

Pelecypoda and Rostroconchia of the
Amsden Formation (Mississippian
and Pennsylvanian) of Wyoming

GEOLOGICAL SURVEY PROFESSIONAL PAPER 848-E



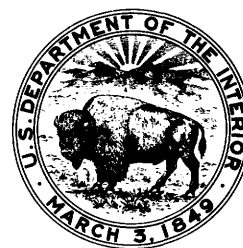
Pelecypoda and Rostroconchia of the Amsden Formation (Mississippian and Pennsylvanian) of Wyoming

By MACKENZIE GORDON, JR., and JOHN POJETA, JR.

THE AMSDEN FORMATION (MISSISSIPPIAN AND PENNSYLVANIAN)
OF WYOMING

GEOLOGICAL SURVEY PROFESSIONAL PAPER 848-E

*Descriptions and illustrations of
41 taxa of pelecypods and 1
rostroconchian, 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-

Pelecypoda and Rostroconchia of the Amsden Formation (Mississippian and Pennsylvanian) of Wyoming.

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

Bibliography: p.

Includes index.

Supt. of Docs. no.: I 19.16:848-E.

1. Lamellibranchiata, Fossil. 2. Rostroconchia. 3. Paleontology—Carboniferous. 4. Paleontology—Wyoming. I. Pobjeta, John, joint author. II. Title. III. Series. IV. Series: United States. Geological Survey. Professional paper ; 848-E.

QE811.G67

564'11'09787

74-32078

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C. 20402
Stock Number 024-001-02638-4

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THE AMSDEN FORMATION (MISSISSIPPIAN AND PENNSYLVANIAN) OF WYOMING

PELECYPODA AND ROSTROCONCHIA OF
THE AMSDEN FORMATION (MISSISSIPPIAN AND PENNSYLVANIAN) OF WYOMING

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ABSTRACT

The study of the pelecypods of the Amsden Formation of Wyoming is based on 285 specimens from the collections of the U.S. Geological Survey, the U.S. National Museum, the University of Missouri, and the University of Wyoming. Of these, 275 are recognizable at least to genus and are assigned to 16 families, 22 genera, and 41 species. Although this material is not particularly well preserved, it is sufficient to show pelecypod diversity at the species level on both sides of the Mississippian-Pennsylvanian boundary. Thus it helps to fill a gap in existing knowledge. In the late Paleozoic, most pelecypod genera are long ranging and are of little use as biostratigraphic tools; at the species level the pelecypods can be useful in this respect. Although all of the Amsden specimens are assigned to Mississippian or Pennsylvanian parts of the formation, this has been accomplished almost solely by reliance on the foraminifers and brachiopods.

All the principal subclasses of late Paleozoic pelecypods are present in the Amsden, as are a quarter of all Paleozoic families; the latter include all the common marine late Paleozoic families with the exception of the Parallelodontidae.

Because of the poor preservation of the material, the nomenclature is of necessity limited. Only five taxa have been identified to species; one of these, *Aviculopecten gravidus*, is new. A lectotype is designated for *Paleyoldia amsdenensis* (Branson and Greger). The rostroconchians are limited to a single fragmentary specimen.

INTRODUCTION

All too often the less well preserved elements of a fossil biota are omitted in otherwise comprehensive systematic studies, yet these organisms may have formed an important part of the biota. Even though such fossils do not lend themselves to formal descriptive paleontology, they may fill important gaps in paleontologic knowledge. We include, therefore, a special chapter on the Amsden pelecypod fauna which, although restricted in its distribution and generally not well preserved, contains representatives of 25 percent of all Paleozoic pelecypod fami-

lies. Our study of this fauna has provided information as to what happened to this important molluscan class as it crossed the Mississippian-Pennsylvanian boundary and has added to our knowledge of the mode of life and diversification of pelecypods in the late Paleozoic.

The pelecypod fauna of the Amsden Formation is highly varied. Compared to the brachiopods, the pelecypods are much fewer in number, but there is greater diversity in proportion to their number. Our study of these pelecypods was based upon 285 specimens from the collections of several institutions. Of these specimens, 8 are unidentifiable below class level, 2 are identifiable only to subclass, and the remaining 275 are considered to belong in 41 species, 22 genera, and 16 families.

PREVIOUS WORK

Relatively little work has been done previously on the Amsden pelecypods. They have figured only incidentally in three brief descriptive papers. Branson and Greger (1918, p. 321-323, pl. 19, figs. 11, 23-26; text fig. 1) described and figured three species of pelecypods in their paper on the Amsden fauna. These are listed below, together with our present assignments.

Branson and Greger (1918)	This paper
<i>Microdon</i> cf. <i>M. oblongus</i> (Hall)	<i>Nuculopsis</i> sp. A
	<i>Cypricardella</i> sp.
<i>Myalina sancti-ludovici</i>	
(Worthen)	----- <i>Septimyalina</i> sp.
<i>Paleoneilo amsdenensis</i> n. sp	----- <i>Paleyoldia amsdenensis</i>
	(Branson and Greger)

C. C. Branson (1937, p. 657, 658, pl. 89, fig. 2³) added three more species to the list, one a rostroconchian; these are cited below in the same manner as above.

C. C. Branson (1937)	This paper
<i>Nucula</i> sp -----	<i>Nuculopsis</i> sp. A.
<i>Schizodus</i> sp -----	<i>Schizodus</i> cf. <i>S. depressus</i> (Worthen).
<i>Conocardium orientale</i> n. sp -----	<i>Conocardium orientale</i> C. C. Branson.

Burk (1954, p. 14, 15, pl. 1, figs. 38-40) added *Allorisma terminale* (Hall) to the list. His material is included in the present paper as *Sanguinolites* sp., *Wilkingia terminalis* (Hall), and *W.* sp.

All previously described material has come from the Mississippian part of the Amsden in the Wind River Range. The fauna from the Pennsylvanian part of the formation has been cited only in faunal lists. The original description of the Amsden Formation (Darton, 1906, p. 34) listed one collection of Pennsylvanian age among which several species of pelecypods had been identified by Girty and assigned to *Edmondia*, *Pleurophorus* [= *Permophorus*], and *Entolium* [= *Pernopecten*]. These are included in the present study (colln. 52).

Blackwelder (1913, p. 176) also published Girty's identifications of several pelecypods from the Mississippian part of the Amsden and a rostroconchian from the Pennsylvanian part, both in the section at Darwin Peak. We have also restudied and briefly described this material (collns. 137, 139).

Shaw (1955, p. 63) listed some pelecypods from the vicinity of Rawlins, Wyo., and mentioned a pelecypod fauna not yet studied. We have not seen Shaw's Rawlins material but some of the species are probably the same as those in our collections from the Rawlins hills (collns. 1, 2, 3, 5).

PRESENT INVESTIGATION

Our study of the Amsden pelecypods includes a restudy of material in the collections of the University of Missouri and the University of Wyoming that has been described and figured or mentioned by previous authors and also includes description of new material from the collections of the U.S. National Museum and the U.S. Geological Survey.

Because of the generally poor preservation of the Amsden pelecypods, only five species, one of them new, are cited by name in this report. Formal descriptions are given only for the better preserved material. Nearly all of the specimens are identified as to genus, some in terms of a closely allied or possibly identical species. Lectotypes have been chosen where necessary and synonymies are given where appropriate. The synonymies have been compiled from the literature and, for the most part, do not imply actual examination of the specimens. Type

material belongs to the U.S. National Museum (USNM), the University of Missouri (UM), and the University of Wyoming (UW).

ACKNOWLEDGMENTS

We are grateful to our colleagues from other institutions who have loaned us Amsden pelecypods for this study. We thank G. A. Cooper and E. G. Kauffman of the U.S. National Museum, A. G. Unklesbay, J. A. Wolleben, R. L. Ethington, R. E. Peck, and J. H. Witt of the University of Missouri, and D. W. Boyd of the University of Wyoming for this kindness. Photographs were prepared by Robert McKinney and Haruo Mochizuki, U.S. Geological Survey. The manuscript was reviewed by E. G. Kauffman and E. L. Yochelson.

COMPOSITION OF THE FAUNA

All of the major subclasses recognized by Pojeta (1971) are present in the Amsden, although the occurrence of the Isofilibranchia is based on questionable material. Considering the number of specimens at the subclass level one finds the following representation: Palaeotaxodonta (30.2 percent), Isofilibranchia (0.7 percent), Pteriomorpha (32.9 percent), Heteroconchia (20.9 percent), and Anomalodesmata (15.2 percent). The class Rostroconchia is represented by a single fragmentary specimen.

In table 1 the families and genera of pelecypods recorded in the Amsden Formation are listed, the number of specimens of Mississippian age and of Pennsylvanian age and the total for each genus are given, as are the percentages of the total number of pelecypods that these figures represent. The isofilibranchians (two specimens) have been omitted from this table because they are not identifiable as to family and genus.

Amsden pelecypods can be divided into three major life-habit groups: infaunal labial palp deposit feeders, burrowing infaunal suspension feeders, and attached suspension feeders. The distribution of the Amsden genera in these groups is shown in table 2. In our selection of these groups no attempt has been made to separate attached epifaunal suspension feeders (epibyssate and cemented species) from attached semi-infaunal suspension feeders (endobyssate species). Stanley (1972) proposed that the great bulk of equivalved byssate pelecypods with anterior lobes were semi-infaunal (endobyssate). Kauffman (1969) felt that many mytilids with an anterior lobe were epifaunal and related current

TABLE 1.—Taxonomic relationships and relative abundance of pelecypods in the Amsden Formation

Family	Genus	Mississippian specimens		Pennsylvanian specimens		Totals	
		Number	Percent	Number	Percent	Number	Percent
Nuculidae	<i>Nuculopsis</i>	4	1.46	7	2.54	11	4.00
Nuculanidae	<i>Phestia</i>	---	---	2	.73	2	.73
	<i>Paleyoldia</i>	69	25.09	2	.73	71	25.82
Myalinidae	<i>Myalina</i>	---	---	13	4.73	13	4.73
	<i>Septimyalina</i>	9	3.27	2	.73	11	4.00
Pterineidae	<i>Caneyella</i>	1	.36	---	---	1	.36
	<i>Leptodesma</i>	1	.36	15	5.45	16	5.81
Posidoniidae	<i>Posidonia</i>	4	1.46	---	---	4	1.46
Pinnidae	<i>Aviculopinna</i>	---	---	1	.36	1	.36
Entoliidae	<i>Pernopecten</i>	---	---	3	1.09	3	1.09
Pseudomonotidae	<i>Pseudomonotis</i>	---	---	1	.36	1	.36
Aviculopectinidae	<i>Streblopteria</i>	1	.36	---	---	1	.36
	<i>Aviculopecten</i>	14	5.09	26	9.45	40	14.54
Myophoriidae	<i>Schizodus</i>	8	2.91	10	3.64	18	6.55
Permophoridae	<i>Permophorus</i>	4	1.46	23	8.36	27	9.82
Crassatellidae	<i>Cypricardella</i>	2	.73	---	---	2	.73
Astartidae	<i>Astartella</i>	1	.36	10	3.64	11	4.00
Edmondiidae	<i>Edmondia</i>	---	---	9	3.27	9	3.27
Grammysiidae	<i>Sphenotus</i>	2	.73	---	---	2	.73
	<i>Sanguinolites</i>	1	.36	---	---	1	.36
	<i>Sedgwickia</i>	---	---	1	.36	1	.36
Pholadomyidae	<i>Wilkingia</i>	8	2.91	21	7.64	29	10.55
Total		129	46.91	146	53.08	275	99.99

flow patterns to the shell morphology of such exposed forms. The empirical base from which Stanley drew his conclusions is rather small; most of his hypothesis is based upon the study of eight species of mytilids from the North Atlantic. Stanley's hypothesis nevertheless has great potential as a unifying concept in the study of attached pelecypods. It needs a broader data base, however, particularly one derived from the study of fossil forms that have been preserved in place.

TABLE 2.—Major life-habit groups of Amsden pelecypods

Infaunal labial palp deposit feeders	Infaunal burrowing suspension feeders	Attached suspension feeders
<i>Nuculopsis</i>	<i>Schizodus</i>	<i>Myalina</i>
<i>Phestia</i>	<i>Permophorus</i>	<i>Septimyalina</i>
<i>Paleyoldia</i>	<i>Astartella</i>	<i>Pseudomonotis</i>
	<i>Cypricardella</i>	<i>Posidonia</i>
	<i>Edmondia</i>	<i>Pernopecten</i>
	<i>Sphenotus</i>	<i>Streblopteria</i>
	<i>Sanguinolites</i>	<i>Aviculopecten</i>
	<i>Sedgwickia</i>	<i>Aviculopinna</i>
	<i>Wilkingia</i>	<i>Leptodesma</i>
		<i>Caneyella</i>
		Isophlibranchian?

FAUNAL DIVERSITY

The diversity of the Amsden pelecypod fauna is noteworthy. Representatives of all the common marine late Paleozoic families, except the Paralleodontidae, have been found in the formation. At the generic level the Amsden fauna supports the concept of a period of late Paleozoic stability in the increase in diversity of the Pelecypoda (Stanley,

1968). Although some of the genera found in the Amsden are limited to either its Mississippian or Pennsylvanian parts, elsewhere all of them except *Paleyoldia* and *Caneyella* range from Mississippian into Permian rocks. Some of the genera range downward into the middle Paleozoic and some upward into the Mesozoic. In contrast to generic stability, however, numerous demonstrable differences exist between Mississippian and Pennsylvanian specimens of these genera that occur in both parts of the formation. For the most part, we have treated these morphological differences as indicating different species. Thus we see no period of late Paleozoic stability at the species level.

