Fossils From the Ordovician Bioherm at Meiklejohn Peak, Nevada

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GEOLOGICAL SURVEY PROFESSIONAL PAPER 685

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March 3, 1849

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By REUBEN JAMES ROSS, JR.

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Distribution of fossils in the bioherm and in flanking beds is documented. Species of 12 genera of brachiopods and 20 genera of trilobites are described. They compare closely with contemporary forms in Quebec and western Newfoundland

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FOSSILS FROM THE ORDOVICIAN BIOHERM AT MEIKLEJOHN PEAK, NEVADA

By Reuben James Ross, Jr.

ABSTRACT

A great limestone bioherm, 270 feet thick, lies within the thin-bedded silty limestone of the lower member of the Antelope Valley Limestone (Pogonip Group) at Meiklejohn Peak, Nev. Fossils from the flanking beds show that the bioherm lies mostly within the *Orthidiella* zone, but the base of the bioherm may rest as low as the *Pseudocybele nasuta* zone of the upper Canadian. Fossils from both the bioherm and the flanking beds include trilobites, brachiopods, cephalopods, conodonts, gastropods, and a few pelecypods, ostracodes, bryozoans, and algae. However, the greatest volume of fossil debris is derived from the pelmatozoans.

Fossils from within the bioherm resemble those from similar limestone bodies in lower Middle Ordovician formations in Quebec and western Newfoundland. All shelly fossils in the bioherm are encrusted with sparry calcite, which may be algal in origin.

The 12 genera of brachiopods and 20 genera of trilobites of which species are described constitute only a part of the total fossile assemblage. They include *Cyrtonotella, Phragmorthis, Raymondites?*, and *Pliomerops*—all genera that are expected in Chazy or younger strata. *Petroria* is described for the first time south of the United States–Canadian border. It is suggested that *Paucicostella* of Quebec and Newfoundland is a synonym of *Ingria* of Nevada.

INTRODUCTION

This report deals with the fossils found from 1960 through 1969 in the great early Middle Ordovician bioherm at Meiklejohn Peak, Nev., and in the silty flanking limestone. The bioherm is exposed on the southwest side of Meiklejohn Peak in the SW¼NE¼ sec. 24, T. 12 S., R. 47 E., Bare Mountain 15-minute quadrangle, Nevada (Ross, 1964, p. C25–C26). The base of this biohermal structure rests on silty limestones that are gradational from the Ninemile Formation into the lower member of the Antelope Valley Limestone. These beds include brachiopods and trilobites of the *Pseudocybele nasuta* zone. Beds that lie above the bioherm and flank its higher sides carry brachiopods of the *Orthidiella* zone.

A considerably diverse fossil assemblage has been taken from the limestone of the bioherm as well as from the thin-bedded silty limestone that flanks it. Although our knowledge of the fauna is far from complete, the trilobites and brachiopods obviously are very similar to those from Table Head and Lower Head, western Newfoundland (Whittington, 1963, 1965; Cooper, 1965, p. 11–12), as well as to brachiopods listed from boulders in the Mystic Conglomerate and Lévis Shale of Quebec (Cooper, 1956, p. 15, 31; Ross and Ingham, 1970, p. 400).

PREVIOUS WORK

During the stratigraphic work in southern Nevada in 1960, three small biohermal masses were discovered on the Nevada Test Site and adjacent Bombing and Gunnery Range in the lower part of the Antelope Valley Limestone. Subsequently, a similar but much larger bioherm was called to my attention by Cornwall in the Bare Mountain quadrangle, and both these occurrences were reported shortly thereafter (Ross and Cornwall, 1961; Ross, 1964, p. C25–C26, pl. 1; Ross, 1967, pl. 11). Unfortunately, the bioherms on the gunnery range in the vicinity of Aysees Peak, east of Frenchman Flat, have not been comfortably accessible in recent years; but, repeated short visits have been made to the reef at Meiklejohn Peak in the Bare Mountain quadrangle (fig. 1).

In 1966, R. H. Flower assisted in the work at the Meiklejohn Peak bioherm and collected a considerable number of cephalopods.

Several of the trilobites reported by Holliday (1942, p. 472) were obtained from the silty limestones that flank the bioherm at Meiklejohn Peak. These were identified by Holliday as *Ectenonotus connemaricus* (Reed), *Ectenonotus marginatus* n. sp.; *Parapilekia beattyana* n. sp., *Pseudomera* sp., and *Niobe? feitleri* n. sp.

The Bare Mountain quadrangle was mapped geologically by Cornwall and Kleinhampl (1960, 1961). Their map indicates the presence of a fault that cuts across the Ordovician section on the southwest side of

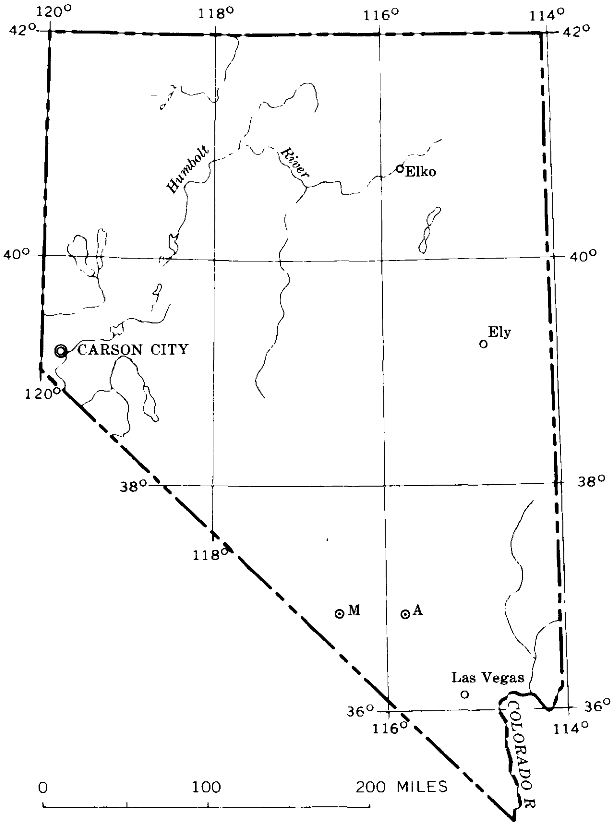

FIGURE 1.—Index map showing relative locations of bioherms at Meiklejohn Peak (M) and Aysees Peak (A), Nev.

Meiklejohn Peak. This fault passes west of the main mass of the bioherm, cutting its coarsely calcarenitic apron (figs. 3, 10).

Although two small bioherms were found east of Frenchman Flat in 1960, their regional importance was not fully appreciated; their stratigraphic position is in the Ranger Mountains Member (Byers and others, 1961, p. C108). The bioherm at Meiklejohn Peak is in the same stratigraphic position but a more generalized stratigraphic terminology has been used and the reef is considered to be high in the lower member of the Antelope Valley Limestone.

ACKNOWLEDGMENTS

H. R. Cornwall and F. G. Kleinhampl first called my attention to the bioherm at Meiklejohn Peak in 1960. Since then several paleontologists have visited this feature with me and have contributed much counsel and assistance; they include A. R. Palmer in 1960–61; G. A. Cooper, J. T. Dutro, Jr., R. S. Boardman, B. S. Norford, F. C. Shaw, and H. B. Whittington in 1965; R. H. Flower in 1966 and N. F. Sohl in 1969.

The manuscript was read critically by Dr. Valdar Jaanusson, William T. Dean, and Michael Taylor, to each of whom I am indebted for important comments and corrections. John L. Wray, Dr. Jaanusson, and Richard Rezak were particularly helpful in advising me on interpretation of carbonate petrology of the bioherm.

During my visit to Sweden in 1968, Dr. Valdar Jaanusson called attention to *Idiostrophia* in the Asaphus shale in the district of Töyen, where it had been called *Rhynchonella digitata* by Brögger. Dr. Gunnar Henningsmøen of the Paleontological Museum in Oslo kindly permitted me to illustrate and describe Brögger's specimen for comparison with the myriad specimens of *Idiostrophia* found in the Meiklejohn bioherm. Dr. Jaanusson also showed me the somewhat younger but very similar Ordovician bioherms near Lake Siljan, Dalarna, in Sweden.

Part of grant GA–4020 from the National Science Foundation made possible the visit to areas of Swedish Ordovician exposure under the guidance of Dr. Jaanusson.

Through the efforts of colleagues, a more complete coverage of fossils in and around the bioherm has been possible. Ellis Yochelson identified the gastropods, Jean Berdan the ostracodes, Olgarts Karklins the bryozoans, and John Huddle the conodonts. A. J. Rowell of the University of Kansas has made a brief examination of inarticulate brachiopods with unusual results. Parablastoids were identified by James Sprinkle. John Pojeta, Jr., identified the pelecypods and Rousseau H. Flower the cephalopods.

STRATIGRAPHIC SETTING

The biohermal limestone at Meiklejohn Peak (fig. 2) has been recorded as 163 feet thick and 68 feet above the base of the Antelope Valley Limestone (Ross, 1964, p. C26). The original measurement of the section was taken across the bioherm on its thinned north side. It is actually about 270 feet thick in its thickest part (figs. 3, 4). About 20 collections of fossils have been made subsequently to those previously published by Ross (1964, p. C27–C28). Positions of these collections are shown diagrammatically in figure 10. The constituent fossils of each collection are listed below.

The bioherm is about 1,000 feet wide along the face of outcrop. Its other lateral dimension is not known. The main mass is devoid of clearly defined bedding. Locally, the limestone is a coarse bioclastic calcarenite composed of a wealth of megafossils—brachiopods, trilobites, and gastropods, among others. Shells and carapaces are encrusted with thin calcitic deposits of a sparry nature. This sparry calcite seems to be the binder in the bioherm (fig. 5). It is seen to separate thin laminae of finer grained limestone (fig. 6) in

FIGURE 2.—Meiklejohn Peak, as seen from the west-northwest at a distance of about 2 miles. The peak is composed of light-colored Eureka Quartzite. The larger bioherm is in the lower slopes to the right.

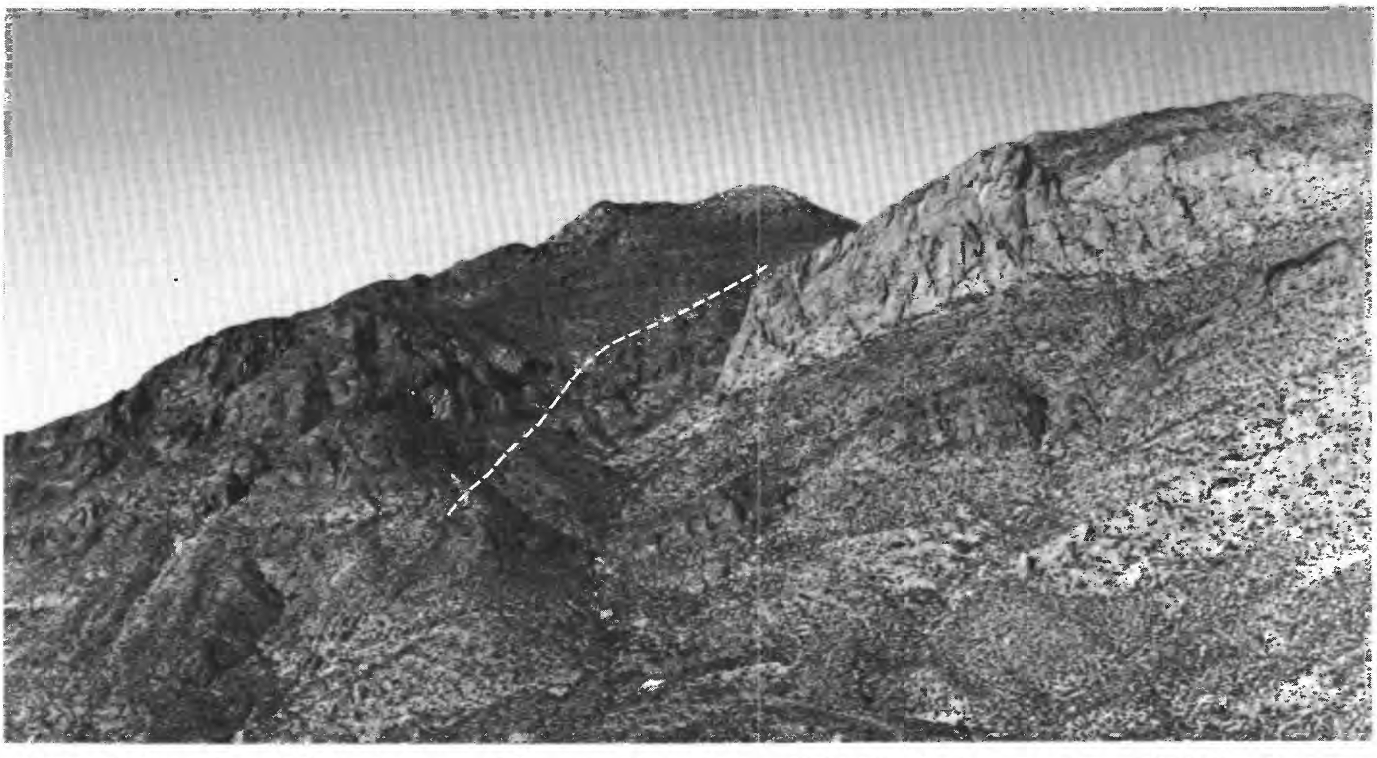

FIGURE 3.—Scarp face of the main mass of the great bioherm below Meiklejohn Peak, as seen from hill 4966 on the west side of Secret Pass (sec. 24, T. 12 S., 47 E., Bare Mountain quadrangle, Nevada). Bioherm is 270 feet thick; exposed lateral dimension approximates 1,000 feet. View looking northeast. Approximate position of fault indicated by dotted line.

FIGURE 4.—Exposed northwest end of bioherm. Thin overlying beds bear brachiopods of the *Orthidiella* zone. Standing to left of small cave are L. A. Wilson and R. H. Flower (circled). Thin beds in left foreground butt against flank of biohermal mass and overlap its top. Thinned biohermal mass passes beneath viewer right of center. Contact between bioherm and flanking beds is obscured by postdepositional shearing.

FIGURE 5.—Sparry calcite encrusts all kinds of fossil skeletons and fills chamber of cephalopods. Butt end of ½-inch chisel lies above sectioned nautiloid.

