Gastropoda, Cephalopoda, and Trilobita of the Amsden Formation (Mississippian and Pennsylvanian) of Wyoming

GEOLOGICAL SURVEY PROFESSIONAL PAPER 848-F

Gastropoda, Cephalopoda, and Trilobita of the Amsden Formation (Mississippian and Pennsylvanian) of Wyoming

By MACKENZIE GORDON, JR., *and* ELLIS L. YOCHELSON

THE AMSDEN FORMATION (MISSISSIPPIAN AND PENNSYLVANIAN) OF WYOMING

GEOLOGICAL SURVEY PROFESSIONAL PAPER 848-F

Descriptions and illustrations of 44 taxa of gastropods, 4 of cephalopods, and 2 of trilobites, with comments on their distribution

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1975

UNITED STATES DEPARTMENT OF THE INTERIOR

ROGERS C. B. MORTON, *Secretary*

GEOLOGICAL SURVEY

V. E. McKelvey, *Director*

Library of Congress Cataloging in Publication Data

Gordon, Mackenzie, 1913–

Gastropoda, Cephalopoda, and Trilobita of the Amsden Formation (Mississippian and Pennsylvanian) of Wyoming.

(The Amsden Formation (Mississippian and Pennsylvanian) of Wyoming) (Professional paper—Geological Survey ; 848–F)

Includes bibliographical references and index.

Supt. of Docs. no.: I 19.16:848–F

1. Gasteropoda, Fossil. 2. Cephalopoda, Fossil. 3. Trilobites. 4. Paleontology—Carboniferous. 5. Paleontology—Wyoming. I. Yochelson, Ellis Leon, 1928– joint author. II. Title. III. Series: The Amsden Formation (Mississippian and Pennsylvanian) of Wyoming. IV. Series: United States. Geological Survey. Professional paper ; 848–F.

QE808.G67 564'.3'09787 74–32014

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C. 20402
Stock Number 024-001-02632-5

CONTENTS

ILLUSTRATIONS

[Plates follow index]

TABLES

THE AMSDEN FORMATION (MISSISSIPPIAN AND PENNSYLVANIAN) OF WYOMING

GASTROPODA, CEPHALOPODA, AND TRILOBITA OF THE AMSDEN FORMATION (MISSISSIPPIAN AND PENNSYLVANIAN) OF WYOMING

By MACKENZIE GORDON, JR., and ELLIS L. YOCHELSON

ABSTRACT

The study of the gastropod fauna of the Amsden Formation is based upon 288 specimens, of which 233 are identifiable and assigned to 27 genera and 38 species or species groups, probably totaling 44 taxa. Although most of this material is poorly preserved, this relatively large fauna from beds of latest Mississippian and Early Pennsylvanian age fills a gap in the existent literature. The gastropods have not been used, however, to differentiate Mississippian and Pennsylvanian beds in the Amsden.

Bellerophontaceans account for nearly half the number of individuals. Euomphalaceans constitute the second most abundant group, accounting for slightly more than one-sixth of the generically identifiable specimens. The remaining one-third of the fauna is distributed among nine superfamilies. Because of the poor quality of the material, an extremely open nomenclature is necessitated. Only two species are compared with previously known forms, and two others, *Straparollus* (*Euomphalus*) *calix* and *Dictyotomaria carlbransoni*, are described as new. *Euphemites sacajawensis* C. Branson is redescribed and reillustrated, and a new genus, possibly allied to *Colpites*, is described but not named.

One additional specimen is added to the four specimens of cephalopods previously reported from the Amsden. A previously mentioned specimen is described and illustrated as *Cravenoceratoides* sp. indet., a genus restricted to the upper part of the *Eumorphoceras bisulcatum* (E_2) Zone of early Namurian Age.

Two species of trilobites are also included here because the material is too sparse to warrant a separate chapter. *Paladin moorei* (C. Branson) is redescribed and reillustrated. It is limited to the Mississippian part of the Amsden. Another species of *Paladin* occurs in the Pennsylvanian part.

INTRODUCTION

This report is concerned principally with the mollusks of the Amsden Formation of Wyoming other than pelecypods. Among the material under study are about 44 gastropods and 4 cephalopods. Like the pelecypods, the gastropods are rather few in number but rich in variety. With the exception of the bellerophontaceans and the euomphalaceans, Amsden gastropod species are rarely represented in our collections by as many as five specimens. Most of the gastropods occur together with pelecypods at the few mollusk-rich localities in the formation.

Two species of trilobites occur in the Amsden and are included here because the relative sparseness of the material does not warrant treatment in a separate chapter.

ACKNOWLEDGMENTS

We are indebted to workers at other institutions who kindly have lent us material for study. We thank A. G. Unklesbay, J. A. Wolleben, R. L. Ethington, R. E. Peck, and J. H. Stitt of the University of Missouri, D. W. Boyd of the University of Wyoming, and Copeland MacClintock of Yale University. We are also indebted to Roger Batten of the American Museum of Natural History for helpful comments and review of the gastropod part of this report and to our colleague Michael E. Taylor for his review of the trilobite part.

Photographs were prepared by Robert McKinney and Haruo Mochizuki.

PREVIOUS WORK

The record of Amsden gastropods is exceedingly sketchy. Only three authors have previously dealt with this part of the fauna. The earliest paper on Amsden fossils, that of Branson and Greger (1918, p. 322–324), mentioned and figured three gastropods from the Mississippian part of the formation. C. C.

Branson (1937, p. 658, 659) mentioned six species and listed a seventh; these included those previously recorded by Branson and Greger. He figured two species: one was *Euphemites sacajawensis* C. Branson, a new species, and the other a shell that he identified as *Ptychomphalus wortheni* Weller, but which is here described as *Dictyotomaria carlbransoni* n. sp.

The only Pennsylvanian gastropods recorded from the Amsden Formation are in faunal lists. The most noteworthy of these lists six forms identified by Girty; it was published by Darton (1906, p. 34) in his original description of the Amsden Formation. These gastropods are included in the present study.

Cephalopods have received only passing mention by previous authors. Two orthoconic nautiloids were cited by Branson and Greger (1918, p. 324), and a goniatite was mentioned by Burk (1954, p. 15) and identified by Sadlick (1960, p. 1211) as a *Cravenoceras*. A trilobite was mentioned as *Phillipsia* sp.? by Branson and Greger (1918, p. 324), and a new species was described as *Griffithides moorei* C. Branson (1937, p. 659).

PRESENT INVESTIGATION

No monographic treatment exists of Mississippian (Chesterian) gastropods or of Early and Middle Pennsylvanian (Morrowan and Atokan) species. The Amsden gastropods documented on these pages, therefore, fill a gap in the existing literature. For this reason, the writers have attempted to describe them in as much detail as possible.

The poor preservation of the gastropod material cannot be overemphasized. Were it not for the fact that this is part of a comprehensive treatment of the principal components of the Amsden fauna, the gastropods would hardly warrant systematic description. Nevertheless, the painstaking examination of each specimen and fragment required by the unsatisfactory preservation has in part been responsible for our recognition of the diversity of the fauna.

Cephalopoda are exceedingly rare in the Amsden Formation, and for this reason have not been assigned a special chapter in this report. No representatives of three other molluscan classes, Hyolitha, Monoplacophora, or Polyplacophora have been found in the Amsden.

The one remaining class to consider is Scaphopoda. Although C. C. Branson (1937, p. 659) noted the presence of abundant internal molds referred by him to *Plagioglypta*? sp., we are unable to confirm this identification. Several short segments of tapering smooth steinkerns or internal molds have been seen, but they are nondescript in character and might belong to any of several nonmolluscan phyla. Accordingly, we prefer not to perpetuate the record of the occurrence of scaphopods in the Amsden Formation, though this is largely a matter of subjective opinion.

FOSSIL LOCALITIES

For the purpose of simplification, the collections studied during our investigations of the Amsden Formation and its faunas have been given numbers from 1 to 160. Material is included from U.S. Geological Survey (USGS) and U.S. National Museum (USNM) collections and collections in the University of Wyoming (UW), University of Missouri (UM), and Yale University's Peabody Museum (YPM). The permanent numbers of these collections, locality descriptions, and complete lists of identified fossils are given in the first report in this series on the Amsden Formation (Sando and others, in press). A checklist of the gastropod, cephalopod, and trilobite collections is given in table 3.

COMPOSITION AND DISTRIBUTION OF GASTROPOD FAUNA

In spite of a relatively limited number of individuals as compared with the brachiopods, the gastropod fauna of the Amsden Formation is remarkably diverse. Twenty-seven genera representing at least 20 families are included under Systematic paleontology. A minimum of 38 species has been recorded. When one takes into account poorly preserved material in which more than one species of a given genus has been recognized but not differentiated and several specimens too poor to include in the systematic discussion, 44 Amsden gastropod species are probably represented in our collections.

In table 1, the families and genera of gastropods recorded in the Amsden Formation are listed in the first two columns. In the third column, the number of specimens of Mississippian age for each genus is recorded and in the fourth, the percentage that this represents of the identifiable gastropods. In the fifth and sixth columns, the same data are recorded for the Pennsylvanian specimens. Totals for the specimens of both systems are shown in the seventh and eighth columns. In addition to the shells listed in table 1, we have examined and found unidentifiable another 55 specimens, 44 from the Mississippian part of the formation and 11 from the Pennsylvanian part.

TABLE 1.—*Taxonomic relationships and relative abundance of gastropods in the Amsden Formation of Wyoming*

Family	Genus	Mississippian specimens		Pennsylvanian specimens		Totals	
		Number	Percentage of total identifiable gastropods	Number	Percentage of total identifiable gastropods	Number	Percentage of total identifiable gastropods
Bellerophontidae	*Bellerophon*	10	4.29	61	26.17	71	30.46
	Euphemites	8	3.43	--	----	8	3.43
	Knightites (Retispira)	11	4.72	22	9.44	33	14.16
Euomphalidae	*Straparollus (Euomphalus)*	15	6.44	25	10.73	40	17.17
Sinuopeidae	*Colpites*	--	---	6	2.58	6	2.58
?	New genus aff. *Colpites*	2	.86	--	----	2	.86
Lophospiridae	*Worthenia?*	1	.43	--	----	1	.43
Phymatopleuridae	*Borestus*	--	---	2	.86	2	.86
	Dictyotomaria	4	1.72	--	----	4	1.72
Raphistomatidae	*Baylea?*	--	---	2	.86	2	.86
Eotomariidae	*Mourlonia*	--	---	1	.43	1	.43
Gosseletinidae	*Gosseletina*	2	.86	--	----	2	.86
Portlockiellidae	*Shansiella*	--	---	1	.43	1	.43
Holopeidae	*Yunnania?*	--	---	2	.86	2	.86
Platyceratidae	*Strophostylus*	2	.86	--	----	2	.86
Microdomatidae	*Microdoma?*	--	---	1	.43	1	.43
Elasmonematidae	*Anematina*	--	---	2	.86	2	.86
Neritopsidae	*Naticopsis*	5	2.15	3	1.29	8	3.44
Murchisoniidae	*Goniasma?*	--	---	3	1.29	3	1.29
	Murchisonia?	--	---	2	.86	2	.86
Pseudozygopleuridae	*Palaeostylus (Pseudozygopleura)*	4	1.72	2	.86	6	2.58
Turritellidae	*Orthonema*	--	---	2	.86	2	.86
Subulitidae	*Ianthinopsis*	5	2.15	--	----	5	2.15
	Soleniscus?	--	---	1	.43	1	.43
Meekospiridae	*Meekospira?*	--	---	2	.86	2	.86
	Girtyspira	5	2.15	3	1.29	8	3.44
Streptacidae	*Donaldina*	15	6.44	1	.43	16	6.87
Total		89	38.22	144	61.82	233	100.04

Considering the number of individuals at the superfamily level, the Bellerophontacea make up nearly half the gastropod fauna. The Euomphalacea account for slightly more than one-sixth. The remaining one-third of the fauna, in decreasing order of abundance, is distributed among the Pleurotomariacea (9 percent), Subulitacea (7 percent), Pyramidellacea (7 percent), Neritacea (3½ percent), Loxonematacea (2½ percent), Murchisoniacea (2 percent), Platyceratacea (1¾ percent), Microdomatacea (1¼ percent), and Cerithiacea (0.9 percent). In more general terms, essentially five-sixths of the individual specimens are referrable to the Archaeogastropoda.

Gastropods occur in 25 of the collections from the Amsden Formation, but this figure is misleading because many of these records are based upon sporadic occurrences of one or two specimens. Only three collections can be said to be predominantly molluscan, all of them from the Pennsylvanian part of the formation. In these, gastropods are as common as or slightly more numerous than pelecypods. The fossils in these beds occur either as molds in fine granular chert or recrystallized in tan porous limestone. One chert faunule (colln. 52) consists mainly of *Bellerophon* and *Straparollus (Euomphalus)* together with some murchisoniids and rare pleurotomariaceans. The other chert collection (colln. 40) and the one from the impure limestone (colln. 50) have a more varied fauna, *Knightites (Retispira)* replacing *Bellerophon* as the most common form. Pleurotomariaceans are even rarer than in collection 52.

Four more collections, three of which are Pennsylvanian in age, can be regarded as brachiopod-mollusk assemblages, the pelecypods being by far the most common of the mollusks. In contrast to the predominantly gastropod collections, these brachiopod-pelecypod assemblages occur in gray fine- to medium-grained limestone. Gastropods are so scarce that comparisons are not warranted.

The Mississippian part of the formation has yielded almost as many specimens (46 percent of the total gastropod collection) as the Pennsylvanian part, but a larger proportion of them are indeterminate as to genus. Most of the Mississippian gastropods are from the Little Popo Agie River drainage, including Cherry Creek. Here the mollusks occur in limonite probably derived from replacement of limestone layers in shale. Limonitic coating of many gastropods renders them unidentifiable. In this area, high-spired gastropods predominate,

pleurotomariaceans are rare, and bellerophontaceans are uncommon.

At the only other place where a significant Mississippian gastropod faunule occurs (colln. 137), the badly recrystallized specimens are in a limestone bed. This faunule resembles the Pennsylvanian collections in the greater number of bellerophontaceans, although here *Knightites* (*Retispira*) and rare *Bellerophon* occur together.

Of the 27 genera differentiated, 14 are in the Mississippian part of the Amsden. Twenty are present in the Pennsylvanian. The 7 genera that are "exclusively Mississippian" are based on 24 specimens, 4 of them on a total of 9 specimens. The 13 genera that are "exclusively Pennsylvanian" are represented by 27 specimens; 11 of these are based on only 18 specimens. Obviously, the chance finding of an additional gastropod locality in the Mississippian or the failure to discover one in the Pennsylvanian would have a profound effect on the relative percentages of the genera in either system.

In broader perspective, on the basis of studies from other areas, it is difficult to point to any genus that is significant for age dating within the interval under consideration. Most of the genera listed are known from both systems. A few have been occasionally reported from one or the other and are not exclusive indicators of age.

STRATIGRAPHIC CONSIDERATIONS

Four members are recognized within the Amsden Formation, three of them extending throughout its outcrop area in Wyoming. The three are, in descending order:

Ranchester Limestone Member
Horseshoe Shale Member
Darwin Sandstone Member

In western Wyoming, the fourth member, the Moffat Trail Limestone Member, tongues into the upper two-thirds of the Horseshoe Shale Member, separating in this manner a thin Horseshoe Shale Member from the overlying Ranchester. The lithology and biostratigraphy of the Amsden Formation are discussed in some detail by Sando, Gordon, and Dutro. (In press.)

The Amsden and its individual members are transgressive in a general west-to-east direction. For this reason, we speak of the Mississippian and Pennsylvanian parts of the Amsden in general terms without always identifying the member or members. Nevertheless, all the fossil collections are referred to their respective members in the data on occurrence that follows the descriptions.

No fossils have been found in the Darwin Sandstone Member, but available data indicate that it is Late Mississippian in age throughout its area of outcrop. The coraliferous Moffat Trail Limestone Member has been determined to be Late Mississippian (Chesterian) in age throughout. The Horseshoe Shale Member in western and west-central Wyoming is Mississippian in age from bottom to top; in eastern-most east-central Wyoming the same member is Pennsylvanian (Morrowan) in age from bottom to top; in between, it is part Mississippian and part Pennsylvanian.

The lower part of the Ranchester Limestone Member in western Wyoming is Mississippian (late Chesterian) in age, and its upper part is Pennsylvanian (Morrowan and probably early Atokan). In west-central and east-central Wyoming this member is Pennsylvanian (Morrowan and early Atokan).

