELLIDAE
Subfamily RHYNCHONELLINAE
Genus RHYNCHOPORA King

Rhynchopora taylori Girty

Plate II, figures 17-19; Plate III, figures 5-9.

1910. *Rhynchopora taylori* Girty, U. S. Geol. Survey Bull. 436, p. 34, pl. 3, fig. 8.

Phosphate beds of the Park City formation: Montpelier, Idaho.

The Pustula member is the only part of the formation in which this form is found in central Wyoming. The specimens from that region agree well with the one specimen on which the description is based. In most specimens, however, there are but five plications on the fold and in the sinus. A considerable variation occurs, and an extra plication sometimes appears on the fold.

Sections show the median septum forked posteriorly, becoming a single wall, and extending half way to the front margin. The teeth are supported by dental lamellae which lie rather close to the sides of the pedicle valve, and which are only about one-fifth as long as the shell. There is no cardinal process, and the hinge-plate is divided medially. The entire surface is punctate.

Horizon and locality:—Pustula member: Wind River and Owl Creek Mountains, Wyoming; basal black shale: Montpelier, Idaho.

Genus PUGNOIDES Weller

Pugnoides osagensis (Swallow)

Plate III, figures 10-11.

1915. *Pugnax osagensis* Girty, U. S. Geol. Survey Bull. 544, pp. 81-83, pl. 10, figs. 11-11c. Synonomy to 1915.

Wewoka formation: Oklahoma.

1920. *Pugnoides osagensis* Girty, U. S. Geol. Survey Prof. Paper 111, pl.54, figs. 17-17a.

Pennsylvanian: Utah.

This is a rare species in the Phosphoria. It occurs only in the Pustula member. One of the specimens is not typical in that it is longer and less gibbous than the average. Others have only two plications on the fold; a characteristic which is like specimens of *P. osagensis* var. *occidentalis* Girty from the Phosphoria formation in Idaho. In all other respects the specimens are typical of Swallow's species, and because of the association the variation is here considered as conspecific.

Superfamily TEREBRATULACEA
Family TEREBRATULIDAE
Subfamily DIELASMATINAE
Genus DIELASMA King

Dielasma phosphoriensis C. Branson, n. sp.

Plate II, figures 21-25.

Shell terebratuloid, longer than wide, moderately convex, greatest width near middle. Brachial valve subcircular, slightly beaked, with low fold near the front margin; cardinal process grooved on outer surface, bifid anteriorly, strongly developed; the short median septum extends anteriorly from the notch of the cardinal process. Pedicle valve extended posteriorly, overhangs brachial valve; beak greatly produced and bent past the beak of the brachial valve; foramen circular, small, situated in the termination of the beak; a broad, shallow sinus is developed near the anterior margin; median septum extends slightly more than half the length of the valve; short dental plates diverge from the median septum in the beak of the valve.

The surface of both valves is marked by fine growth lines and by a few concentric undulations. The relation of width to length is rather variable. One specimen is 13 mm. long and 11.5 mm. wide. There is a gradation in the direction of slenderness to the maximum, which is 16 mm. long and 12 mm. wide. The average specimen is about 15 mm. long and 12 mm. wide. Immature specimens, one only 5 mm. long, have been found.

D. spatulatum Girty is very similar, but differs in lacking a fold and in being widest near the anterior margin. A single specimen from the Pustula member seems to be *D. bovidens* Morton, but is too fragmentary for positive identification.

Horizon and locality:—Top Limestone member: Wind River and Owl Creek Mountains, Wyoming; Hustedia member: Owl Creek Mountains, Wyoming.

Superfamily SPIRIFERACEA
Family SPIRIFERIDAE
Subfamily SPIRIFERINAE
Genus SPIRIFER Sowerby

Spirifer pseudocameratus Girty

Plate VI, figures 6-8.

1877. *Spirifer cameratus*? Meek, U. S. Geol. Expl. 40th Par., vol. 4, pp. 91-92, pl. 9, figs. 2-2a.
Carboniferous: White Pine District, Nevada.

1920. *Spirifer pseudocameratus* Girty, U. S. Geol. Survey Prof. Paper 111, pp. 644-645, pl. 56, figs. 10-15.
Permian: Utah.

S. pseudocameratus is a remarkably variable species in regard to shape; specimens from the same bed range from individuals with almost square outlines to some having greatly extended hinges. The species is very abundant in the Pustula member in the Wind River and Owl Creek Mountains, and it occurs in the Rex chert member in Utah and Idaho. The specimens from Wyoming differ in one respect from Girty's description. The groove dividing the fold into two parts, which is found more or less developed in the types, is, in the Wyoming specimens, either poorly developed or even replaced by a plication.

Horizon and locality:—Pustula member: Wind River and Owl Creek Mountains, Wyoming; Rex chert member: Utah and Idaho.

Subfamily RETICULARINAE
Genus SQUAMULARIA Gemmellaro

Squamularia perplexa ? (McChesney)

Plate III, figures 12-13.

A single specimen resembles this species, but is imperfect. If the specimen belongs to the species, it is not typical, for the surface bears prominent concentric undulations, and the pedicle valve only slightly exceeds the brachial valve in convexity.

Horizon and locality:—Pustula member: Wind River Mountains, Wyoming.

Subfamily MARTINIIDAE
Genus AMBOCOELIA Hall

Ambocoelia arcuata Girty

Plate II, figures 12-14.

1910. *Ambocoelia arcuata* Girty, U. S. Geol. Survey Bull. 436, p. 35, pl. 6, figs. 15-17.
Phosphate beds of the Park City formation: Sublette Range and Thomas Fork, Wyoming; Montpelier, Idaho.

This species is rather abundant in western Wyoming and at Montpelier, Idaho. It is rarely found in central Wyoming, however, and only two specimens have been collected by the writer.

Horizon and locality:—Pustula member: Wind River Mountains, Wyoming; phosphate beds: Thomas Fork and Sublette Range, Wyoming; Montpelier, Idaho.

Family SUESSIDAE
Genus SPIRIFERINA D'Orbigny

Spiriferina pulchra Meek

Plate VI, figures 9-11; Plate IX, figure 1.

1860. *Spirifera pulchra* Meek, Proc. Acad. Nat. Sci. Phil., p. 310.
Upper Carboniferous: Long Valley, Nevada.

1864. *Spiriferina pulchra* Meek, Pal. Upper Mo., p. 19.
Nevada territory.

1876. *Spirifer* (*Spiriferina*) *pulchra* Meek, Simpson's Exped. Gt. Basin, Utah, p. 352, pl. 2, figs. 1a-h.
Yellow L. S. (Upper Carboniferous): Long Valley and Ruby Valley, Nevada.

1877. *Spiriferina pulchra* Meek, U. S. Geol. Expl. 40th Par., vol. 4, p. 85, pl. 8, figs. 1-1e, pl. 12, figs. 12-12d.
Carboniferous L. S.: White Pine County, Nevada; mouth of Weber Canyon, Utah.

1912. *Spiriferina pulchra* Girty, U. S. Geol. Survey Prof. Paper 77, p. 54, pl. 7, figs. 8-8d.
Park City formation: Park City Mining District, Utah.

1920. *Spiriferina pulchra* Girty, U. S. Geol. Survey Prof. Paper 111, pl. 56, figs. 9-9a.
Carboniferous: Nevada.

S. pulchra is common in the Phosphoria of Wyoming. The specimens are typical except in one particular. Meek states that the breadth is from two to three times the length. Our specimens are rarely more than twice as wide as they are long. As Meek's figures do not support his statement, but show instead that his specimens were usually about twice as wide as long, or often less than that ratio, it is probable that he unintentionally exaggerated the breadth.

The Phosphoria specimens show a median septum in the ventral valve which extends from a point near the beak to a point about half way to the front margin of the valve. The septum gradually increases in height anteriorly, reaching a height of 2 mm. or more at its anterior extremity, and there ending abruptly. The margins of the delthyrium are prolonged into two short, rounded teeth supported by dental plates. These are fused to the posterior portion of the shell between the second and third internal plications, and extend forward to a point near the middle of the shell. Here the plates curve gently inward and terminate at the sides of the ridge made by the sinus.

S. pulchra is a common and easily identified form. It is considered an index fossil of the Permian by Girty.

Horizon and locality:—Pustula member and Top Limestone member: Cody, Wyoming; Pustula, Hustedia, and Top Limestone members: Wind River and Owl Creek Mountains, Wyoming.

Spiriferina kentuckyensis (Shumard)

Plate III, figures 14-16.

1852. *Spirifer octoplicata*? Hall, Stansb. Exped. to Gt. Salt Lake, p. 409, pl. 4, figs. 4a-b.
Carboniferous: Missouri River, near Weston, Missouri.

1855. *Spirifer Kentuckyensis* Shumard, Geol. Rept. Mo., p. 203.
Coal Measures: Missouri River, near Weston, Missouri; Grayson County, Kentucky.

This species is abundant in both the Pustula and Hustedia members. The specimens are typical, except that the width is usually not much greater than the length. Some shells from the Top Limestone member may belong to this species, but are poorly preserved.

Horizon and locality:—Pustula and Hustedia members: Wind River and Owl Creek Mountains, Wyoming.

Family RHYNCHOSPIRIDAE

Genus HUSTEDIA Hall

Hustedia phosphoriensis C. Branson, n. sp.

Plate IX, figures 2-7.

This species is very common in the top of the cherty shales in central Wyoming, outnumbering all other forms in that member except Bryozoa. On account of its dominance, the beds in which it occurs are referred to as the "Hustedia member." *H. phosphoriensis* is found also in the Pustula member, but is rare.

The shell is sub-ovate in outline; the beak of the ventral valve extends well past that of the dorsal valve; the greatest width is near the front margin and is not much less than the length; both valves are strongly convex, with the greatest thickness behind the umbo of the dorsal valve. The average size of an adult specimen is: length 11 mm., width 9 mm., height 7 mm.

Both valves are marked by evenly-spaced, rounded plications separated by moderately deep grooves. The dorsal valve bears one less plication than the ventral, the number being twelve or fourteen on the ventral and eleven or thirteen on the dorsal. The plications of the two valves lap past each other about 2 mm. at the front margin. Fine concentric lines mark the valves, especially anteriorly. The large, nearly circular foramen opens in the tip of the beak of the ventral valve. The hinge-line is short and the cardinal area very small. An indistinct sinus is present in some specimens. The shell substance of both valves is finely punctate.

H. phosphoriensis resembles *H. mormoni* (Marcou) in some respects. It differs, however, in having fewer plications, in usually lacking a sinus, in having greater overlap of the plications at the front margin, and in having one less plication on the dorsal than on the ventral valve. *H. phosphoriensis* bears the same number of plications as *H. papillata* (Shumard), but in that species the plications turn to the lateral margins and increase in number by implantation.

Horizon and locality:—Hustedia member: Wind River and Owl Creek Mountains, Wyoming; Pustula member: Wind River Mountains, Wyoming.

Family ATHYRIDAE
Subfamily ATHYRINAE
Genus COMPOSITA Brown

Composita subtilita (Hall)

Plate IX, figures 8-11.

A large number of the specimens collected from the Phosphoria can be assigned to this species. Very few are typical, however, for no two of the specimens are exactly alike. There are elongate forms, one of which has a very deep and steeply emarginated sinus. One specimen is remarkably globose and has an obscure sinus and an almost smooth surface. Since there is no abundance of the end forms, and since all of the variations arise from a type nearly typical of *C. subtilita*, all of the specimens which can be regarded as closely related to it are included in that species.

Horizon and locality:—Pustula member: Wind River Mountains, Wyoming.

Composita gigantea C. Branson, n. sp.

Plate IX, figure 17.

A single specimen, though not particularly well preserved, is yet so distinctively large that it deserves specific isolation. Shell extremely large, very gibbous, longer than wide, sides nearly parallel; sinus apparently broad and shallow, but small in area compared to the size of the shell; fold low and broad, prominent at front margin; beaks blunt, that of the pedicle valve slightly overhanging; surface of shell marked by numerous fine, closely-spaced growth lines. Length 60 mm., width 45 mm., thickness 40 mm.

Horizon and locality:—Pustula member: Wind River Mountains, Wyoming.

Composita quadricostata C. Branson, n. sp.

Plate III, figures 17-20.

Shell small, sub-trigonal, rather narrow longitudinally, greatest width in front of middle, longer than wide, thickest from beak of brachial valve to a point anterior to the umbo of the pedicle valve; beaks and umbones prominent, beak of pedicle valve sharply bent through ninety degrees to overhang that of the opposite valve; foramen circular, terminal. Immediately anterior to the umbo of the pedicle valve, a broad, rounded, raised area appears, resembling a fold. This area bifurcates near the middle of the shell and extends as two broadly rounded costae to the anterior margin and includes a sinus-like depressed area between, which at the front margin is about the same width as either of the costae. Opposite the point where the bifurcation takes place, two shallow sinus-like depressions originate. These lie along the outer sides of the costae and increase in size so that they are about as wide as the costae at the front margin. The outer side of each of these depressions is sharply bounded by a steep rise to the lateral slopes of the valve. The lateral slopes appear as costae on account of the depressions. Thus the anterior portion of the pedicle valve bears four raised areas and three intermediate depressed areas. The anterior surface of the brachial valve is folded in the opposite way, so that a depressed area opposes each raised area of the pedicle valve and vice versa. The costae and depressions of the brachial valve do not extend as far posteriorly as those of the pedicle valve, and the outer pair of depressions are shallow and indistinct. The anterior margin is folded where the costae and depressions intersect it, and it shows five major crenulations and two minor ones, the latter outermost. The surface of the shell is concentrically marked by fine growth lines, a few larger than the rest. The shell is much thickened at the front margin. The holotype is 14 mm. long, 11.5 mm. wide, and 7.3 mm. thick.

Only one specimen was found, but fortunately it is well preserved. No described species of *Composita* resembles this one at all closely. The costae and depressions are unique in development, and the peculiarly narrow and produced beak is distinctive. The specific name refers to the four-fold division of the anterior portion of the pedicle valve.

Horizon and locality:—Top Limestone member: Wind River Mountains, Wyoming.

Composita parva C. Branson, n. sp.

Plate II, figure 26; Plate IX, figures 12-16.

Shell small, gibbous, longer than wide, greatest width in front of middle; beaks prominent, that of pedicle valve produced and bent over opposite beak; foramen terminal, slightly ovular, partially gaping toward beak of brachial valve; sinus of pedicle valve broad, shallow, apparent only on anterior part of valve; fold on brachial valve broad, following regular curve of anterior slope, accentuated by shallow depressions on the lateral anterior slopes; front margin trilobate where intersected by fold and sinus, much thickened by additions of shell layers near the margin in old individuals; shell surface marked by numerous prominent growth lines. There is considerable variation in size between young and old individuals. An average specimen is about 12 mm. long, 10 mm. wide, and 6 mm. thick.

This species is very abundant in the Phosphoria. It is easily distinguished from the other Compositas of the formation, and should not be lumped with them. *C. subtilita* varies in similar directions, but typically is much larger, has a narrow sinus lying in a shallow area, and is about as wide as it is long. *C. parva* is small, elongate, smooth, and has no sharp emargination of the sinus.

Horizon and locality:—Pustula and Hustedia members: Wind River and Owl Creek Mountains, Wyoming.

Composita plana C. Branson, n. sp.

Plate X, figures 25-27.

Shell large, subcircular, expanded laterally, moderately gibbous, greatest width about middle; beak of pedicle valve prominent, overhanging, blunt, beak of brachial valve stubby, concealed beneath opposite beak; foramen large, circular, situated in end of beak of pedicle valve; sinus on pedicle valve, narrow, distinct, expanding slightly near anterior margin; fold on brachial valve, steep, prominent, partially bifurcated near margin; front margin rounded, truncated slightly at junction of fold and sinus; hinge-line extended, more than half as long as the width of the shell; surface of both valves marked by fine radial striae and by rather prominent concentric lines of growth. The type is slightly crushed in a dorsal-ventral direction. It measures 42 mm. long, 47 mm. wide, and 22 mm. thick. Variation from the type is all in the direction of increased gibbosity and diminution of hinge-line.

C. ovata Mather from the Hale formation of Arkansas is similar, but is not so broad, nor is its hinge-line so extended. The sinus in the two species is very similar, but that of *C. ovata* is typically narrower and its sides are nearly parallel throughout its length.

Horizon and locality:—Pustula member: Wind River Mountains, Wyoming.

Phylum MOLLUSCA
Class PELECYPODA
Order PRIONODESMACEA
Section PALAEOCONCHA
Family SOLENOMYACEA
Genus SOLENOMYA Lamarck

Solenomya radiata ? Meek and Worthen

Plate IX, figures 21-22.

1860. *Solemya radiata* Meek and Worthen, Proc. Acad. Nat. Sci. Phil., p.457.
Coal Measures: Grayville, Illinois.

1866. *Solenomya radiata* Meek and Worthen, Geol. Survey Ill., vol. 2, p. 349, pl. 26, figs. 10a-b.
Coal Measures: Schuyler County, Illinois.