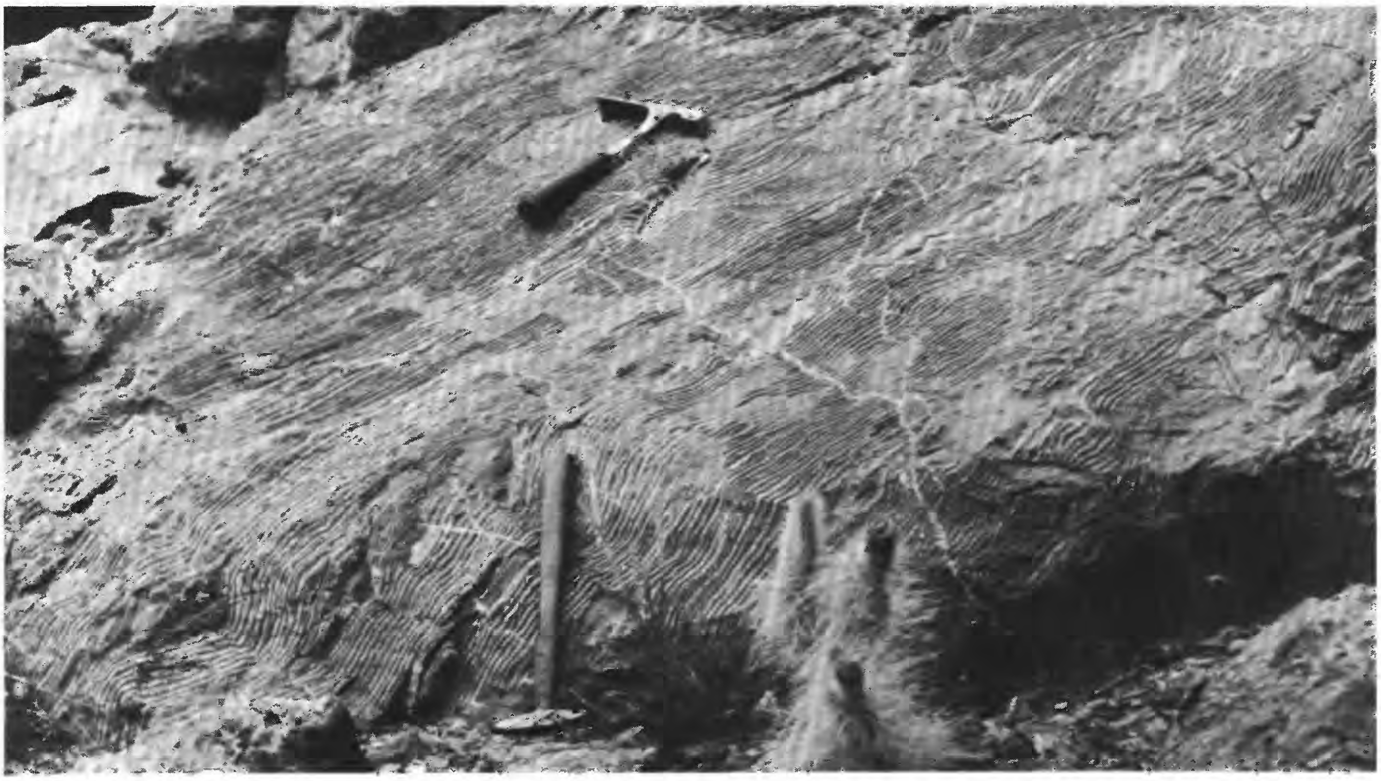

FIGURE 6.—Thin laminae of fine lime wackestone separated by sparry calcite (laminoid fenestrae). This lithology is of great extent on northwest side in lower part of bioherm.

other parts of the reef. Even the interiors of fossils, such as the chambers of cephalopods, seem to be encrusted.

Dr. Valdar Jaanusson (Thorslund and Jaanusson, 1960, p. 31) has called attention to and on June 9, 1968, showed me similar biohermal structures in the Ordovician Kullsberg Limestone at the Unkarsheden quarry, north of Rattvik, Dalarna, Sweden. Whittington (1963, p. 10–11) has compared a white limestone boulder at Lower Head, western Newfoundland, to Upper Ordovician Swedish limestone that forms numerous similar reefs.

This Newfoundland boulder and the boulders recorded in the Lévis Shale (Cooper, 1956, p. 14–15) near Quebec, and in the Mystic Conglomerate near Phillipsburg, Quebec (Cooper, 1956, p. 31), have yielded similar faunas.

On Meiklejohn Peak, as in the "boulder" at Lower Head (Whittington, 1963, p. 11–12), some fossils are preserved in pockets or channels. But the trilobites are all disarticulated, and some brachiopods seem to have been abraded. Clearly, animals living on or in the bioherm were subjected to physical destruction; as pointed out by Norman F. Sohl (oral commun., June 13, 1969), a thin northerly extension of the bioherm is a coarse bioclastic deposit of material derived from the main part of the bioherm. We found no recognizable megafossils in this deposit.

The nature of basal beds of this bioherm indicates that the bioherm did not slide into its present position from some other place. However, the bioherm seems to have acted as an extremely competent pod during late tectonic activity. As a result, the zone of contact with less competent flanking beds seems to have been sheared and is poorly exposed (fig. 4). In this respect, the small bioherms east of Frenchman Flat (Ross and Cornwall, 1961) are better preserved.

PETROLOGY OF BIOHERM, PRELIMINARY STATEMENT

No detailed petrologic analysis of the bioherm has been attempted. Thin sections of two samples from within the mass and one from flanking beds show important contrasts. Samples are from USGS collections D1991 CO, D2058 CO, and D1970 CO.

Collection D1991 CO is from a highly fossiliferous (brachiopods and trilobites) pocket in the main mass of the bioherm. Megascopically, shells and carapaces seem to be coated with coarse-grained calcite. Much bioclastic material is present. No stratified structure is apparent in the bioherm at this spot.

In thin section (figs. 7*C*, 8), this sample (colln. D1991 CO) is a mixed-fossil wackestone grading to packstone in the terminology of Dunham (1962). Although brachiopod shells and parts of trilobite carapaces are conspicuous, most of the fossil material is pelmatozoan debris. Ostracodes are present.

Cavities filled with calcite spar are abundant. In one example, mud seems to have filled brachiopod shells and trilobite skeletons only partially so that the remainder of interiors are filled with spar (fig. 8*B*).

Some of the cavities resemble the fenestrae described by Tebbutt, Conley, and Boyd (1965, p. 4–12) and the bird's-eye structure shown by Shinn (1968) (fig. 7*C*).

Associated with these features are some laminoid fenestrae (Tebbutt and others, 1965, p. 4–12) that seem to have the same smooth particle-covered floors and irregular ceilings.

Although the three sections of sample D1991 CO from the seemingly unstructured part of the bioherm are different in detail, they share characteristics of a very high percentage of spar-filled voids and a layering which is very real, although obscure in some views.

Collection D2058 CO was taken from a strikingly laminated part of the bioherm (fig. 6), which is best developed in the lower levels. At this locality, laminae 1–10 mm thick are composed of mixed-fossil wackestone separated by laminae of sparry calcite of considerable lateral extent. These sparry layers seem to have the smooth, particle-covered bottoms and irregular tops (figs. 7*A*, *B*, *D*) attributed to laminoid fenestrae. The stratified concentration of bioclastic debris in the wackestone is particularly noticeable (fig. 7*A*). Most fragments are pelmatozoan. Trilobite and ostracode fragments, however, are conspicuous. Some of the sparry laminae contain zoned spar (fig. 7*A*), which suggests that some secondary replacement has taken place. Under high magnification it is indeed clear that much of the spar resulted from replacement and crystal growth.

This sample (colln. D2058 CO) resembles that from the more massive part of the bioherm (colln. D1991 CO) in its high percentage of spar, its basic layering of skeletal debris within wackestone, and its high percentage of pelmatozoan debris.

The features seen here have been interpreted by Shinn (1968) as supratidal or intertidal. Tebbutt, Conley, and Boyd (1965, p. 11–12) have offered a similar explanation for their existence.

These Ordovician bioherms seem to have been large mounds of calcite mud, mixed with skeletal fragments. Sorting of these fragments along crude layers indicates some sort of reworking, perhaps by waves. Pockets and channels filled with sorted brachiopod shells (USGS colln. D1968 CO) seem to have been present in the mound. Evidence of possible algal mats suggests that the surface was held together by filamentous

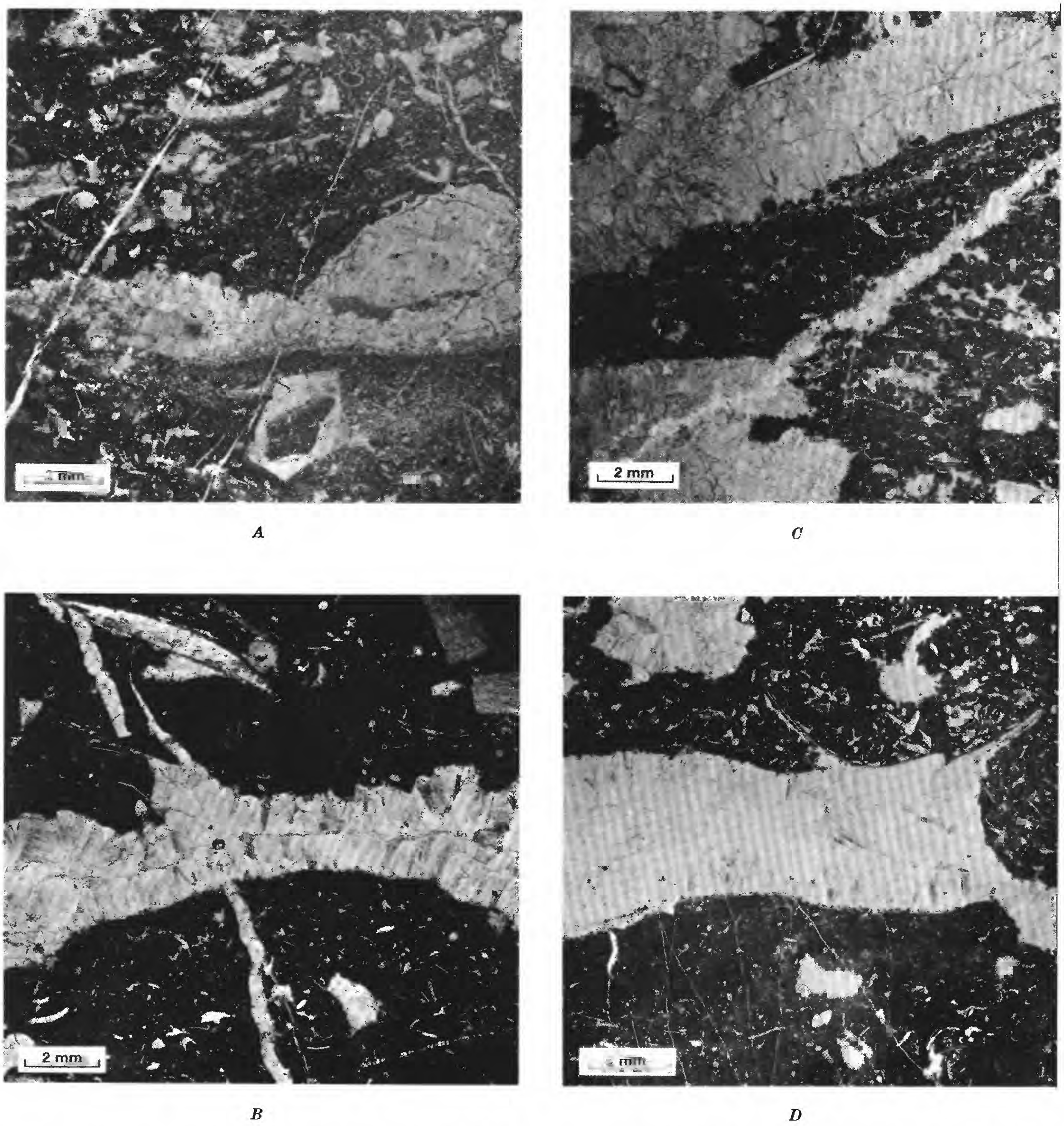

FIGURE 7.—Thin sections. × 6.5. *A*, Fenestrae and laminoid fenestrae in wackestone from massive part of bioherm (USGS colln. D1991 CO). *B*, Laminated mixed-fossil wackestone (USGS colln. D2058 CO; fig. 6) and laminoid fenestra with zones of spar. Note crude but obvious layering of fossil fragments in overlying wackestone. Pelmatozoan fragments compose most of fossil debris. *C*, Laminated wackestone (USGS colln. D2058 CO; fig 6) and laminoid fenestra. Although trilobite fragments are conspicuous most of fossil debris is pelmatozoan. *D*, Mixed-fossil wackestone and laminoid fenestra (USGS colln. D2058 CO; fig. 6).