The distribution of the gastropods, cephalopods, and trilobites in the Mississippian part of the Amsden equates with the coral and brachiopod zones that have been recognized in this study. The Pennsylvanian ones, however, are not as well equated with these zones. The coral and brachiopod zones are as follows:

Pennsylvanian:
- *Mesolobus* Zone [1]
- *Neokoninckophyllum hamatilis* Zone [1]
- *Antiquatonia blackwelderi* Zone [2]

Mississippian:
- *Anthracospirifer welleri-shawi* Zone [2, 3]
  - *Composita poposiensis* Subzone [3]
  - *Carlinia amsdeniana* Subzone [3]
- *Caninia* Zone [2]

Gastropods occur in both Mississippian zones and subzones but are moderately common only in the *Carlinia amsdeniana* Subzone. They are even more common in the early Morrowan part of the formation in east-central Wyoming, but in this region *Antiquatonia blackwelderi* is not present. One occurrence, near the top of the Amsden on the east slope of the Bighorn Mountains, may be as young as the *Mesolobus* Zone of Atokan Age but cannot be dated so precisely. Cephalopods have been found only in the *Anthracospirifer welleri-shawi* Zone and at the base of the Pennsylvanian in west-central Wyoming. Trilobites are known from the *Caninia*

[1] East-central Wyoming.
[2] Western Wyoming.
[3] West-central Wyoming.

Zone, *Carlinia amsdeniana* Subzone, and the Morrowan of east-central Wyoming, including the *Neokoninckophyllum hamatilis* Zone.

STRATIGRAPHIC AND GEOGRAPHIC OCCURRENCE OF THE GASTROPODS

The gastropod collections are discussed below under two main headings: those from beds of Mississippian age and those from beds of Pennsylvanian age. This should not imply, however, that the gastropods have been of any use in identifying the containing beds as either Mississippian or Pennsylvanian. Recognition of the ages of the strata has been based almost exclusively on evidence from foraminifers and brachiopods.

Most of the gastropod genera are so long ranging that their usefulness is precluded for distinguishing Upper Mississippian from Lower Pennsylvanian rocks. However, in genera present in both the Mississippian and Pennsylvanian parts of the Amsden, we have noted that they are represented by different species in each part. This suggests that with better material derived from more exhaustive collecting, it might be possible to distinguish Mississippian from Pennsylvanian Amsden on the basis of gastropods alone.

All the Pennsylvanian gastropod-bearing collections are from the west-central and east-central regions of Amsden outcrop. The Mississippian gastropod collections are from the central and western regions. In table 2 the distribution of the gastropods by collection and by stratigraphic member is shown, and table 3 is the checklist of collecting localities.

TABLE 2.—*Gastropods, cephalopods, and trilobites of the Amsden Formation of Wyoming*

	Horseshoe Shale Member																	Moffat Limestone Member								Ranchester Limestone Member		
	1	3	8	30	31	34	35	36a	36c	36d	36e	45	48	53	116	137	159	E	76	77	78	79	92	93	105	109	40	50	52
Gastropoda:																													
Bellerophon cf. *B. crassus* Meek and Worthen			×														×												×
spp						×										×													×
Bellerophon? sp. indet																			×	×	×	×	×		×	×			
Euphemites sacajawensis C. Branson									×	×																			
Knightites (*Retispira*) sp. A										×						×													
sp. B																												×	×
?*Knightites* (*Retispira*) sp. indet													×																
calix n. sp																													
aff. *S.* (*E.*) *plummeri* Knight																	×												
sp. indet	×	×																										×	×
Straparollus (*Euomphalus*)														×															
Colpites sp. A																												×	×
New genus aff. "*Colpites*" sp																		×											
Worthenia? sp. indet																×													
Borestus sp. indet																												×	
Borestus? sp																													×
Baylea? sp. indet										×																		×	×
Mourlonia sp. indet														×															
Gosseletina sp. indet												×																	
Gosseletina? sp. indet							×																						
Dictyotomaria carlbransoni n. sp										×																			
Shansiella sp. indet																													×
Yunnania? sp. indet																												×	
Strophostylus sp. indet										×																			
Microdoma? sp. indet																												×	
Anematina sp. indet																												×	
Naticopsis (*Naticopsis*) spp. indet													?			×												×	
(*Jedria*?) sp. indet												×																	
Goniasma? sp. indet																												×	
Murchisonia? sp. indet																												×	
Palaeostylus (*Pseudozygopleura*) spp. indet		?						×		×																		×	
Orthonema sp. indet																												×	×
Ianthinopsis spp. indet										?	×		?																
Soleniscus? sp. indet																												×	
Meekospira? sp. indet																												×	
Girtyspira sp. A								×		×																			
sp. B																												×	
Donaldina aff. *D. pygmaea* (Weller)										×																			
sp. indet																													×
Cephalopoda:																													
Reticycloceras? sp. indet																		?											
Orthoconic nautiloid, gen. and sp. indet																		?											
Cravenoceratoides sp. indet							×																						
Goniatitacean, gen. and sp. indet																												×	
Trilobita:																													
Paladin moorei (C. Branson)				×	×					×					?					?			×						
sp		×																										×	?

TABLE 3.—*Checklist of gastropod, cephalopod, and trilobite collections*

Collection No. in report	Permanent institutional locality No.	Name of locality	Mountain Range	County	Location	Member
1	USGS 5441–PC	Cherokee Spring	Rawlins hills	Carbon	Probably in SW¼ sec. 11, T. 21 N., R. 88 W.	Horseshoe Shale Member
3	USGS 3139–PC	do	do	do	NW¼SW¼ sec. 11, T. 21 N., R. 88 W.	Do.
8	USGS 21728–PC	Meadow Ranch	do	do	SW¼NE¼ sec. 25, T. 22 N., R. 88 W.	Do.
30	UW 3199/19B4	Cherry Creek	Wind River Range	Fremont	SE¼NW¼ sec. 19, T. 31 N., R. 99 W.	Do.
31	UW 3199/19B5	do	do	do	do	Do.
34	UW 3199/19B8	do	do	do	do	Do.
35	UW 3199/19A	do	do	do	NW¼ sec. 19, T. 31 N., R. 99 W.	Do.
36a	UM specimens	do	do	do	Sec. 19, T. 31 N., R. 99 W.	Do.
36c	do	Near Lander	do	do	Not known exactly	Do.
36d	do	Little Popo Agie River.	do	do	do	Do.
36e	USNM 487A	Cherry Creek	do	do	Sec. 19, T. 31 N., R. 99 W.	Do.
40	USGS 21676–PC	Bull Lake Creek	do	do	SW¼ sec. 2, T. 2 N., R. 4 W.	Ranchester Limestone Member.
45	USGS 21719–PC	Livingston Ranch.	Washakie Range	do	SW¼SW¼ sec. 29, T. 43 N., R. 106 W.	Horseshoe Shale Member.
48	YPM 20101–20110	Wiggins Fork	do	do	SW¼ sec. 7, T. 42 N., R. 105 W.	Do.
50	USGS 19187–PC	Trout Creek	Bighorn Mountains	Washakie	Sec. 19, T. 41 N., R. 88 W.	Ranchester Limestone Member.
52	USGS 2461–PC, 2461A–PC.	North Fork, Crazy Woman Creek.	do	Johnson	SE¼ sec. 28 or NE¼ sec. 33, T. 49 N., R. 83 W.	Do.
53	USGS 19241–PC	South Fork, Rock Creek.	do	do	SW¼ sec. 25, T. 52 N., R. 84 W.	Horseshoe Shale Member.
76	USGS 22987–PC	Moffat Trail	Salt River Range	Lincoln	NW¼NE¼ sec. 3, T. 33 N., R. 117 W.	Moffat Trail Limestone Member.
77	USGS 6960A–PC	do	do	do	do	Do.
78	USGS 6960B–PC	do	do	do	do	Do.
79	USGS 22981–PC	do	do	do	do	Do.
92	USGS 6965–PC	Covey Cutoff	do	do	NW¼NE¼ sec. 27, T. 34 N., R. 117 W.	Do.
93	USGS 6951–PC	do	do	do	do	Do.
105	USGS 17907–PC	Haystack Peak	do	do	Center sec. 19, T. 34 N., R. 117 W.	Do.
109	USGS 23002–PC	South Indian Creek.	Snake River Range	do	NE¼ sec. 14, T. 38 N., R. 118 W.	Do.
116	USGS 18798–PC	Hoback Canyon	Hoback range	Teton	Sec. 3, T. 38 N., R. 115 W.	Horseshoe Shale Member.
137	USGS 6191–PC	Darwin Peak	Gros Ventre Range	do	S½ sec. 28, T. 40 N., R. 112 W.	Do.
159	USGS 24050–PC	Elk Ridge	Teton Range	do	SW¼ sec. 26, T. 47 N., R. 116 W.	Do.
E	USNM specimens	Near Lander	Wind River Range	Fremont	Not known	Do.

MISSISSIPPIAN FAUNA

In the Mississippian parts of the Amsden only two areas have yielded gastropod faunules: 1) the area south of Lander, Fremont County, including the Cherry Creek and Amsden Hill exposures, which have been exhaustively collected over a long period; and 2) a unique collection from the Darwin Peak section in Teton County.

Lincoln County.—A single gastropod species has been recorded in the Moffat Trail Limestone Member. It is a moderately large bellerophontacean, here identified as *Bellerophon*? sp. indet. This shell, invariably poorly preserved, is found in association with corals of the *Caninia* Zone; it commonly is overgrown with chaetetiform bryozoans. This species was recorded in seven collections made in Lincoln County, in the Moffat Trail, Covey Cutoff, Haystack Peak and South Indian Creek sections (collns. 76–79, 92, 105, 109).

Teton County.—In the Darwin Peak section, a brachiopod-mollusk assemblage was collected by Blackwelder and its fossils identified first by Girty

(in Blackwelder, 1918, p. 422). The gastropods from this locality (colln. 137) have been reidentified as follows:

Bellerophon sp.
Knightites (*Retispira*) sp. A
Straparollus? sp. indet. (too poorly preserved to include in systematic paleontology)
Worthenia? sp. indet.
Naticopsis (*Naticopsis*) sp. indet.

At Berry Creek in the Teton Range, a limestone bed in the Horseshoe Shale Member of latest Mississippian age (colln. 159), the following species were recorded:

Bellerophon cf. *B. crassus* Meek and Worthen
Straparollus (*Euomphalus*) *calix* n. sp.

The age determination at this locality was by foraminifers and in part by brachiopods. Like some of the brachiopods, these snails suggest Pennsylvanian affinities, as the *Bellerophon* is widespread elsewhere in Wyoming in beds of Pennsylvanian (Morrowan) age.

Fremont County.—Gastropods from the *Anthracospirifer welleri-shawi* Zone in the Horseshoe Shale Member are known from the Lander area, which includes Cherry Creek and Amsden Hill. Most of these collected were weathered out from shale, and their stratigraphic position is not certain, but the striking limonitic preservation is characteristic of the *Carlinia amsdeniana* Subzone in this region. The following species have been recorded (collns. 34, 35, 36a, 36c–e, E):

Bellerophon sp.
Euphemites sacajawensis C. Branson
Knightites (*Retispira*) sp. A
New genus aff. *Colpites* sp.
Dictyotomaria carlbransoni n. sp.
Gosseletina? sp. indet.
Strophostylus sp. indet.
Palaeostylus (*Pseudozygopleura*) sp. indet.
Ianthinopsis sp. indet.
Girtyspira sp. A
Donaldina aff. *D. pygmaea* (Weller)

In the Washakie Range, beds that contain brachiopods of the *Carlinia amsdeniana* Subzone have provided the following gastropod species at Livingston Ranch (colln. 45):

Gosseletina sp. indet.
Naticopsis (*Jedria*?) sp. indet.

At approximately the same level at Wiggins Fork, also in the Washakie Range (colln. 48), are these species:

?*Knightites* (*Retispira*) sp. indet.
?*Naticopsis* (*Naticopsis*) sp. indet.
Ianthinopsis? sp. indet.

PENNSYLVANIAN FAUNA

Gastropods were found in beds of Pennsylvanian age at seven localities—four of them in the Horseshoe Shale Member and three in the Ranchester Limestone Member. These provided most of the Amsden species.

Fremont County.—The westernmost occurrence of gastropods of Pennsylvanian age in the Amsden Formation was at Bull Lake Creek (colln. 40) in the Wind River Range. Here the mollusks occur as molds in a chert bed in the basal 2 feet of the Ranchester Limestone Member. These include external molds of high-spired gastropods too poor to identify even as to family. The following gastropods are recorded:

Knightites (*Retispira*) sp. B
Colpites sp. A
Borestus sp. indet.
Baylea? sp. indet.
Microdoma? sp. indet.
Anematina sp. indet.
Palaeostylus (*Pseudozygopleura*) sp. indet.
Orthonema sp. indet.

Washakie County.—On the west slope of the Bighorn Mountains, on Trout Creek, a mollusk-bearing marl in the Ranchester Limestone Member (colln. 50) yielded the following species:

Knightites (*Retispira*) sp. B
Straparollus (*Euomphalus*) aff. *S.* (*E.*) *plummeri* Knight
Colpites sp. A
Moderately high-spired pleurotomariacean indet. (too poorly preserved to include in systematic paleontology)
Yunnania? sp. indet.
Naticopsis (*Naticopsis*) sp. indet.
Orthonema sp. indet.
Meekospira? sp. indet.
Girtyspira sp. B
Soleniscus? sp. indet.

Johnson County.—One of the earliest collections made in the Amsden Formation, mentioned by Darton (1906, p. 34), has provided the largest single gastropod faunule among our collections. It came from near the top of the Ranchester Limestone Member on the North Fork of Crazy Woman Creek (colln. 52). The fossils occur as molds in a granular chert bed. The following species have been identified:

Bellerophon cf. *B. crassus* Meek and Worthen sp.

Straparollus (*Euomphalus*) aff. *S.* (*E.*) *plummeri* Knight

Colpites sp. A

Borestus? sp.

Baylea? sp. indet.

Shansiella sp. indet.

Goniasma? sp. indet.

Murchisonia? sp. indet.

Donaldina sp. indet.

A collection from the base of the Horseshoe Shale Member at South Fork of Rock Creek, on the eastern flank of the Bighorn Mountains (colln. 53), contained the following species:

Bellerophontacean indet. (too poorly preserved to include in systematic paleontology)

Straparollus (*Euomphalus*) sp. indet.

Mourlonia sp. indet.

Carbon County.—Three collections from limestone beds in the Horseshoe Shale Member made in the Rawlins hills region at Cherokee Spring and Meadow Ranch (collns. 1, 3, 8), yielded the following species in brachiopod-mollusk assemblages:

Bellerophon cf. *B. crassus* Meek and Worthen

Straparollus (*Euomphalus*) aff. *S.* (*E.*) *plummeri* Knight

?*Palaeostylus* (*Pseudozygopleura*) sp. indet.

Nearly all these collections of gastropods from the Pennsylvanian part of the Amsden Formation come from beds dated by other fossils as Morrowan in age. The prime exception to this statement is the large faunule from Crazy Woman Creek (colln. 52). The bed in which these fossils occur is near the top of the formation and might be either Morrowan or Atokan in age. The fauna is largely molluscan, and although some of the same species occur in it that are present in beds of known Morrowan age, the ranges of the molluscan species are not well enough known at present to be used for precise dating.

CEPHALOPODS

Four different cephalopods have been recognized in the Amsden Formation, on the basis of five specimens, three of which cannot presently be located in the University of Missouri collections. None has been figured previously, In the course of our investigation only one new specimen was found, an indeterminate juvenile ammonoid (USNM 173621) preserved as an internal mold in a gastropod-bearing chert bed of Pennsylvanian age (colln. 40), in the Bull Lake Creek section, Fremont County.

The rest came from what is now called the Horseshoe Shale Member in the Little Popo Agie River drainage southwest of Lander. These include two orthoconic nautiloids cited by Branson and Greger (1918, p. 324), which seem not to have been deposited in the University of Missouri collection. These were originally identified as *Orthoceras* sp? and *Cycloceras* sp?

The best preserved cephalopod, a specimen from Cherry Creek (colln. 35) in the collection of the University of Wyoming (IT–243), is here identified as *Cravenoceratoides* sp. indet. This genus is restricted to the middle and upper parts of the *Eumorphoceras bisulcatum* Zone in northwest Europe.