1900. *Solenomya radiata* Williston, Univ. Geol. Survey Kan., vol. 6, p. 160, pl. 22, figs. 5-5b.
Upper Coal Measures: Topeka, Kansas.

The shape of the specimens from the Phosphoria agrees very well with the types of this species. Radial markings such as those which are characteristic of S. *radiata* can be seen indistinctly in the Phosphoria specimens.

Horizon and locality:—Top Limestone member: Cody, Wyoming.

Family GRAMMYSIIDAE
Genus EDMONDIA De Koninck

Edmondia gibbosa Swallow

Plate X, figures 28-30.

1858. *Edmondia gibbosa* Swallow, Trans. St. Louis Acad. Sci., vol. 1, p. 189.
Lower Permian: Valley of the Cottonwood, Kansas.

1866. *Astarte gibbosa* Geinitz, Carb. und Dyas in Nebraska, p. 16, tab. 1, figs. 23-24.
Upper Coal Measures: Plattsmouth, Nebraska.

1903. *Edmondia gibbosa* Girty, U. S. Geol. Survey Prof. Paper 16, p. 447, pl. 9, figs. 7-9.
Rico formation: San Juan region, Colorado.

1920. *Edmondia gibbosa* Girty, U.S. Geol. Survey Prof. Paper 111, pl. 54, fig. 14.
Rico formation: San Juan region, Colorado.

The specimens at hand agree well with the descriptions of this species. The Phosphoria specimens are marked by concentric undulations and by finer growth lines separated by furrows. Casts of the interior of the shell show fine, bifurcating radial striations, which sometimes appear pustulose. Girty's figures show similar markings on his specimens. The beak of the Phosphoria specimens is more produced and the shells are more gibbous than typical specimens. An average Phosphoria specimen is 35 mm. long, 30 mm. high, and 25 mm. wide.

Horizon and locality:—Lower Chert member: Wind River Mountains, Wyoming.

Section TAXODONTA
Superfamily NUCULACEA
Family NUCULIDAE
Genus NUCULA Lamarck

Nucula poposiensis C. Branson, n. sp.

Plate X, figures 1-6.

Shell small, somewhat quadrangular, moderately wide, greatest length about middle of shell; anterior margin semicircular, ventral margin broad and evenly rounded, posterior margin short and straight, dorsal margin slightly concave; pallial line distinct, parallel to edge of shell; adductor scars large, situated against the pallial sinus beneath the extremities of the cardinal margin; lunule and escutcheon not well defined; teeth strong about twenty in number, twelve anterior, eight posterior; beaks prominent, near posterior, and directed toward the shorter or posterior side. The size is variable; the length ranges from 5 mm. to 13 mm. An average specimen is 10.5 mm. long, 8 mm. high, and 4.5 mm. wide. The surface is marked by a few concentric undulations, but otherwise is smooth.

A Wewoka form which Girty identifies as *N. anodontoides*? Meek is very similar in some respects, but is larger, has fewer teeth, and is less concave along the dorsal margin. Some specimens from the Lower Phosphate member are probably conspecific. E. B. Branson described them as *N.* sp., and mentioned *N. beyrichi* Von Schauroth as identified by Meek at Nebraska City, and *N.* sp. a. from the Guadalupian as being similar in shape and size, but as his specimens were poor, identification was impossible. The specimens now at hand show that the forms are not of those species.

The specific name is derived from "Poposia", a local form of the name "Popo Agie", and refers to the fact that nearly all of the specimens were found in the canyon of the Popo Agie River, near Lander, Wyoming.

Horizon and locality:—Pustula member and Lower Phosphate member (?): Wind River Mountains, Wyoming.

Nucula montpelierensis Girty

Plate X, figures 7-9.

1910. *Nucula montpelierensis* Girty, U. S. Geol. Survey Bull. 436, pp. 38-39, pl. 4, figs. 1-3.
Phosphate beds of the Park City formation: Thomas Fork, Wyoming; Montpelier, Idaho.

Although all of the specimens found in the Wind River Mountains are internal molds, they agree closely in shape with Girty's species. They have been compared with specimens collected at Montpelier, and undoubtedly belong to the same species. The Wind River forms vary greatly in size; most of them are smaller than those from Montpelier.

Horizon and locality:—Pustula member: Wind River Mountains, Wyoming; phosphate beds: Thomas Fork, Wyoming, and Montpelier, Idaho.

Nucula pulchella Beede and Rogers

Plate X, figures 12-14.

1916. *Nucula pulchella* Branson, Jour. Geol., vol 24, p. 658, pl. 3, figs. 7-8. Synonomy to 1916.
Lower Embar formation: Wind River Mountains, Wyoming.

The shape and size of the specimens agree so well with the description that there seems to be no doubt of the identification. All of the specimens are internal molds. *N. montpelierensis* Girty is much more gibbous, and its beaks are nearly central, while those of *N. pulchella* are distinctly lateral.

Horizon and locality:—Lower Phosphate member and Pustula member: Wind River Mountains, Wyoming.

Family LEDIDAE
Genus LEDA Schumacher

Leda bellistriata Stevens

Plate X, figures 15-20.

1858. *Leda bellistriata* Stevens, Am. Jour. Sci., 2nd ser., vol. 25, p. 261.
Coal Measures: Danville, Illinois; Summit, Ohio.
1915. *Leda bellistriata* Girty, U. S. Geol. Survey Bull. 544, pp. 122-123, pl. 14, figs. 1-9a. Synonomy.
Wewoka formation: Oklahoma.
1916. *Leda bellistriata* Branson, Jour. Geol., vol. 24, p. 659, pl. 3, figs. 9-12.
Lower Embar formation: Wind River Mountains, Wyoming.
1921. *Leda bellistriata* Plummer and Moore, Univ. Tex. Bull. 2132, pl. 7, figs. 1, 5-6a; pl. 14, figs. 13-14; pl. 19, fig. 9.
Barnett shale and Caddo Creek formations: north-central Texas.

Internal molds referred to this species are found in large numbers in the Lower Phosphate member and in the phosphate bed at the top of the Pustula member. All of the specimens are small, ranging in size from a length of 2 mm. to a length of 12 mm., the average being about 5 mm. The surface markings are never well preserved, but the uniformly small size suggests that these specimens may belong to the variety *attenuata*. Typical specimens of *L. bellistriata* occur in the Rex chert member of the Fort Hall Indian Reservation, Idaho. These attain a length of about 25 mm.

Horizon and locality:—Pustula member: Wind River and Owl Creek Mountains, Wyoming; Lower Phosphate member: Wind River Mountains, Wyoming; Rex chert member: Fort Hall Indian Reservation, Idaho.

Leda obesa (White)

Plate X, figures 21-22.

1879. *Nuculana obesa* White, U. S. Geol. and Geog. Survey Terr., vol. 5, p. 216.
Carboniferous: Wild Band Pockets, Arizona.

1910. *Leda obesa* Girty, U. S. Geol. Survey Bull. 436, pp. 40-41, pl. 4, figs. 7-8. Synonomy to 1910.

Phosphate beds of the Park City formation: Thomas Fork, Wyoming; Montpelier, Idaho; Preuss Range, Idaho.

Girty has referred some shells from the Phosphoria in Idaho and western Wyoming to this species. Two specimens found in the Lower Phosphate member in the Wind River Mountains, Wyoming, are exactly like those which the writer collected at Girty's locality near Montpelier, Idaho. The most complete specimen from the Wind River Mountains is 35 mm. long, 22 mm. high, and 9 mm. thick. The other specimen is half again as large, but is imperfect.

Horizon and locality:—Lower Phosphate member: Wind River Mountains, Wyoming; phosphate beds: Thomas Fork, Wyoming; Preuss Range, Idaho; Montpelier, Idaho.

Section SCHIZODONTA
Superfamily PTERIACEA
Family PTERIIDAE
Genus MONOPTERIA Meek and Worthen

Monopteria sp.

Plate X, figure 24.

All of the specimens at hand are poorly preserved. The wing is short and not well separated from the slopes of the shell. The beak is only slightly curved posteriorly and is not prominent. The surface of the shell is marked by concentric striae and by growth lines. The specimens may belong to *M. gibbosa* Meek and Worthen, but in their state of preservation, it is impossible to determine their specific affinities.

Horizon and locality:—Top Limestone member: Wind River Mountains, Wyoming.

Family CYRTOROSTRA C. Branson, n. gen.

Shell short, convex, sub-conical; beak pointed, situated anterior of middle, extended beyond hinge, twisted posteriorly; posterior ear larger than anterior ear, margin of ear slightly concave, turned over at edge; margin of shell with long spines; surface ribbed; area below the beaks concave; hinge-plate short, flat, with alternating teeth and sockets.

The genotype is *C. varicostata*, described below. The genus *Acanthopecten* has a similar spinose front margin, but the valves are flatter and the beak is blunt and not noticeably curved.

Cyrtorostra varicostata C. Branson, n. sp.

Plate XI, figures 16-19.

Shell small, short, high; beak anterior of middle of shell, pointed, extending past and over the hinge, curved toward the posterior in such a manner that it appears twisted; ears distinct, flat, extending well away from the

beaks, dorsal margin of ear slightly concave, turning over to the hinge; surface of shell marked by twenty alternating broad and narrow ribs; the narrow set higher and extending beyond the ventral margin as long, pointed spines; the broad set ending in a concave edge and giving the ventral margin a scalloped appearance; hinge half as long as the length of the shell, hinge-plate flat, bearing alternating linear teeth and sockets. Four teeth can be seen in a left valve. These are oblique, point toward the beak, and are largest at their extremities. An average specimen is 9 mm. long, 12 mm. high, and 10 mm. wide.

Horizon and locality:—Top Limestone member: Wind River and Owl Creek Mountains, Wyoming.

Cyrtorostra sexradiata C. Branson, n. sp.

Plate XI, figures 13-15.

Shell small, gibbous, elongate, sub-trigonal, equivalve, higher than long; beaks pointed, strongly recurved, turned over about one hundred forty degrees, the greatest curvature in the umbonal region; ears large, sloping ventrally away from the beaks, posterior ear largest, consisting of a heavy, rounded marginal fold with an included depression between the fold and the umbonal slope, anterior ear alate, flat, not so much ventrally directed as the opposite ear, marked by numerous concentric lines arched dorsally at the junction of the ear and the shell proper; surface of shell marked by six high, narrow ribs, separated by broad, deep, evenly-rounded depressions; ribs protruding well past the ventral margin as spines, anterior rib largest and highest, diverging from the next one as it approaches the margin; numerous concentric lines cross the ribs, turning sharply toward the ventral margin as they do so, and arching dorsally in broad curves as tney cross the depressions between the ribs; lateral slopes abrupt, almost vertical. An average specimen is about 8 mm. long, 12 mm. high, and 12 mm. wide.

The species differs from *C. varicostata* in number and size of ribs, in its more strongly recurved beaks, and in the structure of the ears.

Horizon and locality:—Top Limestone member: Wind River Mountains, Wyoming.

Family MYALINA De Koninck
Genus MYALINIDAE

Myalina sinuata C. Branson, n. sp.

Plate XII, figure 1.

Shell large, sub-rectangular, abruptly convex on the umbonal slope, sharply curved thru approximately one hundred ten degrees; beak produced, terminal, slightly twisted; cardinal margin distinctly incurved below the beak; surface of shell marked by fine concentric growth lines about 1 mm. apart. These run almost straight ventrad from the anterior margin to the crest of

the umbonal slope, turn almost as far dorsad on the opposite side, straighten out toward the posterior margin, and then turn abruptly to the cardinal margin. In some specimens the umbonal slope is concave anteriorly; in others it is convex. An average specimen is 45 mm. long, 20 mm. wide, and 75 mm. high. *M. permiana* Swallow is similar in shape and size, but does not have the sinuous markings.

A large number of small Myalinas in the collection may belong to the same species. These are about half as large as the above type.

Horizon and locality:—Top Limestone member: Wind River and Owl Creek Mountains, Wyoming; Hustedia member: Owl Creek Mountains, Wyoming.

Superfamily TRIGONIACEA
Family TRIGONIIDAE
Genus SCHIZODUS King

Schizodus concinnus C. Branson, n. sp.

Plate XIII, figures 12-13.

Shell small, wide anteriorly, narrow posteriorly, outline ovuloid; beaks prominent, not greatly curved, slightly recurved posteriorly; anterior slope of umbo steep, umbonal ridge strong, increased in height where it joins the base of the posterior margin; margins smooth, anterior margin semicircular, very little truncated; ventral margin long, smooth and broadly curved, truncate; dorsal margin almost straight; hinge of medium length; pallial line simple; anterior and posterior adductor scars large. A second posterior muscle scar is situated directly above the scar of the posterior adductor and is about one third as large. Surface of shell marked by low, regular, concentric lines. The size is variable; extremes in length measured were 11 mm. and 32 mm. An average specimen is 21 mm. long, 16 mm. hign, and 12 mm. wide.

Probably *S. ovatus* Meek and Hayden is the species most likely to be confused with *S. concinnus*, but the shape of the latter is not nearly so ovate. *S. wheeleri* Swallow is not only much larger, but is more elongate and has a concave dorsal margin. The new species is named *concinnus* from the strikingly regular curvature of the shell, particularly in the umbonal region.

Horizon and locality:—Lower Chert member: Wind River and Owl Creek Mountains, Wyoming.

Schizodus canalis C. Branson, n. sp.

Plate XIII, figure 1.

Shell small, sub-trigonal, convex; beaks sub-terminal, symmetrical, curved posteriorly, curved over the hinge and extending a short distance past the hinge; posterior margin very short and sharply curved; dorsal margin slightly concave, abruptly turned over to the hinge, flaring and flat at extremity; anterior margin curved slightly, truncate near the beak; ventral margin long, regularly curved except near the posterior margin, where it straightens out into a point and leaves a slight indentation anterior to the point; anterior umbonal slope steep. From the posterior portion of the umbo

a linear depression extends to the ventral margin and ends in the indentation mentioned above. The depression widens and deepens ventrally; it is distinctly emarginated posteriorly and dorsally by a sharp ridge which extends along the dorsal edge of the shell and terminates in an extended point which is coextensive with the posterior margin. Surface of shell marked by concentric undulations and by narrow growth lines, irregularly spaced; length of average specimen 16 mm., height 13.5 mm., width 12 mm.

A specimen which Girty figures from the Wewoka formation and identifies as *S. affinis*? Herrick? is somewhat similar, but differs in having a more rounded anterior margin, a broader depression, and a dorsal margin which is not so sharply bent over. Typical specimens of *S. affinis* are even more unlike *S. canalis*.

The specific name refers to the depression on the posterior portion of the umbo.

Horizon and locality:—Lower Chert member: Wind River Mountains, Wyoming.

Schizodus phosphoriensis C. Branson, n. sp.

Plate XIII, figures 2-7.

Shell large, sub-trigonal, slightly longer than high, wide at the umbones, narrow posteriorly; beaks prominent, recurved posteriorly, situated somewhat anterior to the middle of the dorsal margin, curved closely over the hinge; anterior margin semicircular, not truncate; ventral margin long, smooth, evenly curved; posterior margin short, sharply curved; dorsal margin straight; pallial line distinct, curved in a deep pallial sinus; anterior and posterior adductor scars large, circular. A large deep sinus originates on the anterior side of the beak of the left valve and extends to the ventral margin, progressively widening and curving posteriorly. Each valve beras a similar, but much narrower sinus on posterior side of the beak, the sinus following the posterior curve of the umbonal slope and becoming obsolete a short distance posterior to the beak. Shell at the umbones thick, especially so on the posterior side; hinge-plate massive, short, thick, posterior portion club-shaped, bearing a groove on its dorsal surface and another on its inner surface; ventral side of hinge-plate smooth, almost flat, attached to the inner side of the umbo; anterior portion of hinge-plate not preserved. Surface of shell marked by fine concentric ridges and by finer, irregularly-spaced growth lines. An average specimen is 60 mm. long, 50 mm. high, and about 40 mm. wide.

The species resembles *S. wheeleri* Swallow, but is not so elongate and has an anterior sinus which that species does not possess. Other features of *S. wheeleri* are not well enough known for comparison.

Horizon and locality:—Top Limestone member: Wind River and Owl Creek Mountains, Wyoming.

Superfamily PECTINACEA
Family PECTINIDAE
Genus AVICULIPECTEN McCoy

Aviculipecten alatus C. Branson, n. sp.

Plate XI, figures 9-10.

Shell small, auriculate, more or less trigonal, moderately convex, length greater than height, beak curved, extending beyond the hinge; hinge 7 mm. long in a left valve 16 mm. long. The beak is nearly terminal. The margin is scalloped, the scallops being rounded and extending 2 mm. past the inner borders. The surface of the valve is marked by broad, low, rounded ribs, separated by grooves one-third as wide as the ribs. Each of these grooves is occupied by a much smaller, sharper rib. There is a total of twenty-two ribs, all of the same size in the umbonal region, but differentiated into the two sizes on the slope to the ventral margin. The narrower ribs run into the points of the marginal scallops. Four or five concentric growth lines can be seen near the anterior margin and on the anterior ear.