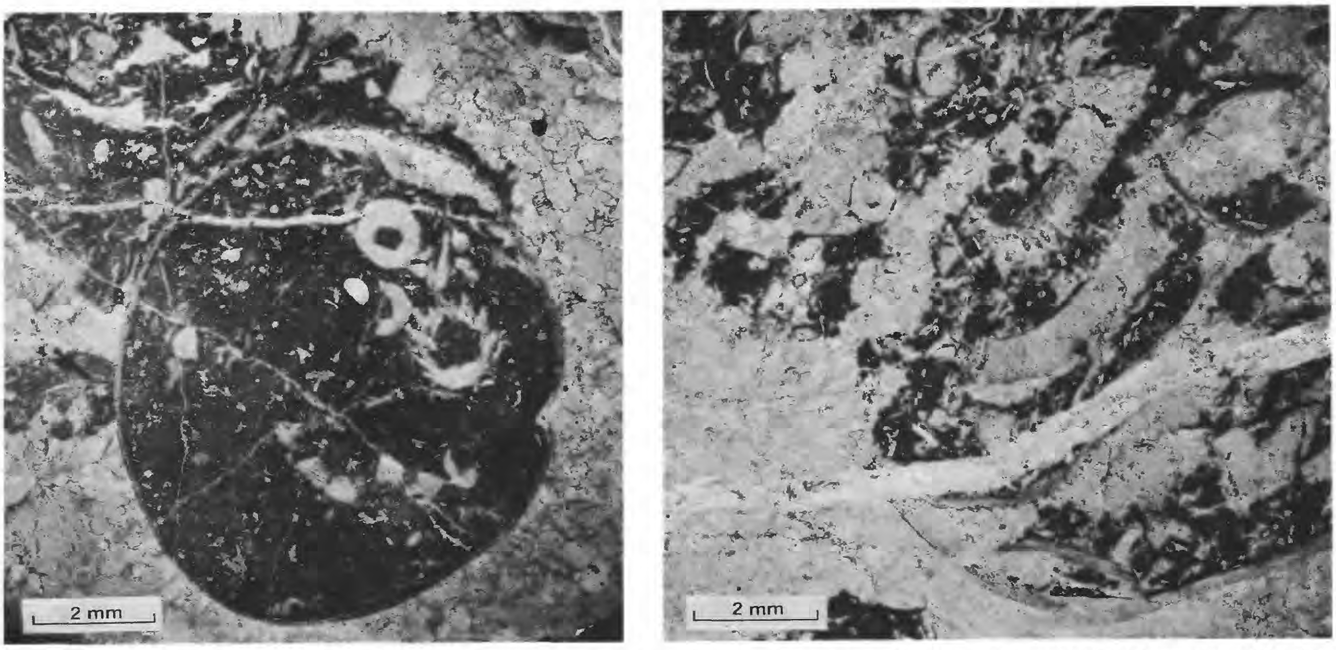

FIGURE 8.—Thin sections through fossiliferous pocket in massive part of bioherm (USGS colln. D1991 CO). × 6.5. *A* (left), Mixed-fossil wackestone and spar-filled cavities. Trilobite is cranidium of *Illaenus*. *B* (right), Mixed-fossil packstone in which brachiopod shells are conspicuous. Cavities around and in shells filled with spar. Pelmatozoan fragments compose most of fossil debris.

algae in extremely shallow or intertidal waters and that these algae contributed to trapping additional mud.

In marked contrast is the lithology of the well-stratified limestone that flanks the bioherm. This rock, exemplified by USGS collection D1970 CO, is the source of abundant large trilobites, particularly *Ectenonotus*. It is dark gray and very fine grained to calcarenitic. Thin sections (fig. 9) show that it is also a mixed-fossil wackestone. However, it contains no spar-filled fenestrae or laminae. Fossil fragments lie in crude layers but show no sorting as to size or shape. Pelmatozoan fragments are the most abundant.

In some of the mudstone, abundant spherical bodies, three-tenths of a millimeter in diameter, are now composed of coarse calcite. These small bodies lack any internal structure such as one might expect in oolites or in fecal pellets.

There is no evidence that the skeletal material has been reworked after deposition; this fact suggests that the flanking beds were deposited in deeper water than the biohermal mudbanks and may have received periodic "showers" of animal remains swept from the top of the mudbanks.

These speculations are based on very few samples and lack the systematic coverage that the structure seems to warrant. They suggest that the animals populating this and correlative mudmounds in Nevada, Quebec, and western Newfoundland lived in very shallow water.

FOSSIL COLLECTIONS

Fossils collected from this area have great variety and have been examined by several specialists. Pelecypods have been identified by John Pojeta, bryozoans by Olgarts Karklins, conodonts by John Huddle, and ostracodes by Jean Berdan. Dr. Rousseau H. Flower has collected cephalopods from the reef and surrounding beds. Ellis Yochelson has collected and identified gastropods from this locality. The author is responsible for collection and identification of brachiopods and trilobites.

All collections shown in figure 10, except D1976 CO, D740 CO, D2050 CO, and D1974 CO, whose fossils have not yet been identified, are listed below. These four collections were, however, included in figure 10 to show their position in relation to the other collections.

The stratigraphically lowest collection is listed first. Stratigraphic position relative to the base of the bioherm is indicated, and it should be noted that the bottom of the bioherm is 68 feet above the base of the Antelope Valley Limestone.

USGS colln. D1991 CO, Antelope Valley Limestone, 10 ft above base of bioherm (78 ft above base of formation).
  Brachiopods:
    Schizambon sp.
    Pleurorthis sp.
    Orthidiella? sp.
    Cuparius? sp.
    Idiostrophia conciliata Ross, n. sp.
    Idiostrophia nuda Cooper

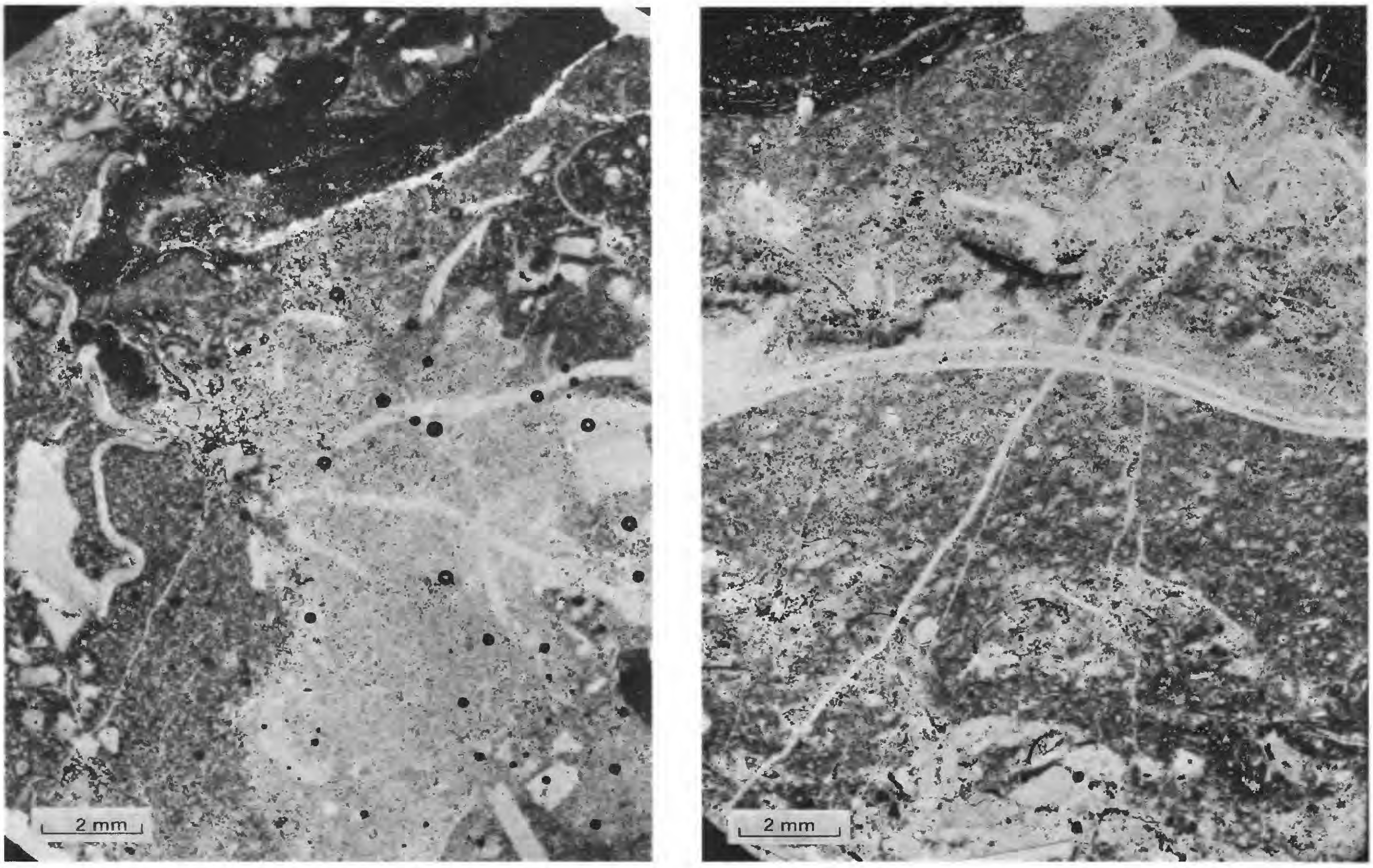

FIGURE 9.—Thin sections of well-stratified limestone (mixed-fossil wackestone) flanking bioherm (USGS colln. D1970 CO). × 6.5. *A* (left), Section cut nearly parallel to layering. *B* (right), Section cut perpendicular to layering. Large trilobite fragments conspicuous. Layers of fossil debris unsorted. Spar-filled spheres, 0.3 mm in diameter, not identified.

- *Orthidium*? aff. *O. fimbriatum* Ulrich and Cooper
- *Camerella* cf. *C.* sp. 1
- Plectambonitid, indet.

Trilobites:

- *Nileus* sp.
- *Peraspis*? sp.
- *Illaenus* sp. c
- *Lehua* aff. *L. argus* Whittington
- *Bathyurellus* sp. 4

Conodonts were studied by J. W. Huddle (written commun., Mar. 6, 1969), who commented as follows:

	Number of specimens
"*Drepanodus* sp	1
Drepanodus n. sp. D	1
Periodon aculeatus? Hadding:	
cordylodus element	19
ligonodina element	7
falodus element	15
oulodus element	7
ozarkodina element	7
Tetraprioniodus? n. sp.:	
ligonodina element	6
cordylodus element	12
roundya element	3
Oistodus sp	2
Oistodus sp	1
Scandodus species	1
Scandodus unicostatus Sweet and Bergström	2
Scolopodus varicostatus Sweet and Bergström	7

"This is a very interesting little fauna and quite puzzling. The *Scolopodus* and *Scandodus* species were first described from the Pratt Ferry [Formation of Cooper (1956)] but have since been found in older Middle Ordovician rocks in other Nevada sections. *Periodon aculeatus* appears in a number of Nevada sections of the Antelope Valley Limestone and is not restricted to the *Orthidiella* zone. The *Tetraprioniodus*? is apparently a new species but a multi-element one. The cordylodus element was described from the Joins Formation by Mound (1965) as *Cordylodus flexosus* but his identification is incorrect.

"It is possible that the forms here referred to *Tetraprioniodus*? are merely variable elements of a new more complex multi-element species of *Periodon* than *P. aculeatus* Hadding but as yet I don't know enough about multi-element species to be sure. However, Mound did not report any *Periodon* sp. from the Joins Formation but did report the tetraprioniodus, roundya and cordylodus elements. This (D1991 CO) collection lacks the tetraprioniodus element

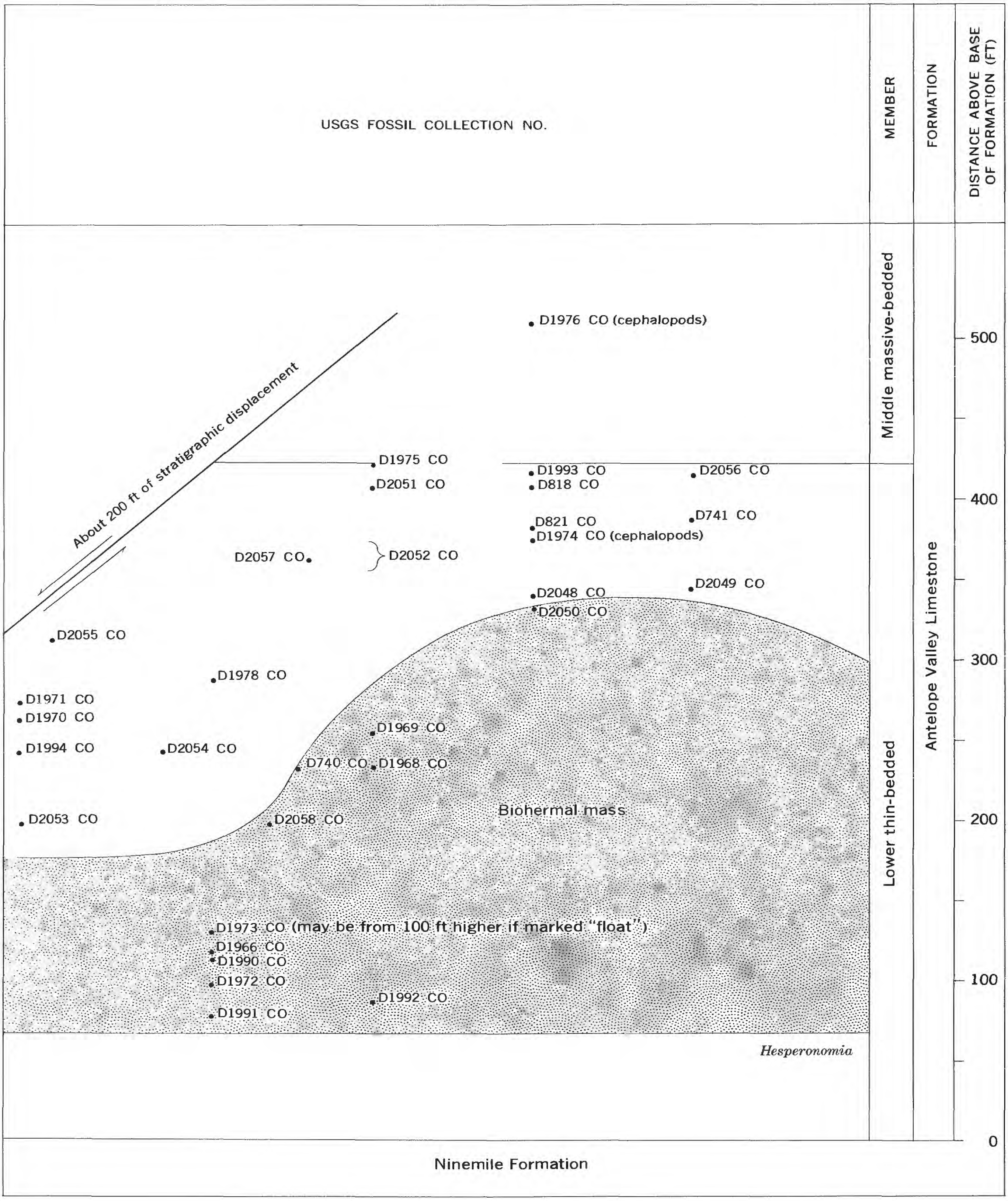

FIGURE 10.—Relative positions of fossil collections from bioherm (stippled) and flanking beds of Meiklejohn Peak (Ross, 1964, p. C24–C28).

and the Joins Formation lacks the ligonodina element reported here. It will take a lot more collections to straighten out this taxonomy."

USGS colln. D1992 CO. Antelope Valley Limestone, in lower 20 ft of bioherm, to east of other collections (approximately 88 ft above base of formation).