In North America, except for a relatively few taxa, it is difficult to recognize the upper Paleozoic systems and series on the basis of pelecypod genera alone. One must turn instead to pelecypod species. Unfortunately, except for the aviculopectinids and myalinids (Newell 1937, 1942), the species-level taxonomy of North American late Paleozoic pelecypods is poorly understood and badly in need of monographic systematic treatment.

RELATION TO THE MISSISSIPPIAN-PENNSYLVANIAN BOUNDARY

Our study of 41 species shows that 21 are present in the Mississippian part of the formation and 22 occur in the Pennsylvanian part; 2 species, *Permophorus* sp. A and *Wilkingia terminalis* (Hall), occur in both parts. Although some Amsden genera

seem to be restricted to either the Mississippian or the Pennsylvanian, all of the genera present in the Amsden are known to cross the Mississippian-Pennsylvanian boundary elsewhere in North America and to range widely through upper Paleozoic rocks. The pelecypods, therefore, because of their sporadic occurrence in the Amsden, their generally poor preservation, and the long ranges of the genera, have limited use as biostratigraphic tools. Nevertheless, because of their diversity at the species level they can be used in some sections in the absence of foraminifers and brachiopods.

STRATIGRAPHIC CONSIDERATIONS

The lithology and biostratigraphy of the Amsden is discussed by Sando, Gordon, and Dutro (1974). In considering the distribution of the fossil faunas within this formation, its transgressive nature must be borne in mind. The same member may contain Mississippian or Pennsylvanian fossils at different localities or in different strata at the same locality.

Four members are recognized within the Amsden Formation, three of them throughout its outcrop area in Wyoming. These three, in descending order, are: the Ranchester Limestone Member, the Horseshoe Shale Member, and the 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, thus separating a thin Horseshoe Shale Member from the overlying Ranchester.

No fossils have been found in the Darwin Sandstone Member, but fossils in the underlying and overlying rocks and the derived depositional history of the basin indicate that it is Late Mississippian in age throughout its area of outcrop. The Moffat Trail Limestone Member, as shown by its contained fossils, is Late Mississippian (Chesterian) in age.

The Horseshoe Shale Member is Late Mississippian (Chesterian) in age in western and west-central Wyoming, but in east-central Wyoming it is Mississippian (late Chesterian) and Pennsylvanian (Morrowan).

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 early Atokan). In west-central and east-central Wyoming this member is Pennsylvanian (Morrowan and early Atokan) throughout.

For these reasons one must designate the Mississippian and Pennsylvanian parts of the formation as well as identify its members.

The pelecypod distribution is, for the most part, the same as the coral and brachiopod zones that have been recognized during this study. These are, in descending order:

Pennsylvanian:

Mesolobus Zone ----- East-central
Wyoming.
Neokoninckophyllum hamatilis Zone -- Do.
Antiquatonia blackwelderi Zone ----- Western
Wyoming.

Mississippian:

Anthracospirifer welleri-shawi Zone -- Western and
west-central
Wyoming.
Composita poposiensis Subzone ----- West-central
Wyoming.
Carlina amsdeniana Subzone ----- Do.
Caninia Zone ----- Western
Wyoming.

Pelecypods have been found in all but the *Mesolobus* Zone, but are particularly common in the *Carlina amsdeniana* Subzone and the *Neokoninckophyllum hamatilis* Zone. At several Pennsylvanian localities in west-central and east-central Wyoming, mollusks predominate and cannot be definitely assigned to coral or brachiopod zones.

GEOGRAPHIC AND STRATIGRAPHIC OCCURRENCE OF THE PELECYPODS

Pelecypods are present in 31 collections from this formation, but in 16 of them only one species is present. Only three collections can be said to be predominantly molluscan (collns. 40, 50, 52), and all of these are in the Pennsylvanian part of the formation. The remaining collections are mixed brachiopod-mollusk assemblages with the brachiopods predominant. Of these, eight occur in Mississippian rocks (collns. 20, 22, 28, 29, 36c, 36d, 46, 137) and four in Pennsylvanian rocks (collns. 1, 3, 5, 53). In the discussion that follows, the collections of Mississippian and Pennsylvanian age are discussed separately.

The Mississippian pelecypod localities in Wyoming are restricted to the western and central regions of Amsden outcrop which include Teton, Lincoln, and Fremont Counties. Pennsylvanian pelecypod localities are limited to one in each of these two regions. The western locality is represented by two collections having the same species from the same locality and bed. Most of the Pennsylvanian localities occur in the eastern region of Amsden outcrop, which includes Sheridan, Johnson, Washakie, and Carbon Counties.

TABLE 4.—Checklist of pelecypod and rostroconchian collections from the Amsden Formation

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 SW $\frac{1}{4}$ sec. 11, T. 21 N., R. 88 W.	Horseshoe Shale.
2	USGS 8071-PC	do	do	do	Probably in SW $\frac{1}{4}$ sec. 11, T. 21 N., R. 88 W.	Do.
3	USGS 3139-PC	do	do	do	NW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 11, T. 21 N., R. 88 W.	Do.
5	USGS 3085-PC	Cherokee Peak	do	do	SE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 10, T. 21 N., R. 88 W.	Do.
20	USGS 19285-PC	Tweed Creek	Wind River Range.	Fremont	Probably in SE $\frac{1}{4}$ sec. 22, T. 30 N., R. 99 W.	Do.
22	UW 3099/9A	South Pass	do	do	Center sec. 9, T. 30 N., R. 99 W.	Do.
27	USGS 19283-PC	Cherry Creek	do	do	Probably in sec. 30, T. 31 N., R. 99 W.	Do.
28	UW 3199/19B2	do	do	do	SE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 19, T. 31 N., R. 99 W.	Do.
29	UW 3199/19B3	do	do	do	do	Do.
30	UW 3199/19B4	do	do	do	do	Do.
31	UW 3199/19B5	do	do	do	do	Do.
36a	UM specimens	do	do	do	Sec. 19, T. 31 N., R. 99 W.	Do.
36b	do	Cherry Creek (?)	do	do	Same, but labeled "sec. 31, T. 19 N., R. 99 W."	Do.
36c	do	Near Lander	do	do	Exactly locality not known.	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	SW $\frac{1}{4}$ sec. 2, T. 2 N., R. 4 W.	Ranchester Limestone.
41	USGS 19156-PC	Soda Creek	Washakie Range.	Teton	Trail in sec. 5, T. 45 N., R. 110 W.	Horseshoe Shale.
43	UW 43106/19B	Horse Creek	do	Fremont	SW $\frac{1}{4}$ sec. 19, T. 43 N., R. 106 W.	Do.
46	USGS 16197-PC	Wiggins Fork	do	do	SW $\frac{1}{4}$ 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.
52	USGS 2461-PC, 2461A-PC.	North Fork, Crazy Woman Creek.	do	Johnson	SE $\frac{1}{4}$ sec. 28 or NE $\frac{1}{4}$ sec. 33, T. 49 N., R. 83 W.	Do.
53	USGS 19241-PC	South Fork, Rock Creek.	do	do	SW $\frac{1}{4}$ sec. 25, T. 52 N., R. 84 W.	Horseshoe Shale.
67	USGS 16215-PC	Amsden Creek	do	Sheridan	SW $\frac{1}{4}$ sec. 34, T. 57 N., R. 87 W.	Ranchester Limestone.
79	USGS 22981-PC	Moffat Trail	Salt River Range.	Lincoln	NW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 3, T. 38 N., R. 117 W.	Moffat Trail Limestone.
92	USGS 6965-PC	Covey Cutoff	do	do	NW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 27, T. 34 N., R. 117 W.	Do.
118	USGS 16207-PC	Hoback Canyon	Hoback range	Teton	Sec. 2, T. 38 N., R. 115 W.	Horseshoe Shale.
130	USGS 18786-PC	do	do	do	Sec. 2, T. 38 N., R. 115 W.	Ranchester Limestone.
131	USGS 16210-PC	do	do	do	do	Do.
137	USGS 6191-PC	Darwin Peak	Gros Ventre Range.	do	S $\frac{1}{2}$ sec. 28, T. 40 N., R. 112 W.	Horseshoe Shale.
139	USGS 6191A-PC	do	do	do	S $\frac{1}{2}$ sec. 28, T. 40 N., R. 112 W.	Ranchester Limestone.
159	USGS 24050-PC	Elk Ridge	Teton Range	do	SW $\frac{1}{4}$ sec. 26, T. 47 N., R. 116 W.	Horseshoe Shale.

stone Member. The base of the Moffat Trail Limestone Member is shown by Mamet's foraminiferal studies to be somewhat younger here than in Lincoln County due to transgressive stratigraphic relationships, so this *Aviculopecten* may not be quite as early as the previously cited species.

At Soda Creek in the Washakie Range, a hetero-

conch pelecypod identified as *Astartella* sp. was found in the basal 10 feet of the Horseshoe Shale Member (colln. 41). It was associated with a brachiopod fauna that includes *Diaphragmus nivosus* n. sp., a productoid characteristic of the Heath Shale of Montana of Late Mississippian (Chertian) age.

The Darwin Peak section in the Gros Ventre

Range includes a limestone bed near the middle of the Horseshoe Shale Member (colln. 137), in which the pelecypods *Septimyalina* sp. A? and *Sphenotus* sp. were found associated with brachiopods characteristic of the *Carlinia amsdeniana* Subzone.

At Berry Creek in the Teton Range, the highest Mississippian beds in the upper part of the Horseshoe Shale Member (colln. 159) contained *Permophorus* sp. A and some pelecypods that are unidentifiable because they are poorly preserved. The Berry Creek beds are in B. L. Mamet's foraminiferal Zone 19. (See Mamet, 1974.)

Fremont County.—In the drainage basin of the Little Popo Agie River, which includes Cherry Creek, considerable collecting over a period of years has turned up the following pelecypods, most, if not all of which are probably from the *Carlinia amsdeniana* Subzone (collns. 20, 27–31, 36a–e):

- Nuculopsis* sp. A
- Paleyoldia amsdenensis* (Branson and Greger)
- Isofilibranchian?, gen. and sp. indet.
- Septimyalina* sp. A
- Leptodesma* sp.
- Aviculopecten* sp. indet.
- Schizodus* cf. *S. depressus* Worthen
- sp. A
- Cypricardella* sp.
- Cypricardella?* sp. indet.
- Sphenotus* sp.?
- Sanguinolites* sp.
- Wilkingia terminalis* (Hall)
- sp.

Fossils from the Horseshoe Shale Member at South Pass in the same mountain range (colln. 20) include *Sanguinolites* sp. and *Wilkingia* sp.

In the Washakie Range, pelecypods occur at two localities in Fremont County. The first is at Horse Creek, where C. A. Biggs collected *Wilkingia terminalis* (Hall), which was figured by Burk (1954, pl. 1, figs. 39, 40). The second is at Livingston Ranch where W. J. Sando found pelecypods in a shale bed with *Lingula*, 8 feet below a limestone containing brachiopods of the *Carlinia amsdeniana* Subzone (colln. 46). These pelecypods are *Caneyella* sp., *Posidonia* sp., and *Streblopteria* sp.

PENNSYLVANIAN FAUNA

Despite the fact that our Pennsylvanian collections contain only one more pelecypod species and a few more individuals than the Mississippian collections available to us, it is evident that pelecypods are much more common in the Pennsylvanian part of the formation, particularly in the eastern region of Amsden outcrop. Had the eastern region been worked as exhaustively as the central one, certainly many more pelecypods and perhaps more pelecypod species would be available.

Teton County.—In the section at Hoback Canyon, a myalinid species identified as *Septimyalina?* sp. is present in the *Antiquatonia blackwelderi* Zone in the Ranchester Limestone Member (collns. 130, 131). This is the only pelecypod species found in the Pennsylvanian part of the Amsden in its western region.

Fremont County.—At Bull Lake Creek in the Wind River Range a bed of fine-grained, very light gray dolomite at the base of the Ranchester Limestone Member (colln. 40) contains a molluscan mold fauna which includes the following pelecypods: *Schizodus* aff. *S. affinis* Herrick, *Astartella concentrica* (Conrad), *Edmondia* sp., and some indeterminate pelecypods. This mold assemblage is the only one of Pennsylvanian age found in the central region, and here the mollusks served to date the rocks.

Washakie County.—At Trout Creek, on the western slope of the Bighorn Mountains (colln. 50), a tan marlstone has provided a fairly large molluscan fauna, among which are the following pelecypods:

- Nuculopsis* sp. B.
- Phestia* sp.
- Paleyoldia* sp.
- Leptodesma* sp.
- Aviculopecten* sp. B
- Schizodus* aff. *S. affinis* Herrick
- Permophorus* sp. A
- Astartella concentrica* (Conrad)
- Edmondia* sp.
- Wilkingia terminalis* (Hall)

These fossils are associated with foraminifers determined by Mamet as belonging in Zone 20 and conodonts determined by J. W. Huddle as Morrowan in age.