TRILOBITES

Thirty-four parts and fragments of trilobites from the Amsden Formation have been available for study. These include, in addition to the holotype, 5 cranidia, 3 librigenae, 2 broken genal spines, and 18 whole or fragmental pygidia; 3 other genal spines mentioned by Branson (1937, p. 659) are indeterminate fragments. All of them are referred to *Paladin* and probably represent two species, one in the Mississippian part of the formation and the other in the Pennsylvanian part.

The Mississippian species is *Paladin moorei* (C. Branson). Most of the specimens of *P. moorei* are from the Horseshoe Shale Member in the Little Popo Agie River drainage (collns. 30, 31, 36d) and Twin Creek, Wind River Range, Fremont County. The same species is rare in the Moffat Trail Limestone Member in the Moffat Trail and Covey Cutoff sections (collns. ?77, 93) in the Salt River Range, Lincoln County.

The Pennsylvanian form has not been identified with any previously described species, though it probably is related rather closely to *P. pyriformis* Chamberlain. It occurs in the eastern region of Amsden outcrop in the Horseshoe Shale Member (colln. 3) and Ranchester Limestone Member (collns. 50, ?52).

SYSTEMATIC PALEONTOLOGY

Phyllum MOLLUSCA
Class GASTROPODA
Subclass PROSOBRANCHIA
Order ARCHAEOGASTROPODA
Suborder BELLEROPHONTINA
Superfamily BELLEROPHONTACEA M'Coy
Family BELLEROPHONTIDAE M'Coy
Genus BELLEROPHON Montfort, 1808

Bellerophon cf. B. crassus Meek and Worthen

Plate 1, figures 1–4

Bellerophon crassus Meek and Worthen, 1860, p. 458; 1866, p. 385, pl. 31, figs. 16a, b.

Description.—Bellerophontacean having inflated conch; whorl profile moderately well rounded, lessening slightly in curvature on lateral slopes so as to appear subglobose. Early whorls unknown. Apertural margin normal to axis of growth, straight across dorsum and essentially straight along lateral slopes, but curving back abruptly along umbilical slopes to attach to preceding whorl; growth lines faint to absent. Selenizone obscure, very slightly raised above rounded dorsum. Slit narrow and short, its depth equal to approximately one-eighth length of body whorl; junction of outer lip with slit emargination being virtually at right angles with no appreciable rounding. Slight depression present within aperture on areas below lateral slopes. Inductural boss not prominent and possibly absent. Shell of moderate thickness throughout, thinning abruptly at margin.

Discussion.—The bellerophontaceans are a rather difficult group because characters that distinguish the species are relatively few. Perhaps the two most commonly used names for late Paleozoic species of the genus *Bellerophon* in North America are *B. sublaevis* Hall, described originally from beds of Mississippian (Meramecian) age, and *B. crassus* Meek and Worthen, from beds of Middle Pennsylvanian age. The two species are closely related and differ principally in that *B. crassus* is slightly more globose.

No comprehensive review has been made of these and other closely related American Carboniferous gastropods. Until such a study is available, no practical purpose would be served in adding yet another name to this species group. Despite the fact that our material is sufficiently abundant and well preserved to show nearly all the salient characters of this Amsden form, the rather limited taxonomic characters are not well enough understood to warrant proposal of a new specific name.

This bellerophontacean is common as poorly to moderately well preserved internal and external molds at Crazy Woman Creek in the Bighorn Mountains. It is associated with other mollusks and brachiopods that include the orthotetid *Pulsia delira* Gordon, n. sp., in a granular chert bed of Pennsylvanian age near the top of the formation. The figured specimens are from that locality. It also is present in beds of latest Mississippian age at Berry Creek in the Teton Range. Five steinkerns from a locality at Meadow Ranch in the Rawlins hills are also included here and another steinkern from the Gros Ventre Range.

Figured specimens.—USNM 168460–168463.

Occurrence and number of specimens.—Horseshoe Shale Member: collections 8 (5), Carbon County; 159 (4), Teton County. Ranchester Limestone Member: collection 52 (50+), Johnson County.

Bellerophon spp.

Plate 1, figure 5

A specimen from the Pennsylvanian mollusk-bearing bed at Crazy Woman Creek, preserved as an incomplete external mold, differs from the common form in the greater rounding of the dorsum, giving the whorl a higher arched, narrower profile. The lateral slopes are somewhat compressed, and the umbilicus immediately behind the thickened lip of the apertural margin is marked by a prominent shallow dimple. The margin swings slightly forward to attach to the preceding whorl, as figured.

A slightly compressed small steinkern, 10 mm in length, from the Mississippian *Carlinia amsdeniana* Subzone at Darwin Peak is questionably referred here, though there is no doubt as to its generic assignment. Another poorly preserved specimen, 16 mm in diameter, from the *Composita poposiensis* Subzone at Cherry Creek agrees with the previous one in being compressed so that the maximum width is equal to about four-fifths of the diameter.

The specimen from the Heath Formation of Montana figured as *Bellerophon* sp. by Easton (962, p. 98, pl. 13, fig. 7) is similar but slightly wider. It is a steinkern, preserving a patch of the shell. Owing to the poor preservation we cannot be sure whether or not the Mississippian shells are properly assigned here or even represent the same taxon.

Figured specimen.—USNM 168464.

Occurrence and number of specimens.—Horseshoe Shale Member: collection 34 (1), Fremont County; 137 (1), Teton County. Ranchester Limestone Member: collection 52 (1), Johnson County.

Bellerophon? sp. indet.

Figure 1

This group consists of some poorly preserved shells, all of them from the *Caninia* Zone in western Wyoming. They have, in addition to basic bilateral symmetry, the following characters in common: closed umbilici, subglobose shape, and rather large size, being more than 2.5 cm in length. Random sections suggest that no spiral lirae are present on the surface and that the inductural boss is rather thin and located far within the whorl. Although several species of *Euphemites* cannot be eliminated as a possibility, the available characters suggest that this form is a typical *Bellerophon*. The specimens at one locality (colln. 105) are overgrown by a chaetetiform bryozoan, a relationship noted by Gordon and Duncan (1970, p. A41) in the *Caninia* Zone of the Oquirrh Mountains, Utah.

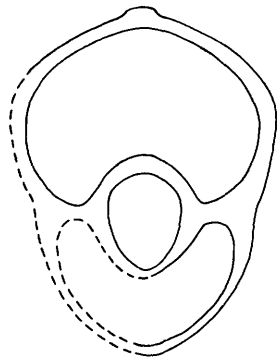


FIGURE 1.—Cross section of *Bellerophon*? sp. indet., × 1½, from specimen USNM 168465, collection 78.

Most of the specimens are fairly uniform in shape, but the one from collection 76 (USNM 173616) may be somewhat narrower than the others; however, it is preserved as a steinkern rather than in cross section. One from collection 109 (USNM 168465) has in cross section a low dorsal ridge on the shell surface. Preservation is much too poor to determine whether these forms are taxonomically distinct or represent variation within one species.

Figured specimen.—USNM 168465.

Occurrence and number of specimens.—Moffat Trail Limestone Member: collections 76 (1), 77 (1), 78 (1), 79 (1), 92 (1), 105 (2), 109 (1), Lincoln County.

Genus EUPHEMITES Warthin, 1930

Euphemites sacajawensis C. Branson

Plate 1, figure 6–9, 11–13

?*Bucanopsis or Bellerophon.* Branson and Greger, 1918, p. 324, pl. 19, figs. 9, 10.

Euphemites sacajawensis C. Branson, 1937, p. 658, 659, pl. 89, figs. 24, 25, 33; ?Easton, 1962, p. 98, pl. 13, figs. 9, 10.

Description.—Shell globose, not geniculate, having infundibuliform umbilical depressions that occupy about one-quarter of total length of shell, set off from flanks by obscure angulation. Flanks and dorsum well inflated, essentially following semicircular arc between umbilical areas. Surface ornamented by raised thick longitudinal cords (lirae) totaling approximately 22 on shell, closely spaced near umbilical area but more widely spaced on slopes and dorsum where interspaces are as much as two times greater than width of cords. Cords dying out abruptly anteriorly; mature part of whorl and aperture unknown.

Dimensions.—Holotype: length 6.5 mm and width 6.0 mm.

Discussion.—This description is based on a restudy of Branson's holotype. The specimen is relatively small, slightly crushed on one side, and partly coated with limonite, as are many of the fossils of the Horseshoe Shale Member of the Amsden. A tiny patch of smooth inductura remains in front of the lirate part of this shell, but no other details of the apertural part remain. The broken section of the inner lip does not seem to be thickened, and it may not extend far out from the main body of the shell, but this is conjectural.

Branson's two figured paratypes are refigured here on plate 1, figures 6, 11–13. These give details of an adult shell but are omitted from our redescription because we feel that they may represent another species. They differ from the holotype in having a narrower shell, lacking prominent umbilical depressions, and are ornamented by fewer and finer lirae, having proportionally wider interspaces. It seems to us very unlikely that these differences could be ontogenetic changes, as the more complete paratype measures 8.5 mm long and 7.0 mm wide, which is not a great deal more than the holotype. Nevertheless, with the paucity of material at our disposal, we feel that splitting *E. sacajawensis* into two species at this time is not warranted.

Easton (1962, p. 98) quite properly questioned C. C. Branson's referral to this species of the steinkern figured by Branson and Greger (1918, pl. 19, figs. 9, 10) as "*Bucanopsis* or *Bellerophon*," because so few characters are available on it for comparison with the more complete type lot. After studying the bellerophontid steinkerns from the Little Popo Agie River region, we are inclined to agree with Branson

that this is a steinkern of *Euphemites*, but cannot be certain if it is *E. sacajawensis*.

Several Mississippian species of *Euphemites* have been described from North America. The Wyoming species is similar to *E. incarinatus* Easton, from the Pitkin Limestone of Arkansas, in its globose shape, but that form differs in its ornamentation of finer, more abundant lirae. The Redoak Hollow species, *E. compressus* Elias, as illustrated, has similar ornamentation, but the shape is somewhat less globose and the umbilical depressions deeper than in *E. sacajawensis*. The Oklahoma species was established on an incomplete juvenile shell and is poorly known.

As noted by Elias (1958, p. 2), both *E. nautiloides* (Winchell) and *E. galericulatus* (Winchell) from the Marshall Formation in Michigan also are poorly known species; both seem to be galeiform in outline and thus distinct from *E. sacajawensis*. *Euphemites subglobosus* Hyde from the Logan Formation of Ohio differs in having a more compressed shell than *E. sacajawensis*, its width equal to three-fourths of its length, the "umbilicus closed," and in having a greater number of longitudinal cords (25 to 30).

Euphemites lentiformis (Weller) from the Ste. Genevieve Limestone in Illinois is easily distinguished by the extreme compression of its shell.

Types.—Holotype and paratypes UM 6631.

Occurrence and number of specimens.—Horseshoe Shale Member: collections 36c (1), 36d (7), Fremont County.

Genus KNIGHTITES Moore, 1941
Subgenus KNIGHTITES (RETISPIRA) Knight, 1945

Knightites (Retispira) sp. A

Plate 1, figures 14, 15

Bucanopsis sp. C. Branson, 1937, p. 659.

Amsden specimens referred to this subgenus are not sufficiently complete or well enough preserved to describe in detail. Two or possibly three species occur in the formation. Perhaps the most distinctive of them is represented in part by a lot of three steinkerns (UM 6627) from the *Carlinia amsdeniana* Subzone in the Popo Agie River area, referred by C. C. Branson (1937, p. 659) to *Bucanopsis* sp. (Branson, however, mentioned only two specimens.) The two largest ones are figured here.

This species expands in width fairly rapidly and has a low arched dorsum bearing a slightly raised selenizone bounded by two shallow grooves. The opening in the umbilical region of the steinkern is moderately small. Surface sculpture, seen on two patches of shell adjacent to the umbilical opening at either side of one of Branson's specimens, consists of closely spaced uniformly fine lirae. The fine even ornament of this form indicates that it belongs in the group of *Knightites* (*Retispira*) *tenuilineata* (Gurley).

In addition to Branson's material, seven specimens from the same subzone at Darwin Peak are referred here. Although it is difficult to equate limonitic steinkerns with partly recrystallized calcareous specimens, the size and overall shape are approximately the same. One fragmental specimen preserves the outer lip and shows that the fine longitudinal lirae are crossed by growth lines bowed slightly forward at either side of the selenizone, which is gently rounded on top and bordered by an almost imperceptible longitudinal depression at either side.

Figured specimens.—UM 6627.

Occurrence and number of specimens.—Horseshoe Shale Member: collections 36d (3), Fremont County; 137 (7), Teton County.

Knightites (Retispira) sp. B

Plate 1, figure 10

Another species referable to *K.* (*Retispira*) occurs at two localities in the Pennsylvanian part of the Amsden. The shell expands in width less rapidly than *K.* (*R.*) sp. A, and the umbilical opening is proportionately larger. Its broadly convex dorsum bears a slightly raised, flattened selenizone. The slit extends backward for about one-fifth of the whorl circumference. The surface lirae are fine, somewhat variable in strength; they are crossed by growth lines shallowly convex toward the aperture on either side of the selenizone and narrowly concave across the selenizone.

The fine sculpture, like that of *K.* (*R.*) sp. A suggests to some degree the group of *K.* (*R.*) *tenuilineata* (Gurley). However, in *K.* (*R.*) sp. B the variable size and strength of the longitudinal lirae and their interruption by fairly strong growth lines are features suggestive of *K.* (*R.*) *textilis* (Gurley), and they differentiate it from the Mississippian form.

Figured specimen.—USNM 168466.

Occurrence and number of specimens.—Ranchester Limestone Member: collections 40 (2), Fremont County; 50 (20), Washakie County.

?Knightites (Retispira) sp. indet.

Love (1939, p. 28) mentioned a *Bellerophon*? sp. in a list of Amsden fossils from Wiggins Fork Can-

yon. We have reexamined the cited specimen (YPM 20101), which is a small steinkern 11.0 mm wide. No trace of shell or impression of ornamentation is preserved. The umbilical areas show small depressions, and the rate of expansion of the shell is rather low. This specimen is too poorly preserved to assign with confidence to any generic taxon, but its overall character suggests *Retispira* as a somewhat more likely placement than either the *Euphemites* or the various species of *Bellerophon* noted above.

Occurrence.—Horseshoe Shale Member: collection 48, Fremont County.

Suborder MACLURITINA
Superfamily EUOMPHALACEA deKoninck
Family EUOMPHALIDAE deKoninck
Genus STRAPAROLLUS deMontfort, 1810
Subgenus STRAPAROLLUS (EUOMPHALUS) J. Sowerby, 1814

Straparollus (Euomphalus) calix n. sp.

Plate 1, figures 20–22

Description.—Conch depressed, discoidal, having steep rounded outer surface. Earliest whorls unknown. Sutures distinct, not impressed. Upper whorl face rising directly from suture, very shallowly inclined upward and outward, abruptly rounded where it meets outer face; upper whorl surface steepening somewhat with age so that mature specimens are very slightly steplike in profile. Outer whorl face gently convex in profile, periphery just above midwhorl. Basal angulation sharp. Umbilicus infundibuliform, deep and prominent, its sutures distinct but not incised. Inner whorl face having steep wall near basal angulation, bending slightly but abruptly inward so that basal angulation mimics but does not constitute circumbilical angulation; most of inner whorl face slightly convex, area of maximum curvature about one-third of distance from suture.

Growth lines obscure on upper face of whorl, apparently nearly orthocline, exact course on outer face unknown; in contrast, growth lines on basal face prominent, closely spaced and distinctly incised, prosocline near angulation, but gradually curving to orthocline on inner half of face adjacent to suture. Faint irregularities seem to be present along upper shoulder of whorl, though not actual nodes or serrations. Shell thick, especially at upper shoulder and basal angulation, as steinkern is well rounded.

Dimensions.—Holotype: width 19.5 mm, height 7 mm.

Discussion.—This species has a distinctly wider (deeper) whorl than *Straparollus* (*Euomphalus*) aff. *S.* (*E.*) *plummeri* Knight. Its most striking feature is the smooth broadly funnel-shaped (infundibuliform) umbilicus which, even on incomplete specimens, distinguishes this species from *S.* (*E.*) *plummeri* and related forms having shallower more steplike umbilici. Among the more common Mississippian and Pennsylvanian species of *Straparollus*, the combination of a sharp basal angulation and smooth funnel-shaped umbilicus is unique, approached only by *S.* (*Amphiscapha*) *hollingsworthi* (Knight) from the Boggy Shale (Des Moinesian) of Oklahoma. In that species, the whorl is narrower and the umbilicus correspondingly shallower.