The anterior rib is separated from the rest by a deep groove, forming a sort of wing which extends 4 mm. in front of the beak. The posterior ear is about half as large, and is rounded from the straight hinge to the margin. It bears a large rib on its surface, and another lies in the shallow sinus that separates the ear from the valve proper. The cardinal margin is nearly 2 mm. high and is 4 mm. long. It is highest under the beak and pinches out on each side at the inner tip of the ear. A plate beneath the beak bears several oblique linear teeth, which articulate with a corresponding arrangement on the opposite valve. The holotype is a left valve 16 mm. long, 14 mm. high, and 6 mm. wide.

Horizon and locality:—Hustedia member: Wind River Mountains, Wyoming.

Aviculipecten landerensis C. Branson, n. sp.

Plate XII, figures 2-3.

Shell small, equilateral, about as high as long, valves moderately convex, widest at the apex of the umbones; hinge about two-thirds the length of the shell; beak extending a short distance beyond the cardinal margin; surface of both valves marked by four fine, even, rounded ribs to the millimeter; ears well developed, extending 2.5 mm. on each side of the beak, nearly equal in size, plain except for fine concentric growth lines which parallel the ventral margin and end on the opposite ear. The growth lines are larger and closer together near the ventral margin than they are on the umbonal slopes. The type is 12 mm. long, 13 mm. high, and 5 mm. thick. Small specimens are only 5 or 6 mm. long.

The shell resembles *A. curtocardinalis* Hall and Whitfield, but that species has a short hinge and is very convex.

The name is derived from the town of Lander, Wyoming, the starting point of the collecting trips in the Wind River Mountains.

Horizon and locality:—Top Limestone member: Wind River Mountains, Wyoming.

Aviculipecten alternatus C. Branson, n. sp.

Plate XI, figures 4-8.

Shell sub-conical, equilateral; beaks prominent, curved over the hinge; ears large, their dorsal margins receding from the beak; surface of shell marked by alternating wide and narrow ribs, the wide ribs six or seven times as wide as the narrow ones; the narrow ribs increasing in height ventrally so that they stand above the others near the ventral margin. All of the ribs on the ends of the shell curve away from the median line and appear to flare out to the anterior and posterior margins. Growth lines are prominent near the ventral margin and on the ears, and they arch ventrally as they cross the wider ribs. The anterior ear lies in the plane of the valves and is distinctly separated from the shell proper by a groove. Its ventral margin is slightly concave, and is 7 mm. long in an average specimen. The posterior ear is more extended, lies opposite the beak, and is more alate. In the region of the posterior ear the narrow ribs are regularly nodose, especially as they approach the posterior margin.

The cardinal margin bears a strong cardinal tooth and a shallow, linear lateral tooth on the left valve. The species is distinguished by the alternation of wide and narrow ribs, and the name is derived from that characteristic.

Horizon and locality:—Hustedia member: Wind River and Owl Creek Mountains, Wyoming.

Genus DELTOPECTEN

Deltopecten vanvleeti (Beede)

Plate XI, figures 1-2.

1877. *Aviculopecten McCoyi* White, U. S. Geog. Survey W. 100th Mer., vol. 4, p. 149, pl. 11, fig. 2a.
Carboniferous: near Bear Spring, Camp Wingate, New Mexico.

1902. *Aviculopecten vanvleeti* Beede, Oklahoma Geol. Survey, Adv. Bull., 1st Bien. Rept., p. 6, pl. 1, figs. 8-8b.
Red beds: Whitehorse Springs, Oklahoma.

1907. *Aviculopecten vanvleeti* Beede, Kansas Univ. Sci. Bull., vol. 4, p. 159, pl. 5, figs. 2-2e.
Upper Permian: Whitehorse Springs, Oklahoma.

1909. *Deltopecten vanvleeti* Lee and Girty, U. S. Geol. Survey Bull. 389, pp. 86-87, pl. 9, fig. 5.
San Andreas formation: Elephant Butte, San Andreas, and Engle, New Mexico; Abo sandstone: Abo Canyon, New Mexico.

The Phosphoria formation yields numbers of shells of this typically Permian species. The largest specimen is a left valve 100 mm. long, and 100 mm. high. The smallest is about 35 mm. long and 35 mm. high.

Horizon and locality:—Top Limestone member: Wind River and Owl Creek Mountains, Wyoming.

Deltopecten occidentalis (Shumard)

Plate XI, figure 21.

1855. *Pecten occidentalis* Shumard, Geol. Rep. Mo., p. 207, pl. C, fig. 18. Coal Measures: near Plattsburg, Missouri.

1909. *Deltopecten occidentalis* Lee and Girty, U. S. Geol. Survey Bull. 389, pp. 84-85. Synonomy to 1909.

Abo sandstone: Abo Canyon, New Mexico.

This species is fairly common in the Phosphoria formation, but the lithology is such that good specimens are obtained but rarely. One specimen shows perfectly the pit beneath the beak, which establishes its position in the genus *Deltopecten*. Most of the specimens are small, although this is due possibly to the difficulty in breaking out large, flat surfaces. The shells are somewhat atypical in the arrangement of the costae. The surface is generally not regular in the alternation of large and small costae, but may have more than one small between two large ones. The small costae are intercalated irregularly.

Horizon and locality:—Hustedia and Top Limestone members: Wind River and Owl Creek Mountains, Wyoming.

Deltopecten sexradiata C. Branson, n. sp.

Plate XI, figures 11-12.

Shell medium in size, sub-trigonal; beaks sharp, terminal, curved toward hinge; dorsal margin straight, parallel to greatest length of shell; anterior margin short, rounded, upper part truncated by the shorter portion of the hinge area; posterior margin very short, angular, almost inseparable from the ventral margin; ventral margin long, evenly rounded, scalloped; surface of shell marked by six sharp, heavy, angular ribs; the dorsal one most prominent. It forms a sharp corner between the surface of the valve and the dorsal margin. The four median ribs are smaller in size and are not so angular. They originate at the beak and extend to the points of the scallops on the ventral margin. The anterior rib is indistinct, and is inseparable from the next one in the region of the beak. Fine concentric lines cross the ribs and turn ventrally in crossing. A specimen of a left valve, which is the largest specimen at hand, is 35 mm. long, 30 mm. high, and 10 mm. wide. The smallest specimen, a right valve, is about 25 mm. long, 23 mm. high, and 8 mm. wide.

This species resembles *Aviculopecten sublaqueatus* Girty in the number of ribs and outline of valve, but does not have the finer intermediate ribs of that species.

Horizon and locality:—Top Limestone member: Wind River Mountains, Wyoming.

Order ANOMALODESMACEA
Superfamily ANATINACEA
Family PHOLADELLIDAE
Genus ALLERISMA King

Allerisma wyomingensis C. Branson, n. sp.

Plate XIV, figures 1-3.

Shell large, sub-quadrangular in side view, appearing like an axe-head in dorsal or ventral view, greatest width just in front of middle; beaks almost terminal. The surface of the valves is marked by low concentric undulations and by growth lines. The entire surface bears wavy, irregular radial striae, about twenty to the centimeter. The striae are flat on top and are about 0.3 mm. wide. They are separated by shallow grooves of about the same width as the striae.

The margins are smoothly rounded. The posterior margin is roughly semicircular, and is somewhat longer than the anterior margin. The ventral margin is a broad, even, almost straight curve, broken in the middle by a slight indentation. The anterior margin lies at right angles to the ventral margin and is semicircular. From the side, the dorsal surface appears concave, the beaks forming the high point anteriorly, and a flaring of the posterior part of the shell forms a high point there.

The nearly terminal beaks are prominent and are curved toward each other. From each beak, a linear depression extends obliquely over the umbo to the center of the ventral margin, causing a slight indentation of the margin at that point. The depression is broad and is deepest at its anterior edge. It is bounded anteriorly by a rather sharp and high ridge, which extends to the beak. Posteriorly, the margin of the depression is not so distinct, for the depression shallows gradually and ends against a broad indistinct ridge. The depression widens gradually from its origin on the beak and flares out to a considerable width as the shell curves to the ventral margin. The striae in the depression parallel its course. The opposite valve bears an exactly similar depression.

An average sized specimen is 110 mm. long, 60 mm. high, and 50 mm. wide. Some specimens are only 90 mm. long, and one is 125 mm. long.

This species is found in the lower part of the formation between the Lower Phosphate member and the Pustula member. It usually occurs alone. The species differs from all previously described members of the genus in its oblique umbonal depressions and in its striae.

Horizon and locality:—Lower Phosphoria formation: Wind River Mountains, Wyoming.

Allerisma sp.

Plate XIV, figures 4-5.

The Lower Chert member contains numerous imperfect specimens of an *Allerisma*. No characteristic is well enough preserved to specifically identify it. The specimens are marked by concentric undulations, and they have a depression on each valve which extends from the beak toward the middle of the ventral margin. In the latter characteristic, they resemble *A. wyomingensis*, but the shape is variable and is usually quite different from that species in that the posterior margin is short.

Horizon and locality:—Lower Chert member: Wind River Mountains, Wyoming.

Order TELEOLESMACEA
Superfamily CYPRICARDIACEA
Family PLEUROPHORIDAE
Genus PLEUROPHORUS King

Pleurophorus pricei C. Branson, n. sp.

Plate XII, figures 8-9; Plate XIII, figures 11-12.

Shell small, sub-rectangular, twice as long as high, narrower posteriorly than anteriorly; beak terminal; anterior margin notched below the beak and flaring out into a small fan-shaped structure below. This is separated from the ventral margin by another notch. The ventral margin is straight and long; the posterior margin sharply rounded and short. The dorsal margin rises in a long, regular curve from the posterior margin to a point 2 mm. in front of the beaks. From that point the beaks turn sharply downward and inward. They stand out as terminal points on the valves.

The surface of the shell is marked by several fine concentric growth lines, and by forty or fifty narrow, rounded, indistinct ribs radiating from the beaks to the ventral and posterior margins. The ribs near the anterior margin parallel it and are more pronounced than those on other parts of the shell.

The adductor muscle scar is deep and cone-shaped. It is separated from the rest of the living chamber by a deep, vertical radial buttress. The pallial line is prominent and parallels the ventral and posterior margins at a distance of about 2 mm.

The shell is thin and moderately convex. It is thickest near the dorsal margin just behind the beaks.

An average shell is 20 mm. long, 10 mm. high, and 4 mm. wide. None of the specimens vary much from these dimensions. The species is fairly abundant.

No other member of the genus has regularly disposed radial ribs such as those of this species. The extreme terminal position of the beaks distinguishes *P. pricei* from nearly all other species of *Pleurophorus*.

The species is named for Arthur S. Price, friend of the writer and fellow student of the Phosphoria, whose collections and assistance have been invaluable.

Horizon and locality:—Top Limestone member: Wind River Mountains, Wyoming.

Pleurophorus pinnaformis C. Branson, n. sp.

Plate XII, figures 5-7; Plate XIII, figure 13.

Shell of medium size, long, narrow, very high posteriorly; beaks sharp, nearly terminal; anterior margin semicircular; a small area bearing the anterior adductor scar protrudes posteriorly farther than the beak. The radial buttress is just behind the scar and slopes back from a point just below the beak to the ventral margin. Muscle scar deep, nearly circular, marked by lines arranged concentrically around the anterior point of the scar; pallial line simple; escutcheon long, deeply sculptured; dorsal margin straight;

ventral margin broadly curved; posterior margin semicircular, high; surface of shell marked by concentric lines which parallel the posterior margin; greatest height at the posterior margin. There is some variation in the ratio of length to height and in the size of the specimens. One shell is 50 mm. long and 20 mm. high; a larger one is 75 mm. long and 35 mm. high. There is a slight indication that there may be one or more ribs running from the beak to the ventral end of the posterior margin.

P. oblongus Meek is the only *Pleurophorus* which resembles this species. The dorsal margin of the former species, however, is curved, its beak is bent down and not terminal, and the anterior area, which is large in proportion to the size of the shell, is flange-like, and its radial buttress is vertical.

The specific name of *P. pinnaformis* designates the great increase in height posteriorly and the pointed terminal beak, which simulate the form of *Pinna*.

Horizon and locality:—Lower Chert member: Wind River Mountains, Wyoming.

Class GASTROPODA
Subclass STREPTONEURA
Order ASPIDOBRANCHIATA
Suborder DOCOGLOSSA
Family BELLEROPHONTIDAE
Genus BELLEROPHON Montfort

Bellerophon depauperatus C. Branson, n. sp.

Plate XV, figures 1-2.

Two casts of the interior of a *Bellerophon* are included in the collection from the oolitic phosphate of the Pustula member. The shell is minute, subspherical, smooth and symmetrically rounded; umbilicus shallow; aperture large, not flaring. The ventral margin of the aperture is semicircular on either side of the short, U-shaped slit. The slit is closed by a narrow slit-band. The larger of the two specimens is 4.5 mm. in diameter, 3.7 mm. wide across the aperture, and measures 1.8 mm. from the inner to the outer lip of the aperture. The smaller specimen's greatest dimension is less than 2 mm.

This species is a member of a typically depauperate faunule. *B. crassus* Meek and Worthen is similar in its smoothness and shape of aperture, but differs in its size, its flaring aperture, and its prominent slit-band crossed by transverse lines.

Horizon and locality:—Pustula member: Wind River Mountains, Wyoming

Genus EUPHEMUS McCoy

Euphemus carbonarius Cox

1855. *Bellerophon Urii* Norwood and Pratten, Jour. Acad. Nat. Sci. Phil., ser. 2, vol. 3, p. 75, pl. 9, figs. 6a-c.
Coal Measures: Illinois and Indiana.

1857. *Bellerophon carbonarius* Cox, Geol. Survey Kentucky, vol. 3, p. 562.
Coal Measures: Kentucky.

1909. *Euphemus carbonarius* Beede and Rogers, Univ. Geol. Survey Kansas, vol. 9, pp. 369, 382.
Coal Measures: Kansas.

1916. *Euphemus carbonarius* Branson, Jour. Geol., vol. 24, pp. 659-660.
Synonomy to 1916.
Lower Embar formation: Wind River Mountains, Wyoming.

Typical specimens of this species are found in the Lower Chert member of the Phosphoria formation in the Wind River Mountains, Wyoming. The average diameter is about 15 mm.

Horizon and locality:—Lower Chert member: Wind River Mountains, Wyoming.

Euphemus subpapillosus (White)

Plate XVI, figures 19-21.

1876. *Bellerophon carboniferus* var. *subpapillosus* White, Powell's Rep. Geology Uinta Mts., p. 92.
Upper Aubrey: Utah.

1910. *Euphemus subpapillosus* Girty, U. S. Geol. Survey Bull. 436, pp. 47-48.
Synonomy to 1910.
Phosphate beds of the Park City formation: Sublette Range, Wyoming.

Shell sub-spherical, coiled in one plane, making three closely-coiled volutions which regularly increase in size from the protoconch anteriorly; umbilicus closed; aperture in an average-sized specimen 18 mm. long, 5 mm. wide, edges parallel, lateral terminations in the form of perfect semicircles; last volution notched to a depth of 5 mm. by the U-shaped slit; slit-band 1.5 mm. wide in an average specimen, not prominent; surface of shell marked toward the apical end by eight strong longitudinal ribs, which become lines of papillae on the last volution. The inner pair of ribs is composed of somewhat larger papillae than the rest; some of the papillae are over a millimeter high. Each papilla is connected to the adjacent ones in its line by low narrow saddles.

The largest specimen in our collection measures 25 mm. from the end of the last volution to the opposite side of the shell. The same dimension in the smallest specimen is 6 mm. The average is about 20 mm.

This species is very abundant in the Top Limestone member in central Wyoming. It is found in the Phosphoria in the Sublette Range, Wyoming, and in the Upper Aubrey group of Utah.

Horizon and locality:—Top Limestone member: Wind River and Owl Creek Mountains, Wyoming; phosphate beds: Sublette Range, Wyoming.

Suborder RHIPIDOGLOSSA
Family PLEUROTOMARIIDAE
Genus PLEUROTOMARIA Defrance

Pleurotomaria phosphatica C. Branson, n. sp.

Plate XV, figures 8-10.

This form belongs to the depauperate faunule of the phosphate bed at the top of the Pustula member. All of the specimens are well preserved tricalcium phosphate casts of the interior of the shell.

Shell small, flat, semicircular, composed of two volutions; spire low, closely coiled, lower half hidden against last volution; suture distinct; shell rapidly increasing in size, section of volution oval, slightly flattened on upper side, not keeled; umbilicus deep, sides moderately steep; aperture large, circular, flaring; slit deep, situated on upper shoulder of whorl, sides nearly parallel, distinctly emarginated by ridges along the sides, closed at end by annulated slit band which stands high above the level of the shell at the slit and rapidly decreases in elevation away from it until it is level with the surface of the whorl 2 mm. from the slit. The specimens at hand show no surface ornamentation, but a more perfect preservation may prove some present. Size variable; largest specimen about 14 mm. in diameter; smallest less than 2 mm. in diameter; average shell about 3.5 mm. in diameter, 2 mm. high, aperture 1.5 mm. in diameter.