Sheridan County.—In the valley of Amsden Creek, on the east slope of the Bighorn Mountains, a small collection from the Ranchester Limestone Member (colln. 67), mostly of brachiopods, contains *Aviculopinna* sp. Also present are Morrowan foraminifers and conodonts.

Johnson County.—At South Fork, Rock Creek, also on the east slope of the Bighorns, pelecypods occur with a predominantly brachiopod fauna at the base of the Horseshoe Shale Member (colln. 53) and include the following:

- Nuculopsis* sp. B
- Paleyoldia* sp.
- Aviculopecten* sp. B
- sp. indet.
- Schizodus alpinus* (Hall)?
- Permophorus* sp. A
- Astartella concentrica* (Conrad)

Most of the pelecypod species at this locality are present also in the collection from Trout Creek cited above.

At North Fork, Crazy Woman Creek a bed of tan granular chert near the top of the Ranchester Limestone Member (colln. 52) has also yielded a predominantly molluscan fauna among which are the following pelecypods:

Pernopecten sp. indet.
Pseudomonotis sp.
Permophorus sp. A
Astartella concentrica (Conrad)
Edmondia 3 spp.

The stratigraphic position of this collection suggests that it is post-early Morrowan, but whether it is late Morrowan or early Atokan in age is not yet known.

Carbon County.—In the region of the Rawlins hills, collections made in the vicinity of Cherokee Spring and at Cherokee Peak (collns. 1, 2, 3, 5) from the *Neokoninckophyllum hamatilis* Zone in the Horseshoe Shale Member contain the following pelecypods:

Myalina (*Myalina*) sp.
Aviculopecten gravidus n. sp.
 sp. indet.
Schizodus sp. B
Permophorus sp. A?
Astartella concentrica (Conrad)?
Sedgwickia? sp. indet.
Wilkingia terminalis (Hall)

These collections are regarded as late Morrowan in age; they are associated with foraminifers identified by Mamet as belonging in Zone 20. *Wilkingia* is common to all four collections.

ROSTROCONCHIANS

This group has recently been made a separate class of mollusks (Pojeta and others, 1972); it is exceedingly rare in the Amsden Formation. A small rostroconch fragment, from the Ranchester Member at Darwin Peak (colln. 139) in the Pennsylvanian part of the Amsden, was listed by Blackwelder (1913, p. 176) on Girty's determination. This specimen is figured in the present report (pl. 4, fig. 22).

Another specimen, presumably from the Horseshoe Shale Member in the drainage basin of the Little Popo Agie River and therefore probably Mississippian in age, was described and figured by C. C. Branson (1937, p. 657, pl. 89, fig. 23) as *Conocardium orientale* n. sp. Unfortunately, the specimen was not available to us for study and seems to be lost.

SYSTEMATIC PALEONTOLOGY

Phylum MOLLUSCA
 Class PELECYPODA
 Subclass PALAEOXODONTA
 Order NUCULOIDA
 Superfamily NUCULACEA Gray
 Family NUCULIDAE Gray
 Genus NUCULOPSIS Girty, 1911

Nuculopsis sp. A

Plate 1, figures 1–5

Microdon cf. *M. oblongus* (Hall). Branson and Greger, 1918 [part], p. 321, 322, pl. 19, fig. 11 [not fig. 25].

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

Four limonitic internal molds of *Nuculopsis*, from the Mississippian part of the formation in the Wind River Range, are present in the University of Missouri collections (UM 2657, 6630, 12791). The molds are elongate, suboval to subtriangular in outline, have prominent umbos, and are boat-shaped in dorsal view, being narrow posteriorly, truncated and beveled anteriorly. They range from about 8 to 16 mm in length, 6 to 11 mm in height, and 4.5 to 8.5 mm in width. The umbos are opisthogyral and located one-fourth to one-third of the length from the posterior end; in the broad area between them, along the plane of commissure, is the small raised mold of the resilifer and a zigzag line marking the underside of the taxodont dentition (pl. 1, figs. 2, 4). The zigzag line is not well enough preserved on any of the specimens to permit a determination of the number of teeth.

Oval anterior and posterior adductor muscle scars are preserved on both valves (pl. 1, fig. 1). The anterior adductor scars are slightly larger than the posterior ones and occupy the beveled end of the valves. Small paired oval anterior and posterior pedal scars are present, one of each in each valve. They are located on the dorsum a short distance behind and in front of the anterior and posterior adductor muscle scars (pl. 1, figs. 2, 4).

The specimen figured here on plate 1, figures 3–5 (UM 2657) was illustrated by Branson and Greger (1918) as *Microdon* [*Cypricardella*]. Two of the other three specimens, one of which is figured here on plate 1, figures 1, 2, are from a lot (UM 6630) identified by C. C. Branson (1937) as *Nucula* sp.

Nuculopsis sp. A occurs in the same beds as *Paleyoldia amsdenensis* (Branson and Greger) but is not nearly as abundant.

Figured specimens.—UM 2657, 6630.

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

Nuculopsis sp. B

Plate 1, figures 6-9

Specimens from two localities in the Pennsylvanian part of the Amsden are placed in this taxon. This species is suboval to subtriangular in outline and smaller than *Nuculopsis* sp. A. The largest specimen (USNM 174018) is a single valve measuring 8.3 mm long, 6.6 mm high, and having a maximum convexity of 2 mm. The umbos are opisthogyral and located about one-third of the length from the posterior end. The surface ornament consists of closely spaced fine concentric growth lines. The zigzag trace of the ventral part of the taxodont dentition and suboval anterior adductor muscle scars are visible on one internal mold (USNM 174020; pl. 1, figs. 8, 9).

The known material of this species consists of two single valves and three articulated internal molds which are suboval in outline and two internal molds of single valves which are subtriangular in outline; the latter are slightly less convex than the suboval specimens. The subtriangular specimens have almost straight anterodorsal margins (pl. 1, fig. 7), whereas the suboval forms have gently convex anterodorsal margins interrupted by a slight medial angulation (pl. 1, fig. 6). It may be that two species are herein included in *Nuculopsis* sp. B, but, as both shapes occur at both localities, we attribute the differences to individual variation and differences in configuration between internal and external molds and place them in a single taxon.

Figured specimens.—USNM 174018-174020.

Occurrence and number of specimens.—Horseshoe Shale Member: collection 53 (2), Johnson County, Wyo. Ranchester Limestone Member: collection 50 (5), Washakie County, Wyo.

Superfamily NUCULANACEA Adams and Adams
Family NUCULANIDAE Adams and Adams
Genus PHESTIA Chernyshev, 1951

Phestia sp.

Plate 1, figures 10, 11

Two specimens assignable to this genus have been collected from a tan marlstone of Pennsylvanian age on the west slope of the Bighorn Mountains. One is an internal mold (pl. 1, fig. 11) in which the rostrum is poorly preserved and which is approximately 11 mm long and 5.5 mm high; the second is an external mold which shows the pointed posterior end and the concentric ornament (pl. 1, fig. 10) and is 5.8 mm long and 3.1 mm high. No internal structures are visible on either specimen.

The external mold closely resembles *Phestia inflata* (Girty) from the Pennsylvanian (Morrowan) Brentwood Limestone Member of the Bloyd Shale in

northwest Arkansas; this species was illustrated by Morningstar (1922, pl. 10, figs. 22-24). However, the Amsden material is not well enough preserved to make a specific identification.

Figured specimens.—USNM 174022, 174023.

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

Genus PALEYOLDIA Lintz, 1958

Paleyoldia amsdenensis (Branson and Greger)

Plate 1, figures 14-31; figure 1

Paleoneilo amsdensensis Branson and Greger, 1918, p. 323, pl. 19, figs. 23, 24, text fig. 1.

Description.—Shell yoldiaform in shape, strongly rostrate; surface marked with concentric growth lines and vague radial markings (pl. 1, fig. 2⁷); beaks opisthogyral, peaks of umbos near midlength, essentially central in younger specimens but offset slightly anteriorly in older individuals.

Pallial line having shallow posterior sinus (pl. 1, fig. 26). Anterior adductor muscle scars large, elongate, and quadrate; posterior adductor muscle scars smaller and more oval (pl. 1, figs. 26, 30, 31). Accessory muscle scars prominent, consisting of paired anterior and posterior pedal scars (pl. 1, fig. 31) and two (pl. 1, fig. 30) or three (pl. 1, fig. 26) pairs of medial muscle scars in the region of the umbos. Dentition consisting of anterior and posterior tooth rows interrupted by a resilifer placed between beaks (pl. 1, figs. 24, 25); anterior tooth row longer than posterior row.

Discussion.—The description is based on the 2 primary types (UM 2665) and 63 additional specimens from another University of Missouri collection (UM 6639). Nine of these specimens are figured in this paper. Branson and Greger (1918, p. 323) mentioned 25 specimens in their collection, but whether their unfigured material has been lost or whether it was incorporated with Branson's later collection (UM 6639) is not known.

The lectotype is herein designated as the specimen figured by Branson and Greger (1918) on plate 19, figures 23, 24; it is figured in this paper on plate 1, figures 14-16. The dimensions of the lectotype are: length 14 mm, height 8 mm, and maximum convexity 4.7 mm (both valves slightly gaping); it probably lacks 1 to 1.5 mm of its former length. The paralectotype is missing the posterior end, but it shows more of the surface sculpture than the lectotype, it was figured by Branson and Greger (1918) as text figure 1 and is here figured on plate 1, figures 17-19. The measurements of the paralectotype are: length (incomplete) 12 mm, height 8.7 mm,

and maximum convexity 5 mm (both valves); it probably lacks 3 to 4 mm of its former length.

The limonitic molds of *Paleyoldia amsdenensis* are the best preserved specimens of any of the Amsden pelecypods we have seen and preserve impressions of virtually all of the shell morphology of the species. *P. amsdenensis* is the first *Paleyoldia* in which the musculature is completely known (fig. 1). Although *P. amsdenensis* is yoldiaform in shape, its musculature differs significantly from that of living

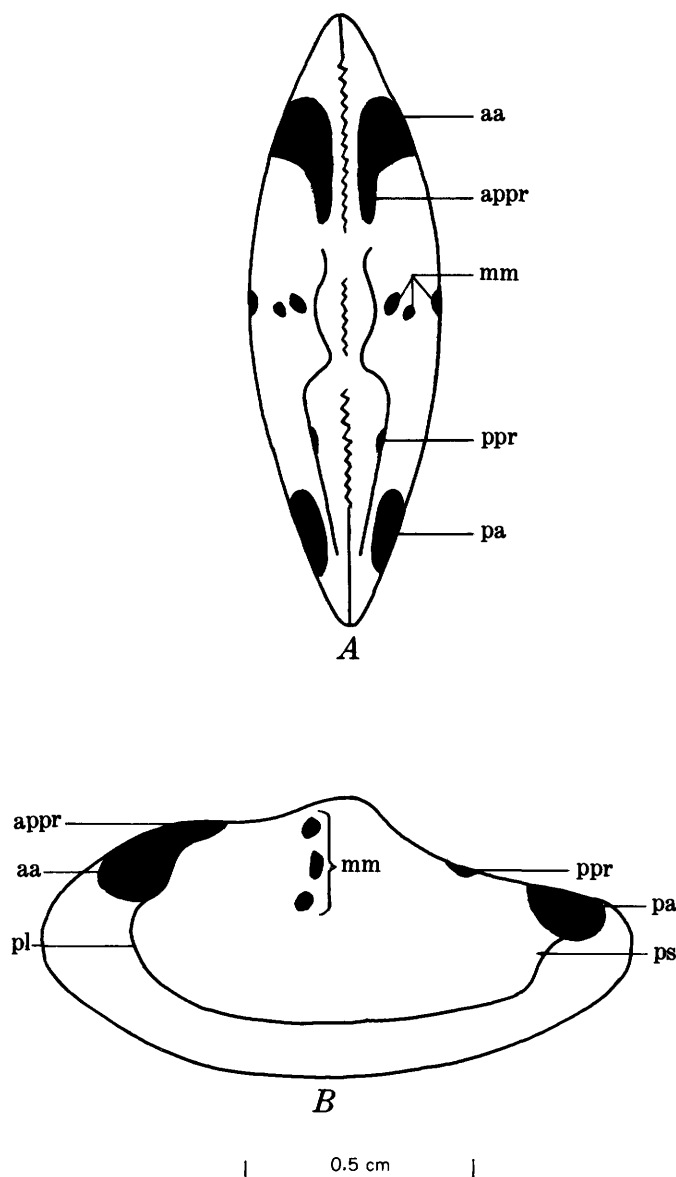


FIGURE 1.—Diagrammatic sketch of muscle scar pattern of *Paleyoldia amsdenensis* (Branson and Greger). A, Dorsal view; B, lateral view. aa, anterior adductor; appr, anterior pedal protractor and retractor; mm, medial muscles; ppr, posterior pedal retractor; pa, posterior adductor; pl, pallial line; ps, pallial sinus.

Yoldia (Heath, 1937, pl. 10; Driscoll, 1964, fig. 2); it is most similar to that of the Paleozoic nuculanid *Phestia* (Driscoll, 1966, figs. 1-5).