- Brachiopods:
  - *Idiostrophia* sp.
  - *Orthidiella*? sp.
- Trilobites:
  - *Nileus*? sp.
  - *Kawina*? sp. (fragmentary cranidium)
- Ostracodes undet.

USGS colln. D1972 CO, Antelope Valley Limestone, from float in bioherm 30 ft above its base (98 ft above base of formation).

- Brachiopods:
  - *Liricamera*? cf. *L. nevadensis* Cooper
  - *Ingria cloudi* Ulrich and Cooper
  - *Pleurorthis*? sp.
- Trilobites:
  - *Illaenus* sp.

USGS colln. D1990 CO, Antelope Valley Limestone, approximately 45 ft above base of bioherm, Meiklejohn Peak and 113 ft above base of formation.

- Brachiopods:
  - *Orthidium* sp.
  - *Orthidiella*? sp.
  - *Pleurorthis*? sp.
  - *Ingria cloudi* Ulrich and Cooper or *Paucicostella* sp.
  - *Liricamera* sp.
  - *Petroria* cf. *P. austrina* Ross
  - *Onychoplecia*? sp.
- Pelecypods (John Pojeta, written commun., Apr. 30, 1969):
  - *Eopteria* sp.
- Cephalopods to be identified by R. H. Flower.
- Trilobites:
  - *Illaenus* sp.
- Ostracodes undet.

The *Paucicostella* of this collection resembles immature specimens of *Ingria cloudi* in convexity and outline but differs in wider spacing of the few prominent costellae. No interiors could be prepared.

USGS colln. D1966 CO, Antelope Valley Limestone, 50 ft above base of bioherm (118 ft above base of formation).

- Gastropod (Ellis Yochelson, written commun., Feb. 4, 1969):
  - "The specimen is a monoplacophoran, which seems to be slightly asymmetrical. No muscle scars are preserved but the shape is more similar to that of *Cyrtonellopsis* than to other genera."
- Brachiopods:
  - *Idiostrophia* cf. *I. paucicostata* Cooper
  - *Onychoplecia*? sp.
  - Orthid, indet.
  - *Camerella* sp. 2
  - *Cuparius* sp.
- Trilobites:
  - *Carolinites* cf. *C. killaryensis* (Stubblefield)
  - *Bathyurellus* sp. 3
  - *Kawina wilsoni* n. sp.
  - *Illaenus* sp.
  - sp.
  - *Dimeropyge*-like trilobite
- Ostracodes:
  - *Hyperchilarina*? sp.

USGS colln. D1973 CO, Antelope Valley Limestone, 60–65 ft above base of bioherm (128–133 ft above base of formation).

- Brachiopods:
  - *Notorthis*? sp.
  - *Orthidium bellulum* Ulrich and Cooper
  - *Orthidium* sp.
  - *Orthidiella* sp.
  - *Trematorthis* sp.
  - *Pleurorthis beattyensis* Ross, n. sp.
  - *Cyrtonotella*? aff. *C. fasciculata* Cooper
  - *Camerella* sp. 1
  - *Ingria cloudi* Ulrich and Cooper or *Paucicostella* n. sp.
  - *Petroria*? *austrina* Ross, n. sp.
  - Plectambonitid, possibly *Syndielasma*
  - *Cuparius cardilatus* Ross
- Gastropods (Ellis Yochelson, written commun., Nov. 22, 1968):
  - ?*Archinacella* sp.
  - *Hyolithes* sp.
  - *Maclurites* sp.
  - *Tropidodiscus* sp.
  - New genus cf. *Raphistoma*
  - *Loxoplocus* (*Lophospira*) sp. (high spired)
  - *Clathrospira* sp.
  - *Liospira* sp. indet.
  - ?Pycnomphalid gastropod
  - *Clisospira* sp. indet.
  - ?*Helicotis* sp.
  - ?*Mimospira* sp.
  - Indet. genus aff. *Trochonema*
- Pelecypods:
  - *Eopteria* sp. (John Pojeta, written commun., Dec. 4, 1968)
  - Pelecypod (John Pojeta, written commun., Apr. 30, 1969)
    - "This specimen is a bivalve of uncertain affinities—it may be a conocardiid related to *Eopteria*."
- Trilobites:
  - *Trinodus* sp. 1
  - *Carolinites* cf. *C. killaryensis* Stubblefield
  - *Nileus* aff. *N. scrutator* Billings
  - *Illaenus* sp. a (cf. *I. auriculatus* Ross)
  - *Illaenus* sp. d
  - *Endymionia* cf. *E. meeki* (Billings)
  - *Kawina wilsoni* Ross, n. sp.
  - *Xystocrania pyriformis* Ross, n. sp.
  - Undet. pygidium 1
  - Undet. pygidium 2
- Conodonts (identified by J. W. Huddle, written commun., May 1, 1970):

	Number of specimens
Acodus sp. of Bradshaw	1
Acodus sp	4
Acontiodus sp	1
Drepanodus suberectus (Branson and Mehl)	1
Drepanodus sp	3
Oepikodus sp	1
Oistodus lanceolatus Pander	1
Paltodus sp	1

	Number of specimens
Periodon aculeatus Hadding:	
falodus element	3
cordylodus element	3
oistodus element	4
ligonodina element	12
roundya element	9
ozarkodina element	6

USGS colln. D2058 CO, Antelope Valley Limestone, lower member, from bioherm approximately 130 ft above its base (198 ft above base of formation).

Brachiopods:
- *Pleurorthis beattyensis* Ross, n. sp.
- *Petroria*? cf. *P. austrina* Ross, n. sp.
- *Cuparius* sp.
- *Idiostrophia* sp.
- *Paucicostella*? sp. (possibly immature *Ingria*)
- *Ingria* sp.

Trilobites:
- *Carolinites* cf. *C. genacinaca* Ross
- *Bathyurellus* sp. 3
- *Illaenus* cf. *I. auriculatus* Ross

Conodonts (identified by J. W. Huddle, written commun., May 1, 1970):

	Number of specimens
Acontiodus sp	1
Drepanodus sp	3
Drepanodus sp. (hooded form)	1
Periodon aculeatus Hadding:	
oistodus element	10
roundya element	13
cordylodus element	13
ligonodina element	17
ozarkodina element	9

Ostracodes.

USGS colln. D1968 CO, Antelope Valley Limestone, 168 ft above base of bioherm (236 ft above base of formation). This collection and USGS colln. D740 CO include channel or crevice filling packed with hundreds of specimens of *Idiostrophia.*

Brachiopods:
- *Orthambonites* cf. *O. minusculus* (Phleger)
- *Idiostrophia valdari* Ross, n. sp.
- *Idiostrophia lenticularis* Ross, n. sp.
- *Ingria cloudi* Ulrich and Cooper

Trilobites:
- *Glaphurus* sp.
- *Illaenus* cf. *I. auriculatus* Ross
- *Illaenus* sp. b.
- *Illaenus* sp. d.
- *Illaenus* sp. e
- *Illaenus*? sp. f
- *Harpillaenus* sp.
- *Selenoharpes* sp.
- *Endymionia* cf. *E. meeki* (Billings)
- *Pliomerops* sp. (pygidium)
- *Kawina wilsoni* Ross, n. sp.
- *Xystocrania pyriformis* Ross, n. sp.
- *Heliomera* cf. *H. albata* Whittington
- *Apatolichas* cf. *A. jukesi* (Billings)
- *Nileus* sp.
- *Carolinites* sp.
- *Ectenonotus* sp.

Gastropods (Ellis Yochelson, written commun., Nov. 22, 1968):
- cf. *Clisospira* n. sp.
- ?*Helicotis* sp.
- cf. *Helicotis* sp.

"All specimens in this lot are atypical of normal gastropods in their direction of coiling. It is most unexpected to find so many like this. cf. *Clisospira* n. sp. is congeneric and possibly conspecific with two scraps in the museum collections. These were obtained from a large boulder in the Stanbridge Conglomerate near Mystic, Quebec. According to G. A. Cooper the youngest boulders are of Whiterock age."

USGS colln. D1969 CO, Antelope Valley Limestone, 187 ft above base of bioherm (255 ft above base of formation).

Brachiopod:
- Indet. genus (lacks interiors)

Trilobites:
- *Illaenus* sp. b
- *Ectenonotus* sp.

COLLECTIONS FROM FLANKING BEDS

USGS colln. D1994 CO, Antelope Valley Limestone, from flanking beds 173 ft above base of bioherm (241 ft above base of formation).

Brachiopods:
- *Cyrtonotella*? sp.
- *Phragmorthis* sp.
- *Orthidiella* sp.
- Syntrophiid

Trilobites:
- *Trinodus* sp.
- *Shumardia* sp.
- *Ischyrophyma*? sp.
- *Pseudohystricurus* sp.
- *Illaenus* two spp.
- *Nileus* sp.
- *Carrickia* sp.
- *Carolinites angustagena* Ross
- *Bathyurellus feitleri* (Holliday)
- *Miracybele* sp. 1 (Ross, 1967, pl. 8, figs. 24, 25)
- *Ectenonotus whittingtoni* Ross
- *Protocalymene mcallesteri* Ross

Gastropod (Ellis Yochelson, written commun., Feb. 4, 1969):
- "Pleurotomariacean gastropod, indeterminate"

The two most abundant genera in this collection are *Ectenonotus* and *Illaenus.*

Conodonts (identified by J. W. Huddle, written commun., May 1, 1970):

	Number of specimens
Acontiodus varicostatus Sweet and Bergström	4
Distacodus? sp	1
Drepanodus? sp	1
Oistodus parallelus Pander	6
Oistodus sp	1
Ozarkodina macrodentata? Graves and Ellison	1
Paltodus sp	1
Scandodus sp	1

USGS colln. D2054 CO, Antelope Valley Limestone, in beds flanking bioherm, 172 ft above base of bioherm (240 ft above base of formation).

Trilobites:
Selenoharpes sp.
Illaenus sp.

USGS colln. D1970 CO, Antelope Valley Limestone, muddy limestone flanking bioherm about 195 ft above base of bioherm (263 ft above base of formation).

Brachiopods:
Anomalorthis sp.
Orthidiella sp.
Linguloid, large species

Trilobites:
Nileus sp.
Illaenus sp.
Kawina sp. (pygidium)
Ectenonotus whittingtoni Ross

USGS colln. D1971 CO, Antelope Valley Limestone, from beds flanking bioherm, 207 ft above base of bioherm (275 ft above base of formation).

Brachiopods:
Anomalorthis sp.
Orthidiella? sp.
Cuparius sp.
Camerellid, undet. sp.

Trilobites:
Nileus aff. *N. scrutator* (Billings)
Carolinites genacinaca Ross.
Ectenonotus whittingtoni Ross.
Miracybele sp. 1 (Ross, 1967, p. D25, pl. 8, figs. 23–25)
Protocalymene sp.

Conodonts (identified by J. W. Huddle, written commun., May 1, 1970):

	Number of specimens
Periodon aculeatus Hadding:	
ligonodina element	6
cordylodus element	2
oistodus element	1
Fragments	4
Drepanodus n. sp.	1

USGS colln. D1978 CO, Antelope Valley Limestone, lower member, beds of flanking bioherm about 222 ft above base of bioherm (290 ft above base of formation).

Brachiopods:
Orthidiella sp.
Orthambonites minusculus Phleger

Trilobite:
Ectenonotus sp.

Conodonts (identified by J. W. Huddle, written commun., May 1, 1970):

	Number of specimens
Belodina triangularis Stauffer	*1
Drepanodus suberectus (Branson and Mehl)	4
Oistodus multicorrugatus Harris (twin form)	2
Periodon aculeatus Hadding:	
cordylodus element	1
ligonodina element	4
roundya element	2
ozarkodina element	3
oistodus element	1
Scolopodus aff. *S. inculptus* (Branson and Mehl)	1

USGS colln. D2055 CO, Antelope Valley Limestone, lower member, from beds flanking bioherm, 244 ft above base of bioherm (312 ft above base of formation).

Brachiopods:
Orthidiella sp.
Orthambonites sp.

Asteroid ossicles

Conodonts (identified by J. W. Huddle, written commun., May 1, 1970):

	Number of spdcimens
Acodus sp	1
Acontiodus sp	1
Acontiodus sp	1
Distacodus cf. *D. stola* Lindström	1
Drepanodus suberectus (Branson and Mehl)	3
Drepanodus (hooded form)	1
Drepanodus (winged form)	1
Oepikodus sp	1
Oistodus longiramus Lindström	3
Oistodus multicorrugatus:	
Ribbed form	2
Twin form	1
Periodon aculeatus Hadding:	
roundya element	1
ligonodina element	5
cordylodus element	3
ozarkodina element	1

USGS colln. D2057 CO, Antelope Valley Limestone, lower member, beds flanking bioherm; approximately 295 ft above base of bioherm (363 ft above base of formation).

Unidentified cystid

USGS colln. D2048 CO, Antelope Valley Limestone, lower member, from beds 1 ft above thickest part of bioherm—approximately 271 ft above base of bioherm (339 ft above base of formation).

Brachiopods:
Orthidiella sp.
Orthambonites sp.
Anomalorthis? sp. (pedicle valve, primitive type)

Trilobite:
Undet. proparian protaspis

Conodonts (identified by J. W. Huddle, written commun., May 1, 1970):

	Number of specimens
Distacodus cf. *D. stola* Lindström	1
Drepanodus? n. sp. (like that in D1993–CO)	2
Drepanodus n. sp. (also present in D1994–CO)	1
Drepanodus sp	1
Oistodus inclinatus Branson and Mehl	1
Oistodus sp	2
Periodon aculeatus Hadding:	
cordylodus form	3
roundya form	3
ligonodina form	1
falodus	2
Scolopodus sp	1

USGS colln. D2049 CO, Antelope Valley Limestone, lower member, from float derived from 2 to 3 ft of strata above thickest part of bioherm—approximately 273 ft above base of bioherm (340 ft above base of formation).

Sponge, undet.

Brachiopods:
Hesperorthis? cf. *H. matutina* Cooper
Camerellid indet.

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*Contamination (?).

USGS colln. D2052 CO, Antelope Valley Limestone, lower member, 20–40 ft above highest part of bioherm—approximately 290–310 ft above base of bioherm (358–378 ft above base of formation). This collection contains a great representation of species; however, the presence of *Phragmorthis* and *Leptellina* suggested that it had been contaminated by float from higher on the mountain. A subsequent check of the locality shows that the only possible source of such contamination lies to the north and in a position that makes gravity induced contamination impossible.