The largest specimen in the type lot is 21 mm wide. Easton (1962, p. 99) described a *Straparollus* (*Euomphalus*) sp. A from the Upper Mississippian Heath Formation of Montana. This specimen has a width of about 31 mm. It is crushed so that no comparison of the umbilical area is possible, though it appears to be a narrower shell. The rugose character of the upper angulation readily distinguishes that form from *S.* (*E.*) *calix*.

Types.—Holotype, USNM 168467; paratypes, USNM 168468.

Occurrence and number of specimens.—Horseshoe Shale Member: collection 159 (15), Teton County.

Straparollus (Euomphalus) aff. S. (E.) plummeri Knight

Plate 1, figures 16–19

Description.—Conch depressed, discoidal, having steep curved outer whorl face and slightly but distinctly rounded sloping umbilical walls. Early whorls poorly known, possibly with mere incipient angulation at boundary between top and outer surfaces of whorl; early part of shell slightly but distinctly sunk below overall level of upper surface. Sutures distinct, becoming incised and somewhat channeled at maturity and thus gradually modifying upper surface of whorl. Early whorls shallowly steplike, sloping outward and upward from suture with rather flat profile, but becoming concave just inside angulation; top of whorl sloping inward at angle of approximately 20° to horizontal. Mature whorl profile lacking concave zone inside angulation, rising even more abruptly from suture than early whorls, curving more rapidly toward horizontal, and continuing convex in cross section to juncture with outer surface, which it meets at approximately right angles. Outer whorl face uniformly gently arched; periphery below midwhorl; juncture of outer and basal surfaces not shown in

our specimens, but presumably meeting approximately at right angles.

Umbilicus wide and relatively shallow, having curved steplike profile; basal whorl surface horizontal at outer edge, curving gradually upward so that inner edge is nearly vertical, most of curvature occurring on inner half of surface; sutures distinct and slightly incised. Upper angulation irregularly and weakly serrated. Growth lines orthocline on upper surface and outer face, poorly known at upper angulation, but seeming to have small shallow sinus; gently curved on basal surface so that juncture with suture is most anterior point of aperture; trough of broad shallow basal sinus corresponding to area of maximum change in slope of surface. Shell moderately thick. Average-sized specimen is 13.5 mm wide and 4 mm high.

Discussion.—This species is common and well preserved in a chert bed near the top of the formation on the east slope of the Bighorn Mountains (colln. 52); all the illustrated specimens are from this locality. One specimen shows the early whorls less depressed and the ridged angulation of the early whorls less prominent than in the others. Because this difference may in part be due to diagenetic changes in the external mold, rather than to actual morphologic characters of the organism, we are not inclined to separate it as a distinct taxon.

The review by Knight (1934) of the Pennsylvanian euomphalid gastropod species is the only summary paper on these forms. The Amsden species is readily distinguished from those described and illustrated by Knight, with the single exception of *Straparollus* (*Euomphalus*) *plummeri* Knight, from the Upper Pennsylvanian rocks of Kansas and Texas. Although that species is much larger than our material, its configuration at the same size is very similar; at maturity, the body whorl of *S.* (*E.*) *plummeri* is produced slightly downward. The early whorls of the Amsden species seem to be a little more deeply depressed. The upper surface of the early whorls of *S.* (*E.*) *plummeri* slope inward at approximately 30° from the horizontal. The basal surface of the same species appears to have slightly less curvature than in the Amsden shells.

The Mississippian species of this group have not been subject to monographic treatment and are therefore not as well understood as the Pennsylvanian forms. The Amsden species can be distinguished from most of the known Mississippian forms by its lack of an elevated spire. *Straparollus* (*Euomphalus*) *utahensis* (Hall and Whitfield) from beds now assigned to the Gardison Formation of Early Mississippian (Osagean) age is the closest Mississippian species to the Amsden form. Its spire is distinctly depressed, and the angulation is more acute at all stages than in the Amsden shell.

The form described by Easton (1962, p. 99, pl. 13, fig. 15) from the Cameron Creek Shale of Montana as *Straparollus* (*Euomphalus*) n. sp. B is similar in general size to *S.* (*E.*) *plummeri*. It is readily distinguished by its higher whorl and steeper slopes in both the umbilical region and the depressed upper surface. Furthermore, in the Montana form the sutures are not incised.

Figured specimens.—USNM 168469–168472.

Occurrence and number of specimens.—Horseshoe Shale Member: collection 3 (1), Carbon County. Ranchester Limestone Member: collections 50 (9), Washakie County; 52 (10), Johnson County.

Straparollus (Euomphalus) sp. indet.

A third species of *Straparollus* (*Euomphalus*) occurs in a bed of Pennsylvanian age at the base of the Horseshoe Shale Member on the South Fork of Rock Creek in the Bighorn Mountains, but, owing to poor preservation of the material, it cannot be assigned to a species. The conch is depressed and discoidal, the upper surface stepped. The upper face of the whorl is flat and nearly horizontal initially but appears somewhat tilted inward on the later whorls; the angulation at the juncture between top and outer faces is marked by a distinct ridge well within the periphery of the whorl. The outer whorl face is poorly known because of partial crushing but seems to be rather narrow. The umbilicus is shallow, its walls flat; details of the umbilical suture have not been observed. Growth lines are steeply prosocline on the lower part of the outer face and continue this same course into the umbilicus.

The best of our available specimens (USNM 168473) is moderately crushed and is partly covered with matrix; a cross section shows that the initial whorls are badly crushed. Nevertheless, it can be determined that the whorl is narrower and the umbilicus shallower than in *S.* (*E.*) *calix* n. sp. The ridge emphasizing the angulation along the juncture of the top and outer faces distinguishes this form from *S.* (*E.*) aff. *S.* (*E.*) *plummeri*. It is unlikely that this ridge might be the product of crushing of the shell because cross sections of even badly crushed whorls seem to show that the shell is thickened at the top and the base.

The shell that Easton (1962, p. 99, pl. 13, fig. 14)

denoted as *Straparollus* (*Euomphalus*) n. sp. A from the Heath Formation of Montana shows some similarities to this taxon, but they are due entirely to crushing. Both are so poorly preserved that proper comparison cannot be made.

Occurrence and number of specimens.—Horseshoe Shale Member: collection 53 (5), Johnson County.

Suborder PLEUROTOMARIINA
Superfamily PLEUROTOMARIACEA Swainson
Family SINUOPEIDAE Wenz
Genus COLPITES Knight, 1956

Colpites sp. A

Plate 2, figures 1–5

Description.—Shell extremely low spired, having nodose subsutural ornament; body whorl embracing high on side of penultimate whorl. Early whorls very poorly known, but probably including flattened protoconch. Sutures obscure. Whorl profile slightly flattened near suture but otherwise following smooth inflated curve; periphery just below midwhorl; base anomphalous. Shell surface smooth, ornament consisting only of subsutural nodes, which are elongate, steeply prosocline, closely and uniformly spaced; interspaces approximately same width as nodes; 18 to 20 nodes present on each whorl. Growth lines unknown but possibly represented by faint opisthocline markings on lower half of shell.

The most complete shell, a paratype lacking part of the spire, measures 5.2 mm long and 7.0 mm wide.

Discussion.—The six specimens included in this species, with one exception, are external molds that do not preserve the lower half of the shell. Several specimens are partly exfoliated or the mold is partly filled with secondary drusy calcite; at least two of the specimens show impressions of small rounded oblique subsutural nodes. All the specimens included here are from beds of Early Pennsylvanian age.

Two American Pennsylvanian species of *Colpites* have been previously described. The type species *C. moniliferus* (White) is readily distinguished by its higher spire. *Colpites minutus* (Sayre) is similar to *C.* sp. A but has a very slight spire and is even more globose. Furthermore, the subsutural ornament consists of elongate ribs rather than nodes, and their inner edges are closer to the suture.

The Late Mississippian (late Chesterian) form illustrated by Easton (1942, pl. 11, figs. 10, 11) from the Pitkin Limestone of northern Arkansas as *Colpites*? sp. has a flattened outer whorl face and is almost lenticular in profile. If it is a *Colpites*, it is not at all typical. No top view of the specimen was provided, and we cannot suggest a substitute assignment.

Figured specimens.—USNM 168474–168477.

Occurrence and number of specimens.—Ranchester Limestone Member: collections 40 (2), Fremont County; 50 (holotype and two paratypes), Washakie County; 52 (1), Johnson County.

Family uncertain

New genus aff. "Colpites" sp.

Plate 2, figures 6, 7

Description.—Shell turbiniform, body whorl embracing penultimate whorl at periphery. Suture not impressed; upper whorl surface narrow, approximately horizontal and ramplike; outer whorl face convex, periphery approximately at midwhorl; curvature lessening below periphery but continuing smoothly to edge of umbilicus. Umbilicus narrowly phaneromphalus, without circumbilical angulation.

Surface of shell elaborately ornamented by numerous spiral lirae with subequal interspaces; at least 12 occur on outer whorl face and additional lirae on bottom. Juncture of ramp and outer face bearing 3 additional more prominent lirae, slightly wider spaced and interrupted by 21 to 23 prominent smooth nodes elongated normal to suture; spaces between nodes equal to 1½ times width of nodes. Growth lines unknown.

Discussion.—Specimens in the U.S. National Museum collected by I. A. Keyte near Lander are the basis for the description above. These specimens, like all known specimens in the vicinity of Lander, are believed to have come from the *Anthracospirifer welleri-shawi* Zone of Late Mississippian age.

The ramplike upper surface and elaborate spiral ornament of this species is not typical of any species of *Colpites* known to us. Very likely, a new genus will have to be erected for this form, but in the absence of growth lines or any indication pointing to the presence or absence of a selenizone, the material does not provide an adequate basis for erecting such a genus. The assumption of affinity to *Colpites* is on the basis of shape and presence of prominent subsutural nodes.

Figured specimen.—USNM 168479.

Occurrence and number of specimens.—Horseshoe Shale Member: collection E (2), Fremont County.

Family LOPHOSPIRIDAE Wenz
Genus WORTHENIA deKoninck, 1883

Worthenia? sp. indet.

Plate 2, figure 8

This identification is based on poorly preserved material from the Darwin Peak section, consisting of a steinkern partly covered by recrystallized shell material and matrix. Enough of the whorl profile can be seen to show that this is a moderately high spired shell. A distinct upper whorl face slopes downward at an angle of about 30° to the horizontal (observed on middle whorl) ending at an upper angulation; the details of this face are unknown. The outer whorl face of the steinkern is inclined slightly inward from vertical and terminates below in a broad obscure basal angulation. The basal surface is gently inclined and slightly inflated; the base appears anomphalous, though the presence of an umbilical chink cannot be ruled out. No growth lines or details of ornament are preserved. The ridge marking the upper angulation is bordered by two shallowly concave zones; it resembles the selenizone in *Worthenia*.

Figured specimen.—USNM 168480.

Occurrence.—Horseshoe Shale Member: collection 137, Teton County.

Family PHYMATOPLEURIDAE Batten
Genus BORESTUS Thomas, 1940

Borestus sp. indet.

Plate 2, figure 9

A moderately high spired turbiform gastropod preserved as a mold in chert at Bull Lake Creek in the Wind River Range is assigned this identification. Its early whorls are unknown. The suture is not prominent. The upper whorl surface is gently concave in profile, having a general inclination of approximately 45°. The outer whorl face is virtually vertical but also very slightly concave in profile; its curvature is accentuated by the sharp upper and lower angulations, both of which protrude beyond the general curvature of this face. The outer part of the basal surface is flattened and inclined downward, but other details of it are unknown.

No growth lines are preserved. On the body whorl at one point, two obscure parallel markings suggest lirae along the outer face, the area between them occupying about one-third of the width. A reasonable interpretation is that these border a selenizone. The material at hand has a general shape closely similar to that of the type species of *Borestus, B. wrighti* Thomas; the lack of preserved ornamentation precludes identification as to species.

Figured specimen.—USNM 168481.

Occurrence.—Ranchester Limestone Member: collection 40, Fremont County.

Borestus? sp.

Plate 2, figure 10

Description.—Shell turbiform, steplike, and elaborately ornamented; nucleus and early whorls unknown; body whorl embracing penultimate whorl at basal surface; suture distinct but not impressed. Upper surface of whorl sloping outward and downward, divided into two equal segments by fairly prominent, elevated sharp spiral cord along angulate juncture of two segments; inner segment above spiral cord sloping at approximately 50° to vertical and likewise divided in two by smaller subcentral raised spiral lira; outer segment sloping downward at approximately 30° to vertical, concave in profile, terminating below at another sharp spiral lira. Outer face of whorl very steeply inclined, almost but not quite vertical, gently concave overall in profile, its lower edge protruding to form shell periphery; smooth curve of face interrupted by two rounded spiral lirae almost equidistant from upper and lower angulations, area bordered by these lirae occupying central half of outer face, appearing slightly flattened and depressed relative to gentle curvature above and below it; periphery accentuated by rounded cord. All details of base unknown.

Growth lines prominent, raised, nearly the strength of spiral lirae; interspaces approximately twice as wide as growth lines. Growth lines normal to suture, but after crossing cord in middle of inner segment bending slightly opisthocline to central cord, where they turn slightly prosocline to upper angulation; on upper part of outer whorl face, growth lines become more strongly prosocline; central band between lirae apparently constitutes a selenizone, but no lunulae can be observed; on lower part of outer face, faint opisthocline growth lines present.

Discussion.—One very well preserved but incomplete specimen, 7 mm high, consisting of parts of four whorls, is assigned to this genus. This specimen, preserved as an external mold, is from a bed on the east flank of the Bighorn Mountains. It represents an unnamed species and clearly has most of its salient characters, yet this material is not regarded as sufficient for the formal proposal of a name. This Amsden species differs from typical *Borestus* in the preservation of two fairly strong nodose cords on a convex upper whorl slope and

possibly could belong in an undescribed genus. It resembles *Ptychomphalus similis* deKoninck which Batten (1966, p. 50, pl. 5, fig. 18) has assigned to *Borestus*.

Figured specimen.—USNM 168482.

Occurrence.—Ranchester Limestone Member: collection 52, Johnson County.

Genus DICTYOTOMARIA Knight, 1945

Dictyotomaria carlbransoni n. sp.

Plate 2, figures 19–21

Ptychomphalus wortheni Weller. C. Branson, 1937, p. 658, 659, pl. 89, figs. 26, 27.

Description.—Low-spired narrow-whorled turbiform pleurotomariacean having five rather prominent spiral lirae on upper whorl surface. Nucleus and early whorls unknown. Shell broadly steplike in profile; body whorl embracing penultimate whorl at base; suture not accentuated. Upper slope of whorl straight in profile from suture to angulation, inclined about 30° to horizontal; outer face narrower than upper slope, almost vertical, with periphery at basal angulation; basal surface gently convex, nearly flat and inclined strongly inward for approximately two-thirds of its length and then, after crossing an obscure subangulation, curving smoothly into a narrow umbilicus or umbilical chink.

Surface of shell ornamented by fairly strong spiral lirae, of which three occur on upper slope, a fourth at angulation, and a finer thread at suture; outer face having a fine lira a little below upper angulation, two lirae bordering selenizone, and a strong lira accentuating lower angulation; basal surface covered with closely spaced lirae, exact number unknown but no less than eight visible on outer half of this surface. Selenizone of moderate width, flat in profile between bordering lirae, occupying slightly less than half of outer whorl face and situated slightly above middle of that face. Growth lines orthocline on upper slope, minutely beading spiral lirae where they cross them, not visible on outer face and on base, except for closely spaced symmetrical lunulae within selenizone. Shell probably thin.

The holotype has a height of 6.3 mm and a diameter of 7.3 mm.

Discussion.—The holotype of this species is the shell of Late Mississippian age illustrated by C. C. Branson (1937, pl. 89, figs. 26, 27) as *Ptychomphalus wortheni* Weller. The Wyoming shell came from Little Popo Agie River in the Wind River Range. A second specimen in the same lot, consisting of part of the spire of a gastropod of similar size and shape, preserved in a limonitic crust, cannot be identified even as to genus. Questionably included in this species are three immature shells from the Little Popo Agie River (UM 6616) referred by C. C. Branson with question to *Ptychomphalus wortheni*. All are depressed turbinate in shape and bear spiral lirae.

Although Branson (1937, p. 659) considered his material to agree in minute detail with Weller's species from the Ste. Genevieve Limestone of Illinois, several differences can be noted. The Amsden species has a proportionately lower whorl, one more lira on the upper slope of the whorl, and finer and more closely spaced lirae on the base. These basal lirae probably are also more numerous on the Amsden species, which has about as many on the outer half of the basal surface as *P. wortheni* has on the entire base. They have not been preserved, however, on the inner part of the base of the holotype of our new species. *Dictyotomaria carlbransoni* also appears to have a lower spire than the Ste. Genevieve shell, but partial wear on the spire of the holotype precludes a definite statement on this point.