Living species of *Yoldia* are rapid burrowers (Stanley, 1970) and have large well-developed pedal muscles (Heath, 1937, pl. 10). By comparison the pedal muscles of *Paleyoldia amsdenensis* are small (fig. 1) and indicate that the animal probably did not burrow with the same speed and efficiency as modern *Yoldia*. No separation of the anterior pedal protractor and retractor muscle scars occurs in *Paleyoldia*, the posterior pedal retractor scars are much smaller than those of *Yoldia*, and the pallial sinus is only slightly developed.

The similarity of the muscle scar patterns of *Paleyoldia* and *Phestia* suggest a phylogenetic relationship between these Paleozoic nuculanid genera. Because *Phestia* is the older genus, it is the presumed ancestor of *Paleyoldia*. The muscle similarity also suggests that *Phestia* had about the same burrowing ability as *Paleyoldia* and that increase in speed and efficiency of nuculanid burrowing was largely a post-Paleozoic development. All occurrences of *P. amsdenensis* are from the Mississippian (late Chesterian) part of the formation. According to Puri (1969), *Paleyoldia* has not previously been reported from rocks older than Pennsylvanian.

Figured specimens.—UM 2665, 6639.

Occurrence and number of specimens.—Horseshoe Shale Member: collections 27 (3), 29 (1), 36b (2), 36d (63), Fremont County, Wyo.

Paleyoldia sp.

Plate 1, figures 12, 13

Two specimens of *Paleyoldia*, both of which are figured, from the Pennsylvanian part of the Amsden Formation probably represent a second species of the genus. They are from localities on either side of the Bighorn Mountains. The two valves measure 22 and 12 mm in length, 11.7 and 6.8 mm in height, and 4 and 2 mm in greatest convexity, respectively. Although the posterior end is not clearly outlined in either specimen, in both the strongly onisthogyral beaks are slightly more than halfway back from the anterior end, which contrasts with *P. amsdenensis* in which the length of the shell posterior to the beaks is equal to or greater than the length anterior to the beaks.

The smaller of the two specimens (pl. 1, fig. 13) preserves some of the surface sculpture which consists of fine concentric growth lines separated by wider interspaces. Internal features are not preserved on either specimen.

Figured specimens.—USNM 174024, 174025.

Occurrence and number of specimens.—Horseshoe Shale Member: collection 53 (1), Johnson County, Wyo. Ranchester Limestone Member: collection 50 (1), Washakie County, Wyo.

Subclass ISOFILIBRANCHIA

Isofilibranchian? gen. and sp. indet.

Plate 2, figures 1, 2

Two poorly preserved modioliform internal molds from the Mississippian part of the Amsden Formation are here tentatively placed in the Isofilibranchia. As defined by Pojeta (1971), this subclass includes only the mytilaceans. The Amsden specimens have some resemblance to the mytilacean genus *Promytilus* but may belong to the Myalinidae, some of which are homeomorphic in shape to the Mytilacea. These specimens are the only possible representatives of the Isofilibranchia so far found in the Amsden Formation.

The specimen shown on plate 2, figure 1, is 15 mm long, 6.5 mm high, and has a maximum convexity of 2.3 mm. The specimen shown on plate 2, figure 2, is 13 mm long, 7.5 mm high, and has a maximum convexity of 2 mm.

Figured specimens.—UW A201, A1275.

Occurrence and number of specimens.—Horseshoe Shale Member: collections 28 (1), 31 (1), Fremont County, Wyo.

Subclass PTERIOMORPHIA

Order PTERIOIDA

Superfamily AMBONYCHIACEA Miller

Family MYALINIDAE Frech

Genus MYALINA de Koninck, 1842

Myalina (*Myalina*) sp.

Plate 2, figures 6, 7

One poorly preserved lot of specimens consisting of 10 left and 3 right valves, from the *Neokoninkophyllum hamatilis* Zone in the Rawlins hills, is referred to this taxon. The figured right valve (pl. 2, fig. 6) is approximately 19 mm high, 15 mm long, and has a maximum convexity of 5 mm. The angle between the dorsal margin and the umbonal ridge cannot be accurately measured because of the poor preservation of the dorsal margin, but it is about 60°. The shell is moderately thick and is ornamented with concentric growth lines that are particularly prominent near the shell margins. The presence of a small anterior lobe and the shape of the shell suggests that this Pennsylvanian form belongs to *Myalina* (*Myalina*).

Figured specimens.—USNM 174026, 174027.

Occurrence and number of specimens.—Horseshoe Shale Member: collection 3 (13), Carbon County, Wyo.

Genus SEPTIMYALINA Newell, 1942

Septimyalina sp. A

Plate 2, figures 8–15

Myalina sancti-ludovici Worthen. Branson and Greger, 1918, p. 322, pl. 19, fig. 26.

Septimyalina n. sp. Easton, 1962 [part?], p. 92, pl. 12, fig. 24 [probably not figs. 23, 25].

Description.—Shell small, prosocline, inequivalve, right valve being slightly less convex than left (pl. 2, figs. 9, 13, 15). Largest and best preserved specimen (pl. 2, figs. 12–15) was previously figured by maximum convexity of 9.2 mm (both valves). Angle between dorsal margin and umbonal ridge (angle alpha) approximates 50° and that between dorsal and posterior margins (angle beta) approximates 120°. Beaks are strongly prosogyral and shell is moderately thick and strongly lamellose; in some specimens a weak umbonal septum is present.

Discussion.—This species is known from specimens in the University of Missouri collections that came from limonitic shales in the Wind River Basin probably belonging in the *Carlinia amsdeniana* Subzone of Late Mississippian age. The largest specimen (pl. 2, figs. 12–15) was previously figured by Branson and Greger (1918, pl. 19, fig. 26) as *Myalina sancti-ludovici* and by Easton (1962, pl. 12, fig. 24) as *Septimyalina* n. sp. The specimens from the Cameron Creek Formation of Montana referred by Easton (1962) to *Septimyalina* n. sp. may belong to a different species than those from the Amsden of Wyoming; in the Montana specimens the angle between the dorsal margin and the umbonal ridge (angle alpha) is greater than the same angle in the Wyoming specimens.

The juvenile specimen shown on plate 2, figures 8, 9, is more strongly prosocline than those shown on plate 2, figures 10, 11, 12–15, angle alpha being about 36°. As demonstrated by Newell (1942, p. 47, 48), this angle tends to be more acute in the young stages of some myalinid species; thus increase in the size of this angle is an ontogenetic trend.

Figured specimens.—UM 2658, 6638.

Occurrence and number of specimens.—Horseshoe Shale Member: collections 36c (1), 36d (6), Fremont County. ?137 (2), Teton County, Wyo.

Septimyalina? sp. indet.

Plate 2, figure 5

Another myalinid, from the Pennsylvanian part of the Amsden at Hoback Canyon, is represented by two left valves, the more complete one of which is figured. The umbonal area and the dorsal margin of this specimen are not well preserved; the angle between the umbonal ridge and dorsal margin ap-

proximates 60°. Both specimens have the prominent concentric lamellae of *Septimyalina* but are so poorly preserved that one cannot determine whether or not an umbonal shelf or an anterior lobe was present. They differ from the Mississippian Amsden shells referred to this genus in their larger size and greater umbonal angle.

Figured specimen.—USNM 174028.

Occurrence and number of specimens.—Ranchester Limestone Member: collections 130 (1), 131 (1), Teton County, Wyo.

Superfamily PTERIACEA Gray, 1847
Family PTERINEIDAE Miller
Genus CANEYELLA Girty, 1909

Caneyella sp.

Plate 2, figure 4

A unique specimen from a shale in the Washakie Range that occurs 8 feet below a limestone containing brachiopods of the *Carlinia amsdeniana* Subzone (Mississippian) is referred to the genus *Caneyella*. This right valve is gently convex in the umbonal area but is otherwise nearly flat. A short remnant of what is probably the dorsal margin is preserved, and the height of the specimen measured down from this point is 17.5 mm. The surface sculpture consists of relatively narrow concentric undulations crossed by low radial costae. The costae are only well preserved near the middle of the valve.

This specimen bears a resemblance to *Caneyella percostata* Girty from the Caney Shale of Oklahoma, but because *C. percostata* disappears in the Oklahoma-Arkansas section at a lower level in the Chesterian series than is represented by the Amsden beds and because the one specimen we have is poorly preserved, we are not extending the range of Girty's species into Wyoming.

Figured specimen.—USNM 174029.

Occurrence and number of specimens.—Horseshoe Shale Member: collection 46 (1), Fremont County, Wyo.

Genus LEPTODESMA, Hall, 1883

Leptodesma spp.

Plate 2, figure 19

A small species of *Leptodesma* occurs in the Pennsylvanian part of the Amsden Formation. The specimens are all molds which are not well preserved. One left valve is figured; it shows the shell shape, the presence of a posterior auricle and an anterior lobe, and the highly prosocline nature of the species; the angle between the dorsal margin and the umbonal ridge (angle alpha) is about 30°. The dimensions of this specimen are: length 10 mm, height 6

mm, diagonal dimension 10 mm, and maximum convexity 2.3 mm.

Also referred to this genus is a small left valve from Cherry Creek, preserved in sandstone, in the collection of the University of Wyoming (A11123). This specimen has ornamentation of narrow concentric growth lines.

Figured specimen.—USNM 174030.

Occurrence and number of specimens.—Horseshoe Shale Member: collection 28 (1), Fremont County, Wyo. Ranchester Limestone Member: collection 50 (15), Washakie County, Wyo.

Family POSIDONIIDAE Frech

Following the suggestion of Stanley (1972) we are herein including this family in the Pteriacea rather than the Pectinacea where it has traditionally been placed.

Genus POSIDONIA Bronn, 1828

Posidonia sp. indet.

Plate 2, figure 3

A small species referred tentatively to *Posidonia* occurs with *Lingula* and *Streblopteria* in a shale of Mississippian age in the Washakie Range. In this form the umbo is located near but not at the anterior end of the hinge, and the surface of the shell is ornamented with several shallow concentric undulations. The dimensions of a moderately large specimen are: length 5.0 mm and height 6.5 mm; the maximum convexity could not be measured because of diagenetic compression of the shell.

This form is somewhat similar to *Posidonia wapanuckensis* (Girty) from the Caney Shale of southeastern Oklahoma, but the Wyoming material is not adequate for detailed comparison with other species.

Figured specimen.—USNM 174032.

Occurrence and number of specimens.—Horseshoe Shale Member: collection 46 (4), Fremont County, Wyo.

Superfamily PINNACEA Leach
Family PINNIDAE Leach
Genus AVICULOPINNA Meek, 1864

Aviculopinna sp.

Plate 2, figures 20-22

An elongate, cuneiform, incomplete, articulated specimen from the Pennsylvanian part of the Amsden Formation at Amsden Creek is placed in this genus. Although the specimen is only a fragment, it has the characteristic shape and concentric markings of *Aviculopinna*. It is most similar to *A. peracuta* (Shumard) which has been reported from many localities in the Pennsylvanian of the American midcontinent.

Figured specimen.—USNM 174033.

Occurrence and number of specimens.—Ranchester Limestone Member: collection 67 (1), Sheridan County, Wyo.

Superfamily PECTINACEA Rafinesque
Family ENTOLIIDAE Korobkov
Genus PERNOPECTEN Winchell, 1865

Pernopecten sp. indet.

Plate 2, figure 23

Three specimens from a granular chert bed of Pennsylvanian age near the top of the Amsden on the east slope of the Bighorn Mountains belong to the genus *Pernopecten*. The specimen shown on plate 2, figure 23, is the most complete of the three; it is probably a left valve and its dimensions are: length 14.5 mm, height 17.3 mm, and maximum convexity 1.2 mm. This shell is gently convex and has two shallow sulci which diverge at an angle of about 60° from the dorsal margin.

These specimens were identified as *Entolium aviculatum* by Girty in a faunal list published by Darton (1906, p. 34) in his original description of the Amsden Formation. In our opinion the material is neither complete enough nor well enough preserved to assign it to a species.

Figured specimen.—USNM 174034.

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

Family PSEUDOMONOTIDAE Newell
Genus PSEUDOMONOTIS von Beyrich, 1862

Pseudomonotis sp.

Plate 2, figure 25

A unique specimen from the same granular chert bed as the previous species is assigned to *Pseudomonotis*. It is a left valve measuring 23.5 mm long, 27.5 mm high, 13.5 mm along the dorsal margin, and having a maximum convexity of 4.5 mm.

The specimen is slightly prosocline and is of moderate convexity. The anterior auricle is weakly set off from the body of the shell by a rounded diagonal concave area, whereas the posterior auricle merges into the body of the shell without a break.

Surface sculpture consists principally of radial costae which increase in number by intercalation and are of somewhat variable strength in an alternating pattern; the costae are not absolutely straight and about 85 occur on this specimen. They are crossed by fine concentric markings that become stronger and somewhat lamellose near the posterior margin; some beading is present where the concentric lirae cross the costae.

Figured specimen.—USNM 174035.

Occurrence and number of specimens.—Ranches-

ter Limestone Member: collection 52 (1), Johnson County, Wyo.

Family AVICULOPECTINIDAE Meek and Hayden
Subfamily STREBLOCHRONDRINAE Newell
Genus STREBLOPTERIA McCoy, 1851

Streblopteria sp. indet.

Plate 2, figure 24

The Amsden record of this genus consists of one left valve preserved in a grayish-tan shale of Late Mississippian age in the Washakie Range. The bed is 8 feet below a limestone containing brachiopods of the *Carlinia amsdeniana* Subzone.