Bryozoans (O. L. Karklins, written commun., July 24, 1970):

"This collection contains several bryozoan specimens, six of which were thin sectioned. All specimens are poorly preserved: the skeletal material is recrystallized or replaced by silica. On the basis of the general appearance of the zoarial structure, five specimens can be assigned to one taxon, probably a nicholsonellid genus and one specimen to a different genus. The five "nicholsonellid-like" specimens appear to be the same or similar to those which occur in collection D821 CO (Meiklejohn Peak) and in the collection D2074–CO (lower Antelope Valley Limestone, *Orthidiella* zone, south of mouth of Keystone Canyon, Tybo quadrangle).

Ostracodes (Jean Berdan, oral commun., Nov. 20, 1970):
- *Eoleperditia* aff. *E. bivia* (White)
- *Eurychilina* sp.
- *Leperditella*? sp.

Brachiopods:
- *Anomalorthis* cf. *A. fascicostellatus* Ross
- *Orthambonites*, two spp.
- *Orthidiella sp.*
- *Cuparius* sp.
- *Phragmorthis antiqua* Ross, n. sp.
- *Leptellina* sp. (one specimen)

Trilobites:
- *Nileus* sp.
- *Ectenonotus* cf. E. *whittingtoni* Ross
- *Pseudomera* sp.
- *Raymondites*? n. sp.
- *Remopleurides* sp.
- *Illaenus auriculatus* Ross
- *Protocalymene* sp.
- *Kawina* sp. (pygidium)

Pelmatozoans (identified by James Sprinkle, written commun., Nov. 7, 1969):
- *Blastoidocrinus*? *elongatus* Sprinkle
- *Blastoidocrinus*? *nevadensis* Sprinkle

Conodonts (identified by J. W Huddle, written commun. May 1, 1970):

	Number of specimens
Drepanodus suberectus (Branson and Mehl)	1
Oistodus multicorrugatus Harris:	
smooth form	3
type form	1
twin form	2
Oistodus aff. *O. venustus* Stauffer	1
Periodon sp.:	
cordylodus form	1
Scandodus sp	1
Scolopodus sp	1

USGS colln. D821 CO, Antelope Valley Limestone, 315 ft above base of biohermal limestone (383 ft above base of formation). (See Ross, 1964, p. C28.)

Brachiopods:
- *Orthidiella* cf. *O. longwelli* Ulrich and Cooper
- *Anomalorthis* cf. *A. fascicostellatus* Ross
- *Orthambonites* sp.

Dasycladacean algae

Concerning the ostracodes from this collection, Jean M. Berdan (written commun., 1962) reported: "This collection contains *Eoleperiditia* sp. aff. *E. bivia, Leperditella*?, *Aparchites*?, *Ballardina* simplex Harris, and unidentified small smooth ostracodes. *Eoleperditia* sp. aff. *E. bivia* and *Ballardina simplex*? occur in the lower part of the Antelope Valley Limestone in Goodwin Canyon, in the Eureka District. The other forms listed here also occur in the Antelope Valley Limestone elsewhere in Nevada, but seem to have longer ranges. The form listed as *Eoleperditia* sp. aff. *E. bivia* is not *E. bivia* s.s., but a closely related species, which may prove to have stratigraphic value."

USGS colln. D741 CO, Antelope Valley Limestone, lower member, silty beds above highest part of bioherm.

Brachiopods:
- *Orthidiella* sp.
- *Anomalorthis* sp.

Trilobites:
- *Trinodus* sp.
- *Nileus* sp.
- *Ectenonotus* sp.
- *Pseudomera* sp.

USGS colln. D818 CO, Antelope Valley Limestone, 340 ft above base of biohermal limestone (408 ft above base of formation) (Ross, 1964, p. C27).

Brachiopods:
- *Orthidiella longwelli* Ulrich and Cooper
- cf. *O. costellata Cooper*

Trilobites:
- Agnostid
- Dimeropygid

Dasycladacean algae

USGS colln. D1993 CO, Antelope Valley Limestone, rubbly beds above bioherm, approximately 415 ft above base of formation.

Brachiopods:
- *Orthidiella longwelli* Ulrich and Cooper
- *Ingria cloudi* Ulrich and Cooper

Trilobite:
- *Ectenonotus* sp.

Pelmatozoans:
- *Blastoidocrinus*? sp.

Conodonts (identified by J. W. Huddle, written commun., May 1, 1970):

	Number of specimens
Drepanodus suberectus	1
Drepanodus n. sp	13
Oepikodus aff. *O. quadratus* (Graves and Ellison)	1
Oistodus sp	5
Oistodus sp	1
Oistodus parallelus Pander	11
Panderodus sp	1
Paltodus sp	4

	Number of specimens
Periodon aculeatus Hadding	14
roundya element	
cordylodus element	
ligonodina element	

USGS colln. D2051 CO, Antelope Valley Limestone, lower member; from float derived from top 20 ft of the member.

Trilobite:

Pliomerops cf. *P. canadensis* (Billings)

USGS colln. D2056 CO, Antelope Valley Limestone, lower member; from top 8 ft of lower member.

Sponges:

Two genera undet.

USGS colln. D1975 CO, Antelope Valley Limestone, from float derived 420 ft above base of formation and from above bioherm.

Brachiopods:
- *Isophragma*? sp. or *Taphrodonta* one sp.
- *Anomalorthis* sp.
- *Orthidiella* sp.
- *Desmorthis*? sp. or *Orthambonites*? sp. (small)
- *Ingria cloudi* Ulrich and Cooper
- *Cuparius* sp.

Trilobites:
- *Bathyurellus* sp.
- *Pseudomera* sp. (pygidium, dissolved in order to obtain free silicified specimen of *Anomalorthis*)

Conodonts (identified by J. W. Huddle, written commun., May 1, 1970):

Oistodus multicorrugatus Harris:	*Number of specimens*
ribbed	1
smooth	2
two denticles	2
Periodon aculeatus Hadding:	
ligonodina element	2
Scolopodus sp	2

STRATIGRAPHIC ANOMALIES

Several genera are worthy of note because of stratigraphic position. *Schizambon*, *Cyrtonotella*, *Phragmorthis*, and *Pliomerops* are genera not previously reported as low as the *Orthidiella* zone in North America. Occurrences of three of these genera are in older strata in northwestern Europe. Valdar Jaanusson (written commun., May 25, 1970) has called attention to the occurrence of *Schizambon* in Tremadocian strata of northwestern Russia. He has further noted that the type species of *Cyrtonotella* came from the Kunda Stage (Llanvirn) of the Leningrad district and Estonia and that *Cyrtonotella* has been reported as early as the Langevoja Substage of the Volkhov Stage (Late Arenig). *Pliomerops*, according to Jaanusson, is not uncommon in Arenig strata in the Baltic region.

The identification of *Ingria* within the bioherm are questionable for lack of good interiors of valves; all these specimens were identified initially as *Paucicostella*. But interiors of *Paucicostella* have never been described, and all known species come from correlative boulders in the Mystic Conglomerate of Quebec (Cooper, 1956, p. 31). Exteriors are virtually indistinguishable from those of immature shells of *Ingria cloudi* which is present in beds flanking the bioherm. Inasmuch as no practical way has been found to distinguish *Paucicostella* from *Ingria* except that the former is found in reefs and the latter in flanking beds, they have been considered synonyms here.

Anomalorthis is ordinarily represented in the *Orthidiella* zone by a primitive species with very low cardinal area and rudimentary pseudospondylium. Here a species almost the same as *A. fascicostellatus* Ross is present as low as collection D2052 CO. This fact plus the presence of *Phragmorthis* in D2052 CO led me to consider that some float from higher on the mountain probably was included in this collection. Similarly, the discovery of a peculiar bathyurid pygidium tentatively assigned to *Raymondites* in the same collection and *Pliomerops* cf. *P. canadensis* in D2051 CO suggest possible contamination from above. However, *Phragmorthis* is present as low as collection D1994 CO, and *Pliomerops* seems to be in the high part of the bioherm as high as collection D1968 CO.

Dr. A. J. Rowell kindly examined inarticulate brachiopods from two of the collections in the bioherm. His examination, he insists (written commun., Apr. 16, 1970), resulted in only a "quick list":

> "Colln. D2058 CO:
> - *Rhysotreta* sp. Nov. 1.
> - *Torynelasma* sp. A Nov.
> - *Torynelasma* sp. B Nov.
> - *Conotreta* sp.
> - ?*Conotreta* sp. B.
> - *Eoconulus* sp.
> - Glossellinid, gen. and sp. indet.
> - *Dictyonites* sp. (fragment)
> - Acrotretid gen. Nov. X sp. 1
>
> Colln. D1973 CO:
> - *Rhysotreta* sp. Nov. 1
> - *Torynelasma* sp. A Nov.
> - ?*Conotreta* sp. B
> - Acrotretid gen. Nov. sp. 1"

"Although generically very similar to the Pratt Ferry fauna, when one looks at the material closely there are consistent differences. I do not really know what they mean * * *."

It is of interest that conodonts from the *Orthidiella* zone over a wide area in Nevada have led J. W. Huddle (in Ross, 1970) and others to remark on a resemblance to the Pratt Ferry beds of the Appalachians.

Concerning the conodonts listed on preceding pages, Huddle (written commun., May 1, 1970) comments:

"The abundance of *Periodon* in these collections agrees with what you called the lower member of the Antelope Valley at Ikes Canyon and in the Groom Range. It occurs through-out the Fort Pena Formation and in the Pratt Ferry Formation, Ala., but has not been reported by Ethington from the section at Ibex, Utah. *Periodon* and *Oepikodus* are both members of the Atlantic Ordovician conodont fauna. *Periodon* may be restricted to certain facies."

SUMMARY OF FOSSIL DISTRIBUTION

The stratigraphic occurrences of fossils presented on the foregoing pages are summarized in figures 10 and 11. Positions of collections—relative to the bioherm—are shown in figure 10. The distribution of genera is shown in figure 8.

Distribution at the species level is confusing and lacks stratigraphic continuity. Species, for instance, those of *Idiostrophia* and *Illaenus*, are numerous and seem to be short ranging. Nor do they provide a means of correlating with other areas, a circumstance already noted by Whittington (1965, p. 287–292) in discussions of Newfoundland and Quebec species.

The distribution of genera in the bioherm and flanking beds is shown in figure 11. Obviously some genera have been found only in the bioherm and others only in the flanking beds. Is this because of environmental control? Stratigraphic (temporal) control? Incomplete collecting? The answers to each of these questions is "partly, yes."

The genera collected only from the bioherm are:

Schizambon
Orthidium
Trematorthis
Notorthis?
Pleurorthis
Camerella
Idiostrophia
Liricamera
Petroria
Onychoplecia
Paucicostella (if not immature *Ingria*)
Eopteria
Glaphurus
Peraspis
Harpillaenus
Endymionia
Heliomera
Lehua
Xystocrania
Apatolichas

Several of these are known from very muddy limestone or shale in other parts of the Basin Ranges; they include *Peraspis*, *Liricamera*, *Orthidium*, *Notorthis?*, *Trematorthis*, and *Xystocrania*. *Camerella* is a widespread genus of many environments. Only *Pleurorthis*, *Idiostrophia*, *Lehua*, *Paucicostella*, *Petroria*, *Eopteria*, *Glaphurus*, *Endymionia*, and *Apatolichas* seem to be "biohermal dwellers,' but even this limited list is unconvincing. *Endymionia* in Newfoundland occurs in a shaly part of the Middle Table Head (Whittington and Kindle, 1963, fig. 3) as does *Onychoplecia* (Cooper, 1956, p. 11); neither is found in the reeflike boulder at Lower Head (Whittington, 1963), in which *Lehua* does occur. *Petroria* is found in sandy and argillaceous dolomites of the Skoki Formation of the Canadian Rocky Mountains (Norford, 1969, p. 21, 37).

The occurrence of a few brachiopod genera—*Pleurorthis*, *Idiostrophia*, and *Paucicostella*—seems to be related to pure limestone boulders or bioherms in conglomeratic deposits of the Lévis Shale at Quebec City (Cooper, 1956, p. 15) and the Mystic Conglomerate at Phillipsburg, Quebec (Cooper, 1956, p. 31). However, the genera found in Nevada in both bioherm and coevally deposited muddy limestone are represented in Quebec and Newfoundland boulders as well as or better than *Pleurorthis*, *Idiostrophia*, and *Paucicostella.*

A comparison of lists of trilobites found in the reeflike boulder at Lower Head, Newfoundland (Whittington, 1963), in the Table Head Formation (Whittington, 1965, p. 283–285), in the boulders of the Lévis Shale (Whittington, 1965, p. 291), and in the Mystic Conglomerate (Whittington, 1965, p. 291) with those from the bioherm and flanking beds at Meiklejohn Peak shows a strong general resemblance. There are no obvious categories of "reef-dwellers" or "flank dwellers" in the areas of northeastern North America or in Nevada. As noted by Ross and Ingham (1970, p. 393), time and stage of evolution do not entirely explain the similarity of some of these fossil assemblages.

If, however, the biohermal surface were swept by storm waves which dumped skeletal debris into deeper flanking sediments, the fossils of the flanking beds should represent both the biohermal and flanking assemblages. Data shown in figure 11 support this possibility without completely confirming it. In the flanking beds are 35 taxa; 20 have not yet been found in the bioherm, but only 15 of these are generically determined. Of the 36 taxa found in the bioherm, 16 are found in the flanking beds at Meiklejohn Peak and all but the 10 noted above have been found in Nevada in beds comparable to the flanking beds.

Genera of brachiopods, pelecypods, and trilobites are tabulated in an attempt to discover reliable indices of the two environments. Number of genera is indicated in parentheses.