Batten (1958, p. 210) suggested that *Dictyotomaria* be reduced to the rank of a subgenus under *Glyptotomaria* Knight, 1945. He based this suggestion on the presence in the Pennsylvanian of species which seemed to him to bridge the gap between the strikingly different shapes of the two type species. However, upon examining specimens of the type species, we note that in *Glyptotomaria apiarum* Knight the growth lines are sweepingly prosocline from the suture to the upper edge of the selenizone. In *Dictyotomaria scitula* (Meek and Worthen) growth lines are nearly vertical below the suture and across several spiral lirae; they are obliquely inclined for only a short distance from the lowest of the upper set of lirae to the edge of the selenizone. We believe this difference to be at least as significant as the presumed intergradation in shape and prefer to regard the geologically older *Dictyotomaria* as a full genus.

Dictyotomaria carlbransoni is readily distinguished from *D. scitula*, because its upper whorl face is gently inclined and upper angulation fairly abrupt, whereas on the type species this surface is nearly horizontal and the upper angulation is strongly convex. *D. scitula* is far more steplike than in our species. The selenizone of *D. carlbransoni* is both slightly wider and slightly higher on the outer

whorl face than in the type species. Some differences in the ornament are apparent, that of *D. scitula* being more elaborate, but the more subdued ornamentation of *D. carlbransoni* may be the result of poor preservation of the holotype in a limestone matrix. Other species assigned to the genus by Knight are markedly different in shape and need not be compared.

Type.—Holotype UM 6626.

Occurrence and number of specimens.—Horseshoe Shale Member: collection 36d (1, ?3), Fremont County.

Family RAPHISTOMATIDAE Koken
Genus BAYLEA deKoninck, 1883

Baylea? sp. indet.

Plate 2, figure 11

This form, occurring as an internal mold in chert of Pennsylvanian age, is angulated turbiform in shape. Sutures are obscure but are set off by a very narrow ramp bordered by a prominent angulation. A concave area inclined outward and downward lies between this upper angulation and a lower, more ridgelike one. A slightly wider concave area, inclined almost vertically, forms the outer face; the angulation at its base protrudes to form the periphery. On the lower side of the periphery, the profile is concave and curves smoothly into the umbilical area. The shell is anomphalous.

No growth lines are preserved. Generic assignment is therefore entirely arbitrary and based on gross similarity of shell form.

Figured specimen.—USNM 168483.

Occurrence and number of specimens.—Ranchester Limestone Member: collection 40 (1), Fremont County; 52 (1), Johnson County.

Family EOTOMARIIDAE Wenz
Genus MOURLONIA deKoninck, 1883

Mourlonia sp. indet.

Plate 2, figures 12, 13

A small specimen from a silty limestone bed of Pennsylvanian age on the east slope of the Bighorn Mountains is referred to this genus with considerable confidence. The shell has a spire of moderate height, the whorls embracing some distance below the periphery. The upper part of the whorl profile is flattened and ramplike at the suture, but otherwise slopes outward and gently downward, with increasing curvature in the outer part of this segment. The selenizone forms the outer face and appears as a flattened band slightly raised above the rounded whorl; although the selenizone is mainly vertical, its upper edge forms the periphery. Below this raised band the whorl profile curves inward for a short distance, but details of the lower part of the whorl and the base are not preserved. Growth lines are prosocline at an angle approximating 45° about midway between suture and selenizone, but their course cannot be traced on other parts of the shell; several asymmetrical lunulae are preserved on the selenizone. The specimen, consisting of parts of five whorls, is 4.3 mm high and 4.5 mm in diameter.

Although the presence of a broad selenizone on the periphery is a feature similar to that on the outer whorl face of *Dictyotomaria carlbransoni* n. sp., the two shells have little in common and are readily distinguished. In *D. carlbransoni* the selenizone is flat and sunk between bordering lirae, rather than raised. Moreover, the shape of the two shells is different, the rounded profile of *Mourlonia* sp. indet. contrasting with the more angulated outline of the *Dictyotomaria;* the *Mourlonia* is also slightly narrower at a comparable whorl height.

Figured specimen.—USNM 168484.

Occurrence.—Horseshoe Shale Member: collection 53, Johnson County.

Family GOSSELETINIIDAE Wenz
Genus GOSSELETINA Fischer, 1885

Gosseletina sp. indet.

Plate 2, figures 14–16

A specimen from the *Carlinia amsdeniana* Subzone at Livingston Ranch in the Washakie Range is assigned to this genus. The shell is littoriniform, its otherwise rounded-subconical profile slightly indented at the suture. No ramp is present, but the upper part of the outer face is more gently inclined than most of the length of this face. The periphery is low on the whorl, and below it the whorl curves smoothly inward so that no flattened basal area is present. The specimen appears anomphalus but may have a shallow umbilical chink. On the final part of the body whorl, markings on the steinkern suggest a broad shallow band bordered by grooves about one-third of the distance from suture to periphery. An even more obscure pair of lirae can be distinguished just above the periphery at the broken edge of the shell. Recrystallized calcite on the outer surface, which may be a remnant of the original shell, obscures all other details.

The assignment of this species is based on general shape and the assumption that the band high on the whorl constitutes a selenizone.

Figured specimen.—USNM 168485.

Occurrence.—Horseshoe Shale Member: collection 45, Fremont County.

Gosseletina? sp. indet.

Plate 2, figures 17, 18

Naticopsis sp. Burk, 1954, p. 15.

This record is based on a poorly preserved specimen that Burk (1954) assigned to *Naticopsis.* Three whorls are present, and their rate of expansion is significantly less than in naticopsids of comparable size. The whorl profile also is not typical of *Naticopsis;* it is steeply arched outward near the suture; then the curvature lessens so that the slope is flatter to the periphery, which is well below midwhorl; beyond the periphery the curvature follows a semicircle to complete the lower part of the whorl. The steinkern is not umbilicate, though a very narrow umbilical chink may be present. No shell is preserved. The presumed vertical striations noted by Burk appear to be vertical alinements of secondary calcite crystals and thus may be secondary features due to recrystallization of the shell.

This specimen, not identifiable with certainty even as to genus, is questionably assigned to *Gosseletina* on the basis of its general shape. It is readily separable from *Gosseletina* sp. indet. by its more rounded whorl profile and its slightly narrower whorl.

Figured specimen.—UW IT–242.

Occurrence.—Horseshoe Shale Member: collection 35, Fremont County.

Family PORTLOCKIELLIDAE Batten
Genus SHANSIELLA Yin, 1932

Shansiella sp. indet.

Plate 2, figure 22

An incomplete external mold of the upper part of a very low turbiniform shell is tentatively referred to *Shansiella.* At least six whorls are preserved; the first three are well rounded and smooth; the rest are ornamented by prominent narrow spiral lirae, of which five are present and nearly equally spaced on the upper part of each whorl between the sutures. The suture is obscure, bounded by a ramp that ends at the first lira; the areas between each pair of lirae are increasingly steep downward, the one bordering the next suture being vertical. The greater part of the body whorl is not preserved. Growth lines and all other details are not known.

This specimen is slightly higher spired than typical *Shansiella carbonaria* (Meek and Worthen), the common Pennsylvanian species.

Figured specimen.—USNM 168486.

Occurrence.—Ranchester Limestone Member: collection 52, Johnson County.

Suborder TROCHINA
Superfamily PLATYCERATACEA Hall
Family HOLOPEIDAE Wenz
Genus YUNNANIA Mansuy, 1912

Yunnania? sp. indet.

Plate 2, figure 27

Shells from Trout Creek on the west flank of the Bighorn Mountains are referred with question to this genus on the basis of shape somewhat comparable to *Yunnania* and the presence of spiral lirae. They are moderately high spired, of few whorls, and resemble modern *Littorina.* The whorl profile is fairly well rounded and somewhat inflated, though a slight flattening is present on the upper half of the whorl. The sutures are deep. Few details can be seen of the shell surface. Spiral lirae occur near the periphery and extend onto the base; at least 10 of them can be counted. The columellar area is not known, nor have any growth lines been observed. A faint depression at the aperture just above midwhorl may mark a selenizone between the spiral lirae, but as it is not preserved on the rest of the shell, one can with equal reason assume no selenizone is present and that a nonpleurotomarian shell like *Yunnania* is represented. The incomplete specimen figured, consisting of about 2½ whorls, is 9.0 mm high and 7.3 mm in diameter.

Figured specimen.—USNM 168487.

Occurrence and number of specimens.—Ranchester Limestone Member: collection 50 (3), Washakie County.

Family PLATYCERATIDAE Hall
Genus STROPHOSTYLUS Hall, 1859

Strophostylus sp. indet.

Plate 2, figures 31, 32

Strophostylus sp. C. Branson, 1937, p. 658.

Two steinkerns were referred to this genus by C. C. Branson but not illustrated. The more complete one is figured here merely for documentation. It is depressed lenticular in shape and expands rapidly. No external characters are preserved.

Figured specimen.—UM 6645.

Occurrence.—Horseshoe Shale Member: collection 36d, Fremont County.

Superfamily MICRODOMATACEA Wenz
Family MICRODOMATIDAE Wenz
Genus MICRODOMA Meek and Worthen, 1867

Microdoma? sp. indet.

Plate 2, figure 36

A small incomplete external mold is referred with question to this genus. The sutures are impressed,

the whorl embracing on the base a little below the periphery. The outer face is flat in profile and inclined steeply downward to an expanded rounded periphery clearly delimited from the upper surface; below the periphery the whorl curves abruptly into the flattish base. Details of the base are not preserved. The periphery is ornamented by a row of nodes, elongated upward, separated by interspaces about as wide as the nodes; an estimated 20 nodes occur on each whorl. The nodose periphery is on a raised ridge set off from the general inclination of the whorl face.

Typical *Microdoma* has three rows of nodes on each whorl. The single row on the Amsden form combined with a complete lack of evidence as to the course of the growth lines is responsible for our questioning the generic assignment. However, no closely related genus is known.

Figured specimen.—USNM 168488.

Occurrence.—Ranchester Limestone Member: collection 40, Fremont County.

Family ELASMONEMATIDAE Knight
Genus ANEMATINA Knight, 1933

Anematina sp. indet.

Plate 2, figure 28

Two small external molds in chert, one preserving at least five whorls, are referred to this genus. The shell is high subconical in shape, its sutures distinctly impressed, and the periphery at the base of the slope narrowly rounded. The whorls embrace on the outer edge of the basal surface. The outer whorl face below the overhanging preceding whorl is steeply inclined and principally flat, sloping at an angle of 60° to the vertical axis of the shell. Growth lines on the surface are straight and steeply prosocline at an angle of about 20° to the vertical.

Figured specimen.—USNM 168489.

Occurrence and number of specimens.—Ranchester Limestone Member: collection 40 (2), Fremont County.

Suborder NERITOPSINA
Superfamily NERITACEA Rafinesque
Family NERITOPSIDAE Gray
Genus NATICOPSIS M'Coy, 1844

Naticopsis (Naticopsis) spp. indet.

Plate 2, figures 23, 24

A Mississippian species is readily identified as *Naticopsis* s.s. by its exceedingly low spire, globose shape, and rapid expansion of the whorl. The shell material is not preserved, and the early growth stages are therefore obscure. No more than two complete whorls seem to be present in the best preserved of three specimens in a collection from the Darwin Peak section. Patches of calcite adhere to the steinkern; these almost certainly result from recrystallization of the shell. Recrystallization of shells preserved in a limestone matrix is common in *Naticopsis* and may be a consequence of their thickness and aragonitic composition.

The illustrated specimen is the only one complete enough to be identified with certainty. The other two are comparable in size and show part of the whorl and similar crystallization of the shell material. Another shell, from Wiggins Fork, may belong here but is too poorly preserved for one to be certain even of its generic assignment.

Three poorly preserved specimens from a bed of Pennsylvanian age on the west side of the Bighorn Mountains are also referred here, but represent a different species as they are slightly higher spired. They differ in overall shape from *Colpites* sp. A, with which they are associated. These shells expand more rapidly and have a higher, less well rounded whorl than *C.* sp. A.

The specimen listed by Burk (1954, p. 15) as *Naticopsis* sp. is assigned here to *Gosseletina*? sp. indet.

Figured specimen.—USNM 173606.

Occurrence and number of specimens.—Horseshoe Shale Member: collections ?48 (1), Fremont County; 137 (3), Teton County. Ranchester Limestone Member: collection 50 (3), Washakie County.

Subgenus NATICOPSIS (JEDRIA) Yochelson, 1952

Naticopsis (Jedria?) sp. indet.

Plate 2, figures 25, 26

Another Mississippian *Naticopsis* present in the Amsden fauna differs from the typical subgenus in having the aperture produced strongly downward. Shells of this shape are generally referred to the subgenus *N.* (*Jedria*) Yochelson. Specimens of both subgenera are comparable in size. On the single specimen from Livingston Ranch, a slight suggestion of a subsutural shoulder is present, and some indication of impressed growth lines can be seen in this area. The poor preservation, however, precludes positive demonstration of these features, and therefore the subgeneric assignment is questioned. *Naticopsis* (*Jedria*) has not previously been illustrated from North American beds of Mississippian age.

Figured specimen.—USNM 173607.

Occurrence.—Horseshoe Shale Member: collection 45, Fremont County.

Order ARCHAEOGASTROPODA?
Suborder MURCHISONIINA
Superfamily MURCHISONIACEA Koken
Family MURCHISONIIDAE Koken
Genus GONIASMA Tomlin, 1930

Goniasma? sp. indet.

Plate 2, figure 30

High-spired gastropods with an angulation near but slightly below midwhorl are assigned with question to *Goniasma*. These occur as molds in a granular chert bed of Pennsylvanian age near the top of the formation on the east flank of the Bighorn Mountains. The suture of this form occurs at the narrowest part of the whorl but does not indent the shell profile in any way. About three-fifths of the whorl is above the angulation and is gently concave in profile; the other part below the angulation is very gently convex. No growth lines are preserved, and although there is a high probability that a selenizone was present, its position on the surface of the whorl cannot be determined.

Figured specimen.—USNM 173608.

Occurrence and number of specimens.—Ranchester Limestone Member: collection 52 (3), Johnson County.

Genus MURCHISONIA d'Archiac and deVerneuil

Murchisonia? sp. indet.

Plate 2, figure 37

Another high-spired gastropod occurs with *Goniasma*? sp. indet. but lacks its distinctly keeled profile. Instead, the whorls are broadly subangular to subrounded in profile. The pleural angle is slightly narrower than in *Goniasma*? sp. indet., and the individual whorls are correspondingly wider. The sutures also are not deeply incised. No growth lines are preserved, and no spiral ornament is present to even suggest the position of the selenizone.

Figured specimen.—USNM 173609.

Occurrence and number of specimens.—Ranchester Limestone Member: collection 52 (2), Johnson County.

Order CAENOGASTROPODA
Superfamily LOXONEMATACEA Koken
Family PSEUDOZYGOPLEURIDAE Knight
Genus PALAEOSTYLUS Mansuy, 1914

Palaeostylus (Pseudozygopleura) spp. indet.

Plate 2, figure 38

Loxonema wortheni Weller. Branson and Greger, 1918, p. 324, pl. 18, fig. 6.

Solenospira pygmaea Weller. C. Branson, 1937 [part], p. 658.

Distinction between *Loxonema* and some of the pseudozygopleurids is difficult, particularly if the characteristic nuclear whorls are missing. Both *Palaeostylus* (*Pseudozygopleura*) and *Loxonema* have prominent collabral costae ornamenting the shell surface. Reassignment to *P.* (*Pseudozygopleura*) of Branson and Greger's specimen from Cherry Creek, which they illustrated (at approximately natural size, not × 2 as indicated in the plate description) as *Loxonema wortheni* Weller, is based on characters of the ribs. The specimen is not refigured here. In this specimen, the costae, where present, are virtually orthocline and die out abruptly just below the periphery, whereas in *Loxonema* the costae tend to continue across the entire width of the whorl and to be sinuate. Three more specimens of this same form, broken but preserving the axial costae, were found in a lot collected by C. C. Branson from the same region and labeled "*Solenospira pygmaea*" (UM 6628).