This specimen is subcircular, opisthocline, and measures 14.8 mm long and 13.8 mm high; it is gently convex but is probably diagenetically compressed. The shell surface is smooth and the auricles are incompletely preserved.

Figured specimen.—USNM 174036.

Occurrence and number of specimens.—Horseshoe Shale Member: collection 46 (1), Fremont County, Wyo.

Subfamily AVICULOPECTININAE Meek and Hayden
Genus AVICULOPECTEN McCoy, 1851

Aviculopecten gravidus n. sp.

Plate 3, figures 5-7

Description.—Shell markedly inequivalve, having strongly convex left valve and nearly flat right valve, acline to slightly prosocline. Left valve ovate, rounding into auricles; height greater than length; in longitudinal profile, curvature is greatest near umbo, decreasing slightly toward ventral margin; greatest convexity a little above middle. Anterior auricle set off from main part of valve by weak diagonal sulcus; posterior auricle not sharply separated from main part of valve but delimited by shallow posterior embayment.

Right valve gently convex in umbonal region, gradually becoming almost flat near margin. Anterior auricle long and separated from body of valve by deep byssal notch; posterior auricle not so well defined, or preserved, but seemingly with very shallow concave area of intersection with disk.

Surface sculpture of both valves consisting of fine rounded radial costellae separated by subequal interspaces. Costellae increase by intercalation on left valve; method of increase not possible to determine on the only right valve because of inadequate preservation. Roughly 125-135 costellae present on left valve covering both disk of valve and auricles; number uncertain on right valve; anterior auricle of right valve ornamented only by growth lines. Radial sculpture crossed by concentric growth lines, some of which are quite prominent and indicate periods

of slow growth. Toward margins of left valve, growth lines become stronger and lamellose. Occasionally, intersecting costellae and growth lines combine to give reticulate appearance to surface.

Dimensions (in mm).—

	USNM 174041 LV (holotype)	USNM 174042 RV (paratype)
Height -----	44	39
Length -----	37	34
Convexity -----	14	4
Dorsal margin -----	31	24

¹ Approximate because incompletely preserved. LV, left valve; RV right valve.

Discussion.—This species is based on specimens from a single locality in the *Neokoninckophyllum hamatilis* Zone of Pennsylvanian age in the Rawlins hills. The type lot consists of 12 specimens, all but one of which are left valves. Although none of the valves is complete, the aggregate lot gives most of the essential characters, the most distinctive of which are the unusual disparity in convexity between the two valves and the distinctive fine sculpture which has a reticulate appearance in places. The left valve bears some resemblance to that of members of the genus *Pseudomonotis*, but the right valve is that of a typical *Aviculopecten*.

Types.—Holotype USNM 174041, paratypes USNM 174042–174044.

Occurrence and number of specimens.—Horseshoe Shale Member: collection 3 (12), Carbon County, Wyo.

Aviculopecten sp. A

Plate 3, figure 1

This small species has an acline suboval shell with the length of the dorsal margin approximately equal to two-thirds of the length of the shell. The most complete specimen (the larger of the two left valves illustrated) measures 9.9 mm high, 8.9 mm long, and has a maximum convexity of 1.3 mm; the dorsal margin is 6 mm long. The auricles are indistinctly set off from the main part of the shell; the anterior auricle has a straight to rounded anterior margin, whereas the posterior auricle has a concave posterior margin and is slightly alate at its dorsal terminus.

Surface sculpture consists of about 100 radial costellae distributed over the body and auricles which are separated by wider to subequal flat-bottomed interspaces. The costae increase in number by intercalation, but the new elements quickly reach the strength of the earlier ones so that the shell appears evenly costellate. The costellae are crossed by fine concentric growth lines.

Most of our specimens are fragmentary; all of them are probably left valves. They came from a bed of Mississippian age just beneath the Moffat Trail

Limestone Member at a locality in the Hoback Range.

Figured specimens.—USNM 174037A, B.

Occurrence and number of specimens.—Horseshoe Shale Member: collection 118 (1), Teton County, Wyo.

Aviculopecten sp. B

Plate 2, figures 16–18; plate 3, figure 2

This small species has a slightly prosocline shell. The specimen shown on plate 3, figure 2, is 10.4 mm high, 10 mm long, and has a maximum convexity of 2.5 mm; the dorsal margin is 7.8 mm long. The shell is unusually convex for its small size. The anterior auricle is relatively short and is sharply set off from the body of the shell; the posterior auricle is longer than the anterior and is not as abruptly set off from the body of the shell.

Shell sculpture is well preserved on only one specimen (USNM 174038). It has 10 narrow primary costae having wide, flat to gently concave interspaces; the primary costae are more closely spaced posteriorly than anteriorly. At 3 to 4 mm from the beak, intercalary costae begin to appear and they increase rapidly in strength. No costae have been seen on the auricles. Concentric growth lines are faintly preserved. Two left valves (USNM 174039, 174040) preserve some details of the dorsal margin (pl. 2, figs. 16–18) which, considering the size of the species, has a wide subtriangular shelf extending from the beak to the commissure. This shelf is marked by horizontal growth lines.

Aviculopecten sp. B is found at two Pennsylvanian localities at either side of the Bighorn Mountains. Of 12 specimens referred to this taxon, 7 are left valves and the others are also probably left valves although they are not complete. The relatively sparse radial sculpture and the wide dorsal shelf readily differentiate this form from other Amsden *Aviculopectens*.

Figured specimens.—USNM 174038–174040.

Occurrence and number of specimens.—Horseshoe Shale Member: collection 53 (3), Johnson County, Wyo. Ranchester Limestone Member: collection 50 (9), Washakie County, Wyo.

Aviculopecten spp. indet.

Plate 3, figures 3, 4

Besides the three distinctive species already described, which are represented by reasonably well preserved material, several fragmental and poorly preserved valves are scattered through the collections, probably representing at least three additional

species of *Aviculopecten*. We will consider these in order of age from older to younger.

Two fragments (USNM 174046, 174047), possibly belonging to the same species, were found in the *Caninia* Zone (Moffat Trail Limestone Member) in the Salt River Range at localities about 1½ miles apart. This species is a medium-sized *Aviculopecten* having the left valve ornamented by rather narrow costae of alternating strength, separated by wider interspaces. The flat right valve has costae that increase by bifurcation, as is typical in this genus.

A lot of three weathered specimens (UW A11102) from the *Carlinia amsdeniana* Subzone (Horseshoe Member) at Cherry Creek belongs in a different species. The shell is convex and ornamented by more than 15 rather strong costae separated by 1 to 3 noticeably weaker ones. Only one of the three shells is well enough preserved to show the finer sculpture. Another poorly preserved specimen (UW A11137) from the underlying bed probably represents the same species.

Lastly, two specimens of *Aviculopecten* occur in beds of Pennsylvanian age in the Horseshoe Shale Member. The more complete of these (USNM 174045, pl. 3, figs. 3, 4) is from the base of this member on the east flank of the Bighorn Mountains. The other one (USNM 174021), a fragment of the umbonal area, probably of a left valve, is from the *Neokoninckophyllum hamatilis* Zone in the Rawlins hills.

Figured specimen.—USNM 174045.

Occurrence and number of specimens.—Horseshoe Shale Member: collections 1 (1), Carbon County; 29 (1), 30 (3), Fremont County; 53 (1) Johnson County, Wyo. Moffat Trail Limestone Member: collections 79 (1), 92 (1) Lincoln County, Wyo.

Subclass HETEROCONCHIA
Order TRIGONIOIDA
Superfamily TRIGONIACEA Lamarck
Family MYOPHORIIDAE Bronn
Genus SCHIZODUS deVerneuil and Murchison, 1844

Schizodus cf. *S. depressus* Worthen

Plate 3, figures 10–13

Schizodus depressus Worthen, 1884, p. 11; 1890, p. 100, pl. 18, figs. 8, 8a; Girty, 1915a, p. 98, pl. 9, figs. 13, 13a; Weller, 1916, p. 250, pl. 16, figs. 25–27.

Schizodus sp. Branson, 1937, p. 658.

Description.—Shell moderately small, subtriangular, having convex curved margins, length slightly exceeding height; anterior margin rather evenly rounded, posterior margin having two subangulations interrupting its curved outline; valves moderately shallow. Umbonal ridge rounded but fairly well marked; postumbonal slope gently concave, in-

clined at angle of roughly 50° to plane of commissure.

Dimensions (in mm).—

	UW A11121 LV	UW A1288 RV	UM 6630 BV	USNM 174048 RV
Height	14.5	13.4	---	8.2
Length	16.7	16.2	9.0	8.4
Convexity	2.9	3.0	(2.2)	2.2
Thickness (both valves)	---	---	4.4	---

¹ Ventral part broken off. BV indicates both valves.

Discussion.—The first two specimens in the table above are from a calcareous sandstone collected in place in the *Carlinia amsdeniana* Subzone, 45 feet above the base of the Amsden Formation at Cherry Creek. These shells approximate in their dimensions and configuration typical specimens of *S. depressus* from the Ste. Genevieve Limestone of Late Mississippian (Meramecian) age in Monroe County, Ill. The two specimens from the limonitic shale beds of the Amsden are smaller and in the more complete valve the length is subequal to the height. One well preserved but incomplete internal mold (pl. 3, figs. 10, 11) preserves the imprint of the lower side of the cardinal tooth, which is small and delicate.

The references given in the synonymy as *S. depressus* are limited to those of the Illinois form. Girty (1915a, p. 98) identified two specimens of the Illinois form with question from the Batesville Sandstone of northern Arkansas. This identification implies that the Arkansas specimens might actually represent one of the end points in the range of variation of the subspecies *S. depressus abruptus* Girty, which differs in the decidedly steeper inclination of the posterodorsal slope. The Wyoming shells do not exhibit this steeper inclination. Because our specimens are few in number and not very well preserved, we are merely comparing the Wyoming form with the Illinois species.

Figured and measured specimens.—UM 6630, UW A1288, A11121, USNM 174048; A1288 not figured.

Occurrence and number of specimens.—Horseshoe Shale Member: collections 20 (1), 28 (4), ?29 (1), 36d (1), Fremont County, Wyo.

Schizodus aff. *S. affinis* Herrick, 1887

Plate 3, figures 15, 16

Schizodus affinis Herrick, 1887, p. 41, pl. 4, figs. 22, 22a.

This species occurs in a tan marlstone on the west side of the Bighorn Mountains and in a chert bed in the Wind River Range; both occurrences are Pennsylvanian in age. The specimens are mostly small internal molds, longer than high, with the umbo occurring about one-third to two-fifths of the length posterior to the anterior edge. The most complete specimen (pl. 3, fig. 16) is a right valve which

measures 12.4 mm long, 10.4 mm high, and has a maximum convexity of 3.5 mm. In this specimen the peak of the umbo is 4.5 mm behind the anterior edge. The umbonal ridge is narrowly rounded, slopes steeply posteriorly, and in some specimens is subcarinate on the posterior slope. The shell outline is typical of the genus, rounded anteriorly and obliquely but weakly truncated posteriorly. Fragments of shell adhering to the internal molds show that the species is thin shelled and has a smooth shell surface. Internal features are not preserved.

The Amsden specimens are similar to *S. affinis* Herrick, a common form in the Pottsville (Pennsylvanian) of Ohio. However, they differ in being smaller and slightly more tumid than *S. affinis* and having the angle formed by the dorsal and posterior margins larger than in the Pottsville form.

Figured specimens.—USNM 174049, 174050.

Occurrence and number of specimens.—Ranchester Limestone Member: collections 40 (1), Fremont County; 50 (7), Washakie County, Wyo.

Schizodus alpinus (Hall)?

Plate 3, figure 17

Dolabra? alpina Hall, 1858b, p. 716, pl. 29, fig. 2.

Schizodus alpina (Hall), Meek and Hayden, 1865, p. 58; Keyes, 1891, p. 249; Plummer and Moore, 1921, pl. 21, fig. 28.

Schizodus alpinus (Hall), Girty, 1915b, p. 130, pl. 17, fig. 3; Morgan, 1924, pl. 48, figs. 7, 7a; Morse, 1931, p. 317, pl. 52, fig. 1.

A right valve from a bed of Pennsylvanian age on the east flank of the Bighorn Mountains is referred with question to this species. It measures 21.8 mm in length, 19.1 mm in height, and has a maximum convexity of 6.6 mm. The somewhat inflated umbo is subcentral, located 10 mm posterior to the anterior edge. The umbonal ridge extends to the posteroventral margin, it is subangular to about mid-height and then becomes rounded. The postumbonal slope is gently concave and very steep.

The Amsden specimen is quite close to Hall's (1858b) drawing and description of the type specimen of *S. alpinus* from the "Lower Coal Measures" of Iowa.

Figured specimen.—USNM 174051.

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

Schizodus sp. A

Plate 3, figures 8, 9

Among the specimens from Cherry Creek in the University of Missouri collections is a larger, more tumid species of *Schizodus* than the one compared to *S. depressus* Worthen. The figured internal mold

is 18.0 mm long, 15.4 mm high, and 10.8 mm wide. Impressions of the underside of the interlocking cardinal teeth show that each valve had a rather large cardinal tooth. Vestiges of the anterior and posterior adductor muscle scars are also preserved. The anterior scar (very slightly elevated on the internal mold) was situated close to the anterior margin and was almost twice as long as the posterior one.