Known only from bioherm (10)	*Known in bioherm and in flanking beds (16)*	*Known only from flanking or comparable beds in Nevada (5)*
Paucicostella (unless synonym of *Ingria*)	*Orthidiella*	*Phragmorthis*
	Trematorthis	*Anomalorthis*
Pleurorthis	*Cuparius*	*Hesperorthis*
Idiostrophia	*Nileus*	*Leptellina*

Known only from bioherm (10)	*Known in bioherm and in flanking beds (16)*	*Known only from flanking or comparable beds in Nevada (5)*
Petroria	*Illaenus*	
Onychoplecia	*Bathyurellus*	*Isophragma* or *Taphrodonta*
Lehua	*Kawina*	
Endymionia	*Ingria*	
Glaphurus	*Carolinites*	
Eopteria	*Cyrtonotella*	
Apatolichas	*Trinodus*	
	Orthambonites	
	Selenoharpes	
	Pliomerops	
	Ectenonotus	
	Heliomera	

It is likely that *Paucicostella* is a synonym of *Ingria*; that likelihood removes another genus from the 10 seemingly restricted to the bioherm.

The list of five genera known only in flanking beds probably is more significant than the list of 10. Although at least four of the 10 genera are known elsewhere in beds that seem unrelated to bioherms, in this place they may be indices of an environmental contrast not yet understood.

Based on collections made to date, the contrast in generic assemblages exists, and will be modified by future collections. Why the contrast exists here and whether a similar contrast exists in Newfoundland and Quebec in coeval strata remains to be seen.

Regarding younger Ordovician bioherms in Sweden, Dr. Valdar Jaanusson has called my attention to Warburg's (1925, p. 413–416) tabulation in which she showed that none of 41 trilobite genera were restricted to bioherms and that only three of 119 species were so restricted.

DESCRIPTIONS OF FOSSILS

Phylum **BRACHIOPODA**
Class **ARTICULATA**

Genus **ORTHIDIUM** Ulrich and Cooper, 1938
Orthidium bellulum Ulrich and Cooper

Plate 1, figures 1–5

Orthidium bellulum Ulrich and Cooper, 1938, Geol. Soc. America Spec. Paper 13, p. 111, pl. 16F, figs. 19–26.

Orthidium bellulum Ulrich and Cooper. Cooper, 1956, Smithsonian Misc. Colln., v. 127, p. 340, pl.30A, figs. 1–5.

Orthidium cf. *O. bellulum* Ulrich and Cooper. Ross, 1970, U S. Geol. Survey Prof. Paper 639, p. 54, pl. 1, fig. 1.

Figured specimens.—USNM 167177a, b.

Occurrence.—USGS collection D1973 CO, 60–65 feet above base of bioherm, Antelope Valley Limestone, Meiklejohn Peak.

Discussion.—*Orthidium bellulum* occurs low in the biohermal mass at Meiklejohn Peak and may be far more abundant than is apparent. Many specimens removed from the coarsely calcitic matrix are decorticated, like that illustrated on plate 1, figure 5; such specimens cannot be identified with confidence, yet are representative of a large number.

O. bellulum differs from *O. barnesi* Ross in its greater width, shallower pedicle valve, and wider spacing of concentric lamellae. *O. fimbriatum* Cooper has ornamentation similar to that of *O. bellulum*, a deep pedicle valve like that of *O. barnesi*, and a sulcus in both the brachial valve and the pedicle valves.

O. bellulum occurs at Meiklejohn Peak low in the *Orthidiella* zone. Listed by Cooper (1956, p. 127) from his *Rhysostrophia* zone in the Toquima Range the species is one of several that show the *Rhysostrophia* zone to be synonymous with the *Orthidiella* and *Anomalorthis* zones; at Ikes Canyon, *O. bellulum* occurs 516 feet below the top of the Antelope Valley Limestone (USGS colln. D1516 CO, Ross, 1970, p. 54) in an *Orthidiella* zone fauna.

Orthidium? aff. O. fimbriatum Cooper

Plate 1, figures 6–10

Two unusual brachiopod specimens have been found in the lowest beds of the bioherm at Meiklejohn Peak. These are unequally biconvex shells that have a strong sulcus in both valves, lamellose ornamentation, and faint radial ribbing.

Shells large for the genus, less than twice as wide as long. Greatest shell width near midlength; cardinal angles obtuse. Outline almost elliptical, with front margin obtusely indented at midline. Pedicle valve almost twice as deep as brachial valve. Surface very faintly costellate and concentrically lamellose. Costellae spaced about two per millimeter, lamellae about four per millimeter.

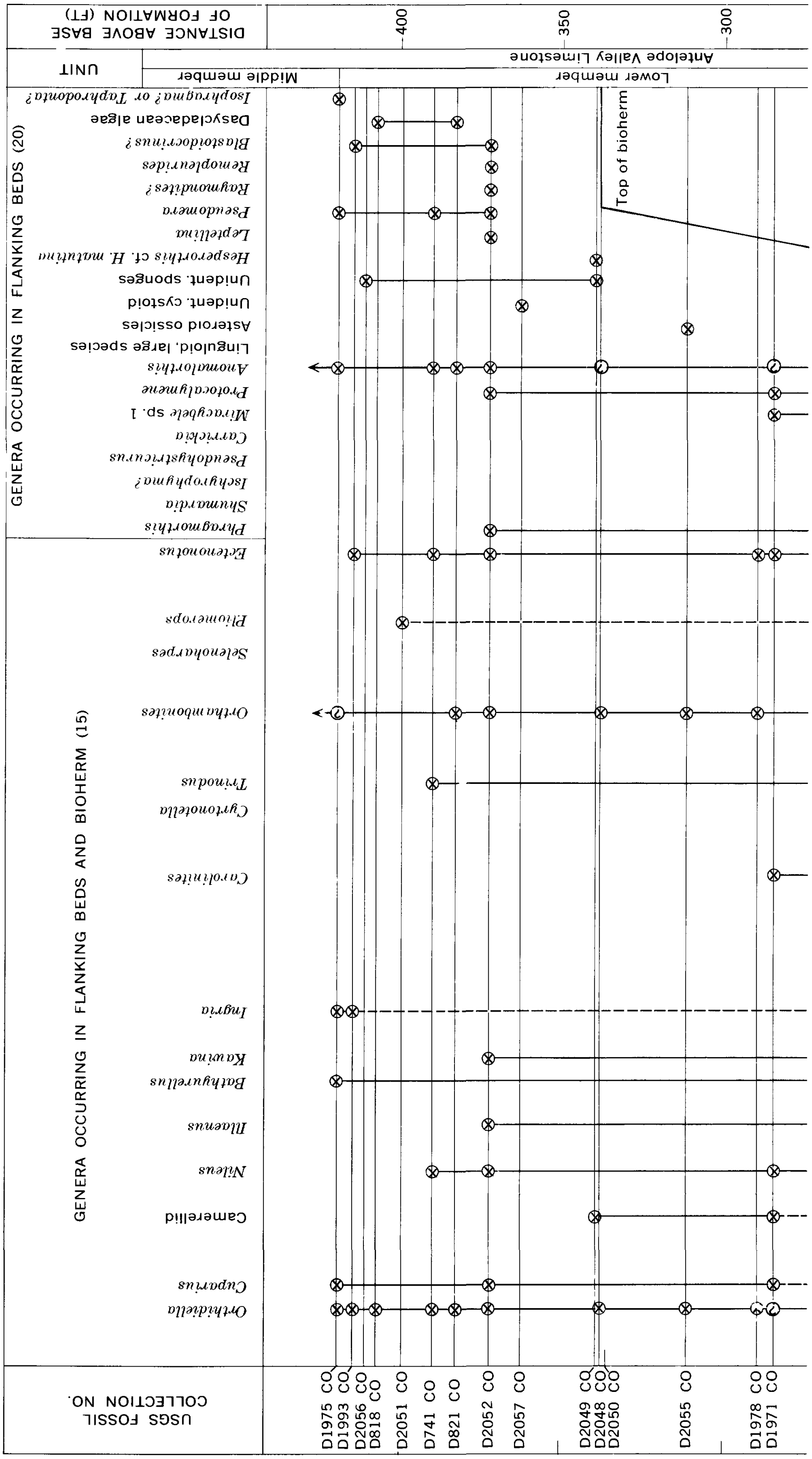
Pedicle valve with greatest convexity near prominent umbo. Sulcus begins at umbo, deepening and widening anteriorly, involving about one-third width of valve at anterior margin. Flanks of valve convex. Umbo protrudes behind hinge. Cardinal area curved in lateral profile, apsacline.

Brachial valve evenly convex in both lateral and anterior profiles except for shallow median sulcus. Umbo inconspicuous.

No interiors available.

Measurements of figured specimens are given below. L/W indicates ratio of length to width. Parentheses indicate estimated measurement.

USNM	Length (mm)	Width (mm)	Hinge width (mm)	Thickness (mm)	L/W
167178b	5.1	8.5	?	?	0.6
167178a	8.3	13.3	(10.5)	6.5	.62


DISTANCE ABOVE BASE OF FORMATION (FT)
400
350
300
UNIT
Antelope Valley Limestone
Middle member
Lower member
Top of bioherm
GENERA OCCURRING IN FLANKING BEDS (20)
Isophragma? or *Taphrodonta*?
Dasycladacean algae
Blastoidocrinus?
Remopleurides
Raymondites?
Pseudomera
Leptellina
Hesperorthis cf. *H. matutina*
Unident. sponges
Unident. cystoid
Asteroid ossicles
Linguloid, large species
Anomalorthis
Protocalymene
Miracybele sp. 1
Carrickia
Pseudohystricurus
Ischyrophyma?
Shumardia
Phragmorthis
GENERA OCCURRING IN FLANKING BEDS AND BIOHERM (15)
Ectenonotus
Pliomerops
Selenoharpes
Orthambonites
Trinodus
Cyrtonotella
Carolinites
Ingria
Kawina
Bathyurellus
Illaenus
Nileus
Camerellid
Cuparius
Orthidiella
USGS FOSSIL COLLECTION NO.
D1975 CO
D1993 CO
D2056 CO
D818 CO
D2051 CO
D741 CO
D821 CO
D2052 CO
D2057 CO
D2049 CO
D2048 CO
D2050 CO
D2055 CO
D1978 CO
D1971 CO

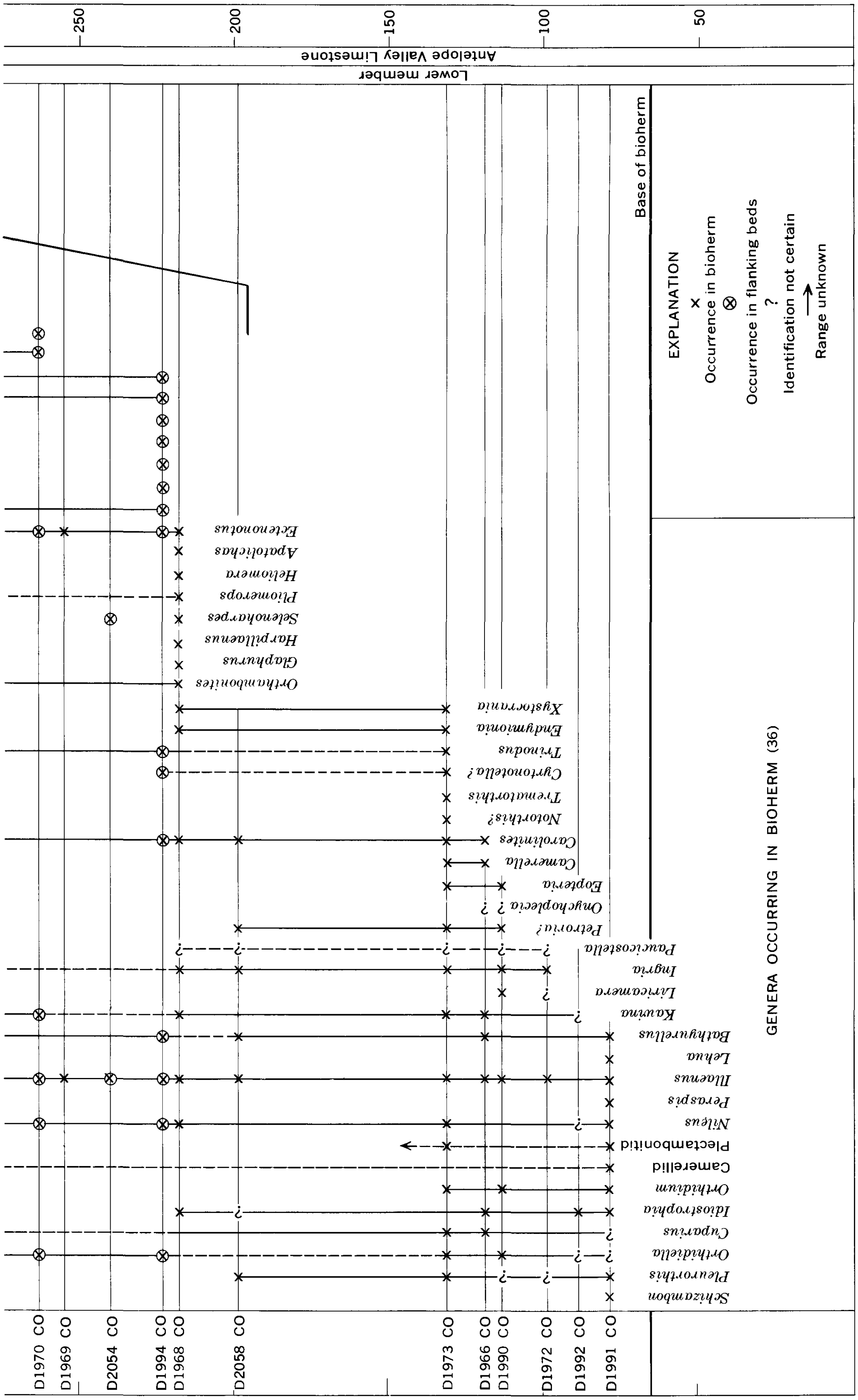


FIGURE 11.—Ranges of genera of trilobites and brachiopods in flanking beds, in bioherm, and in both.

Occurrence.—USGS collection D1991 CO, 10 feet above base of bioherm. Antelope Valley Limestone, Meiklejohn Peak.

Discussion—Because of lack of interiors, generic assignment of these specimens is very uncertain. The only other Ordovician species that combines the same kind of ornamentation and sulci in both valves is *Orthidium fimbriatum* Cooper from the Table Head Formation of Newfoundland (Cooper, 1956, p. 340–341, pl. 31A, figs. 1–6). *O fimbriatum* is smaller and has closer spaced and stronger costellae and more widely spaced lamellae. The Nevada species is clearly not conspecific, but it almost certainly is congeneric. *O. gemmiculum* (Billings) has an accentuated sulcus on the brachial valve but lacks the deep sulcus in the pedicle valve (Ulrich and Cooper, 1938, pl. 16G).