In addition, the figured specimen, preserved as a mold in a chert bed of Pennsylvanian age, is also assigned to this subgenus. Its costae are straight and stronger than in the Cherry Creek form, so that one cannot ascertain whether or not they die out below the periphery. Easton (1962, p. 100, pl. 13, fig. 11) has figured a similar though not identical specimen from the Cameron Creek Formation of central Montana.

Probably three distinct species are represented by the Mississippian Cherry Creek specimens, the Pennsylvanian mold, and Easton's Cameron Creek shell. None of the material is complete enough to warrant erecting a new name.

The basal part of a steinkern with a small worn patch of shell on the base is also referred here but with considerable question. Its shape agrees with that of *P.* (*Pseudozygopleura*), but no sculpture can be seen. The specimen is from beds of Pennsylvanian age in the Rawlins hills.

Figured specimen.—USNM 173610.

Occurrence and number of specimens.—Horseshoe Shale Member: collections ?3 (1), Carbon County; 36a (1), 36d (3), Fremont County, Ranchester Limestone Member: collection 40 (1), Fremont County.

Superfamily CERITHIACEA
Family TURRITELLIDAE
Genus ORTHONEMA Meek and Worthen, 1862

Orthonema sp. indet.

Plate 2, figure 29

Among the high-spired gastropods *Orthonema* is rather easily recognized. No other form is known that combines a nearly vertical flattened whorl,

somewhat turreted on top, with weak spiral sculpture. The turreting, in which individual whorls protrude abruptly and distinctly for a short distance adjacent to the suture, produces the effect of an extremely narrow high staircase. Details of the growth lines are not preserved in our specimens, one of which is an external mold and the other an incomplete steinkern.

Figured specimen.—USNM 173611.

Occurrence and number of specimens.—Ranchester Limestone Member: collections 40 (1), Fremont County; 50 (1), Washakie County.

Superfamily SUBULITACEA Lindstrom
Family SUBULITIDAE Lindstrom
Genus IANTHINOPSIS Meek and Worthen, 1866

Ianthinopsis spp. indet.

Five specimens from beds of Mississippian age are tentatively assigned to this genus. One, from Cherry Creek (USNM 173612) is a limonitic steinkern that has been crushed flat and thus shows no meaningful details. Four whorls are present, showing embracement rather high on the outer whorl face, well above the periphery. The broken aperture seems to be produced downward in a siphonlike extension. The associated silicified brachiopods are typical of the *Composita poposiensis* Subzone.

Three additional limonitic steinkerns were found in a lot of 67 gastropods labeled *"Solenispira pygmaea"* in the University of Missouri collection (UM 6628) and are referred with some question to this genus. These were collected at Little Popo Agie River. They are partly crushed and resemble specimens referred here to *Girtyspira* sp. A, but are slightly more tumid and shorter spired.

Finally, a steinkern from the collection of Yale University's Peabody Museum (YPM 20105) collected at Wiggins Fork is referred here with some question. Although this specimen is uncrushed, it is not complete, showing only part of the globose, slightly elongate body whorl. This shell is twice the size of the Cherry Creek specimen. Because of differences in preservation, comparison between the specimens is not possible. None of the specimens warrants illustration.

Occurrence and number of specimens.—Horseshoe Shale Member: collections ?36d (3), 36e (1), ?48 (1), Fremont County.

Genus SOLENISCUS Meek and Worthen, 1861

Soleniscus? sp. indet.

Plate 2, figures 40, 41

A steinkern showing the body and penultimate whorls is referred with question to this genus. The body whorl is inflated elongate with little constriction at the suture. The columellar lip is produced downward but is broken, so that we cannot determine whether or not a columellar fold is present. This specimen is higher spired than those that have been assigned to *Ianthinopsis* spp. indet. but wider than those referred to *Girtyspira*.

Figured specimen.—USNM 173613.

Occurrence.—Ranchester Limestone Member: collection 50, Washakie County.

Family MEEKOSPIRIDAE
Genus MEEKOSPIRA Ulrich

Meekospira? sp. indet.

Plate 2, figure 39

The presumedly advanced Paleozoic gastropods of the Order Caenogastropoda commonly are less well preserved than those of the Order Archaeogastropoda. The Wyoming material is no exception to this generalization. Possibly this is a reflection of shell architecture, which may be more susceptible to recrystallization or solution in the caenogastropods.

This particular species is represented by a steinkern and a poorly preserved external mold which is illustrated. Flattened whorls and an absence of ornament combined with relatively high whorls and a narrow pleural angle are the characters upon which the tentative assignment to *Meekospira* is based. This shell is much more slender and has more whorls than the more common Mississippian ones assigned to *Girtsyspira* sp.

Figured specimen.—USNM 173614.

Occurrence and number of specimens.—Ranchester Limestone Member: collection 50 (2), Washakie County.

Genus GIRTYSPIRA Knight

Girtyspira sp. A

Plate 2, figures 42, 43

Bulimorpha canaliculata (Hall). Branson and Greger, 1918, p. 322, 323, pl. 19, fig. 15.

Soleniscus (*Bulimorpha*) *bulimiformis* (Hall). C. Branson, 1937, p. 658.

The specimen from Cherry Creek figured by Branson and Greger (UM 2659) is a flattened limonitic steinkern indeterminate as to species; because of its distortion, it has not been refigured. The shells figured here are from material collected later by C. C. Branson in the same region and provide more details. This lot (UM 6629) was referred by him (C. C. Branson, 1937, p. 658) to *Soleniscus* (*Bulimorpha*) *bulimiformis* (Hall).

The shell is high spired, the whorls higher than wide. The suture is impressed, but most of the whorl profile is gently convex, the periphery occurring near

midwhorl. The body whorl is moderately long; the columellar lip is very slightly reflexed and produced downward. The shell surface is polished except for fine growth lines, most of which are striae; they are very steeply prosocline, approaching orthocline in course.

This species is higher spired and has more whorls for its size than *Girtyspira canaliculata* (Hall), to which the first specimen was referred by Branson and Greger (1918). It differs also from *Bulimorpha bulimiformis* (Hall), to which the Amsden form was referred by C. C. Branson, in having a proportionately longer body whorl and a higher spire.

Although these shells do not seem to be referrable to any previously described species, the lack of complete information as to the shape of the aperture causes us to feel that no formal name should be proposed for it at this time.

Figured specimens.—UM 6629.

Occurrence and number of specimens.—Horseshoe Shale Member: collections 36a (1), 36d (4), Fremont County.

Girtyspira sp. B

Another species of *Girtyspira* is represented by three broken and very incomplete steinkerns from a bed of Pennsylvanian age. The whorl is very slightly wider than in the Mississippian form, with greater curvature and less development of a shoulder in the sutural area. The proportion of height to width is mainly the same as in *Girtyspira* sp. A but is very difficult to estimate. The specimens do not warrant figuring.

This species, like *Girtyspira* sp. A, differs from *Meekospira*? sp. indet. in having a wider pleural angle.

Occurrence and number of specimens.—Ranchester Limestone Member: collection 50 (3), Washakie County.

Order uncertain
Superfamily PYRAMIDELLACEA
Family STREPTACIDAE
Genus DONALDINA Knight, 1933

Donaldina aff. D. pygmaea (Weller)

Plate 2, figure 44

Solenospira pygmaea Weller. C. Branson, 1937 [part], p. 658.
Donaldina sp. cf. *D. tenuis* (de Koninck). Elias, 1958, p. 20, 21, pl. 2, fig. 5, text fig. 1.

This record is based on 15 specimens from a lot of 64 gastropods, no. 6628 in the University of Missouri collection, labeled "*Solenospira pygmaea*" and collected by C. C. Branson at Little Popo Agie River. These are presumably the specimens cited under this name by Branson (1937). One of them is figured here. The lot also contains several specimens referrable to *Palaeostylus* (*Pseudozygopleura*) and *Ianthinopsis* and numerous unidentifiable small high-spired snails covered with a limonitic coating.

The better shells of *Donaldina* in this lot have apical angles approximating 20°, gently convex whorls, and rather deeply impressed sutures; spiral lirae and finer threads provide the main ornamentation. Most of the shells have six or seven moderately strong lirae ornamenting the lower three fourths of the whorl, becoming more closely spaced downward. The best preserved specimen, which is illustrated, also shows three finer, closely spaced faint threads on the upper one-fourth of the whorl, above the highest of the stronger lirae. As many as five similar fine lirae are present on the base, becoming weaker toward the umbilical area. This specimen, lacking parts of base and spire, is 8.2 mm long.

Comparison of our specimens with the description and figures of *Donaldina* cf. *D. tenuis* (de Koninck), described by Elias 1958) from the Redoak Hollow Formation of southern Oklahoma, suggests that the Amsden and Redoak Hollow forms are conspecific, agreeing in shape, apical angle, and number of both coarse and fine lirae on the whorls.

On the other hand, direct comparison of the Amsden specimens with topotypes of *Donaldina pygmaea* (Weller) from the Ste. Genevieve Limestone at Waterloo, Ill., which Elias (1958) placed in synonymy with the Redoak Hollow form, convinces us that the Illinois species is distinct from the Wyoming and Oklahoma one. *D. pygmaea* has a smaller shell, each whorl bearing four or five lirae on the lower three-fourths of the whorl; no fine lirae have been distinguished. Both the American species are closely related to but not regarded as conspecific with *Donaldina tenuis* (de Koninck) from the Tournaisian of Belgium.

The Amsden material is not complete enough nor well enough preserved to serve as a basis for erecting a new name for this late Chesterian species.

Figured specimen.—UM 6628.

Occurrence and number of specimens.—Horseshoe Shale Member: collection 36d (15), Fremont County.

Donaldina sp. indet.

Plate 2, figure 45

This record is based on a specimen from the east slope of the Bighorn Mountains. In spite of the coarseness of its preservation in granular chert, at

least five closely spaced spiral lirae can be observed on one whorl. This feature and the slender shape, the flattened whorl profile, and the slightly impressed sutures support the identification of the specimen as a *Donaldina*, even though the specimen lacks the characteristic heterostrophic nucleus.

Figured specimen.—USNM 173615.

Occurrence.—Ranchester Limestone Member: collection 52, Johnson County.

Class CEPHALOPODA
Sublcass NAUTILOIDEA
Order ORTHOCERIDA
Superfamily PSEUDORTHOCERATACEA Flower and Caster
Genus RETICYCLOCERAS Gordon, 1960

Reticycloceras? sp. indet.

Cycloceras sp.? Branson and Greger, 1918, p. 324.

Branson and Greger (1918) reported collecting a fragment of a cyclocerid nautiloid resembling the species now known as *Reticycloceras sequoyahensis* (Snider), which occurs in the Fayetteville Shale and Pitkin Limestone of Arkansas and Oklahoma. Unfortunately, the Amsden specimen was never figured and was not placed in the collection at the University of Missouri, so we have not been abe to study it.

Superfamily unknown
Family unknown

Orthoconic nautiloid, gen. and sp. indet.

Orthoceras sp.? Branson and Greger, 1918, p. 324.

Two fragments of an orthocerid nautiloid were also recorded by Branson and Greger (1918). These are not in the collection at the University of Missouri and have not been studied.

Subclass AMMONOIDEA
Superfamily GONIATITACEA deHaan
Family HOMOCERATIDAE Spath
Genus CRAVENOCERATOIDES Hudson, 1941

Cravenoceratoides sp. indet.

Plate 2, figures 33–35; figure 2

Goniatite, Burk, 1945, p. 15.
Cravenoceras [sp.]. Sadlick, 1960, p. 1211.

Description.—Conch subglobose, moderately involute, diameter of umbilicus equal to slightly less than one-third shell diameter; venter broadly convex, rounding gradually into steep but narrow flanks; umbilical shoulder narrowly rounded. Surface of internal mold ornamented by low flat transverse lirae, either faintly but distinctly dichotomous or increasing by intercalation on flanks between umbilical shoulder and ventrolateral zone; course of lirae nearly straight but bulging very slightly orad ventrolaterally and similarly bowed almost imperceptibly apicad over venter. Outer shell surface not known.

Suture at diameters of 6 to 8 mm (fig. 2) has ventral lobe of moderate width, with fairly straight

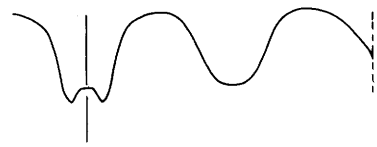


FIGURE 2.—External suture of *Cravenoceratoides* sp. indet., × 8, at a diameter of slightly more than 6 mm.

sloping sides diverging adorally and terminating adapically in short rounded prongs. First lateral saddle slightly wider than ventral lobe and broadly rounded adorally; first lateral lobe symmetrical, rounded adapically, and about same width as ventral lobe. Second lateral saddle fairly low and curving asymmetrically across umbilical shoulder; umbilical lobe not clearly distinguishable, but shallow and located on outer part of umbilical wall. Fifteen camerae present on final volution.

Dimensions and proportions.—Although the only shell available is partly crushed from front to back, measurements (in millimeters) taken in plane of adoral end are reasonably undistorted: diameter 8.3, height of last whorl 4.0, width of last whorl 6.2, diameter of umbilicus 2.6 mm. These give the following shell ratios: $U/D = 0.31$, $W/D = 0.75$, and $W/H = 1.55$.

Discussion.—The unique specimen upon which this description is based is a small septate internal mold of a goniatite collected by C. A. Biggs in float 60 to 90 feet above the base of the Amsden Formation at Cherry Creek. It was mentioned by Burk (1954) but not identified as to genus. Later, Sadlick (1960, p. 1211) identified it as a "*Cravenoceras* exhibiting coarse ornamentation similar to *Cravenoceras scotti* Miller & Youngquist."

This specimen is figured for the first time. Its assignment to the genus *Cravenoceratoides* is on the basis of its dichotomous transverse lirae that show faintly on the internal mold. Presumably, if the shell surface were preserved, the lirae would be seen to be rather prominent and elevated. This genus is typical of the upper part of the *Eumorphoceras bisulcatum* (E_2) Zone which occurs in the Namurian A Substage of Europe and its equivalents in other parts of the Northern Hemisphere. A related form, *Cravenoceratoides* cf. *C. nititoides* (Bisat), slightly more involute than the Amsden one and preserving the surface sculpture, has been reported from the

Rest Spring Shale (as Chainman Shale) of the Inyo Mountains, Inyo County, Calif., by Gordon (1964, p. A16, A17, pl. 4, figs. 18–23). The containing beds in California and in Wyoming are presumably of about the same age, very late Chesterian (latest Mississippian).

Figured specimen.—UW IT–243.

Occurrence.—Horseshoe Shale Member: collection 35, Fremont County.

Family uncertain

Goniatitacean, gen. and sp. indet.

A small external mold in chert of an ammonoid (USNM 173621) preserving the protoconch and slightly more than 2½ volutions of the shell is too immature to be assigned to a genus. The shell is thick discoidal at a diameter of 4 mm. The whorl is rather rapidly expanding, oval in cross section, and wider than high; the greatest diameter is near midwhorl where the curvature is greatest. Faint growth lines on the final one-third volution are straight across the umbilical wall to the periphery, which is located at midwhorl. No sutural elements are preserved.

The low, rapidly widening whorl of this form places it in the suborder Goniatitina rather than in Prolecanitina and indicate the superfamily Goniatitacea as the most likely major category for assignment of this early Pennsylvanian form from Bull Lake Creek in the Wind River Range. Its small size and lack of evidence as to the character of its suture preclude more precise assignment of this shell.

Occurrence.—Ranchester Limestone Member: collection 40, Fremont County.

Phylum ARTHROPODA
Class TRILOBITA
Order PTYCHOPARIIDA
Suborder ILLAENINA
Superfamily PROETACEA Salter
Family PHILLIPSIIDAE Oehlert

Genus PALADIN Weller, 1936

Discussion.—This genus was erected by Weller (1936, p. 707) for *Griffithides morrowensis* Mather and related species that have the cephalon bearing a flat marginal band anterior to the glabella, which is expanded in front. The eyes are large and the basal furrows only slightly curved. Following a thorax of nine segments, the pygidium is bordered by a distinct smooth flange without continuations of the interpleural furrows, except at the anterior end. Typically, 14 to 16 axial rings and 9 or 10 pleurae are present.

Weller considered *Paladin* to differ from *Kaskia,* which he erected (Weller, 1936, p. 708) for *K. chesterensis* (S. Weller and J. M. Weller), and related species, in which the marginal band in front of the glabella is obsolete or lacking entirely. Subsequent workers (Whittington, 1954; Cisne, 1967; Chamberlain, 1969) have generally regarded *Paladin* and *Kaskia* as intergrading and therefore congeneric; Whittington used Weller's two taxa as subgenera.