A second specimen, roughly one-third larger, is present in the same lot but is so poorly preserved that one cannot be sure it represents the same species.

Figured specimen.—UM 6637.

Occurrence and number of specimens.—Horseshoe Shale Member: collection 36a, Fremont County, Wyo.

Schizodus sp. B

Plate 3, figure 14

An internal mold of a right valve from a limestone bed of Pennsylvanian age in the Rawlins hills has the shell shape of *Schizodus*, but is proportionally longer than other Amsden representatives of the genus and probably belongs to a separate species. It measures 30.4 mm in length, about 19.5 mm in height, and has a maximum convexity of 8 mm. These measurements are proportionally quite close to those of *S. morrowensis* Mather from the Hale Formation of Arkansas, but the outline of that species differs significantly from the Amsden form in its more triangular shape. Two other fragments, probably of right valves, occur at the same locality and may represent the same species.

Easton (1962, p. 96, pl. 12, fig. 26) described another elongate shell, from beds of similar age in the Big Snowy Mountains, Montana, as *Schizodus?* sp. A reexamination of Easton's specimen, however, shows that it is an *Edmondia*.

Figured specimen.—USNM 174052.

Occurrence and number of specimens.—Horseshoe Shale Member: collection 3 (3), Carbon County, Wyo.

Order VENEROIDA
Superfamily CARDITACEA Fleming
Family PERMOPHORIDAE van de Poel
Genus PERMOPHORUS Chavan, 1954

Permophorus sp. A

Plate 3, figures 18–23

?*Pleurophorus* sp. Easton, 1962 [part], p. 96, pl. 12, fig. 33.

Description.—Shell moderately small, elongate, having subparallel dorsal and ventral margins and well rounded anterior and posterior margins, and strongly convex in cross section. Valve length about twice height and five times valve convexity. Dorsal margin nearly straight, umboes protruding only

slightly above it; ventral margin nearly straight to gently concave in outline; dorsal and ventral margins diverging slightly posteriorly; anterior and posterior margins protrude so that the greatest length is below midheight. Umbonal ridge extends toward posteroventral margin, usually poorly defined and rounded but may be angular. Broad shallow sulcus present on some specimens anterior to umbonal ridge.

Lunule narrow, heart shaped, bounded by angular margin; escutcheon linear, bounded by nearly straight rib, both characters shown on one left valve (USNM 174053). Radial ornamentation not normally preserved on our material but the same specimen shows two faint ribs lateral to escutcheon. Surface of shell covered by fine closely spaced growth lines.

Internal features not well preserved, but all internal molds show straight myophoric buttress on posterior side of oval anterior adductor muscle scar. One left valve (USNM 174055) shows cardinal socket and the lower of the two lateral teeth that are typical of this genus.

Dimensions (in mm).—

	USNM 174055 LV	USNM 174054 RV	USNM 174053 LV	USNM 174057 LV	USNM 174058 RV	USNM 174056 RV
Length -----	18.8	18.2	14.4	12.8	12.6	11.2
Height -----	8.5	9.5	7.7	6.9	7.3	6
Convexity ----	3.5	3.5	3.2	3.2	3	2.2

¹ Posterior edge missing. The first two specimens are from collection 52, the next one from collection 53, and the last three from collection 50.

Discussion.—The description is based upon specimens from Amsden beds of both Mississippian (colln. 159) and Pennsylvanian (collns. 50, 52, 53) ages. Specimens from collection 50 on the west side of the Bighorns are somewhat smaller than those from collections 52 and 53 on the east side of the Bighorns but otherwise do not differ significantly. Specimens from collection 159 (pl. 3, fig. 20), from Berry Creek in the Teton Range, are latest Mississippian in age. They differ from the Pennsylvanian forms in having a more angular umbonal ridge and in being nearly smooth. They may represent another species of *Permophorus*, but for the present are placed in *Permophorus* sp. A.

Permophorus sp. A is recognized by its evenly convex valves and the paucity of radial ornament which is limited to a rib or two near the hinge. These characteristics distinguish it from other Late Mississippian and Early and early Middle Pennsylvanian species of the genus. However, because of the limited present state of knowledge of species of the genus *Permophorus* we are not proposing a new name for the Amsden forms.

A form similar to *Permophorus* sp. A from the Alaska Bench Limestone of central Montana, was figured by Easton (1962, p. 96, pl. 12, fig. 3E) as *Pleurophorus* sp. Easton's unique internal mold measures: length 19 mm, height 10.7 mm, and maximum convexity (both valves) 8 mm. The left valve is distorted near the posterior end, probably due to shell damage during the life of the animal, and the shell is not preserved. Hence it is difficult to compare the Alaska Bench form to the Amsden species. Nonetheless, they are similar in outline, high convexity, and shell proportions and the Montana and Wyoming forms are probably conspecific. Furthermore, the range zone of the Wyoming form includes Amsden beds now regarded to be biostratigraphically equivalent to the Alaska Bench Limestone.

Easton (1962, p. 96) also referred to *Permophorus*? [as *Pleurophorus*?] a specimen from the Otter Shale (USGS locality 13374-PC) and another from the Heath Formation (USGS locality 13366-PC). On reexamination we transfer these specimens to the genus *Caneyella*.

Figured and measured specimens.—USNM 174053–174059; USNM 174058 not figured.

Occurrence and number of specimens.—Horseshoe Shale Member: collections ?3 (2), Carbon County; 53 (3), Johnson County; 159 (4) Teton County, Wyo. Ranchester Limestone Member: collections 50 (14), Washakie County; 52 (4), Johnson County, Wyo.

Superfamily CRASSATELLACEA Ferussac
Family CRASSATELLIDAE Ferussac
Genus CYPRICARDELLA Hall, 1858a

Cypricardella sp.

Plate 4, figure 11

Microdon cf. *M. oblongus* (Hall), Branson and Greger, 1918 [part], p. 321, pl. 19, fig. 25 [not fig. 11].

One left valve of this species, from the Mississippian part of the Amsden, is present in the University of Missouri collections. It is subcircular in outline and has pronounced, closely spaced concentric rugae and a prominent posterior umbonal carina; nothing is known of the internal features. The specimen measures 14 mm long, 12.4 mm high, and has a maximum convexity of 4 mm.

This species was compared to *Cypricardella oblonga* Hall by Branson and Greger; however, the latter species is quadrate rather than subcircular, so the Amsden form probably belongs to a different species.

Figured specimen.—UM 2657.

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

Cypricardella? sp. indet.

Plate 4, figures 8-10

A small articulated and slightly distorted mold from the Mississippian part of the formation has prominent, closely spaced concentric rugae and is more or less like *Cypricardella* in shape. It measures 6 mm high, and has a maximum convexity of 2.8 mm (both valves flattened).

Because of the small size and poor preservation, positive generic assignment of this specimen is not possible. It is probably a *Cypricardella* but it could be a young stage of some other concentrically rugose genus.

Figured specimen.—USNM 174060.

Occurrence.—Horseshoe Shale Member: collection 20, Fremont County, Wyo.

Family ASTARTIDAE D'Orbigny
Genus ASTARTELLA Hall, 1858b

Astartella concentrica (Conrad), 1842

Plate 4, figures 4-7

Nuculites concentrica Conrad, 1842, p. 248, pl. 15, fig. 19.

Posidonia moorei Gabb, 1859 [1860], p. 297; 1860 [1861], p. 55, pl. 1, fig. 2.

Edmondia concentrica McChesney, 1859 [1860], p. 55; 1865, pl. 2, figs. 21a, b.

Astartella concentrica (McChesney). McChesney, 1867 [1868], p. 43, pl. 2, figs. 21a, b; Keyes, 1894, p. 126; Plummer and Moore, 1921, pl. 13, figs. 38, 38a, 40, pl. 31, figs. 15, 16; Morgan, 1924, pl. 46, fig. 5.

Astartella concentrica (Conrad). Meek, 1875, p. 341; Girty, 1915b, p. 142, pl. 18, figs. 2-9; Price, 1916, p. 725; Morningstar, 1922, p. 241, pl. 13, figs. 11-13; Girty, 1927, p. 418, text figs. 1-11; Morse, 1931, p. 319, pl. 52, fig. 3; Plummer, 1950, pl. 21, figs. 3a, b; Chow, 1951, p. 33, pl. 4, fig. 3; Nicol, 1955, p. 157, text figs. 2, 3.

Specimens of this widespread and distinctive species are known from several Amsden localities of Pennsylvanian age. *Astartella* has a recognizable shape and *A. concentrica* is ornamented with prominent concentric rugae that in typical mature specimens are spaced so that about seven occur in a space of 5.0 mm. The specimen shown on plate 4, figures 4, 5, measures 12 mm in length, 9.4 mm in height, and has a maximum convexity of 3.2 mm. Most of our specimens of this species are fragmentary and not well preserved, but they are readily identifiable because of their distinctive ornamentation (pl. 4, figs. 6, 7).

Figured specimens.—USNM 174061, 174062.

Occurrence and number of specimens.—Horseshoe Shale Member: collections ?3 (1), Carbon County; 53 (2), Johnson County, Wyo. Ranchester Limestone Member: collections 40 (2), Fremont County;

50 (4), Washakie County; 52 (1), Johnson County, Wyo.

Astartella sp.

Plate 4, figures 1-3

A second species of *Astartella* is present in the Mississippian part of the Amsden. This species is less erect than *A. concentrica* and it lacks the concentric rugae, being ornamented instead by closely spaced, fairly even, relatively fine growth lines. It is known from only one left valve which measures 17 mm long, 11.3 mm high, and has a maximum convexity of 7 mm. Nothing is known of the internal features.

Astartella sp. has a shape much like *Nuculopsis*, however the presence of an escutcheon readily separates *Astartella* from the latter genus.

Figured specimen.—USNM 174063.

Occurrence.—Horseshoe Shale Member; collection 41, Teton County, Wyo.

Subclass ANOMALODESMATA
Order PHOLADOMYOIDA
Superfamily EDMONDIACEA King
Family EDMONDIIDAE King
Genus EDMONDIA deKoninck, 1841

Edmondia spp.

Plate 4, figures 12-16

At least three forms of this genus herein treated as species are present in the Pennsylvanian part of the Amsden Formation. None of them is well preserved, and all are represented by very few specimens. They are distinguished by minor differences in shape. All three of them are present in one collection, from a granular chert bed high in the Amsden Formation on the east slope of the Bighorn Mountains (colln. 52); this casts some doubt as to whether they actually belong in three different species.

The most widespread of the three forms, represented by seven specimens from three localities, is a small elongate *Edmondia* (pl. 4, figs. 14, 15), oval in shape and similar to *E. nebrascensis* (Geinitz). The better preserved of the two figured specimens measures: length 7.9 mm, height 5.7 mm, and maximum convexity 1.9 mm.

A subcircular form (pl. 4, figs. 12, 13) is known from a single specimen (colln. 52). It preserves remnants of the adductor muscle scars and is erect, having the umbo projecting well above the dorsal margin. Measurements of this specimen are: length about 15 mm, height 13.8 mm, and maximum convexity 6 mm.

The third form (pl. 4, fig. 16), also known from one specimen, from the same locality as the last, is

elongate quadrate and preserves some of the concentric surface ornamentation. It measures 21.5 mm in length, about 17 mm in height, and has a maximum convexity of 6.3 mm.

Figured specimens.—USNM 174064–174067.

Occurrence and number of specimens.—Ranchester Limestone Member: collections 40 (1), Fremont County; 50 (2), Washakie County; 52 (6), Johnson County, Wyo.

Superfamily PHOLADOMYACEA Gray
Family GRAMMYSIIDAE Miller
Genus SPHENOTUS Hall, 1885

Sphenotus sp.

Plate 4, figures 17, 18

The figured specimen has the shape, posterior auricle, and umbonal carina typical of *Sphenotus*; it comes from the *Carlinia amsdeniana* Subzone at Darwin Peak. It is a small internal mold which measures 14.6 mm long, 7.1 mm high, and 3.5 mm in maximum convexity. Another example, a poorly preserved articulated internal mold from the same part of the formation in Wind River Range (UM 12791), is referred tentatively to this taxon.

Difference of opinion has existed for some time (Hind, 1900; Driscoll, 1965; Pojeta, 1969; Newell and LaRocque, 1969) as to whether the genus *Sphenotus* Hall is separable from *Sanguinolites* McCoy. We have followed Driscoll (1965) in this regard and have treated the two as separate genera. In general, forms assigned to *Sphenotus* have a less prominent concentric sculpture than those placed in *Sanguinolites*.

Figured specimen.—USNM 174068.

Occurrence and number of specimens.—Horseshoe Shale Member: collections ?36d (1), Fremont County; 137 (1), Teton County, Wyo.

Genus SANGUINOLITES McCoy, 1844

Sanguinolites sp.

Plate 4, figures 19–21

Allorisma terminale (Hall). Burk, 1954 [part], p. 14, 15, pl. 1, fig. 38 [not figs. 39, 40].

A single dorsoventrally crushed articulated limonitic mold from the Mississippian part of the Amsden is here placed in the genus *Sanguinolites*. It has prominent concentric ornament from the umbonal ridge across the anterior part of the shell; the strength of the ornament is reduced posterodorsal to the umbonal carina. In this way it is similar to species placed in *Sanguinolites* by Hind (1900) and Pojeta (1969). Measurements of the specimen were not made because of its distorted condition.