The distinguishing features of the species are its small size, the shape of the slit, and the lack of carinae.

Horizon and locality:—Pustula member; Wind River and Owl Creek Mountains, Wyoming.

Pleurotomaria reticulata C. Branson, n. sp.

Plate XVI, figures 11-13.

Shell small; spire low; whorls two and a fraction, last one increasing rapidly in size; sutures distinct, deep; about half of first whorl lying above inner shoulder of the last; umbilicus wide, steep-sided; lower side of shell nearly flat; whorls carinate, upper keel low, forming slight shoulder; lower keel prominent, its surface coinciding with the greatest diameter of the shell; lower portion of last whorl flattened below the keel; surface of last whorl marked by about fifty longitudinal ribs and by vertical lines which cross the ribs at right angles and give the surface a reticulate appearance.

This species is rare. It is more nearly like *P. robusta* C. Branson than any other described species. The spire is distinctly lower than the spire of that species, the doubly carinate condition is different, and the reticulate ornamentation is distinctive. This ornamentation is referred to in the specific name.

Horizon and locality:—Top Limestone member: Owl Creek Mountains, Wyoming.

Pleurotomaria robusta C. Branson, n. sp.

Plate XIII, figures 14-15.

Shell small, subglobose, spire moderately low; whorls about two and one-half, each standing nearly clear of the succeeding; suture distinct, deep; umbilicus circular, deep, sides moderately steep: last whorl with flaring lower side, which gives the whorl a twisted appearance; whorl with a single broad, round-

ed keel situated below middle of side of last whorl; surface of whorls marked by about twenty longitudinal ribs, prominent on the top and side of last whorl, indistinct on its lower surface; average shell 11 mm. in diameter, 7 mm. high, umbilicus 1.8 mm. in diameter.

As pointed out in the description of that species, *P. reticulata* is similar in size and shape, but has distinct differences. No species is closely similar to *P. robusta*. *P. discoidea* Girty from the Guadalupian has a similar low spire and longitudinal ribs, but is discoidal, has more whorls, is much smaller, and has a papillate carina.

Horizon and locality:—Top Limestone member: Wind River and Owl Creek Mountains, Wyoming.

Pleurotomaria sp.

Plate XII, figure 4.

One specimen of *Pleurotomaria* has a higher spire than the others. The last whorl is marked by alternating large and small longitudinal striae.

Horizon and locality:—Top Limestone member: Cody, Wyoming.

Genus WORTHENOPSIS

Worthenopsis bicarinata C. Branson, n. sp.

Plate XVI, figures 14-16.

Shell small. Spire moderately high, whorls four or five, body whorl much larger than the spire. The whorls are like low conical disks with flat edges. The outer edge of each whorl bears two keels, one above, the other below, the upper more prominent. These keels stand out so prominently that the area between appears depressed. The lower keel of each whorl usually is hidden at least partially beneath the upper portion of the succeeding whorl. The upper surface of each volution is slightly concave as it slopes away from the keel, and bears a heavy rib near its junction with the preceding whorl. This surface is marked by a few fine longitudinal striations. The concave area between the two keels of a whorl and the surface of the keels bear like longitudinal striations; each keel bears one at its crest and one on each side; the concave area bears five or six. The lower side of the last whorl is heavily striated. The aperture is large and asymmetrically pentagonal; the corners are opposite the terminations of the keels, at the junction of the lip with the next to last whorl, and at the points where the margins of the aperture touch the columella. The size of the cotypes is almost equal; height 11 mm., width 8 mm., vertical diameter of aperture 4 mm.

Worthenopsis sp. from the Permian "red beds" at Dozier, Texas, described by Beede, resembles this species. However, *W. bicarinata* has fewer volutions and its upper keel is not completely concealed. Beede's description mentions no longitudinal striae, but his figure appears to show some.

Horizon and locality:—Rex chert member: Fort Halll Indian Reservation, Idaho.

Family TROCHONEMATIDAE
Genus STROPHOSTYLUS Hall

Strophostylus ? sp.

Plate XIV, figures 11-12.

A single specimen from the phosphate bed of the Pustula member may be a *Strophostylus*. It is flat and has a very large flaring aperture. The specimen is 9 mm. long from the outer lip to the opposite side of the coil; the aperture is 4.5 mm. in diameter.

Horizon and locality:—Pustula member: Wind River Mountains, Wyoming.

Family NERITOPSIDAE
Genus NATICOPSIS McCoy

Naticopsis gracilis C. Branson, n. sp.

Plate XV, figures 11-12.

Shell small, somewhat top-shaped; about two and one-half volutions, last one increasing rapidly in size; suture distinct; spire very low, rising no more than a millimeter above the surface of the last whorl; aperture egg-shaped in outline, widest below, large in comparison to the size of the shell. The type is 9 mm. long and 9 mm. wide. The aperture of the type is 5 mm. long and 4 mm. wide. Other specimens at hand range down to 5 mm. in length.

N. nana Meek and Worthen resembles this species, but is more globose, is wider than long, and its aperture is widest near the middle.

Horizon and locality:—Rex chert member: Fort Hall Indian Reservation, Idaho.

Family EPITONIIDAE
Genus ORTHONEMA Meek and Worthen

Orthonema sp.

Plate XII, figure 10.

Two specimens have the typical features of this genus, but are so poorly preserved that no attempt was made at specific identification.

Horizon and locality:—Top Limestone member: Owl Creek Mountains, Wyoming.

Subclass EUTHYNEURA
Order OPISTHOBRANCHIA
Suborder CONULARIIDA
Family CONULARIIDAE
Genus CONULARIA Miller

Conularia crustula ? White

1880. *Conularia crustula* White, Cont. to Pal. no. 8, p. 170, pl. 42, fig. 4a. Coal measures: Kansas City, Missouri.

1903. *Conularia crustula* Girty, U. S. Geol. Survey Prof. Paper 16, pp. 332-333.
Upper Hermosa formation: San Juan and Grand River regions.
1915. *Conularia sp.* Girty, U. S. Geol. Survey Bull. 436, p. 20, pl. 6, fig. 8.
Park City formation: Montpelier, Idaho.

Only two specimens, both imperfect, appear in our collection. One is from the Wind River Mountains and the other from the cap rock of the main phosphate bed at Montpelier, Idaho. The preservation of the critical structures is not good enough to make identification certain.

Horizon and locality:—Top Limestone member: Wind River Mountains, Wyoming; phosphate beds: Montpelier, Idaho.

Class SCAPHOPODA
Family DENTALIIDAE
Genus PLAGIOGLYPTA Pilsbry and Sharp

Plagioglypta canna (White)

Plate XV, figure 6.

1874. *Dentalium canna* White, U. S. Geog. Survey W. 100th Mer., Prel. Rep. Inv. Foss., p. 23.
Coal Measures: New Mexico and Arizona.
1877. *Dentalium canna* White, U. S. Geog. Survey W. 100th Mer., vol. 4, p. 156, pl. 12, figs. 6a-b.
1903. *Plagioglypta canna* Girty, U. S. Geol. Survey Prof. Paper 16, p. 452.
1908. *Plagioglypta canna* Girty, U. S. Geol. Survey Prof. Paper 58, p. 450.
Delaware Mountain formation: Guadalupe Point, Texas.
1908. *Plagioglypta canna* Girty, U. S. Geol. Survey Bull. 389, pp. 95-96, pl. 11, fig. 11.
Manzano group: New Mexico.
1910. *Plagioglypta canna* Girty, U. S. Geol. Survey Bull. 436, pp. 44-45, pl. 6, fig. 14.
Park City formation: Montpelier, Idaho.
1916. *Plagioglypta canna* Branson, Jour. Geol., vol. 24, p. 667, pl. 3, fig. 13.
Lower Embar formation: Wind River Mountains, Wyoming.

This species is very common in all the faunules of the Phosphoria up to the base of the Top Limestone member.

Horizon and locality:—Lower Chert, Lower Phosphate, Pustula, and Hustedia members: Wind River Mountains, Owl Creek Mountains, Cody, Wyoming; phosphate beds: Montpelier, Idaho.

Plagioglypta monolineata C. Branson, n. sp.

Plate XV, figure 7.

The Top Limestone member bears a *Plagioglypta* which differs from *P. canna*. The shell is curved and bears a single, heavy longitudinal rib on the convex side of the curve. On either side of the rib is a flattened area about 1 mm. wide. The rib is somewhat less than 1 mm. high and is about three times as wide. Its crest is broadly rounded. In all other respects, the shell is like *P.*

canna. It is cylindrical in outline, slightly curved, and is smooth except for very fine growth lines. The large end flares open, and the shell is thicker in that region.

The largest nearly complete specimen is 42 mm. long, 8 mm. in diameter at the large end, and 5.5 mm. in diameter at the smaller end. The complete shell was probably twice as long. Some very imperfect specimens are larger, one being 10 mm. in diameter at the large end. The average diameter at the large end is about 6 mm. and the average length about 60 mm. Very small specimens are found also; one has a maximum diameter of 2 mm.

Horizon and locality:—Top Limestone member: Wind River and Owl Creek Mountains, Wyoming.

Class CEPHALOPODA
Order NAUTILOIDEA
Suborder ORTHOCHOANITES
Family TRIGONOCERATIDAE
Genus COLOCERAS Hyatt

Coloceras sp.

Plate XV, figure 3.

No specimen in good condition was found. The diameter of the best specimen is about 70 mm. and the width of the umbilicus 10 mm. The chambers are from 6 to 7 mm. in height. The sutures are slightly lobed on the sides, and distinctly lobed on the venter; the greatest lobation is next to the living chamber.

Horizon and locality:—Top Limestone member: Wind River and Owl Creek Mountains, Wyoming.

Family SOLENOCHEILODAE
Genus ASYMPTOCERAS Ryckholt

Asymptoceras phosphoriense C. Branson, n. sp.

Plate XII, figure 11; Plate XV, figures 4-5.

Shell large; first chambers tightly coiled, last five chambers nearly straight; septa broadly curved; chambers widest at the umbilical shoulder, sides only slightly curved, ventral surface broad and almost flat; hyponomic sinus very indistinct, represented by a broad bend of the suture; sutures with a slight but broad lobe on the sides; siphuncle small, situated 6 mm. from the dorsum; dorsum of last whorl broadly grooved to receive the first chambers; aperture apparently sub-ovate and very large; septa of last chambers 10 mm. apart; living chamber at least 70 mm. long, breadth at umbilical shoulders 60 mm., height of chambers 35 mm.; dimension from last preserved part of living chamber to opposite side of coil 120 mm.

The specimen is sufficiently well preserved to show that it is very different from other species of the genus. *A. newloni* Hyatt is similar in many respects, but its hyponomic sinus is a deep lobe and its siphon is near the venter or is central.

Horizon and locality:—Top Limestone member: Owl Creek Mountains, Wyoming.

Phylum CHORDATA
Subphylum VERTEBRATA
Class PISCES
Subclass SELACHII
Order PLAGIOSTOMI
Suborder TECTOSPONDYLI
Family COCHLIODONTIDAE
Genus HELODUS Agassiz

Helodus subpolitus Branson

Plate XVI, figures 6-7.

1916. *Helodus subpolitus* Branson, Jour. Geol., vol. 24, pp. 642-643, pl. 1, figs. 6-16.
Lower Embar formation: Wind River Mountains, Wyoming.

Investigations during the past few summers have extended the known range of this species through most of the Phosphoria formation. In addition to the abundant specimens in the Lower Phosphate member, a few teeth have been found in the Pustula member and in the thin phosphate beds below the Hustedia member.

Horizon and locality:—Lower Phosphate and Pustula members: Wind River and Owl Creek Mountains, Wyoming; phosphate beds below the Hustedia member: Wind River Mountains, Wyoming.

Family PETALODONTIDAE
Genus JANASSA Munster

Janassa unguicula Eastman

Plate XVI, figures 4-5.

1903. *Janassa unguicula* Eastman, Bull. Mus. Comp. Zool. Harvard, vol. 39, pp. 173-174, pl. 2, fig. 13.
Carboniferous: Carlinville, Illinois.

1903. *Janassa unguicula* Woodruff, Nebraska Geol. Survey, vol. 2, p. 290, pl. 18, fig. 8.
Coal Measures: Cedar Creek, Nebraska.

1916. *Janassa unguicula* Branson, Jour. Geol., vol. 24, pp. 646-647, pl. 2, figs. 7-18.
Lower Embar formation: Wind River Mountains, Wyoming.

A single specimen of this species was found in the Pustula member. The species is fairly common in the Lower Phosphate member.

Horizon and locality:—Lower Phosphate and Pustula members: Wind River Mountains, Wyoming.

Family uncertain

Genus HAMATUS C. Branson, n. gen.

Tooth hook-shaped, pointed, crown recurved, base expanded and cup-shaped. Anterior and posterior margins of tooth keeled in part; in immature forms the keels are serrate. Surface of crown crenulate, interior with large dentine core.

The genotype is *Hamatus phosphoriensis*, described below. It has been found only in the Phosphoria formation in the Wind River and Owl Creek

Mountains. The taxonomic position of the new genus is impossible to determine, since no similar form is known. It is possible that the teeth may be from the mouth of an *Edestus*-like form, such as *Lissoprion*, but this suggestion is merely a speculation based upon the fact that *Lissoprion* also occurs in the Phosphoria and has peculiar teeth. The generic name refers to the hook-like appearance of the teeth.

Hamatus phosphoriensis C. Branson, n. sp.

Plate XVI, figures 8-10.

In the thin bed of phosphate at the top of the Pustula member, this peculiar type occurs. It is unlike any known form.

Shape in general hook-like, resembling a bird's claw, crown strongly recurved, forming an arc about one-third the circumference of a circle; crown flattened laterally, oval in cross-section, tip pointed, dentine extending as a core nearly to the tip; base expanded, oval, broader posteriorly, with large dentine core. Surface of crown smooth or marked by crenulations or wrinkles of irregular orientation. Anterior side of crown bearing a narrow serrated keel along its upper half; posterior side of crown with similar keel, not serrated and occupying only the upper third of the edge. The teeth are often scarred, probably by hard materials accidentally bitten, for the scars are always transverse, are fairly regular in depth, and the teeth show almost no signs of erosion.

A small specimen is interpreted as an undeveloped tooth, auxiliary in nature. This view is supported by the unworn condition of the surface. The posterior edge of this specimen bears a heavily serrated keel all along the margin of the crown. The serrations are broadly rounded and are separated by notches nearly as wide as the serrations. They are about one-twentieth as high as the dimension of the tooth from anterior to posterior. Twenty-four serrations were counted, and the tip of the crown is missing. The anterior side bears a similar serrated keel, but here the serrations occupy only the upper two-thirds of the anterior margin of the crown, and they are separated by deep, narrow notches. It seems reasonable to suppose that this tooth represents the early condition of all the teeth, and that the serrated keels degenerate to the short, almost-smooth keels of the mature tooth.

An average tooth is 11 mm. high, 4 mm. long, and 2 mm. wide. The immature specimen is 6 mm. high, 1.5 mm. long, and 0.6 mm. wide. The anterior margin of the largest tooth is 18 mm. long.

Associated with *H. phosphoriensis* are teeth of *Helodus subpolitus*, an ichthyodorulite, and numerous capulid spine denticles. There seems to be no relationship, for all of these forms are found in the Lower Phosphate member, while *H. phosphoriensis* is not. Two specimens from the Owl Creek Mountains are flatter laterally and may belong to a distinct species. The new species is named *phosphoriensis* because of its occurrence in the Phosphoria formation.

Horizon and locality:—Pustula member: Wind River and Owl Creek Mountains, Wyoming.

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PLATE I.

Erisocrinus? sp. (p. 24)

Figure 1. The basals and radials of the only specimen. A view from below, x 2.

Figure 2. Same, anterior view, x 2.

Figure 3. Same, posterior view, x 2.

Figure 4. Same, view from above, x 2.

Ceriocrinus? sp. (p. 24)

Figure 5. The interior of a radial plate, x 2.

Bryozoa (pp.24-5)

Figure 6. Bryozoan B, x 2.

Figure 7. *Leioclema* sp., x 2.

Figure 8. *Batostomella* sp., x 2.

Figure 9. Bryozoan A, x 2.

Figure 10. *Batostomella*? sp., x 2.

Figure 11. *Stenopora* sp., x 2.

Figure 12. *Fenestella* sp., x 2.

Figure 13. *Polypora* sp., x 2.