Genus TREMATORTHIS Ulrich and Cooper, 1936

Trematorthis Ulrich and Cooper, 1938 Geol. Soc. America Spec. Paper 13, p. 112–113.

Trematorthis may be fairly common in the bioherm at Meiklejohn Peak. However, it is virtually impossible to distinguish it from *Orthidiella* under the best conditions of preservation unless one finds a specimen with pseudodeltidium intact. Such specimens are extremely rare. One specimen of *Trematorthis* was found in collection D1973 CO.

Trematorthis sp.

Plate 1, figures 11–14

Complete specimen probably immature. Semielliptical in outline, hinge width twice the length. Cardinal angles acute. Brachial valve sulcate; sulcus occupying 50° sector. Costellae thin, subangular, spaced four to five per millimeter at front edge of shell that is 4.5 mm in length. Costellae in at least three generations by bifurcation and implantation; have bundled appearance.

Ventral valve gently convex, subcarinate from beak to front margin. Cardinal area apsacline, almost catacline, very low; its altitude only 0.75 mm in shell 4.5 mm long. Pseudodeltidium strongly arched.

Interiors of both valves unknown.

Measurements of figured specimen are given below. L/W indicates ratio of length to width. L/HW indicates ratio of length to hinge width.

USNM	Length (mm)	Width (mm)	Hinge width (mm)	L/W	L/HW
167179a	4. 5	7. 5	9. 1	0. 6	0. 5

Occurrence.—USGS collection. D1973 CO, lower member, 60–65 feet above base of bioherm, Antelope Valley Limestone, Meiklejohn Peak.

Discussion.—Two pedicle valves (pl. 1, figs. 11, 12) may belong to this same species. Ornamentation is almost identical. One specimen (pl. 1, fig. 11) possesses a similar outline, but the other (pl. 1, fig. 12) more closely resembles *Trematorthis masoni* or *Orthidiella longwelli* in outline and convexity. Possibly neither belongs to *Trematorthis.* Characters of the interiors have not been ascertained.

Genus PLEURORTHIS Cooper, 1956

This genus is known from the Mystic Conglomerate of Quebec (Cooper, 1956, p. 31, 329–332), from the Table Head Formation of Newfoundland (Cooper, 1956, p. 11, 331–332), and from the Treiorwerth Formation of Anglesey, Wales (Bates, 1968, p. 134). Specimens described here are the first reported from Nevada; they were found low in the bioherm at Meiklejohn Peak.

Pleurorthis beattyensis Ross, n. sp.

Plate 1, figures 15–21

Shells almost semielliptical in outline, hinge equaling greatest width, length about six-tenths of the width. Surface fascicostellate; costellae numbering three to four in space of 1 mm at anterior margin, bundled into fasces of three to five costellae. Approximately 4 fasces in 5 mm at front margin. Valves almost equally biconvex in lateral view.

Pedicle valve very broadly convex in anterior view. Flanks flattened, particularly in the posterolateral parts. Valve broadly and faintly sulcate at anterior margin; greatest convexity between midpoint and low umbo. Pedicle muscle scars trilobed, confined to posterior quarter of shell.

Brachial valve initially sulcate, changing to very broadly and inconspicuously uniplicate. Moderately convex in lateral and anterior views; posterolateral flanks slightly concave. Interior not observed.

Measurements of figured specimens are as follows:

USNM	Type	Valve	Length (mm)	Width (mm)	Hinge width (mm)	Thickness (mm)	Costellae
167180	Holotype	Both	15. 0	21. 6	24. 7	6. 2	4 fasces per 5mm
167181a	Paratype	Brachial	13. 8	22. 8	22. 8	------	------
167181b	do	do	14. 6	22. 0	22. 0	------	------

Occurrence.—USGS collection D1973 CO, 60–65 feet above base of bioherm, Antelope Valley Limestone, Meiklejohn Peak.

Discussion.—*Pleurorthis beattyensis* closely resembles *Pleurorthis fascicostellatus* Cooper in outline and profile, but it differs in being somewhat smaller and in having finer costellae in more pronounced fasces. *P. convexa* Cooper is a smaller, more convex species, but otherwise is similar.

Preservation of the Nevada specimens is not perfect. Decortication of the outer shell surface when specimens are broken from coarse calcitic matrix hinders a reliable census of the considerable variation these shells seem to show. Cooper (1956, p. 329–332) found that he could separate five species of *Pleurorthis* in the Mystic Conglomerate; by use of similar criteria more than one might be distinguished here.

However, the importance of the occurrence is stratigraphic; it provides another in the growing number of links between the *Orthidiella* zone of Nevada and the so-called Whiterock faunas of the east.

Pleurorthis? sp.

Plate 2, figure 1

A single complete shell and three pedicle valves of moderate convexity and strongly fascicostellate ornamentation are tentatively assigned to *Pleurorthis*; one of the pedicle valves is illustrated as a matter of record. The anterior commissure seems to lack the uniplicate form common in the genus. Costellae are spaced about three per millimeter, but only half of the costellae seem to be involved in fascicles of which there are three to four in 5 mm along the margin.

Figured specimen.—USNM 167182.

Occurrence.—USGS collection D1990 CO, 45 feet above base of bioherm, Antelope Valley Limestone, Meiklejohn Peak.

Genus **CYRTONOTELLA** Schuchert and Cooper, 1932

Cyrtonotella Ulrich and Cooper. Cooper, 1956, Smithsonian Misc. Colln., v. 127, p. 318–319.

All specimens obtained from the bioherm are in a very nearly pure calcite matrix. It is therefore very difficult to separate one from the other in order to determine the character of structures inside the valves. It has not been possible to demonstrate the existence of a cardinal process or to determine if one is lacking. If a cardinal process is present in these specimens it seems more than likely that *Cyrtonotella* is represented.

The genus *Cyrtonotella* was reported from strata of Ashby, Porterfield, and Trenton age in the Appalachians, according to Cooper (1956, p. 319–326, chart 1). Its possible occurrence within the *Orthidiella* zone at Meiklejohn Peak is therefore unexpected in terms of age. Two species were reported by Williams (1962, p. 105–106) from the Stinchar Limestone and from Ardwell and Balclatchie Mudstones, Girvan district, Scotland. The genus was also reported in Thailand (Hamada, 1964, p. 213–217). However, Dr. Valdar Jaanusson (written commun., May 25, 1970) has noted that *Cyrtonotella* occurs in the strata of the Kunda and Volkhov Stages (Early Llanvirn and Late Arenig) in Russia and Estonia (Rubel, 1961).

Cyrtonotella? aff. C. fasciculata Cooper

Plate 2, figures 2–6

Outline semielliptical, widest at hinge line; cardinal angles alate when preserved. Hinge width from 1.5 to 1.8 times wider than long. Profile concavo-convex. Brachial valve bearing narrow sulcus within a sector of 65°; sulcus much less pronounced at anterior margin than proximally. Pedicle valve moderately convex; greatest convexity close to beak.

Ornamentation fascicostellate. Medianly in a space of 5 mm at a radius of 5 mm, costellae number 12–14; and at a radius of 10 mm number eight. Finer costellae probably not fully preserved in any specimen of sample; therefore, rib count may be a little higher at 10 mm radius.

Measurements of specimens are given below. Parentheses indicate estimated measurement.

USNM	Valve	Length (mm)	Hinge width (mm)	Costellae in 5 mm—	
				At radius 5 mm	At radius 10 mm
167183a	Brachial	10.8	14.5+	--------	8
167183b	do	9.0	16.0	12	8
167183c	do	8.0	14.0	12	(9)
167183f	do	9.0	(16.0)	--------	(10)
167183e	Pedicle	12.0	(20)	14	8

Occurrence.—USGS collection D1973 CO, 60–65 feet above base of bioherm, lower member of Antelope Valley Limestone, Meiklejohn Peak.

Discussion.—Latex casts of brachial interiors (pl. 2, fig. 2) were made after shell material was picked from matrix. This method does not lend itself to preparation of the brachiophores or the cardinal process which I have been unable to differentiate with certainty. Peeling of the shell by calcining proved ineffective because of the similarity of shell and matrix.

This species most closely resembles *C. fasciculata* Cooper (1956, p. 320–321, pl. 41A) in size, outline, and ornamentation. Cooper's species has somewhat finer costellation and does not seem to be deeply concave. No other species has a coarse fasciculate costellation.

Genus PHRAGMORTHIS Cooper, 1956

Phragmorthis is represented in beds flanking the reef at Meiklejohn Peak. This occurrence of the genus seems to be the oldest known. Specimens come from two collections D2052 CO and D1994 CO (fig. 7). In specimens from the stratigraphically older collection the "pseudospondylium" of the pedicle valve is only slightly developed, and the median septum of the brachial valve is about as strong as that in species of *Skenidioides*. In the stratigraphically younger specimens the pseudospondylium, thickened floor, and paired pallial trunks are well developed, but the median septum of the brachial valve lacks the exceptional height found in the type species, *Phragmorthis buttsi* Cooper.

These Nevada specimens may be the ancestral forms of a genus previously known only from strata of Porterfield and younger age. *Phragmorthis* is another genus that may link the *Orthidiella* zone of Nevada with the Pratt Ferry beds of Alabama.

Phragmorthis antiqua Ross, n. sp.

Plate 2, figures 7–18

Shells very small, wider than long, moderately convex for the genus. Anterior commissure angularly sulcate. Cardinal extremities right angled to obtuse. Lateral margin rounded; anterior margin indented medially. Surface fascicostellate; costellae spaced five to seven per millimeter at anterior margin.

Pedicle valve moderately deep; its greatest convexity close to beak and along midline forward; however, not markedly carinate. Flanks evenly rounded, not particularly swollen. Cardinal area apsacline; its width 2.5 times its altitude. Delthyrium narrow, almost parellel-sided. Dental plates receding. Pseudospondylium occupies one-third midlength of shell. Pallial trunks extend forward from dental plates close to margin. Area between trunks somewhat thickened.

Brachial valve creased by wide angular sulcus. Median septum distinct but low. Cardinal process highly variable in development; almost absent from some specimens but greatly thickened in others. Adductor scars composed of an anterior and posterior pair separated by median septum.

Measurements of figured specimens are given below. L/W indicates ratio of length to width. Parentheses indicate estimated measurements.

Occurrence.—USGS collection D 2052 CO, Antelope Valley Limestone, lower member, thin beds flanking bioherm, Meiklejohn Peak.

USNM	Type	Valve	Length (mm)	Width (mm)	Thick-ness (mm)	L/W
167184	Holotype	Brachial	3. 1	5. 2	1. 3	0. 6
167185a	Paratype	do	2. 7	4. 6	1. 3	. 59
167185b	do	Pedicle	2. 1	3. 4	1. 4	. 62
167185c	do	do	2. 1	3. 6	(1. 2)	. 58

Discussion.—*Phragmorthis antiqua* is characterized by its wide outline, moderate convexity, and low median septum in the brachial valve. The brachial sulcus is like that of *P. buttsi* Cooper, but is much wider than that of *P. crassa*. The median septum is not the enormous partition that Cooper (1956, pl. 146, fig. 36) illustrated for *P. buttsi*.

If this species were larger, the number of costellae per 1 mm at the front margin might be in the range of *P. buttsi*, but they would not be as coarse as in *P. crassa*.

Phragmorthis antiqua differs from specimens collected in the stratigraphically lower collection D1994 CO in its better development of the"pseudospondylium" of the pedicle valve. This structure is comparable to that of *Anomalorthis*. Because *Anomalorthis* also occurs in D2052 CO, it is very difficult to distinguish small specimens of *Anomalorthis* from *Phragmorthis*.

Genus CAMERELLA Billings (1859)

There are at least two species in the lower biohermal limestone at Meiklejohn Peak that defy final identification. Interiors are not available for these forms. They belong in a group that Ulrich and Cooper (1938) named *Rhynchocamara*, and that Cooper (1956, p. 562), without explanation, placed in synonymy with *Camerella*. There is a group of these shells, such as *Camerella breviplicata* Billings, which as suggested by Cooper (1956, p. 565) may be late Canadian in age. They have inflated brachial valves, and are costate only around the margin of the shell. In the bioherm at Meiklejohn Peak these shells demonstrate considerable variety of forms. Whether this variety represents one or two extremely variable species or a great many species can probably not be known with certainty.

These forms are associated with *Idiostrophia* in some collections. Although not found in the bioherm, *Liricamera* is from beds equivalent to those flanking the bioherm. Both of these genera are mimicked to some degree by varieties of the little Camerellas. Cooper (1956, p. 590, pl. 113A) described a small species and assigned it tentatively to *Idiostrophia*?. This little form lacks the characteristically flattened sides of true *Idiostrophia* (Cooper, 1956, pl. 109 A–E), as do the shells of the small species of *Camerella* here under consideration. Some immature specimens of *Idiostrophia*, however, also lack such sides.

Camerella sp. 1

Plate 3, figures 1–18

Outline ovoid to subcircular; longer than wide. Greatest width generally six-tenths of length from beak. Posterior surface smooth; costae present along anterior margin. Costae number 20–30, spaced two per millimeter. Commissure very gently uniplicate.

In lateral profile, pedicle valve evenly convex. In anterior view, flanks slope from rounded crest and steepen near margins. Umbo inconspicuous.

Brachial valve most markedly convex in posterior half. In anterior view increasingly convex from midline to margin.

Figured specimens.—USNM 167186a–d.

Occurrence.—USGS collection D1973 CO.

Discussion.—There is considerable variation in relative thickness and apparent convexity of shells of this species. Some specimens (pl. 3, figs. 5–9, 15–18) might be grouped with *Idiostrophia* because of the flattened sides just anterior to the beak. This flattening is seemingly the result of unusual growth. One specimen (pl. 3, figs. 10–14) is of very low convexity and of subcircular outline and in these respects resembles a smaller specimen from USGS collection D1991 CO (pl. 4, figs. 1–4).

Camerella sp. 1 closely resembles but is narrower than *C. sublaevis* (Ulrich and Cooper) (Ulrich and Cooper, 1938, p. 251, pl. 56E). Its costae are finer and more numerous than those of *C. breviplicata* Billings.

Camerella sp. 2

Plate 4, figures 5–8, 14–17

Outline narrowly ovoid. Widest part of shell in front of midpoint. Pedicle valve the deeper; in lateral profile, greatest convexity of both valves behind midlength. Surface costate around anterior margin; costae number 10–15, spaced two per millimeter except in one specimen (pl. 4, figs. 14–17). Commissure slightly uniplicate.