Figured specimen.—UW IT-237.

Occurrence.—Horseshoe Shale Member; collection 22, Fremont County, Wyo.

Genus SEDGWICKIA McCoy, 1844

Sedgwickia? sp. indet.

Plate 4, figures 23, 24

One highly weathered and incomplete articulated internal mold, from the Pennsylvanian part of the Amsden, has the general outline of some species placed in *Sedgwickia* by Meek and Hayden (1865) and Hind (1899) and is here tentatively referred to that genus. It measures about 55 mm in length, 32.4 mm in height, and has a maximum convexity of 19.5 mm (both valves).

Figured specimen.—USNM 174069.

Occurrence.—Horseshoe Shale Member: collection 5, Carbon County, Wyo.

Family PHOLADOMYIDAE Gray
Genus WILKINGIA Wilson, 1959

Wilkingia terminalis (Hall)

Plate 4, figures 26–30

Allorisma terminalis Hall, 1852, p. 413, pl. 2, figs. 4a, b.

Allorisma terminale (Hall). Girty, 1903, p. 437, 438, pl. 9, figs. 4–6 (for synonymy prior to 1903); 1909, p. 90; Price, 1914, p. 527; 1921, p. 784; Morningstar, 1922, p. 234, pl. 13, fig. 15; Morse, 1931, p. 318, pl. 51, figs. 2.

Allorisma subcuneatum (Meek and Hayden). Barbour, 1903, pl. 2, fig. 18; Raymond, 1910, p. 158, pl. 27, figs. 5, 6; 1911, p. 98, pl. 6, fig. 5; Plummer and Moore, 1921, pl. 24, fig. 18.

Allorisma terminale (Hall). Mark, 1911, pl. 10, fig. 10; Morgan, 1924, pl. 46, figs. 3, 3a; Butts, 1926, p. 200, pl. 66, fig. 16; French, 1940, p. 328, pl. 3, fig. 23; Shimer and Shrock, 1944, p. 414, pl. 165, figs. 10, 11; Branson, 1948, p. 563; Chronic, 1952, p. 146, 147, pl. 9, figs. 4a–c; Chow, 1951, p. 31, pl. 3, figs. 17a–c; Burk, 1954 [part], p. 14, 15, pl. 1, figs. 39, 40 [not fig. 38]; Mudge and Yochelson, 1962, p. 90, pl. 16, figs. 5, 6.

A number of specimens from several localities, both in the Mississippian and Pennsylvanian parts of the Amsden Formation, are referred to this ubiquitous and long-ranging species. None is well preserved but several show the characteristic pholadomyiform shape with subparallel dorsal and ventral margins and the ornament of prominent concentric rugae. The specimen shown on plate 4, figure 26, has the following measurements: length 39 mm, height 20.1 mm, and maximum convexity 7.8 mm. The specimens figured in this paper are from the Pennsylvanian part of the formation. Burk (1954, pl. 1, figs. 39, 40) has previously figured specimens from near the top of the Mississippian part.

Figured specimens.—USNM 174070, 174071.

Occurrence and number of specimens.—Horseshoe Shale Member: collections 1 (2), 2 (1), 3 (8), 5 (3), Carbon County; 36e (1), 43 (4), Fremont

County, Wyo. Ranchester Limestone Member: collection 50 (7), Washakie County, Wyo.

Wilkingia sp.

Plate 4, figure 25

Allorisma terminale (Hall). Burk, 1954 [part], p. 14, 15 [not pl. 1, figs. 38-40].

A second species of *Wilkingia* is represented by one reasonably complete and two fragmentary limonitic molds from the Mississippian part of the Amsden Formation at South Pass in the Wind River Range. In general outline this species is similar to *W. terminalis* but differs in that secondary concentric rugae are intercalated between the primary ones about one-fourth of the way back from the anterior edge. These secondary rugae do not cross the entire shell surface but die out anteriorly. The figured specimen measures 18.2 mm long, about 8 mm high, and has a maximum convexity of 2 mm.

Figured specimen.—UW IT-240.

Occurrence and number of specimens.—Horseshoe Shale Member: collection 22 (3), Fremont County, Wyo.

Class ROSTROCONCHIA
Family CONOCARDIIDAE Miller
Genus CONOCARDIUM Bronn, 1835

"Conocardium" sp. indet.

Plate 4, figure 22

In the Amsden collections available to us, rostroconchians are represented by a single incomplete specimen from the Mississippian part of the formation which has the general aspect of forms presently assigned to the genus *Conocardium*. The class Rostroconchia is currently under revision by Pojeta and Runnegar.

Figured specimen.—USNM 182074.

Occurrence and number of specimens.—Ranchester Shale Member: collection 139 (1), Teton County, Wyo.

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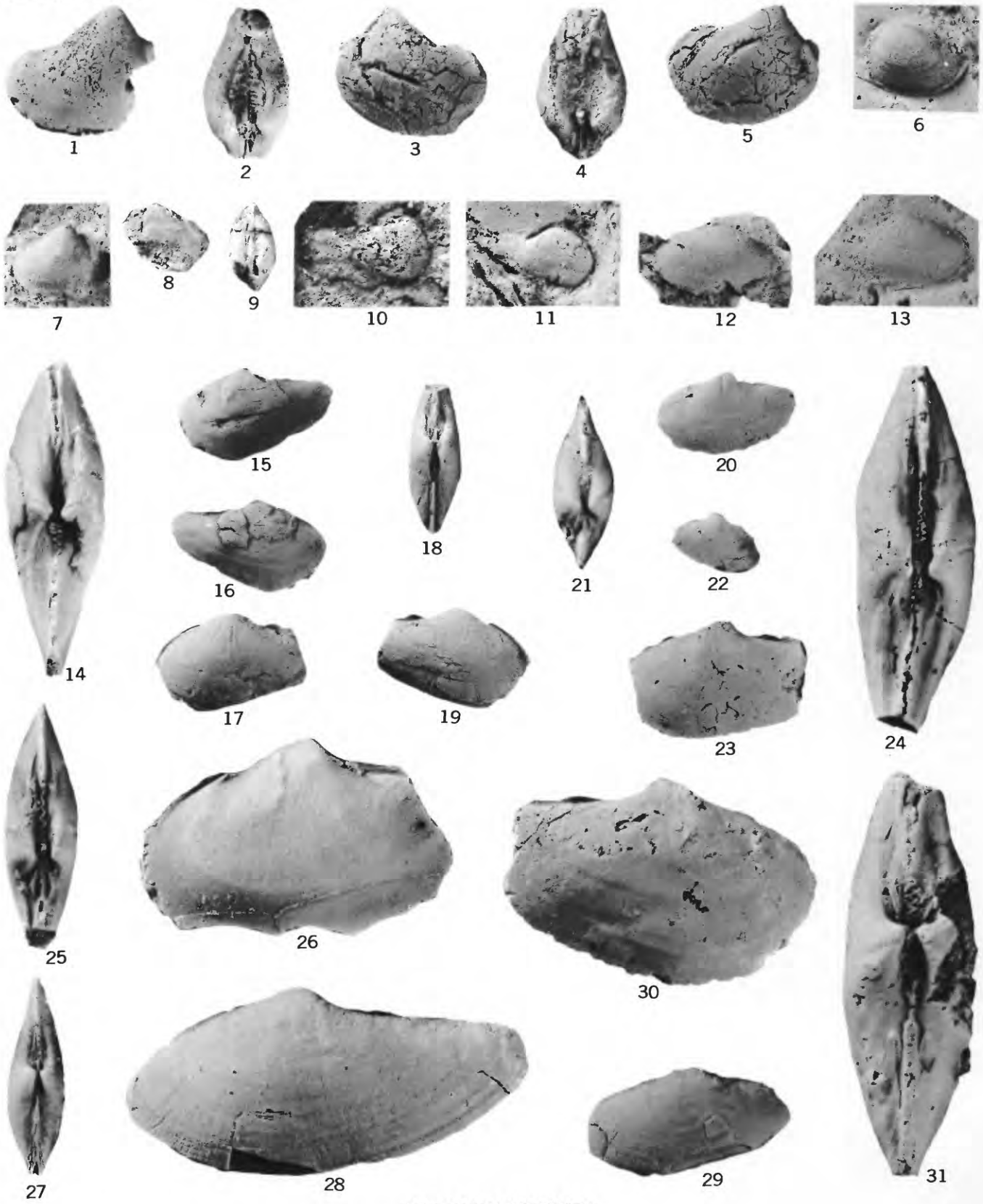
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PLATE 1

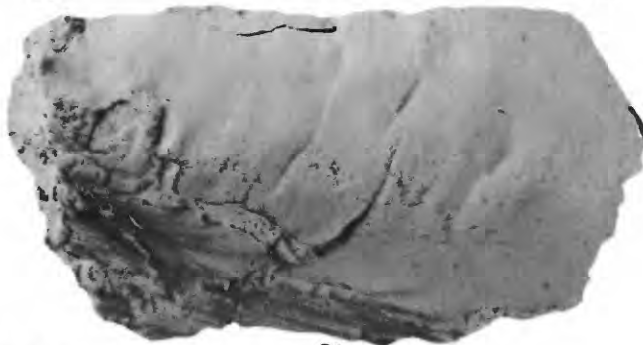
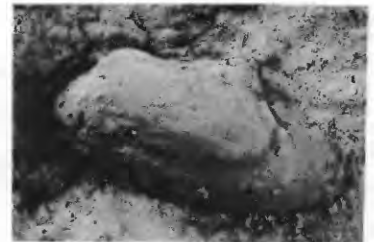
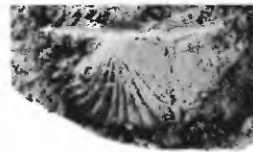
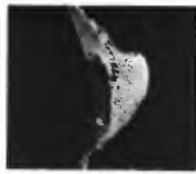
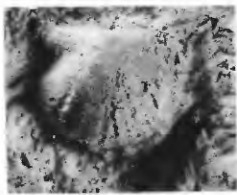
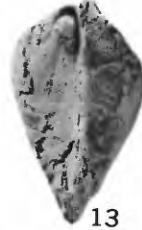
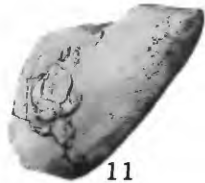
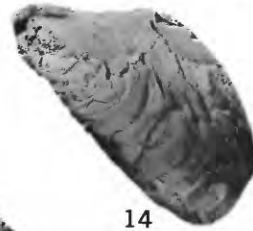
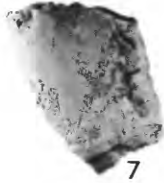
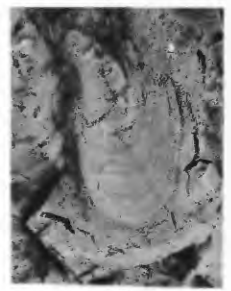
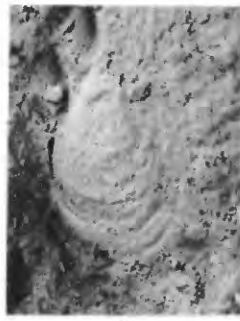
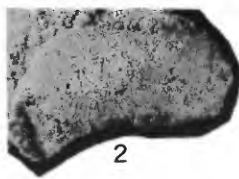
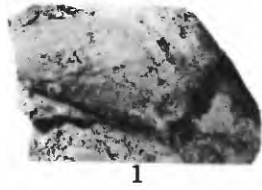
- FIGURES 1-5. *Nuculopsis* sp. A (p. E8).
- 1, 2. Left valve showing adductor muscle scars and dorsal view showing pedal muscle scars and trace of the taxodont dentition ($\times 3$). UM 6630, collection 36d.
 - 3-5. Right valve, dorsal view, and left valve showing adductor muscle scars, pedal muscle scars, and filling of resilifer ($\times 2$). UM 2657, collection 36c.
- 6-9. *Nuculopsis* sp. B (p. E9).
- Collection 50.
6. Right valve ($\times 2$). USNM 174018.
 7. Left valve ($\times 2$). USNM 174019.
 - 8, 9. Right valve showing anterior adductor muscle scar and dorsal view showing trace of taxodont dentition ($\times 3$). USNM 174020.
- 10, 11. *Phestia* sp. (p. E9).
10. Rubber cast of right valve mold showing ornament and shape of rostrum ($\times 4$). USNM 174022, collection 50.
 11. Right valve ($\times 2$). USNM 174023, collection 50.
- 12, 13. *Paleyoldia* sp. (p. E10).
12. Left valve ($\times 1$). USNM 174024, collection 50.
 13. Right valve ($\times 2$). USNM 174025, collection 53.
- 14-31. *Paleyoldia amsdenensis* (Branson and Greger) (p. E9).
- 14-16. Dorsal (anterior end up) ($\times 4$), left valve, ($\times 2$), and right valve ($\times 2$), views of lectotype. UM 2665, collection 36b.
 - 17-19. Left valve, dorsal (anterior end down), and right valve views ($\times 2$), of paralectotype. UM 2665, collection 36b.
 20. Left valve ($\times 3$). UM 6639, collection 36d.
 - 21, 22. Dorsal (anterior end up) ($\times 10$), and right valve ($\times 5$), views. UM 6639, collection 36d.
 - 23, 24. Left valve ($\times 3$), and dorsal (anterior end up) ($\times 6$), views, showing some muscle scars and trace of the taxodont dentition. UM 6639, collection 36d.
 - 25, 26. Dorsal (anterior end up) ($\times 7$), and left valve ($\times 9$), views, showing trace of taxodont dentition, pallial line, pallial sinus, and most other muscle scars. UM 6639, collection 36d.
 - 27, 28. Dorsal (anterior end down) ($\times 3$), and left valve ($\times 6$), views. UM 6639, collection 36d.
 29. Left valve ($\times 3$). UM 6639, collection 36d.
 - 30, 31. Right valve ($\times 5$), and dorsal (anterior end down) ($\times 6$), views showing muscle scars. UM 6639, collection 36d.