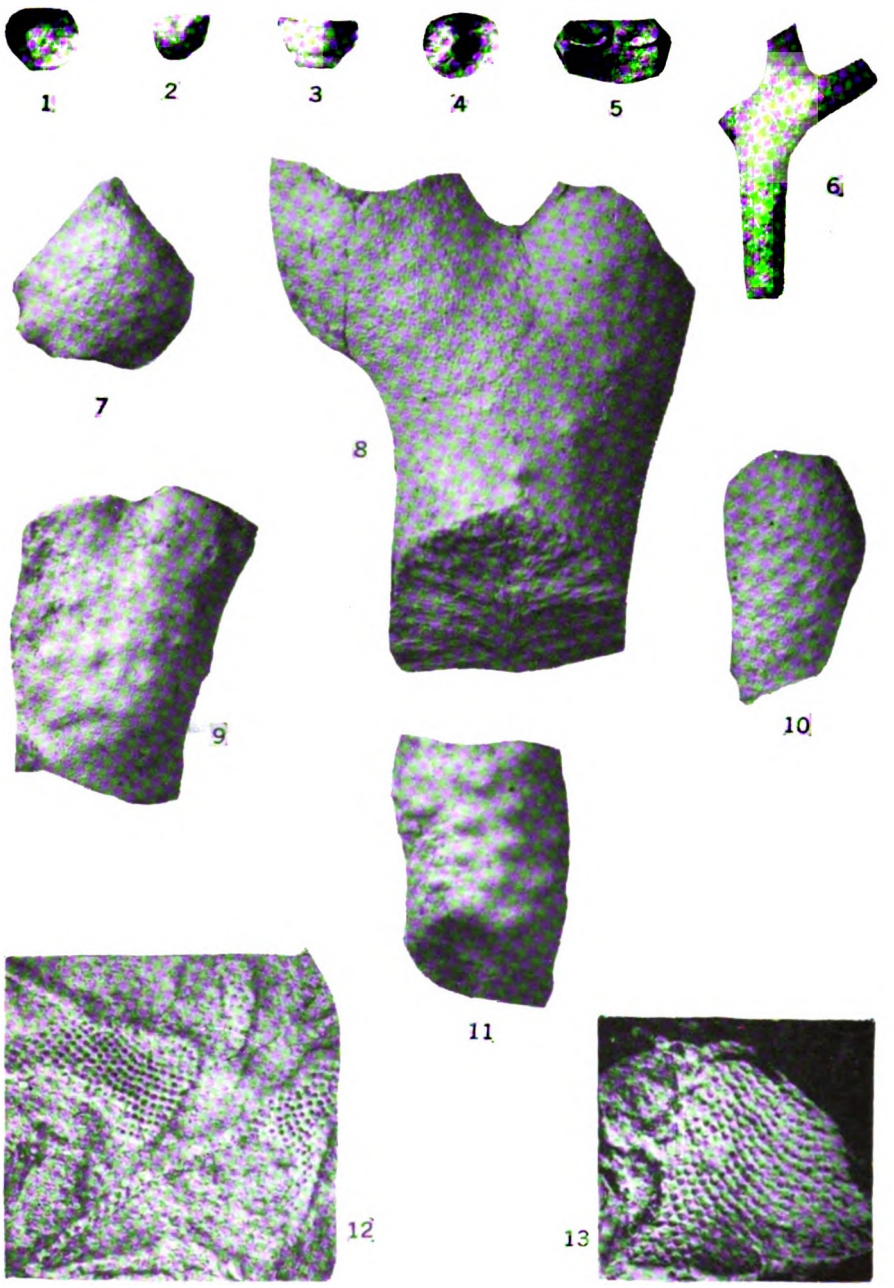

PLATE I

PLATE II

Lingula carbonaria?

Figure 1. A dorsal valve from the phosphate beds at Thomas Fork, Wyoming. (From Girty [42]).

Lingulidiscina missouriensis? (p. 25)

Figure 2. A dorsal valve from Montpelier, Idaho, x 2. (From Girty[42]).
Figure 3. A ventral valve from the Wind River Mountains, Wyoming.

Lingulidiscina sp.

Figure 4. A ventral valve, x 2.
Figure 5. Same, lateral view, x 2.

Orbiculoidea sp. (p. 26)

Figure 6. A specimen from the Owl Creek Mountains, x 2.
Figure 7. A specimen from the Wind River Mountains, x 2.

Orbiculoidea utahensis (pp. 25-6)

Figure 8. Lateral view of a complete internal cast, x 2.
Figure 9. Same, ventral view, x 2.
Figure 10. View of the interior of a pedicle valve (From Branson[13]).
Figure 11. Lateral view of a brachial valve (From Branson[13]).

Ambocoelia arcuata (p. 36)

Figure 12. A pedicle valve from the Wind River Mountains.
Figure 13. A pedicle valve of a specimen from the phosphate beds, Montpelier, Idaho. (From Girty[42]).
Figure 14. Same, dorsal view.

Pugnax wecksi

Figure 15. Anterior view of a complete specimen from Montpelier, Idaho. (From Girty[42]).
Figure 16. Same, dorsal view.

Rhynchopora taylori (p. 34)

Figure 17. Anterior view of a specimen from Montpelier, Idaho. (From Girty[42]).
Figure 18. Ventral view of a specimen from the Wind River Mountains.
Figure 19. Dorsal view of another specimen from the same locality.

Orthotetes sulcus (pp. 27-8)

Figure 20. A brachial valve.

Diclasma phosphoriensis (pp. 34-5)

Figure 21. The type specimen, lateral view, x 2.
Figure 22. Same, ventral view, x 2.
Figure 23. Same, dorsal view, x 2.
Figure 24. Same, posterior view.
Figure 25. An elongate specimen, ventral view, x 2.

Composita parva (p. 40)

Figure 26. The type specimen, ventral view, x 2.

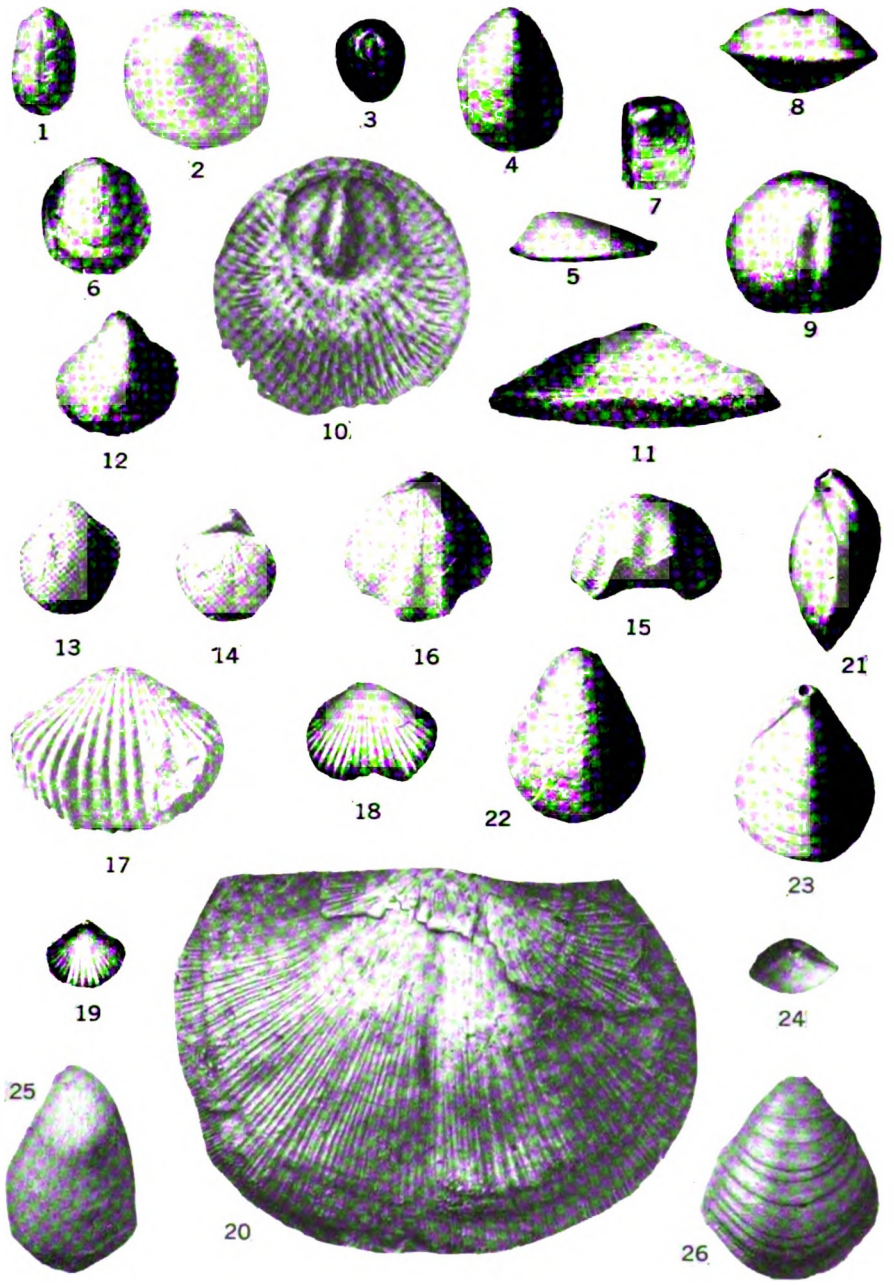

PLATE II

PLATE III.

Orthotetes sulcus (pp. 27-8)

Figure 1. The type specimen, ventral view.
Figure 2. Same, lateral view.
Figure 3. Same, posterior view.
Figure 4. Same, dorsal view.

Rhynchopora taylori (p. 34)

Figures 5-9. Sections through anterior end of shell.

Pugnoides osagensis (p. 34).

Figure 10. A typical specimen, ventral view.
Figure 11. Same, anterior view.

Squamularia perplexa? (p. 36)

Figure 12. A nearly complete specimen, ventral view.
Figure 13. Same, lateral view.

Spiriferina kentuckyensis (p. 37)

Figure 14. A typical specimen, ventral view.
Figure 15. A small specimen, ventral view.
Figure 16. A robust specimen, posterior view.

Composita quadricostata (p. 39)

Figure 17. The holotype, dorsal view, x 2.
Figure 18. Same, natural size.
Figure 19. Same, ventral view.
Figure 20. Same, anterior view.

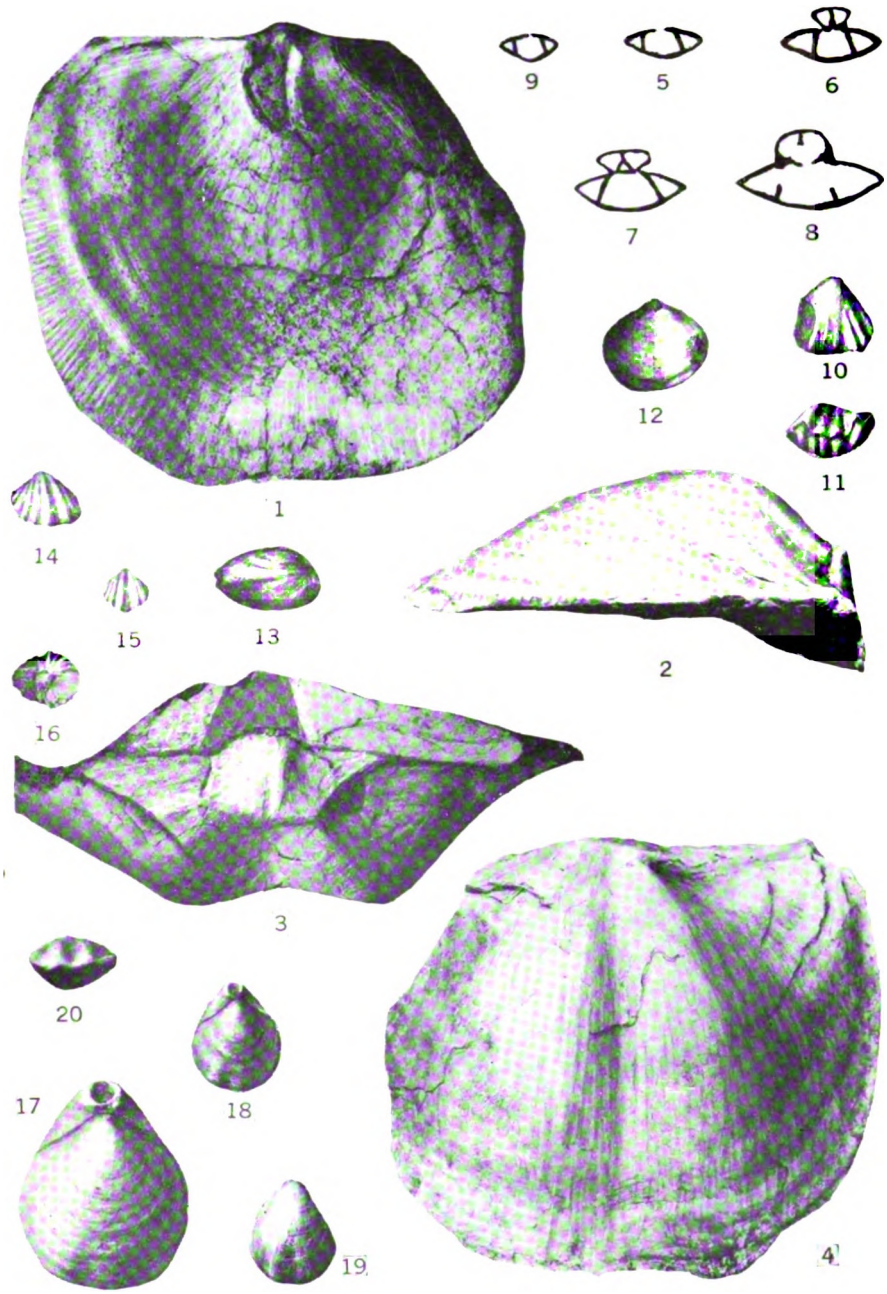

PLATE III

PLATE IV

Orthotetes magnus (pp. 26-7)

Figure 1. A small specimen, view of the cardinal area.
Figure 2. Same, ventral view.
Figure 3. A large brachial valve, lateral view of the posterior portion of the valve, showing the hinge platform, crura, and median septum.
Figure 4. The type specimen, ventral view.
Figure 5. Same specimen as in figure 3, posterior view.

Aulosteges hispidus (pp. 32-3)

Figure 6. A normal specimen, view of the cardinal area.
Figure 7. A silicified specimen, lateral view.
Figure 8. Same, ventral view.

PLATE IV

PLATE V

Meekella rotunda (pp. 28-9)

Figure 1. A cotype, dorsal view, showing cardinal area.
Figure 2. A brachial valve, plaster squeeze of a mold of the interior.
Figure 3. A large specimen, ventral view.
Figure 4. A typical specimen, lateral view.
Figure 5. A small individual, lateral view.
Figure 6. A large specimen, dorsal view.

Chonetes ostiolatus

Figure 7. A pedicle valve from the phosphate beds at Montpelier, Idaho, x 2. (From Girty[42]).

Chonetes phosphoriensis (p. 29)

Figure 8. Interior of a pedicle valve, x 2.
Figure 9. Cast of the interior of a pedicle valve, showing median septum and dental plates, x 2.
Figure 10. A small specimen, ventral view.
Figure 11. The type specimen, ventral view, x 2.

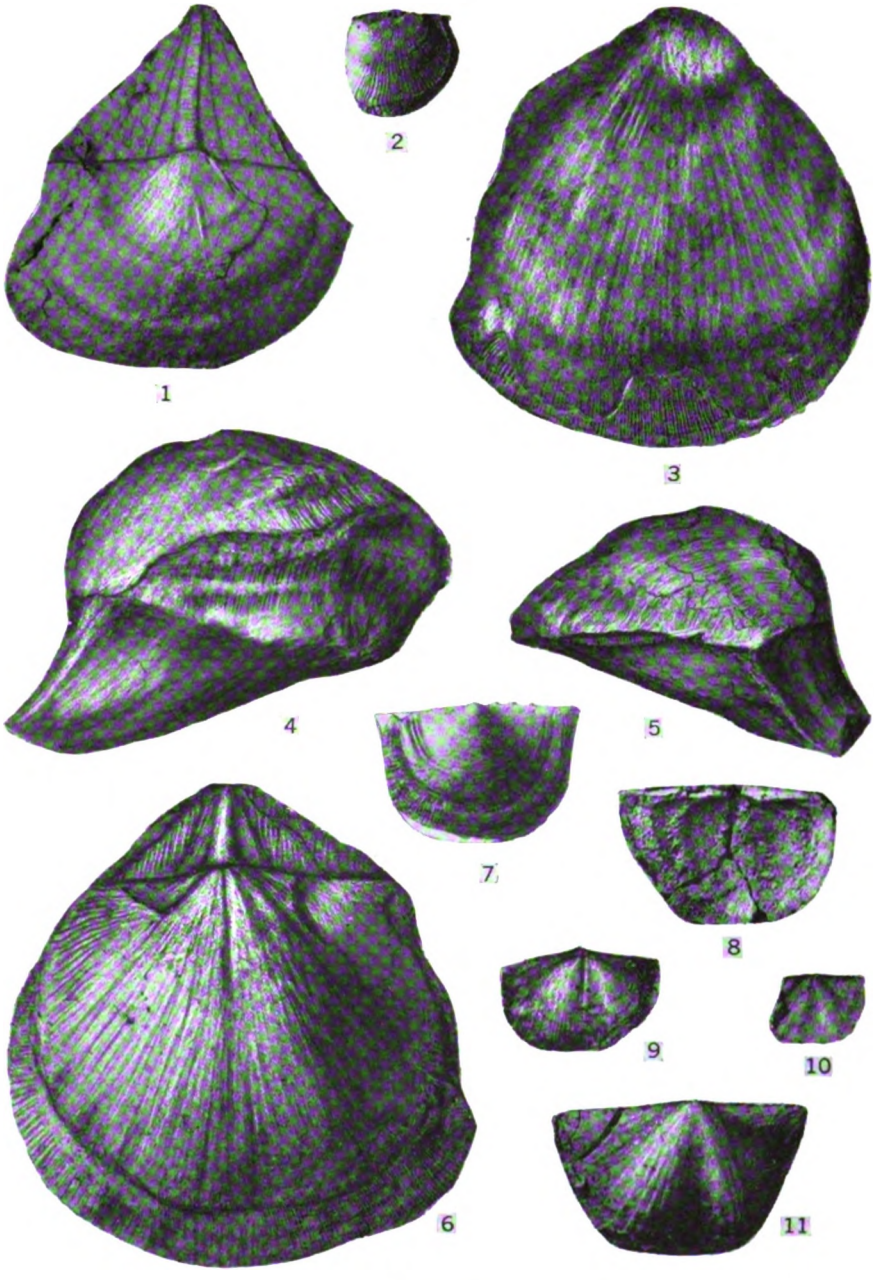

PLATE V

PLATE VI

Aulosteges hispidus (pp. 32-3)

Figure 1. A pedicle valve, ventral view.
Figure 2. Same, dorsal view.
Figure 3. Same, lateral view.
Figure 4. A large specimen, ventral view.
Figure 5. A portion of the anterior slope, showing details of ornamentation, x 4.