So far as the Amsden species are concerned, whether one includes the species of Weller's *Kaskia* in *Paladin* or not is academic, as both Amsden forms possess a distinct shelflike marginal band in front of the glabella and belong, therefore, in *Paladin* in Weller's more restricted sense. For other American species included in *Paladin* s.l., the reader should refer to the papers of Cisne (1967) and Chamberlain (1969).

Paladin moorei (C. Branson)

Plate 1, figures 23–32

Griffithides moorei C. Branson, 1937, p. 659, 660, pl. 89, figs. 28–31.

Paladin moorei (C. Branson). Gordon, 1969, p. 38.

Description.—Cranidium having moderately convex subparallel-sided glabella, slightly constricted medially, bordered by fairly distinct axial and preglabelar furrows and set off by deep occipital furrow; lateral preoccipital glabellar lobes set off by deep diagonal furrows; frontal lobe expanded laterally. Glabella 1.4 times longer than wide and 1¼ times wider anteriorly than posteriorly; greatest height about one-quarter of way forward from posterior end. Three pairs of faint lateral glabellar furrows visible on holotype, in addition to the preoccipital pair.

Anterior border gently convex on top forming frontal shelf, about one-eighth as long as glabella, rounded in front. Fixigenae widest opposite frontal lobe of glabella, narrow anterior to palpebral lobes, which are strongly posterior in location, centering on front part of preoccipital glabellar lobes. Palpebral lobes one-third to three-eighths as long as glabella; palpebral furrows moderately deep. Occipital ring moderately wide, convex in sagittal cross section, sloping anteriorly. Occipital furrow deep, particularly behind lateral preoccipital lobes and posterior end of glabella, and subangular in cross section.

Anterior border of cranidium ornamented by as many as 10 fine terrace lines. On posterior part of glabella, dorsum ornamented by fine to moderately coarse granules, granules largest near posterior end

and bordering preoccipital glabellar furrows. About five granules occur at summit of each lateral preoccipital lobe; finer granules dorsally on palpebral lobes. Fairly prominent mesial tubercle just posterior to center of occipital lobe and about a dozen granules along posterior edge.

Librigenae having steeply sloping lateral border marked by fine subparallel terrace lines; border forming obtuse angle with upper surface outside lateral furrow. Genal angle produced into moderately long spine; details of tip unknown. Slope between eye and furrow marked by fine granules. Visual surface of eye crescentic, relatively narrow for genus.

Full details of thorax not known. First thoracic segment showing row of granules along posterior edge.

Pygidium parabolic in outline, width equal to roughly 1¼ times length. Axis of moderate height, about one-third width of pygidium at anterior end, gently convex on top, having sloping, slightly concave sides; at maturity bearing 16 to 17 axial rings and 10 to 11 pleurae on each of pleural lobes. Axial rings narrow, rounded, ornamented by seven to nine tiny elongate granules along posterior edge. Pleurae moderately narrow, subrounded, their greatest elevation slightly posterior to middle, ornamented by scattered granules. Interpleural furrows subangular and moderately deep.

Border of pygidium smooth, sloping less steeply than outer edge of pleural lobe and set off from pleural field by abrupt termination of pleurae at change in slope. Inner part of border flat to slightly concave; outer part steeper and slightly convex.

Dimensions.—Cranidia of holotype and University of Wyoming specimen A57 measure, respectively: length 9.3 and 8.5 mm, width 8.0 and 7.0 mm. Three pygidia, two of them paratypes (UM 6625, USNM 173617, and UM 6592) measure: length 7.0, 5.3, and 5.1 mm, width 8.8, 6.6, and 6.2 mm.

Discussion.—The holotype is a cranidium crushed against an incomplete pygidium, probably belonging to the same individual. No librigena is preserved, but one crescentic section of the visual surface of the eye is fused, slightly out of place, to a palpebral lobe of the cranidium; a fragment of the first thoracic segment is fused to the occipital ring. The crushed pygidium is complete axially and bears 17 axial rings and 11 pleurae. As the specimen does not appear to have changed since the original figures were made, the mention by Branson (1937, p. 659) of 8 thoracic segments as well as a pygidium of 18 segments is puzzling. Reexamination of the specimen (pl. 2, figs. 29, 30) shows that, except for the fragment of the first thoracic segment fused to the occipital ring, the thorax is missing.

Our description is based on Branson's type material and three additional specimens from the University of Wyoming collection, including an undistorted cranidium (A57) which is figured here (pl. 1, fig. 26). Also referred to this species and figured here (pl. 1, figs. 23–25) is a pygidium having 17 axial rings and 10 pleurae, from the Moffat Trail Limestone Member in western Wyoming. The lateral glabellar furrows mentioned in the description are seen not too distinctly on the two cranidia; the positions of these weak furrows on the two glabellae indicate that at least three pairs may be present in addition to the deep basal or preoccipital pair.

The specimen listed by Branson and Greger (1918, p. 324) as *Phillipsia* sp.? does not appear in the list of Sacajawea Formation fossils compiled by C. C. Branson (1937, p. 652–653). We have not found the specimen in the University of Missouri collection, and as *Paladin moorei* is the only species known from the Mississippian part of the Amsden, presumably it belongs here.

Specimens from the Heath and "Cameron Creek" Shales of Montana described and figured by Easton (1962, p. 103, pl. 13, figs. 27–28b) as *Ameura*? sp. possibly belong in *P. moorei.* The pygidia have 16 to 19 axial rings and 11 pleurae and are parabolic in outline; the axial rings each bear about 6 or 7 large granules along the posterior edge. One small cranidium illustrated by Easton from the "Cameron Creek" in the Delpine section clearly belongs in *Paladin,* but its somewhat worn dorsal surface seems to be somewhat more finely granular than the holotype of *P. moorei.* Sando, Gordon, and Dutro (in press) showed that the beds referred by Easton to the "Cameron Creek" at Delpine, Mont., are well down in the Mississippian (Chesterian) and do not actually represent the true Cameron Creek unit of sections in the Big Snowy Range. Contrariwise, the specimen described and figured by Easton (1962, p. 103, pl. 13, fig. 29) as *Paladin*? sp. does indeed come from the Cameron Creek Member of the Tyler Formation (Maughan and Roberts, 1967, pl. 4) but is Pennsylvanian (Morrowan) in age and should be referred to *Ditomopyge.*

Comparisons and affinities.—This species is among those that have a well-developed frontal lobe protruding as a narrow shelf bordering the glabella, which is slightly expanded in front. In this respect it is like *P. helmsensis* Whittington, *P. morrowensis*

(Mather), *P. mucronatus* (Girty), *P. pyriformis* Chamberlain, and *P. retrolatus* Chamberlain.

The Wyoming species differs from nearly all the other species in this group in having 17 axial rings and 11 pleurae on the adult pygidium (most of the other species of *Paladin* having 14 to 16 axial rings and 9 or 10 pleurae), also in the relatively large number, possibly 4 pairs, of lateral glabellar lobes on the cranidium. Only one other species, *P. helmsensis,* has been reported to have so many axial rings and lateral glabellar lobes.

P. helmsensis differs from *P. moorei* in having a slightly smaller, more depressed carapace. Although the cranidium of *P. helmsensis* bears 4 pairs of lateral glabellar furrows, the preoccipital pair is shallower and the preoccipital lobes lower than in *P. moorei;* also the glabella is less expanded anteriorly, its anterior width only 1.1 times the posterior width, instead of the 1¼ times in *P. moorei. P. helmsensis* commonly has only 15 or 16 axial rings on the pygidium and only exceptionally 17, but in *P. moorei,* the normal number is 17. Finally, the granules ornamenting the axis of both species are much finer and more closely spaced in *P. helmsensis* than in *P. moorei.*

Types.—Holotype, UM 6605; paratypes, UM 6592 (pygidium), 6600 (librigena), 6625 (pygidium and fragments of four pygidia, two genal spines, and three indet.); hypotypes UW A57 (cranidium) and USNM 173617 (pygidium).

Occurrence and number of specimens.—Moffat Trail Limestone Member: collections ?77(1), 93 (1), Lincoln County. Horseshoe Shale Member: collections 30 (2), 31 (1), 36d (13), Fremont County; ?116 (1), Teton County.

Paladin sp.

Plate 1, figures 33–37

This species is fairly common in a collection of Pennsylvanian (Morrowan) age from the Rawlins hills (colln. 3). The figured cranidium (pl. 1, fig. 34) is 8.4 mm long and 7.7 mm wide. The glabella is long and appears pyriform; it is about 1.6 times longer than wide and very slightly wider anteriorly than posteriorly; the frontal lobe is moderately expanded. Its highest point is at the posterior tip, which is lobelike and set off anteriorly by a shallow depression. Faint lateral glabellar furrows are visible opposite and just in front of the moderately large palpebral lobes. The frontal border projects to form a narrow flange in front of the glabella, about one-eighth as long as the glabella. The lateral preoccipital glabellar lobes are diagonally elongate, paralleling the short furrows, and are highest posteriorly. The preoccipital furrow is moderately deep and narrow at the bottom. The occipital lobe is convex in cross section and slopes forward as in *P. moorei.*

Surface ornament consists principally of scattered granules, coarsest over the posterior part of the glabella, sparse on the summits of the lateral preoccipital lobes, and fine on the palpebral lobes. Granules are also present scattered on the surface of the occipital lobe, but no mesial tubercle was observed. No terrace lines were observed on the frontal border.

Librigenae are distinctive, the slightly convex lateral border being raised into a rim where it meets the upper surface at an acute angle. This rim is well shown by highlighting in the figure (pl. 1, fig. 33). Three or four subparallel terrace lines are visible on the lateral border. The lateral furrow is modified into a rounded depression between the raised margin and the slope below the eye. The genal angle is produced into a moderately long genal spine. The visual surface of the eye is moderately large and somewhat globose. The figured librigena is 13 mm long.

Thoracic segments have not been observed. The pygidia from this locality are all incomplete but in composite are parabolic in outline and have a moderately elevated axis, gently convex on top, with sloping, slightly concave sides. The most complete of these has about 15 axial rings and 10 pleurae. The pleurae are asymmetrical and have their greatest elevation posterior to the middle, and their distal parts are ornamented by scattered granules, which also can be seen on some of the axial rings. The smooth border is set off from the pleural shield by a shallow furrow and abrupt termination of the ribs. The border is gently convex and has about the same inclination as the outer part of each pleural lobe.

The above description is based on 12 specimens from locality 3, incluling 4 cranidia, 3 librigenae and 5 pygidia. Three pygidia from other localities (collns. 50, 52) are included in this species. The figured pygidium (pl. 1, figs. 35–37) is a mold of the underside, measuring 9.2 mm long and 11.3 mm wide. The first three pleural ribs encroach rather far on to the border. Another pygidium from the same locality has the upper surface fairly well preserved but lacks most of the border. Both pygidia have 15 axial rings and 9 ribs. The last-mentioned pygidium (loc. 52) is the largest but is poorly preserved in sandstone and only referred with question

to this species. The ring and rib count seems to be the same.

This species differs from *P. moorei* in details of the cranidium which include the lobelike posterior tip and diagonally elongate lateral preoccipital lobes, in the distinctive raised margins of the librigenae, and in the lesser number of axial rings and ribs in the pygidium.

Chamberlain (1969, p. 50) has listed 14 North American species of *Paladin*. Of these, three are from rocks of Pennsylvanian age—*P. morrowensis* (Mather), *P. retrolatus* Chamberlain, and *P. pyriformis* Chamberlain. Only the last mentioned is similar to *P.* sp. from the Amsden. According to Chamberlain (1969, p. 55), *P. pyriformis* likewise has an elongate pyriform glabella, the posterior end suggesting a partially developed medial preoccipital lobe and thus approaching the genus *Sevillia*. Its pygidium has 9 pleurae and 15 axial rings. Differences from the Pennsylvanian Amsden species, however, include a wider expansion of the frontal lobe of the glabella and the subpyramidal shape of the lateral preoccipital lobes. The librigenae, so distinctive in the Amsden form, are unknown in *P. pyriformis*. Because of insufficient material available to evaluate the characters and despite direct comparison with Chamberlain's type specimen, we cannot at this time determine whether or not Chamberlain's name is applicable to the Amsden species but are inclined to regard them as different species.

Figured specimens.—USNM 173618–173620.

Occurrence and number of specimens.—Horseshoe Shale Member: collection 3 (12), Carbon County. Ranchester Limestone Member: collections 50 (2), Washakie County; ?52 (1), Johnson County.

REFERENCES CITED

Batten, R. L., 1958, Permian Gastropoda of the southwestern United States. 2. Pleurotomariacea—Portlockiellidae, Phymatopleuridae, and Eotomariidae: Am. Mus. Nat. History Bull., v. 114, art. 2, p. 153–246, pls. 32–42, 17 figs.

——— 1966, The lower Carboniferous gastropod fauna from the Hotwells Limestone of Compton Martin, Somerset: Palaeontogr. Soc. Mon. v. 119–123, 109 p., 10 pls.

Blackwelder, Eliot, 1918, New geological formations in western Wyoming: Washington Acad. Sci. Jour., v. 8, p. 417–426.

Branson, C. C., 1937, Stratigraphy and fauna of the Sacajawea Formation, Mississippian, of Wyoming: Jour Paleontology, v. 11 no. 8, p. 650–660, pl. 89.

Branson, E. B., and Greger, D. K., 1918, Amsden formation of the east slope of the Wind River Mountains of Wyoming and its fauna: Geol. Soc. America Bull., v. 29, p. 309–326, pls. 18, 19.

Burk, C. A., 1954, Faunas and age of the Amsden formation in Wyoming: Jour. Paleontology, v. 28, no. 1, p. 1–16, pl. 1.

Chamberlain, C. K., 1969, Carboniferous trilobites—Utah species and evolution in North America: Jour. Paleontology, v. 43, no. 1, p. 41–68, pls. 11–13.

Cisne, J. L., 1967, Two new Mississippian trilobites of the genus *Paladin*: Jour. Paleontology, v. 41, no. 5, p. 1267–1273, 2 figs.

Darton, N. H., 1906, Geology of the Bighorn Mountains: U.S. Geol. Survey Prof. Paper 51, 129 p., 47 pls.

Easton, W. H., 1942, Pitkin limestone of northern Arkansas: Arkansas Geol. Survey Bull. 8, 115 p., 12 pls.

——— 1962, Carboniferous formations and faunas of central Montana: U.S. Geol. Survey Prof. Paper 348, 126 p., 13 pls.

Elias, M. K., 1958, Late Mississippian fauna from the Redoak Hollow formation of southern Oklahoma; Pt. 4, Gastropoda, Scaphopoda, Cephalopoda, Ostracoda, Thoracica, and Problematica: Jour. Paleontology, v. 32, no. 1, p. 1–57, pls. 1–4.

Gordon, Mackenzie, Jr., 1964, California Carboniferous cephalopods: U.S. Geol. Survey Prof. Paper 483–A, 27 p., 4 pls.

——— 1969, Revision of some of Girty's invertebrate fossils from the Fayetteville Shale (Mississippian) of Arkansas and Oklahoma—Trilobites: U.S. Geol. Survey Prof. Paper 606–E, p. 35–39, pl. 5.

Hyde, J. E. (Marple, M. F., ed.), 1953, The Mississippian formations of central and southern Ohio: Ohio Div. Geol. Survey Bull. 51, 355 p., 54 pls.

Knight, J. B., 1934, The gastropods of the St. Louis, Missouri, Pennsylvanian outlier; 7, The Euomphalidae and Platyceratidae: Jour. Paleontology, v. 8, no. 2, p. 139–166, pls. 20–25.

——— 1945, Some new genera of Paleozoic Gastropoda: Jour. Paleontology, v. 19, no. 6, p. 573–587, pls. 79, 80.

Love, J. D., 1939, Geology along the southern margin of the Absaroka Range, Wyoming: Geol. Soc. America Spec. Paper 20, 134 p., 17 pls., 3 figs.

Maughan, E. K., and Roberts, A. E., 1967, Big Snowy and Amsden Groups and the Mississippian-Pennsylvanian boundary in Montana: U.S. Geol. Survey Prof. Paper 554–B, 27 p.

Meek, F. B., and Worthen, A. H., 1860, Descriptions of new Carboniferous fossils from Illinois and other Western States: Acad. Nat. Sci. Philadelphia Proc. 1860, p. 447–472 [1861].

——— 1866, Descriptions of invertebrates from the Carboniferous system: Illinois State Geol. Survey, v. 2, p. 143–411, pls. 14–20, 23–32.