PALAEOTAXODONTA

PLATE 2

- FIGURES 1, 2. Isofilibranchian? gen. and sp. indet. (p. E11).
1. Left valve ($\times 2$), UW A1275, collection 31.
2. Right valve ($\times 2$), UW A201, collection 28.
3. *Posidonia* sp. indet. (p. E12).
Left valve ($\times 4$). USNM 174032, collection 46.
4. *Caneyella* sp. (p. E12).
Right valve ($\times 1$). USNM 174029, collection 46.
5. *Septimyalina?* sp. indet. (p. E11).
Left valve ($\times 1$). USNM 174028, collection 131.
- 6, 7. *Myalina (Myalina)* sp. (p. E11).
Collection 3 ($\times 1$).
6. Right valve. USNM 174026.
7. Left valve. USNM 174027.
- 8-15. *Septimyalina* sp. A (p. E11).
8, 9. Left valve and dorsal views ($\times 3$). UM 6638, collection 36d.
10, 11. Anterior and right valve views ($\times 2$). UM 6638, collection 36d.
12-15. Right valve, dorsal, left valve, and anterior views ($\times 2$).
UM 2658, collection 36c.
- 16-18. *Aviculopecten* sp. B (p. E14).
Collection 50 ($\times 3$).
16. Left valve. USNM 174039.
17, 18. Anterior view of rubber cast showing dorsal margin shelf
extending from beak to commissure, and oblique lateral view also
showing shelf. USNM 174040.
19. *Leptodesma* sp. (p. E12).
Left valve ($\times 4$). USNM 174030, collection 50.
- 20-22. *Aviculopinna* sp. (p. E12).
Dorsal ($\times 1$), left valve ($\times 2$), and dorsal ($\times 2$) views. USNM
174033, collection 67.
23. *Pernopecten* sp. indet. (p. E13).
Left valve ($\times 2$). USNM 174034, collection 52.
24. *Streblopteria* sp. indet. (p. E13).
Left valve ($\times 2$). USNM 174036, collection 46.
25. *Pseudomonotis* sp. (p. E13).
Left valve ($\times 1$). USNM 174035, collection 52.



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ISOFILIBRANCHIA? AND PTERIOMORPHA

PLATE 3

- FIGURE
1. *Aviculopecten* sp. A (p. E14).
Two left valves ($\times 3$). USNM 174037A, B, collection 118.
 2. *Aviculopecten* sp. B (p. E14).
Left valve ($\times 3$). USNM 174038, collection 50.
 - 3, 4. *Aviculopecten* spp. indet. (p. E14).
Enlargement showing ornament ($\times 2$) and entire valve ($\times 1$).
USNM 174045, collection 53.
 - 5-7. *Aviculopecten gravidus* n. sp. (p. E13).
Collection 3 ($\times 1$).
5. Holotype showing shape and ornament of left valve. USNM 174041.
6. Paratype showing shape of right valve. USNM 174042.
7. Paratype showing left valve. USNM 174043.
 - 8, 9. *Schizodus* sp. A (p. E16).
Right valve and dorsal (anterior end down) views ($\times 2$). UM 6637, collection 36a.
 - 10-13. *Schizodus* cf. *S. depressus* Worthen (p. E15).
10, 11. Dorsal (anterior end down) and right valve views ($\times 3$).
UM 6630, collection 36d.
12. Right valve ($\times 3$). USNM 174048, collection 20.
13. Left valve ($\times 2$). UW A11121, collection 28.
 14. *Schizodus* sp. B (p. E16).
Right valve ($\times 1$). USNM 174052, collection 3.
 - 15, 16. *Schizodus* aff. *S. affinis* Herrick (p. E15).
Two right valves ($\times 2$). USNM 174049, 174050, collection 50.
 17. *Schizodus alpinus* (Hall)? (p. E16).
Right valve ($\times 1$). USNM 174051, collection 53.
 - 18-23. *Permophorus* sp. A (p. E16).
($\times 2$).
18. Left valve. USNM 174053, collection 53.
19. Right valve. USNM 174054, collection 52.
20. Right valve. USNM 174059, collection 159.
21. Right valve. USNM 174056, collection 50.
22. Left valve. USNM 174057, collection 50.
23. Left valve. USNM 174055, collection 52.



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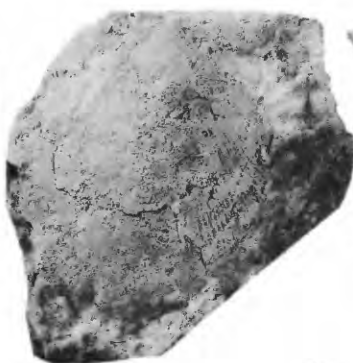
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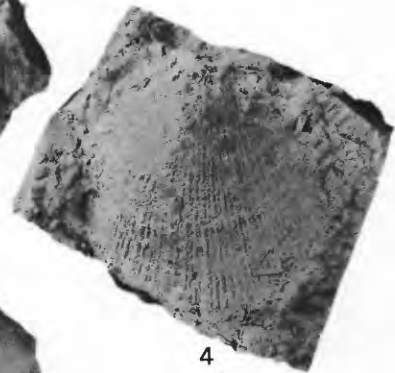
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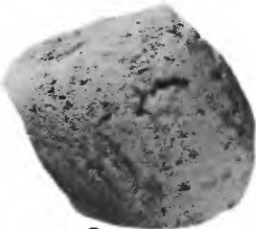
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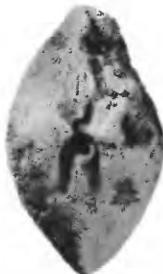
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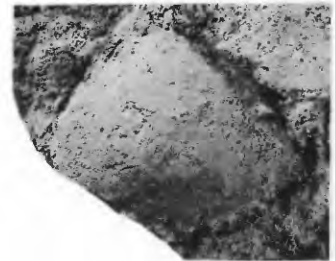
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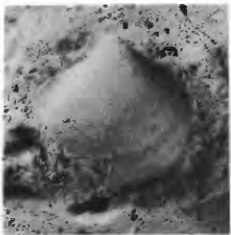
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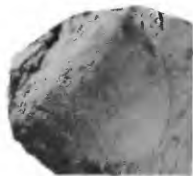
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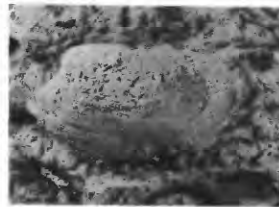
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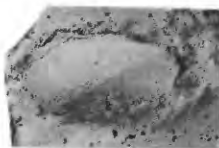
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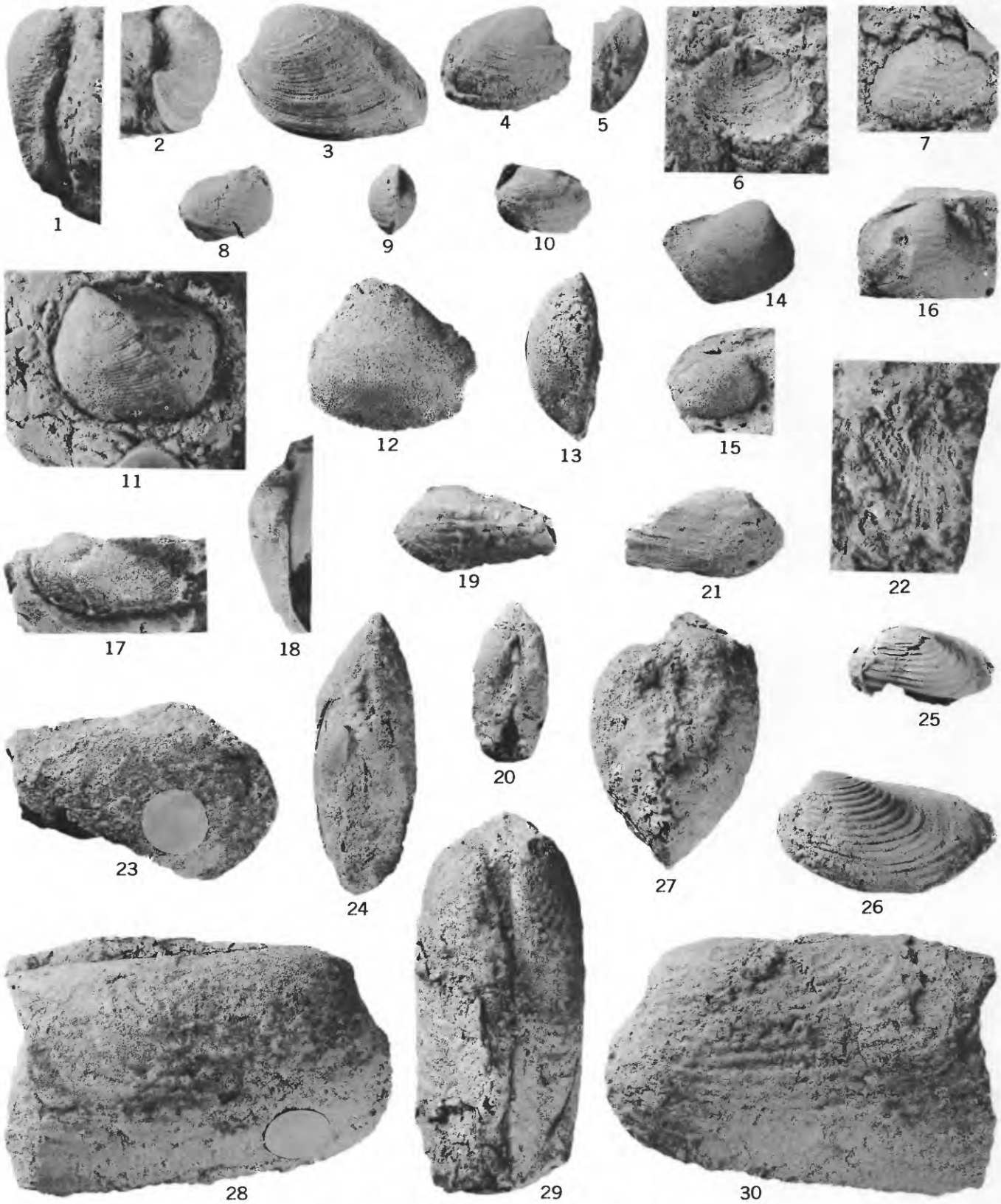


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PTERIOMORPHA AND HETEROCONCHIA

PLATE 4

- FIGURES 1-3. *Astartella* sp. (p. E18).
Dorsal, anterior, and left valve views ($\times 2$). USNM 174063, collection 41.
- 4-7. *Astartella concentrica* (Conrad) (p. E18).
Collection 50 ($\times 2$).
4, 5. Right valve and dorsal views. USNM 174061.
6, 7. External mold right valve and rubber cast of mold showing ornament. USNM 174062.
- 8-10. *Cypricardella?* sp. indet. (p. E18).
Right valve, anterior, and left valve views ($\times 3$). USNM 174060, collection 20.
11. *Cypricardella* sp. (p. E17).
Left valve ($\times 2$). UM 2657, collection 36c.
- 12, 13. *Edmondia* sp. (p. E18).
Left valve and dorsal views showing adductor muscle scars ($\times 2$).
USNM 174066, collection 52.
- 14, 15. *Edmondia* sp. (p. E18).
14. Right valve ($\times 2$). USNM 174065, collection 50.
15. Right valve ($\times 2$). USNM 174064, collection 52.
16. *Edmondia* sp. (p. E18).
Right valve ($\times 1$). USNM 174067, collection 52.
- 17, 18. *Sphenotus* sp. (p. E19).
Left valve and dorsal views ($\times 2$). USNM 174068, collection 137.
- 19-21. *Sanguinolites* sp. (p. E19).
Left valve, dorsal, and right valve views ($\times 2$). UW IT-237, collection 22.
22. "Conocardium" sp. indet. (p. E20).
Fragment of left valve ($\times 3$). USNM 182074, collection 139.
- 23, 24. *Sedgwickia?* sp. indet. (p. E19).
Right valve and dorsal views ($\times 1$). USNM 174069, collection 5.
25. *Wilkingia* sp. (p. E20).
Left valve ($\times 2$). UW IT-240, collection 22.
- 26-30. *Wilkingia terminalis* (Hall) (p. E19).
26. Left valve ($\times 1$). USNM 174071, collection 50.
27-30. Anterior, right valve, dorsal, and left valve views ($\times 1$).
USNM 174070, collection 5.



HETEROCONCHIA, ANOMALODESMATA, AND ROSTROCONCHIA