Spirifer pseudocameratus (p. 35)

Figure 6. A narrow specimen, dorsal view.
Figure 7. A specimen with obsolete ears, ventral view.
Figure 8. A large, typical specimen, lateral view.

Spiriferina pulchra (pp. 36-7)

Figure 9. A specimen with extended ears, dorsal view.
Figure 10. A typical specimen, posterior view.
Figure 11. Same, ventral view.

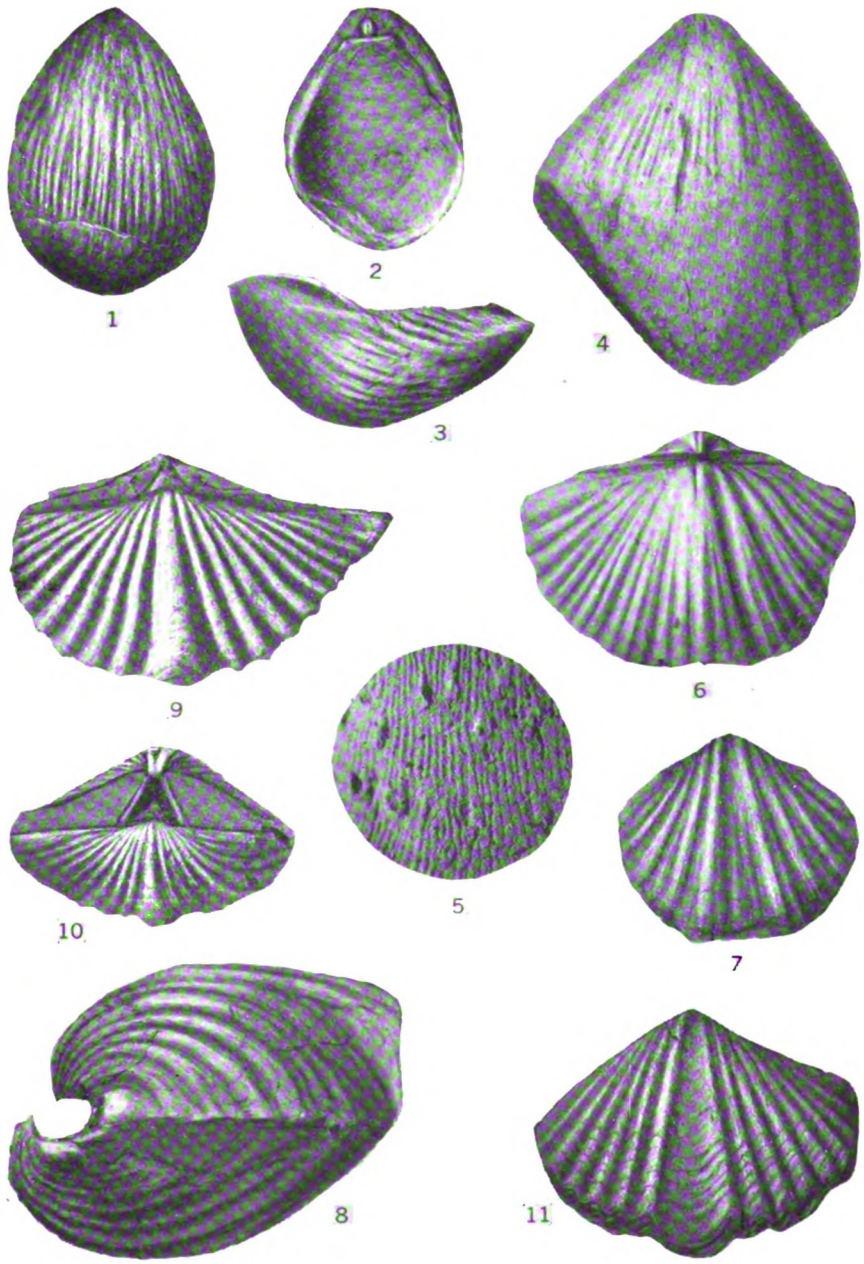

PLATE VI

PLATE VII

Meekella rotunda (pp. 28-9)

Figures 1-7. Sections through the umbonal region, showing the crura and brachidia.

Productus phosphaticus (p. 30)

Figure 8. A pedicle valve, ventral view. (From Girty[42])

Figure 9. A pedicle valve from Wyoming, ventral view.

Productus geniculatus

Figure 10. The type specimen, ventral view. (From Girty[42]).

Productus multistriatus (p. 30).

Figure 11. A typical specimen, dorsal view.

Figure 12. A large specimen, ventral view.

Productus semireticulatus (p. 30)

Figure 13. The only specimen found, dorsal view.

Figure 14. Same, ventral view.

Pustula montpelierensis (p. 32)

Figure 15. The type specimen from Montpelier, Idaho, ventral view. (From Girty[42]).

Figure 16. A complete specimen from the Wind River Mountains, ventral view, x 2.

Figure 17. Same, dorsal view.

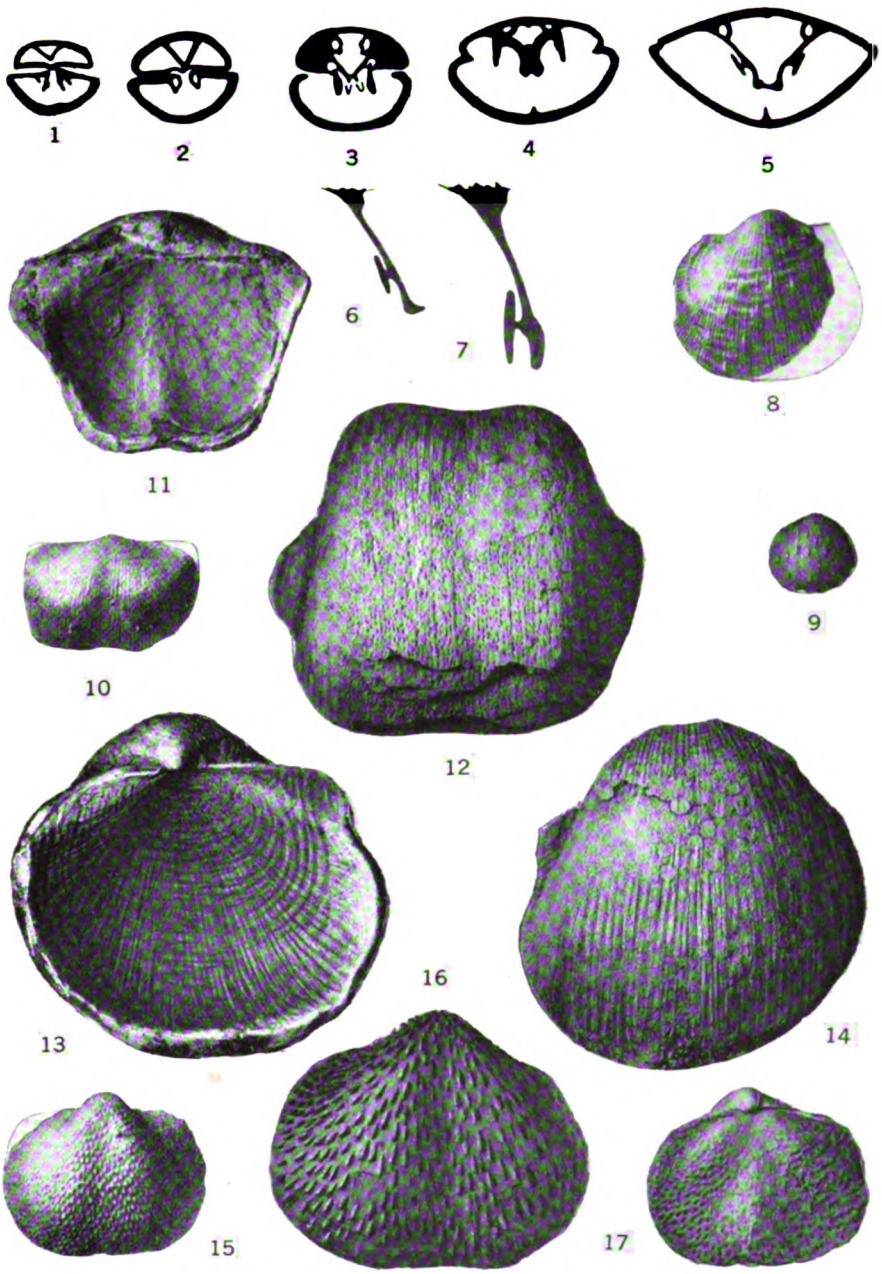

PLATE VII

PLATE VIII

Pustula nevadensis (p. 31)

Figure 1. A typical specimen, ventral view.
Figure 2. Same, dorsal view, showing cardinal process.
Figure 3. A specimen with spines preserved, posterior view.
Figure 4. Same, x 4.
Figure 5. Same, detail of hinge, x 4.
Figure 6. A cardinal process, ventral view.
Figure 7. A very large specimen, ventral view.
Figure 8. A specimen showing muscle scars, dorsal view.

Pustula subhorrida (*p.* 32)

Figure 9. A typical specimen, ventral view.
Figure 10. Same, dorsal view.
Figure 11. Same, lateral view.

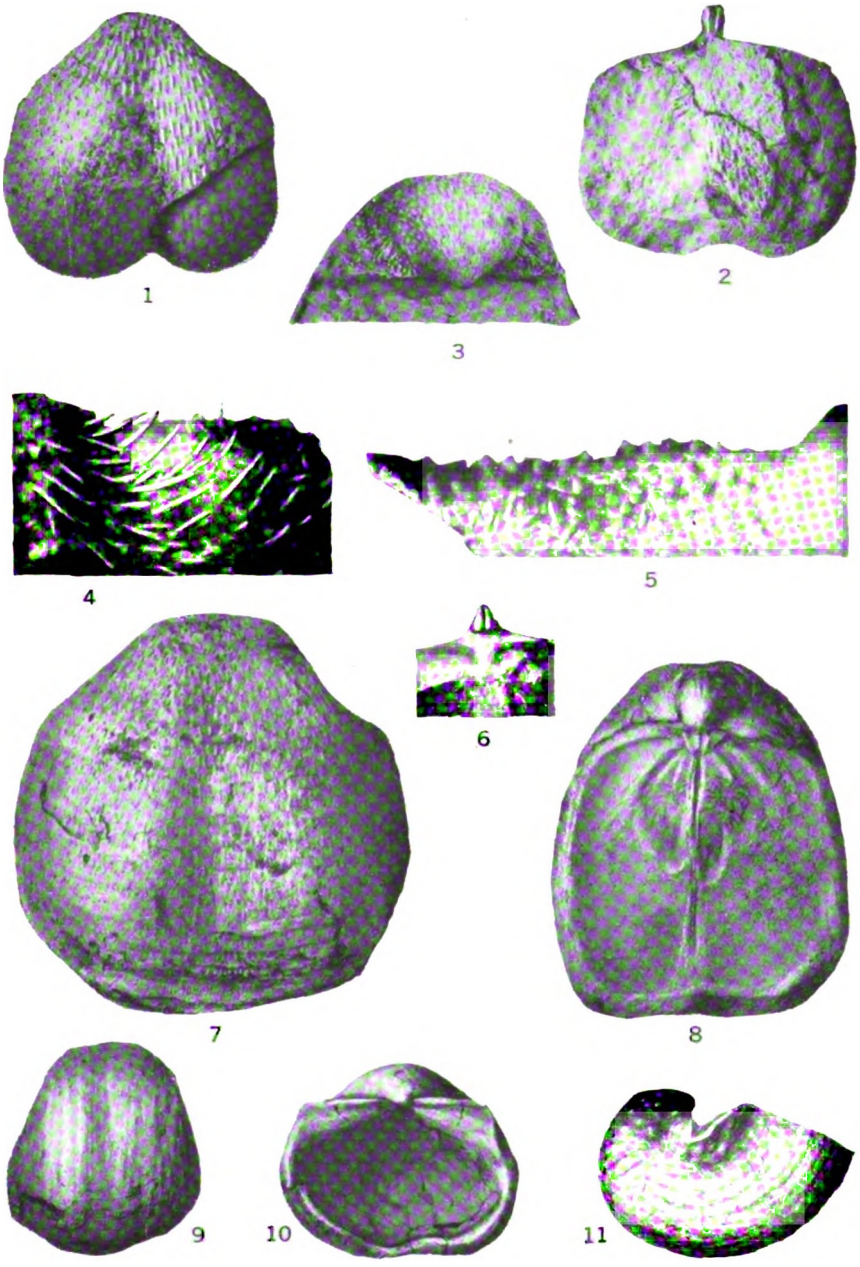

PLATE VIII

PLATE IX

Spiriferina pulchra (pp. 36-7)

Figure 1. A pedicle valve, view of the interior.

Hustedia phosphoriensis (pp. 37-8)

Figure 2. A perfect specimen, dorsal view.
Figure 3. The type specimen, dorsal view.
Figure 4. Same, ventral view, x 2.
Figure 5. Same, dorsal view, x 2.
Figure 6. Same, lateral view.
Figure 7. A robust individual, lateral view, x 2.

Composita subtilita (p. 38)

Figure 8. A typical specimen, ventral view.
Figure 9. A typical specimen, dorsal view.
Figure 10. A globose specimen, lateral view.
Figure 11. An elongate specimen with a deep and narrow sinus, ventral view.

Composita parva (p. 40)

Figure 12. The type specimen, dorsal view.
Figure 13. Same, posterior view.
Figure 14, Same, ventral view.
Figure 15. Same, dorsal view, x 2.
Figure 16. Same, lateral view, x 2.

Composita gigantea (p. 39)

Figure 17. The type specimen, lateral view.

Edmondia? phosphatica

Figure 18. A left valve from Montpelier, Idaho. (From Girty[42]).

Grammysia? Carbonaria

Figure 19. A right valve from Montpelier, Idaho. (From Girty[42]).

Solenomya radiata? (p. 41)

Figure 21. A nearly complete specimen, view of the right valve.
Figure 22. Same, dorsal view.