Sadlick, Walter, 1960, New name for *Spirifer occidentalis* (Girty) and its geologic history: Jour. Paleontology, v. 34, no. 6, p. 1210–1214.

Sando, W. J., Gordon, Mackenzie, Jr., and Dutro, J. T., Jr., in press, Stratigraphy and geologic history of the Amsden Formation: U.S. Geol. Survey Prof. Paper 848–A, in press.

Tooker, E. W., and Roberts, R. J., 1970, Upper Paleozoic rocks in the Oquirrh Mountains and Bingham mining

district, Utah, *with a section on* Biostratigraphy and correlation, by Mackenzie Gordon, Jr., and H. M. Duncan: U.S. Geol. Survey Prof. Paper 629–A, 76 p.

Weller, J. M., 1936, Carboniferous trilobite genera: Jour. Paleontology, v. 10, no. 8, p. 704–714, pl. 95.

Whittington, H. B., 1954, Two silicified Carboniferous trilobites from west Texas: Smithsonian Misc. Colln., v. 122, no. 10, 16 p. 3 pls., 1 fig.

Yochelson, E. L., and Saunders, B. W., 1967, A bibliographic index of North American late Paleozoic Hyolitha, Amphineura, Scaphopoda, and Gastropoda: U.S. Geol. Survey Bull. 1210, 271 p.

INDEX

[Italic page numbers indicate descriptions and major references]

PLATES 1, 2

Contact photographs of the plates in this report are available, at cost, from the U.S. Geological Survey Library, Federal Center, Denver, Colorado 80225.

PLATE 1

[All figures enlarged; magnifications indicated on plate]

FIGURES 1–4. *Bellerophon* cf. *B. crassus* Meek and Worthen (p. F9).
Ranchester Limestone Member, collection 52.
1, 2. Apertural views of two latex casts, USNM 168460 and 168461.
3. Adapertural view of incomplete steinkern showing details of slit and lip, USNM 168462.
4. Side view of steinkern coated with crystalline druse showing small axial hole normally filled with shell material, USNM 168463.

5. *Bellerophon* sp. (p. F9).
Side view of latex cast, USNM 168464, from Ranchester Limestone Member, collection 52.

6–9, 11–13. *Euphemites sacajawensis* C. Branson (p. F10).
UM 6631, from Horseshoe Shale Member, collection 36d.
6. Apertural view of paratype.
7–9. Apertural, side, and adapertural views of holotype.
11–13. Adapertural, side, and apertural views of another paratype.

10. *Knightites* (*Retispira*) sp. B (p. F11).
Dorsal view showing sculpture and slit of a specimen, USNM 168466, from Ranchester Limestone Member, collection 50.

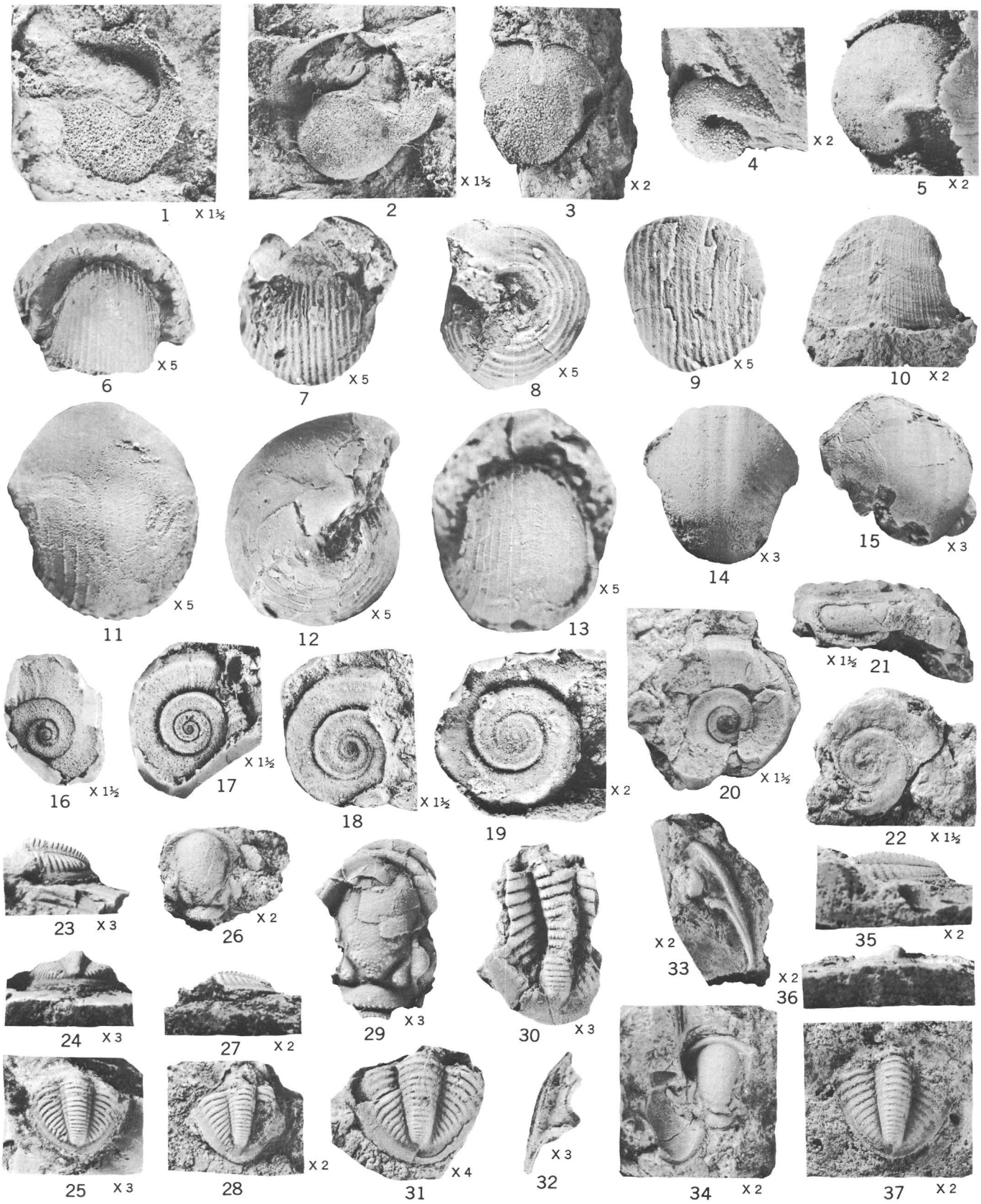
14, 15. *Knightites* (*Retispira*) sp. A (p. F11).
14. Dorsal view of steinkern showing selenizone, U.M. 6627, from Horseshoe Shale Member, collection 36d.
15. Side view of another steinkern from same lot.

16–19. *Straparollus* (*Euomphalus*) aff. *S.* (*E.*) *plummeri* Knight (p. F12).
16. Bottom view of latex cast of external mold, USNM 168472, from Ranchester Limestone Member, collection 52.
17–19. Top views of latex casts of three external molds, USNM 168470, 168471, 168469, from same collection.

20–22. *Straparollus* (*Euomphalus*) *calix* n. sp. (p. F12).
Bottom, side, and top views of holotype, USNM 168467, from Horseshoe Shale Member, collection 159.

23–32. *Paladin moorei* (C. Branson) (p. F24).
23–25. Side, back, and top views of pygidium, USNM 173617, from Moffat Trail Limestone Member collection 93.
26. Top view of cranidium, UW A57, from Horseshoe Shale Member, collection 30.
27, 28. Side and top views of pygidium, UM 6625, from same member, collection 36d.
29, 30. Views of holotype a, specimen folded double, UM 6605, one showing cranidium and the other broken pygidium and part of thorax, from same member at Twin Creek, Wyo.
31. Top view of pygidium of paratype UM 6592, collection 36d.
32. Top view of free cheek paratype UM 6600, collection 36d.

33–37. *Paladin* sp. (p. F26).
33. Top view of free cheek, USNM 173619, from Horseshoe Shale Member, collection 3.
34. Top view of cranidium, USNM 173620, from same collection.
35–37. Side, back, and top views of pygidium, USNM 173618, from Ranchester Limestone Member, collection 50.



GASTROPODS AND TRILOBITES

PLATE 2

[All figures enlarged; magnifications indicated on plate]

FIGURES 1–5. *Colpites* sp. A (p. F14).
1, 2. Top and side views of specimen, USNM 168474, from Ranchester Limestone Member, collection 50.
3. Oblique top view of specimen, USNM 168477, from Ranchester Limestone Member, collection 52.
4, 5. Top views of two specimens, USNM 168475 and 168476, from Ranchester, Limestone Member, collection 50.

6, 7. New genus aff. *"Colpites"* sp. (p. F14).
Top and side views of steinkern, USNM 168479, from Horseshoe Shale Member, collection E.

8. *Worthenia? sp. in*det. (p. F15).
Side view of poorly preserved specimen, USNM 168480, from Horseshoe Shale Member, collection 137.

9. *Borestus* sp. indet. (p. F15).
Side view of latex cast, USNM 168481, from Ranchester Limestone Member, collection 40.

10. *Borestus*? sp. (p. F15).
Side view of latex cast, USNM 168482, from Ranchester Limestone Member, collection 52.

11. *Baylea*? sp. indet. (p. F17).
Apertural view of latex cast, USNM 168483, from Ranchester Limestone Member, collection 52.

12, 13. *Mourlonia* sp. indet. (p. F17).
Top and side views of specimen, USNM 168484, from Horseshoe Shale Member, collection 53.

14–16. *Gosseletina* sp. indet. (p. F17).
Top, side, and bottom views of a steinkern, USNM 168485, from Horseshoe Shale Member, collection 45.

17, 18. *Gosseletina*? sp. indet. (p. F18).
Top and side views of steinkern, UW IT–242, from Horseshoe Shale Member, collection 35.

19–21. *Dictyotomaria carlbransoni* n. sp. (p. F16).
Top, side, and bottom views of holotype, UM 6626, from Horseshoe Shale Member, collection 36d.

22. *Shansiella* sp. indet. (p. F18).
Oblique top view of latex cast, USNM 168486, from Ranchester Limestone Member, collection 52.

23, 24. *Naticopsis* (*Naticopsis*) sp. indet. (p. F19).
Top and side views of specimen, USNM 173606, from Horseshoe Shale Member, collection 137.

25, 26. *Naticopsis* (*Jedria*?) sp. indet. (p. F19).
Top and side views of specimen, USNM 173607, from Horseshoe Shale Member, collection 45.

27. *Yunnania*? sp. indet. (p. F18).
Side view of specimen, USNM 168487, from Ranchester Limestone Member, collection 50.

28. *Anematina* sp. indet. (p. F19).
Strongly oblique side view of latex cast, USNM 168489, from Ranchester Limestone Member, collection 40.

29. *Orthonema* sp. indet. (p. F20).
Side view of latex cast, USNM 173611, from Ranchester Limestone Member, collection 40.

30. *Goniasma*? sp. indet. (p. F20).
Side view of latex cast, USNM 173608, from Ranchester Limestone Member, collection 52.

31, 32. *Strophostylus* sp. indet. (p. F18).
Apertural and top views of steinkern, UM 6645, from Horseshoe Shale Member, collection 36d.

33–35. *Cravenoceratoides* sp. indet. (p. F23).
Back, side, and front views of unique internal mold showing sutures, UW IT–243, from Horeshoe Shale Member, collection 35.

36. *Microdoma*? sp. indet. (p. F18).
Side view of latex cast, USNM 168488, from Ranchester Limestone Member, collection 40.

37. *Murchisonia*? sp. indet. (p. F20).
Side view of latex cast, USNM 173609, from Ranchester Limestone Member, collection 52.

38. *Palaeostylus* (*Pseudozygopleura*) sp. indet. (p. F20).
Side view of latex cast, USNM 173610, from Ranchester Limestone Member, collection 40.

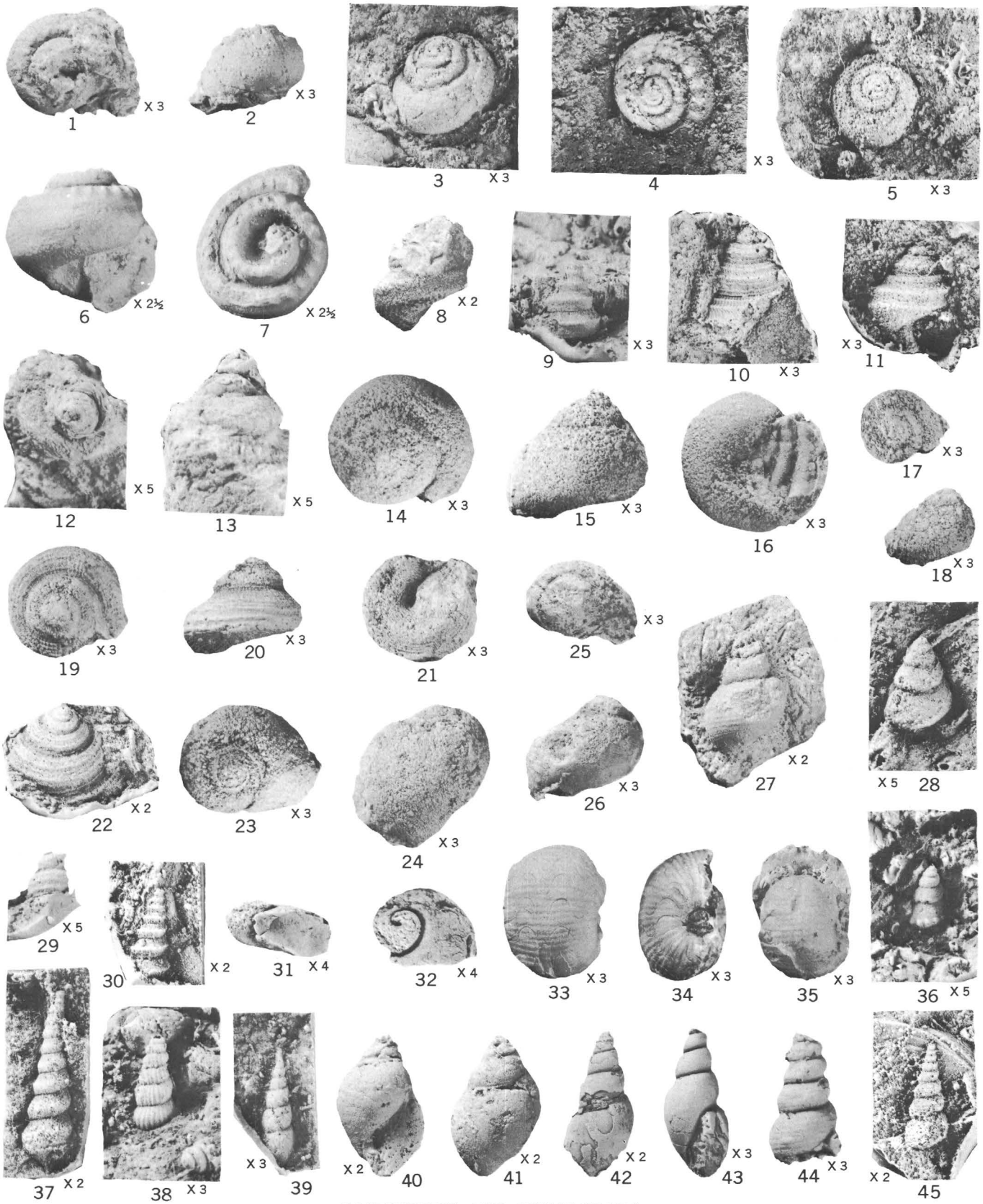
39. *Meekospira*? sp. indet. (p. F21).
Side view of latex cast, USNM 173614, from Ranchester Limestone Member, collection 50.

40, 41. *Soleniscus*? sp. indet. (p. F21).
Apertural and adapertural views of specimen, USNM 173613, from Ranchester Limestone Member, collection 50.

42, 43. *Girtyspira* sp. A (p. F21).
42. Side view of specimen retaining part of shell surface, UM 6629, from Horseshoe Shale Member, collection 36d.
43. Apertural view of steinkern from same lot.

44. *Donaldina* aff. *D. pygmaea* (Weller) (p. F22).
Side view of incomplete specimen, UM 6628, from Horseshoe Shale Member, collection 36d.

45. *Donaldina* sp. indet. (p. F22).
Side view of latex cast, USNM 173615, from Ranchester Limestone Member, collection 52.



GASTROPODS AND CEHALOPODS

* U.S. GOVERNMENT PRINTING OFFICE: 1975 O—585-473/84