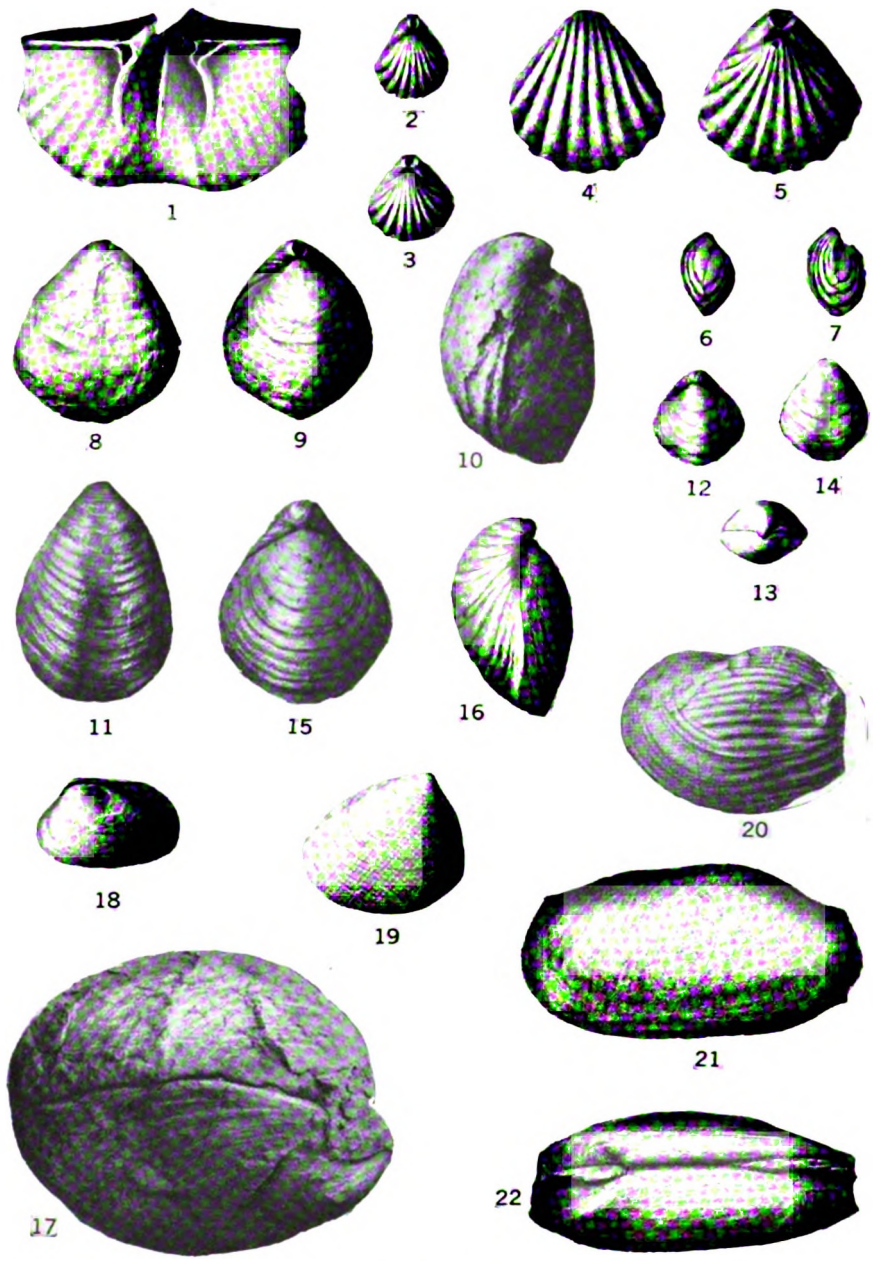

PLATE IX

PLATE X

Nucula poposiensis (p. 42)

Figure 1. A large cast of the interior, view from right side, x 2.
Figure 2. A specimen from the Lower Phosphate member, dorsal view, x 4/3. (From Branson[13]).
Figure 3. Same, lateral view, x 4/3.
Figure 4. A specimen from the Pustula member, lateral view.
Figure 5. The type specimen, view of escutcheon, x 2.
Figure 6. Same, lateral view, x 2.

Nucula montpelierensis (p. 42)

Figure 7. A normal specimen, dorsal view.
Figure 8. Same, lateral view.
Figure 9. A small specimen, lateral view.

Nucula perumbonata

Figure 10. A specimen from the Lower Phosphate member, dorsal view, x 4/3. (From Branson[13]).
Figure 11. Same, lateral view, x 4/3.

Nucula pulchella (p. 43)

Figure 12. A specimen from the Lower Phosphate member, lateral view, x 4/3. (From Branson[13]).
Figure 13. A specimen from the Pustula member, lateral view.
Figure 14. Same, view of the escutcheon, x 2.

Leda bellistriata (p. 43)

Figure 15. An internal cast, lateral view, x 2.
Figure 16. A specimen from the Lower Phosphate member, lateral view, x 4/3. From Branson[13]).
Figure 17. Another specimen from the same member, lateral view, x 4/3. (From Branson[13]).
Figure 18. A specimen from the Pustula member, lateral view.
Figure 19. A large specimen, lateral view.
Figure 20. A specimen from the Lower Phosphate member, dorsal view, x 4/3. (From Branson[13]).

Leda obesa (pp. 43-4)

Figure 21. An internal cast, lateral view.
Figure 22. Same, dorsal view.

Yoldia mechesneyana

Figure 23. A specimen from Montpelier, Idaho, lateral view, x 3. (From Girty[42]).

Monopteria sp. (pp. 44)

Figure 24. A right valve, lateral view.

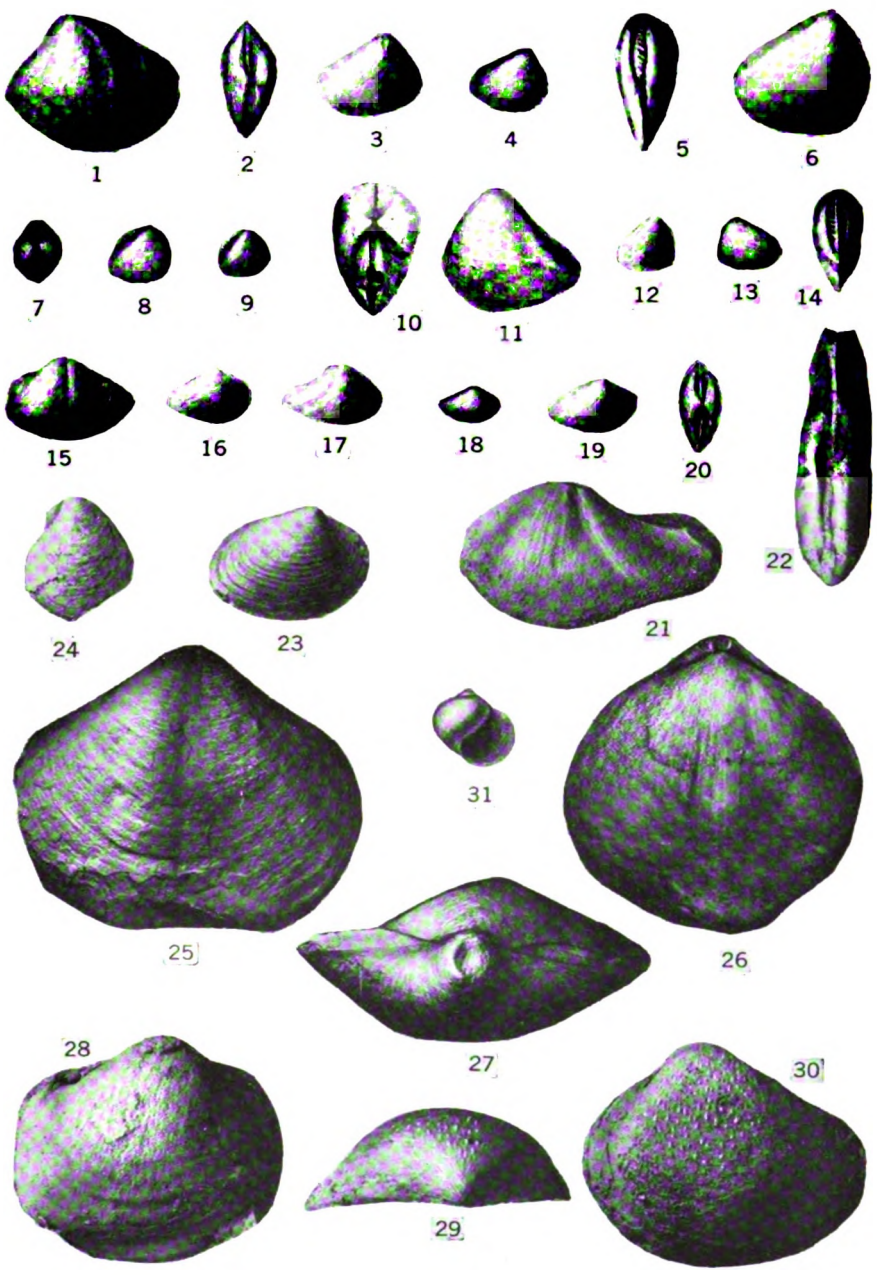
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PLATE X

Composita plana (p. 40)

Figure 25. The type specimen, ventral view.
Figure 26. A less flattened specimen, dorsal view.
Figure 27. The type specimen, posterior view.

Edmondia gibbosa (p. 41)

Figure 28. A typical right valve, lateral view.
Figure 29. A spinose specimen, dorsal view.
Figure 30. A spinose specimen, lateral view.

Naticopsis tayloriana

Figure 31. The type specimen, side view, x 2. (From Girty[42]).

PLATE XI

Deltopecten vanvleeti (p. 49)

Figure 1. A large imperfect specimen, lateral view.
Figure 2. A spinose specimen, lateral view.

Aviculipecten phosphaticus

Figure 3. A squeeze from the typical specimen, the mold of a left valve. x 2. (From Girty[42]).

Aviculipecten alternatus (p. 49)

Figure 4. The cotype, lateral view.
Figure 5. Same, anterior view.
Figure 6. A cotype, a left valve, lateral view, x 2.
Figure 7. Same, dorsal view, x 2.
Figure 8. Same, anterior view, x 2.

Aviculipecten alatus (pp. 47-8)

Figure 9. The type specimen, a left valve, lateral view.
Figure 10. Same, dorsal view.

Deltopecten sexradiata (p. 50)

Figure 11. A cotype, a right valve, lateral view.
Figure 12. A cotype, a left valve, lateral view.

Cyrtorostra sexradiata (p. 45)

Figure 13. The type specimen, a left valve, lateral view.
Figure 14. Same, x 2.
Figure 15. A large specimen, lateral view, x 2.

Cyrtorostra varicostata (pp. 44-5)

Figure 16. The type specimen, a right valve, x 2.
Figure 17. Same, anterior view, x 2.
Figure 18. A specimen with a very curved beak, anterior view, x 2.
Figure 19. A specimen showing ventral spines, lateral view, x 2.

Aviculipecten? montpelierensis

Figure 20. A small right valve, x 2. (From Girty[42]).

Deltopecten occidentalis (p. 50)

Figure 21. A broken right valve, lateral view.

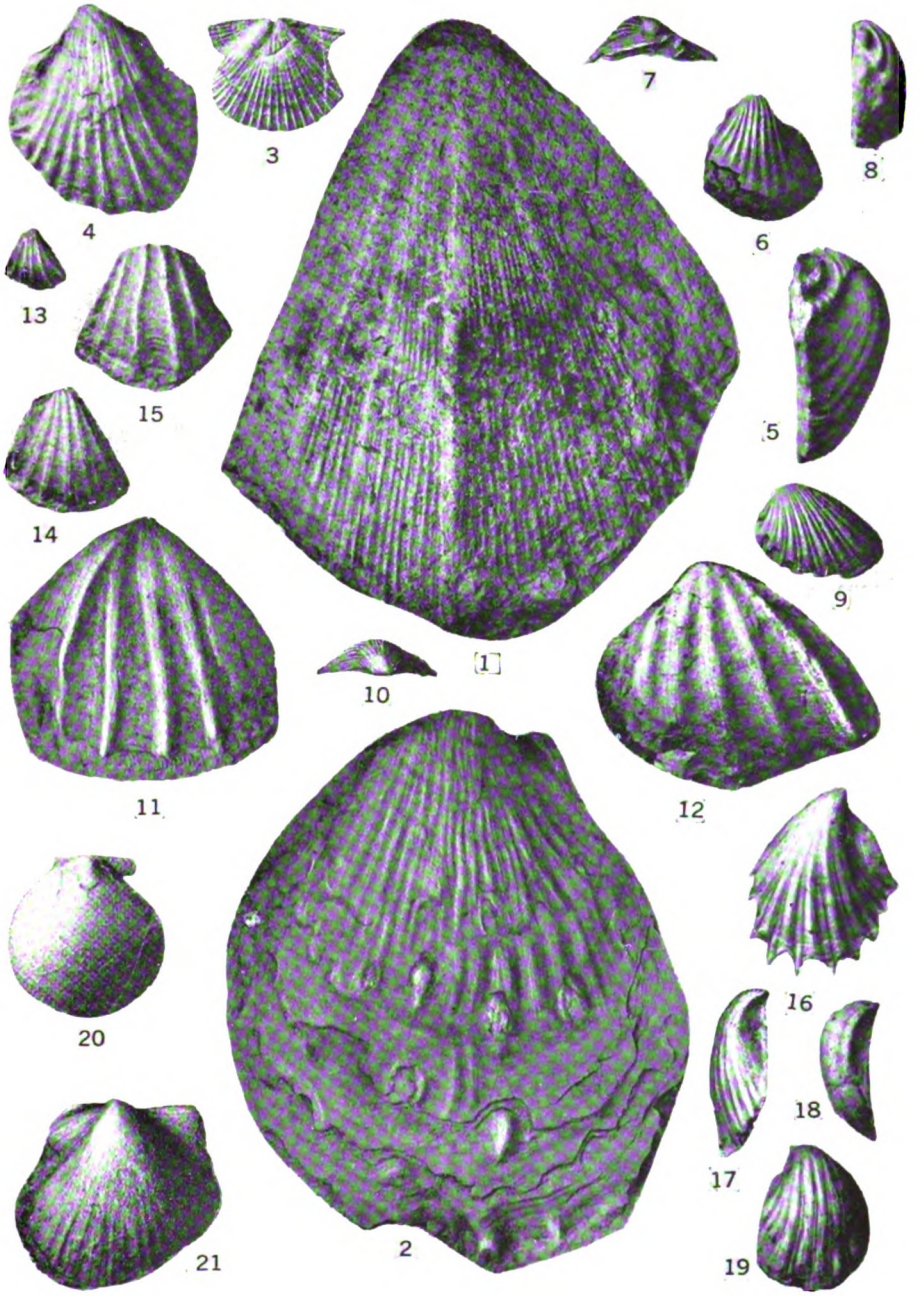

PLATE XI

PLATE XII

Myalina sinuata (pp. 45-6)

Figure 1. The type specimen, a left valve, lateral view.

Aviculipecten landerensis (p. 48)

Figure 2. The type specimen, a right valve, lateral view.
Figure 3. Same, x 4.

Pleurotomaria sp. (p. 56)

Figure 4. The only specimen, side view.

Pleurophorus pinnaformis (pp. 52-3)

Figure 5. The type specimen, view from left side.
Figure 6. Same, dorsal view.
Figure 7. Same, view of right valve.

Pleurophorus pricei (p. 52)

Figure 8. Specimen showing deep muscle pit, x 2.
Figure 9. The type specimen, dorsal view, x 2.

Orthonema sp. (p. 57)

Figure 10. The only specimen, side view.

Asymptoceras phosphoriense (p. 59)

Figure 11. The type specimen, ventral view.

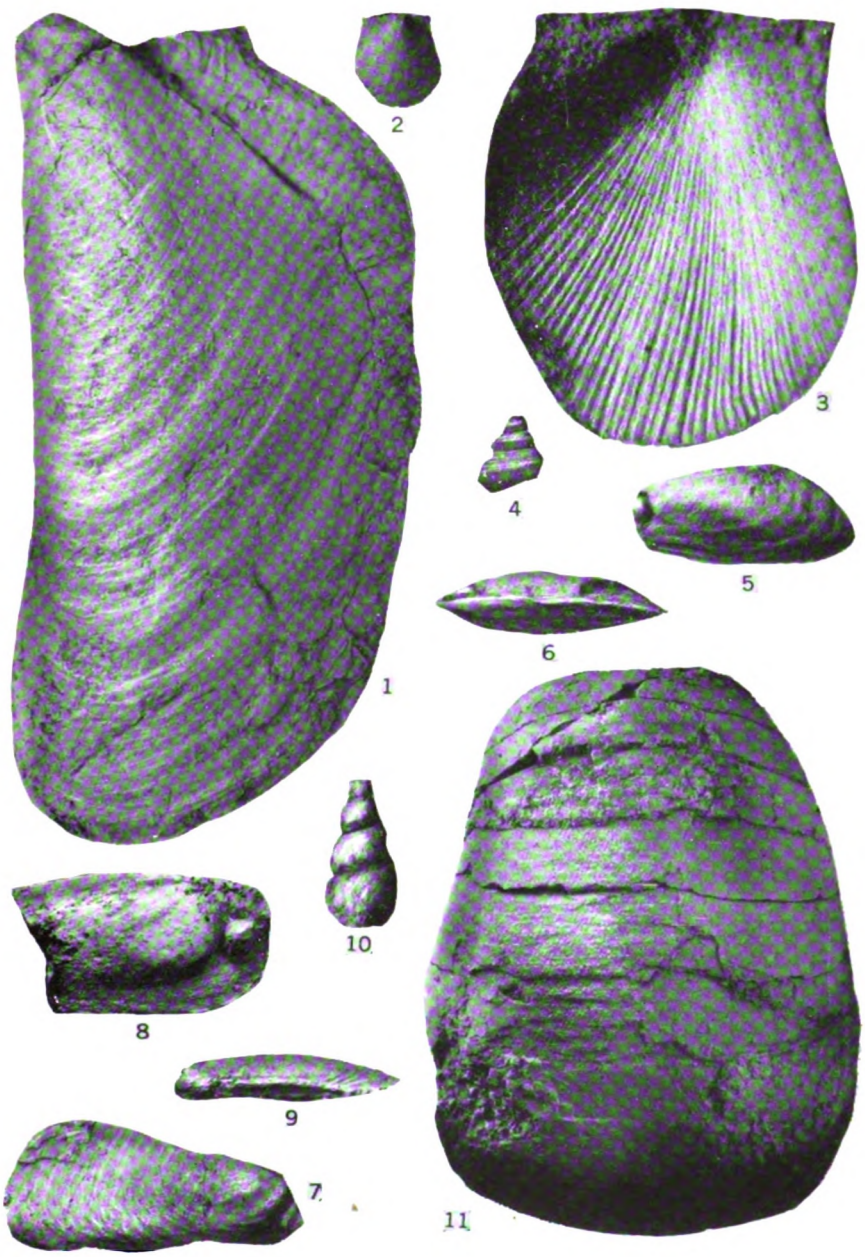

PLATE XII

PLATE XIII

Schizodus canalis (pp. 46-7)

Figure 1. The type specimen, a right valve.

Schizodus phosphoriensis (p. 47)

Figure 2. A large left valve, lateral view.
Figure 3. Cast of the interior showing sinuses, lateral view.
Figure 4. The type specimen, a left valve, lateral view.
Figure 5. Same, dorsal view.
Figure 6. Same, posterior view of dentition, x 2.
Figure 7. Same, view of dentition, x 2.

Schizodus conicinnus (p. 46)

Figure 8. The type specimen, anterior view, x 2.
Figure 9. Same, lateral view, x 2.
Figure 10. An internal cast, lateral view, x 2.

Pleurophorus pricei (p. 52)

Figure 11. The type specimen, a right valve, lateral view, x 4.
Figure 12. Another right valve, lateral view, x 2.

Pleurophorus pinnaformis (pp. 52-3)

Figure 13. A large right valve, lateral view.

Pleurotomaria robusta (pp. 55-6)

Figure 14. The type specimen, top view, x 2.
Figure 15. Same, lateral view, x 2.

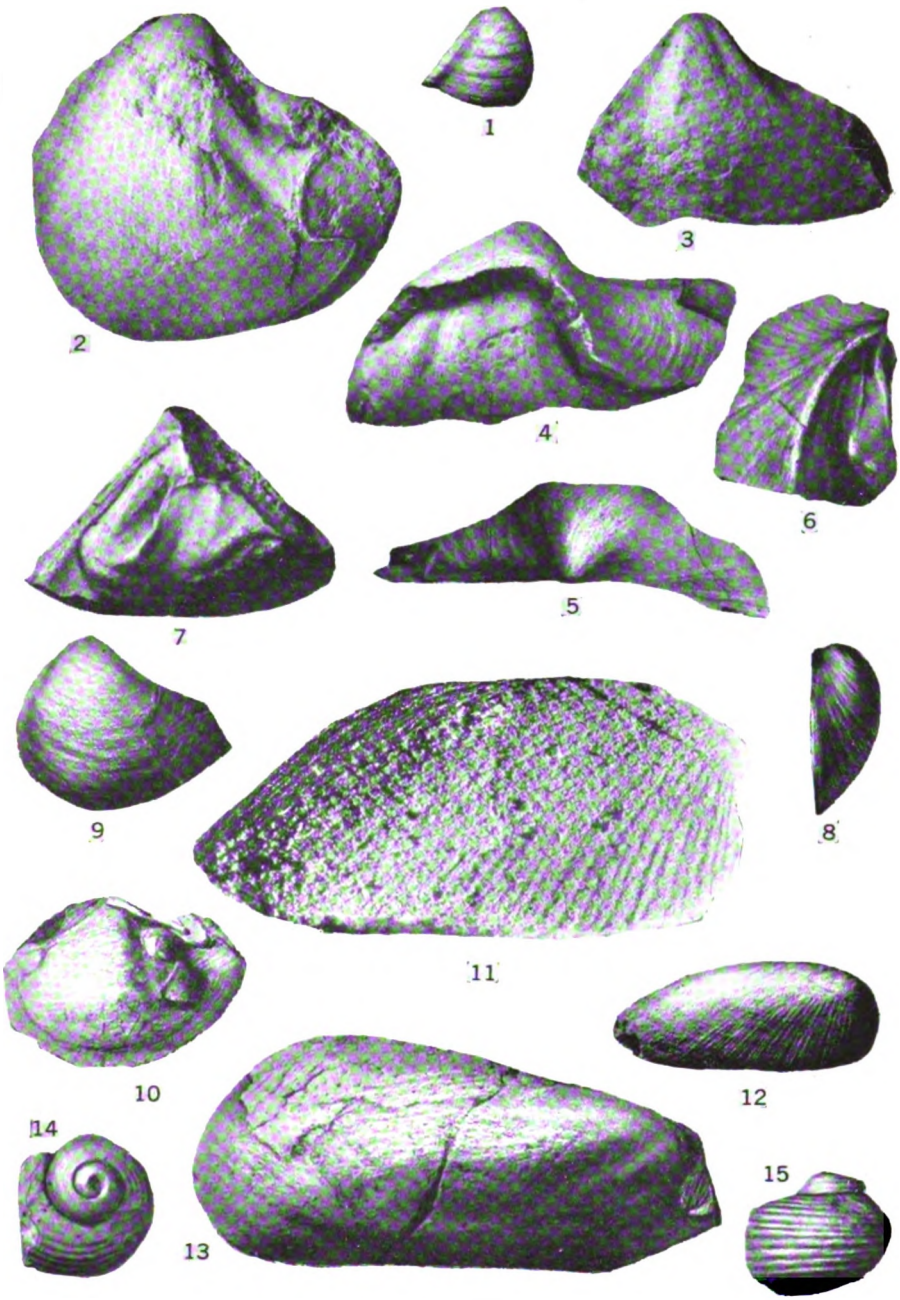

PLATE XIII

PLATE XIV

Allerisma wyomingensis (pp. 50-1)

Figure 1. The type specimen, view of right valve.
Figure 2. Same, dorsal view.
Figure 3. Same, anterior view.

Allerisma sp. (p. 51)

Figure 4. A left valve, lateral view.
Figure 5. Same, dorsal view.

Gastrioceras? sp.

Figure 6. A specimen from the phosphate beds, side view. (From Girty[42]).

Schizodus ferrieri

Figure. 7. A left valve from the phosphate beds. (From Girty[42]).

Omphalotrochus conoideus

Figure 8. A characteristic specimen, side view. (From Girty[42]).

Omphalotrochus ferrieri

Figure 9. A mature specimen, side view. (From Girty[42]).

Pleurotomaria idahoensis

Figure 10. The type specimen, side view, x 2. (From Girty[42]).

Strophostylus sp. (p. 57)

Figure 11. The only specimen, view from above, x 2.
Figure 12. Same, side view, x 2.

PLATE XIV

PLATE XV

Bellerophon depauperatus (p. 53)

Figure 1. The type specimen, view of aperture, x 2.
Figure 2. Same, view of umbilicus, x 2.

Coloceras sp. (p. 59)

Figure 3. A large specimen, side view.

Asymptoceras phosphoricnse (p. 59)

Figure 4. The type specimen, view of a septum showing position of siphon.
Figure 5. Same, side view.

Plagioglypta canna (p. 58)

Figure 6. A large specimen, side view.

Plagioglypta monolineata (pp. 58-9)

Figure 7. The type specimen, side view.

Pleurotomaria phosphatica (pp. 54-5)

Figure. 8. The type specimen, view from above, x 2.
Figure 9. Same, view from below, x 2.
Figure 10. Same, side view, x 2.

Naticopsis gracilis (p. 57)

Figure 11. The type specimen, side view, x 2.
Figure 12. Same, view from above, x 2.

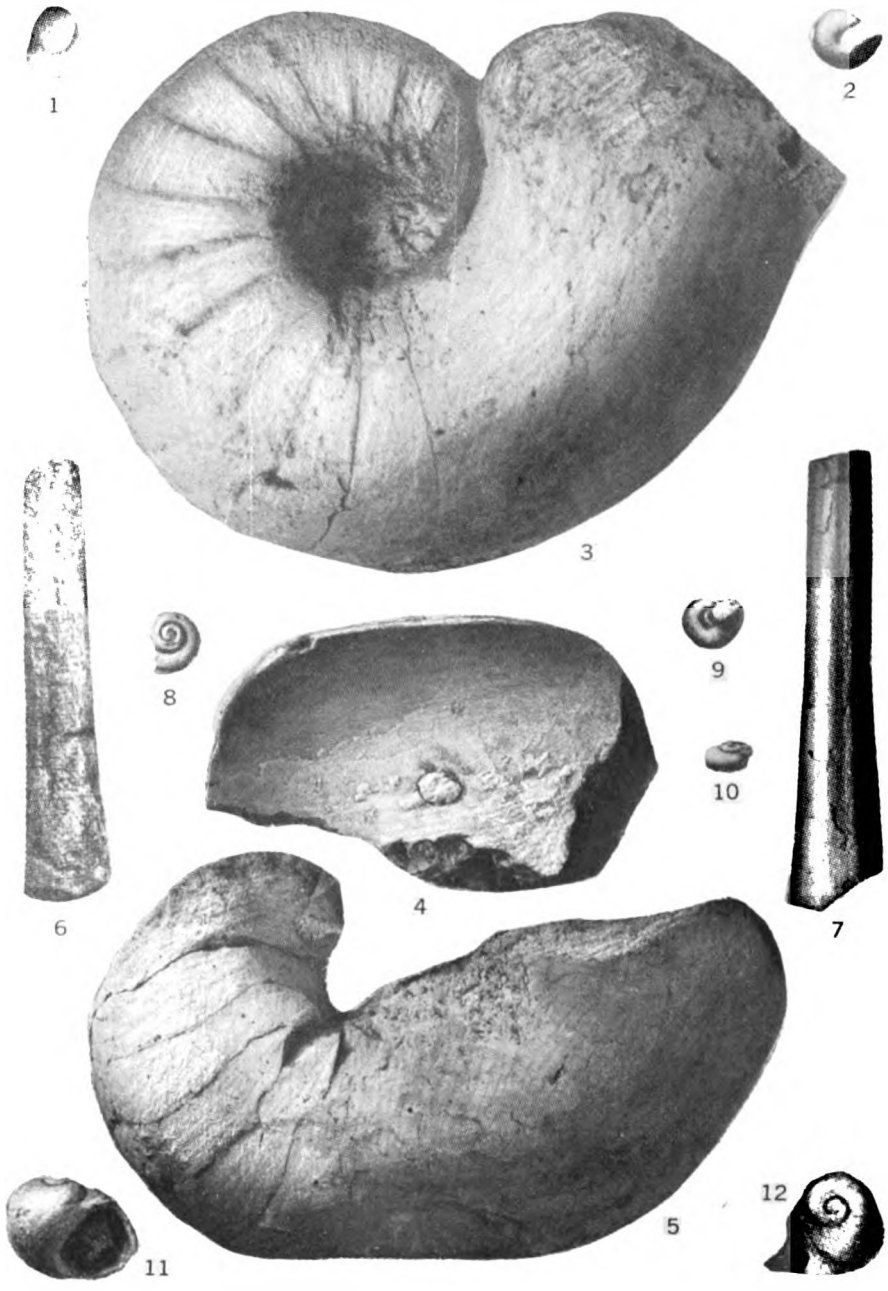

PLATE XV

PLATE XVI

Deltodus mercurii

Figure 1. The upper dentition, x 9/15. (From Branson[13]).

Crassidonta stuckenbergi

Figure 2. A nearly perfect tooth, view of crown. (From Branson[13]).
Figure 3. A typical tooth, end view. (From Branson[13]).

Janassa unguicula (p. 60)

Figure 4. A specimen from the Pustula member, inner coronal view, x 2.
Figure 5. A specimen from the Lower Phosphate member, outer coronal view. (From Branson[13]).

Helodus subpolitus (p. 60)

Figure 6. A type, top view. (From Branson[13]).
Figure 7. A type, side view. (From Branson[13]).

Hamatus phosphoriensis (pp. 60-1)

Figure 8. A cotype, side view, x 2.
Figure 9. A cotype, side view, x 2.
Figure 10. An allotype, side view, x 2.

Pleurotomaria reticulata (p. 55).

Figure 11. The type specimen, view from above, x 2.
Figure 12. Same, side view, x 2.
Figure 13. A specimen showing markings on whorl, x 2.

Worthenopsis bicarinata (p. 56)

Figure 14. The type specimen, view from above, x 2.
Figure 15. Same, side view showing aperature, x 2.
Figure 16. Same, side view, x 2.

Bellerophon bellus

Figure 17. A specimen from the Lower Phosphate member, lateral view, x 4/3. (From Branson[13]).
Figure 18. Same, dorsal aspect, x 4/3.

Euphemus subpapillosus (p. 54)

Figure 19. A typical specimen, view showing slit.
Figure 20. Same, view of aperture.
Figure 21. Same, view of dorsal part of shell.

Hollina emaciata var. *occidentalis*

Figure 22. A left valve, x 15. (From Girty[42]).

Cytherella bennei

Figure 23. A large valve, x 15. (From Girty[42]).

Jonesina carbonifera

Figure 24. A large right valve, side view, x 15. (From Girty[42]).

Ichthyodorulite

Figure 25. A specimen from the Pustula member, side view.

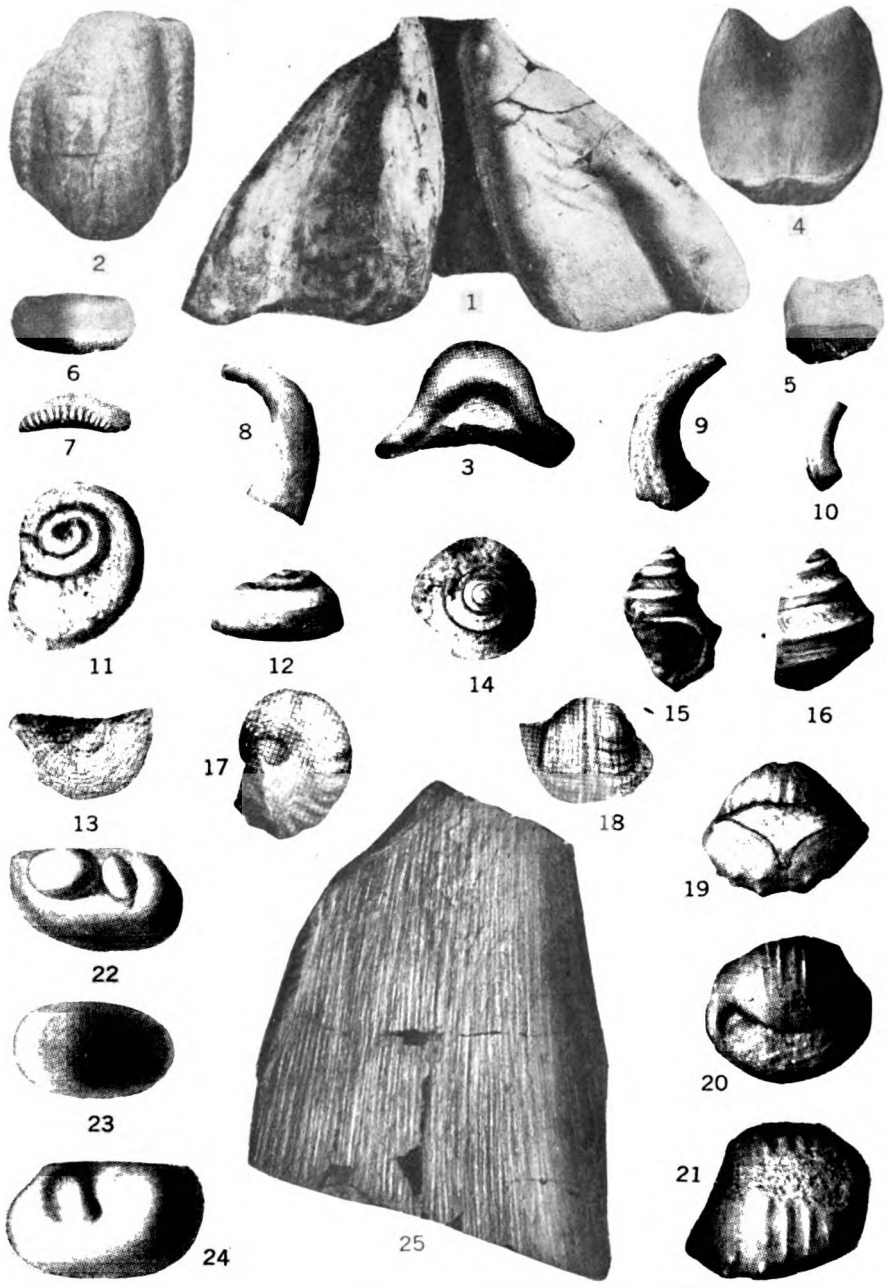

PLATE XVI