Figured specimens. USNM 167188a, b.

Occurrence.—USGS collection D1966 CO.

Discussion.—In number of costae, this species is similar to *Camerella breviplicata* Billings but is narrower than that form. The largest specimen possesses a poorly defined fold and a sulcus composed of two costae; it is the only specimen with this feature. As a result, I have considered that these specimens may be aberrant; if not, they probably represent yet another species.

Genus IDIOSTROPHIA Ulrich and Cooper, 1936

Idiostrophia Ulrich and Cooper, 1936, Jour. Paleontology, v. 10, no. 7, p. 631.

Idiostrophia Ulrich and Cooper, 1938, Geol. Soc. America Spec. Paper 13, p. 249.

Idiostrophia Ulrich and Cooper. Cooper, 1956, Smithsonian Misc. Colln., v. 127, p. 587.

Cooper (1956, p. 587–588) has described the peculiar lateral ridges of the pedicle and brachial valves of *Idiostrophia* and has homologized them with the flanks of valves of *Camerella.* These lateral ridges and the triangular outline of the shell distinguish *Idiostrophia.* However, collections from the bioherm at Meiklejohn Peak prove that these characteristics may not be quite so pronounced in some specimens as Cooper's illustrations (1956, pl. 109, figs. 4, 6, 11, 12) suggest.

For instance, one collection (USGS colln. D1968 CO) has produced camerellid shells packed together in a limestone matrix like peanut brittle. A piece of limestone about the size of one's fist yielded 567 shells, of which 78 were broken and therefore were left out of consideration. These shells were sorted and measured in an effort to determine whether they represented one or several species. The results have been exceedingly disconcerting.

Some specimens are almost smooth, having poorly developed costae and very low flattened "lunulelike" sides. Others have strong costae and high "lunules." Some are wider than long, others longer than wide. Some have as many as 13 costae, others have none. Efforts to separate specimens according to these characteristics have produced no consistent clear-cut groupings. It is clear that study of a small sample would probably have resulted in designation of three or four species. The present large sample has produced many intermediate specimens between various extremes, discouraging any attempt to split the sample. And yet the specimens do show tendencies worth noting.

In general, all specimens are triangular in outline. Some have slightly convex lateral outlines, others have straight diverging sides, and another group has a distinctly flairing bell-shaped outline; in this last group the flattened "lunulelike" sides tend to have a concave outline.

Convexity is highly variable but may eventually prove to be one of the characteristics on the basis of which a division of the sample can be made. The small group of specimens that lack or have only a few poorly defined costae invariably have low convexity but may have almost any of the various outlines displayed by more strongly ribbed shells.

Development of the flattened "lunulelike" sides is highly variable. In some specimens these sides are high and straight so that the shell resembles a sector of a thick disk. In others, the "lunules" are very low or nonexistent; a grouping based principally on presence or absence of the "lunules" clearly would not be a natural one.

Almost all specimens possess a distinct, though shallow, median intercostal groove on the brachial valve. None of the specimens from Meiklejohn Peak bear the strong median intercostal groove on both valves as is found in *Idiostrophia perfecta* and *I. costata* (Cooper, 1956, pl. 109, A, B). Most of them do have such a groove on the brachial valve. A few such as *I. paucicostata* Cooper, *I. plicata* Cooper, and *I. digitata* (Brögger, 1882, p. 52, Tab. XI, fig. 2a–c), and *I. nuda* Cooper lack any such groove.

Only in the one coquinoid collection (USGS colln. D1968 CO) from the bioherm does one have difficulty determining what should or should not constitute a species. The shells probably were washed off the surface of the reef into a narrow crevice or channel. Yet some shells show signs of interference during growth, suggesting that they may have been packed close together in life. Such a highly competitive environment may have resulted in a high degree of variation out of which a few stable species evolved and spread.

Idiostrophia n. sp. A

Plate 4, figures 9–13

Rhynchonella digitata. Brögger, 1882, Die Silurischen Etagen 2 und 3, p. 52, pl. XI, figs. 2, a, b, c.

This description is based on a single specimen, that illustrated by Brögger (1882, pl. XI, fig. 2).

Outline subtriangular, angle between sides about 75°. Anterior margin evenly curved. In profile, valves equally and strongly convex. Flattened "lunulelike" sides well developed, somewhat concave, higher on brachial valve. Costae limited to anterior third of shell, 12 in number, spaced one per millimeter.

Figured specimen.—Paleontologisk Mus. (Oslo) No. 47089.

Occurrence.—Asaphus shale, Töyen district, Oslo. Stage 3cB. Within a short distance of the Palaeontological Museum, according to Dr. Gunnar Henningsmoen (written commun., Feb. 4, 1970).

Discussion.—This specimen was assigned by Brögger to *Rhynchonella digitata* (von Leuchtenberg). Concerning this assignment and synonymy given by Brögger, Dr. Valdar Jaanusson (written commun., Feb. 2, 1970) commented:

> Leuchtenberg's (1843) figure (very poor) and description of *Terebratula digitata* do not resemble Brögger's specimen at all. "*T.*" digitata has only 5 costae along the anterior margin and this is not a juvenile feature since the shell has about the same size as the Norwegian specimen. The outline is triangular and the species may belong to *Idiostrophia* but as the types are lost the species *digitata* is a nomen dubium for all practical purposes. The specimen figured by Eichwald (1860, pl. 35, figs. 12a, b), again, is different from Leuchtenberg's specimen as well as from the Norwegian specimen. It has a greater number of costae, a less clearly triangular outline, and a more convex dorsal valve. It might belong to *Camerella*.
>
> Both Eichwald (1860) and Brögger (1882) suggested that *Terebratula digitata* Leuchtenberg, 1843, may be identical to *Porambonites acuminatus* Pander, 1830. Rubel (1961) has subsequently redescribed the latter species, and has designated a neotype. It is a *Camerella* (or *Rhynchocamara* if this genus is valid) and has nothing to do with either Leuchtenberg's species or Brögger's specimen.

It is interesting to note that *Camerella* appears in North America in the Whiterock Stage and in the Balto-Scandian area in the lowermost Kunda Stage (Hunneberg Substage or Expansus Limestone, BIIIα).

Idiostrophia n. sp. A is larger than any of those from the bioherm at Meiklejohn Peak. In outline and number of costae it is similar to *Idiostrophia perfecta* and *I. nuda*; both of those species have pronouncedly stronger convexity of the brachial valve; in *I. nuda* the convexity is particularly strong close to the umbo. In *I. perfecta* a clear median intercostal groove is present on both valves, but the groove is lacking in *I.* n. sp. A.

The importance of *Idiostrophia* n. sp. A is in indicating a possible correlation between the *Orthidiella* zone and the Scandinavian section.

Idiostrophia lenticularis Ross, n. sp.

Plate 5, figures 1–25

Shells of low convexity, lacking costae until more than 6 mm in length.

Angle between flattened sides 95°–100° in adult specimens. Brachial valve the more convex. Pedicle valve somewhat flattened near umbo, in lateral profile curving more sharply in front of middle. Brachial valve evenly curved in lateral profile. Flattened sides low, barely developed in shells more than 3.9 mm long. Costae very low and limited to peripheral 1 mm in shells more than 6 mm long. Costae number 10, spaced one per millimeter.

Holotype.—USNM 167189.

Paratypes.—USNM 167190a–e.

Occurrence.—USGS collection D1968 CO, from crevice or channel filling, 168 feet above base of bioherm.

Discussion.—I have not yet been able to assemble complete series of growth stages for this species because of a gap between specimens 4.5 mm and 5.9 mm in length. Nonetheless, the four specimens (pl. 5, figs. 6–15, 21–25, and USNM 167190e) are believed to be assignable immature forms. In these immature stages the anterior and lateral profiles are lenticular; in anterior profile the pedicle valve is more convex, particularly behind middle. Median groove on brachial valve in immature stages. Extremely faint costae present near center of shells.

Equally small and smaller shells of *Idiostrophia valdari* n. sp. already have several costae well developed (pl. 8, figs. 16–20). Both *I. paucicostata* and *I. plicata* have strongly developed "lunulelike" flattened sides, quite different from the low sides of *I. lenticularis. I. polita* (Billings) is very similar in outline but more convex in profile.

Idiostrophia valdari Ross, n. sp.

Plates 6–8; plate 18, figures 16–20

The sample on which this description is based numbers about 350 specimens. As noted under the discussion of the genus this sample is exceedingly variable.

Outline subtriangular to bellshaped; valves almost equally convex in anterior profile. Brachial valve slightly deeper in lateral profile. Sides flattened to form a "lunulelike" surface; angle of divergence between two sides ranges from 50° to 100°. Size of angle depends to some extent on length (size) of shell. (Forty-six percent have an angle of 60°–64°, 17 percent are between 55° and 59°, 22 percent are between 65° and 69°, 12 percent are 70°–79°, and 3 percent are 80°–100°.) Distribution relative to length of shell is shown in figure 12. Median intercostal groove present on brachial valve with few exceptions. Costae on anterior two-thirds of valves; in some specimens limited to anterior half. Costae number four to 13; number related in part to size (length) of shells as shown in fig- 13 and in part to angle between flattened sides. Eighty-two percent of the specimens fall in range of length 4.0–5.4 mm. Sixty-three percent have seven to nine costae. Along front edge of shell costae may be spaced approximately one per millimeter.

Holotype.—USNM 167191 (pl. 18, figs. 16–20).

Paratypes.—USNM 167192a–m.

Occurrence.—USGS collection D1968 CO. From crevice or channel filling on west side of bioherm, 168 feet above base of bioherm.

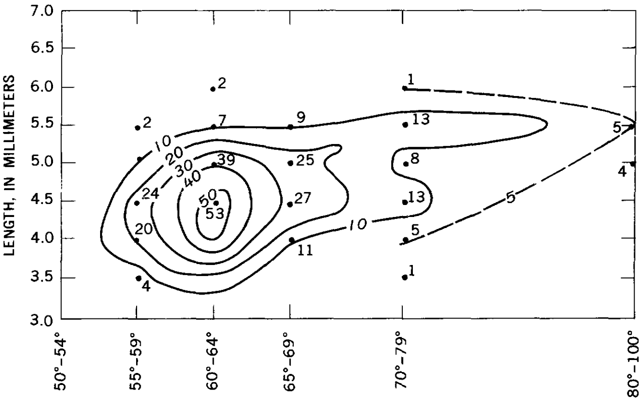


FIGURE 12.—Diagram showing length of shell of *Idiostrophia valdari* Ross, n. sp. versus apical angle, contoured according to number of specimens.

Discussion.—*Idiostrophia valdari* as described here may include more than one species. However, much more than the considerable amount of time already devoted to a possible subdivision would be required to discover consistent criteria on which to base separate species or subspecies.

I. valdari differs from *Idiostrophia perfecta* Ulrich and Cooper in having fewer and somewhat coarser costae. *I. costata* Ulrich and Cooper is twice as long as the largest specimen of *I. valdari* and possesses much coarser costae. *I. conciliata* n. sp. has more numerous costae and is of larger size. *I. nuda* Cooper is almost twice the size of *I. valdari* and has a more convex brachial valve and more numerous costae which are limited to the anterior third of the shell. *I. valdari* is easily discernible from *I. paucicostata* and *I. plicata* which have fewer and less prominent costae.

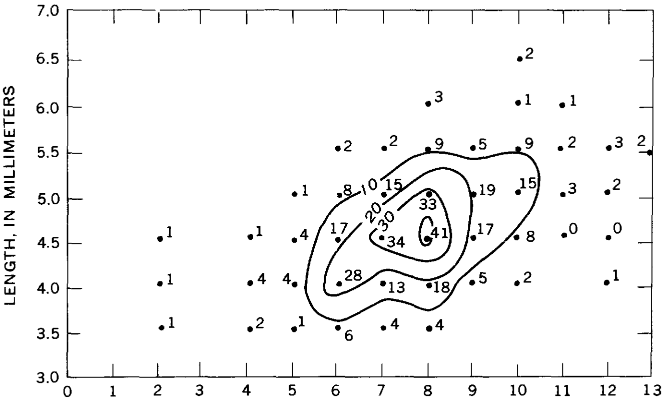


FIGURE 13.—Diagram showing length of shell of *Idiostrophia valdari* Ross, n. sp. versus number of costae, contoured according to number of specimens.

Idiostrophia conciliata Ross, n. sp.

Plate 9, figures 1–7

Shell of medium to large size for genus, triangular in outline, width very slightly greater than length. Apical angle about 65°. Anterior margin broadly curved. Valves unequally biconvex, the pedicle valve slightly the deeper. Anterior commissure virtually straight. Posterior halves of valves smooth. Anterior part marked by 24 costae.

Pedicle valve more strongly convex in lateral than in anterior profile. Flanks between lateral ridge and commissure very narrow. Brachial valve about equally convex in lateral and anterior profiles. Flanks higher than those of pedicle valve.

Measurements of figured specimens are as follows.

USNM	Type	Valve	Length (mm)	Width (mm)	Thickness (mm)
167193	Holotype	Both	9. 9	10. 6	6. 4
167193a	Paratype	Brachial	13. 9	16. 9	7. 4

Occurrence.—USGS collection D1991 CO, 10 feet above base of bioherm, Antelope Valley Limestone, Meiklejohn Peak.

Discussion.—This species more closely resembles *Idiostrophia perfecta* Ulrich and Cooper from the Mystic Conglomerate than any other known species. It differs from any other species in having more costae and in lacking the distinct median groove on both valves. Decortication and lack of interiors prevent a more complete description.

Genus INGRIA Öpik, 1930

Ingria Öpik. Ulrich and Cooper, 1938, Geol. Soc. America Spec. Paper 13, p. 185.

Ingria Öpik. Cooper, 1956, Smithsonian Misc. Colln., v. 127, p. 700, pl. 163B.

Ingria is abundantly represented in beds of muddy and silty limestone that flank the bioherms at Meiklejohn Peak east of the Nevada Test Site. Great numbers of silicified shells have been obtained from south of Frenchman Flat (USGS colln. D719 CO) where two varieties of *I. cloudi* Ulrich and Cooper may have stratigraphic significance.

Within the bioherm at Meiklejohn Peak there occur large numbers of shells of smaller size that might be assigned tentatively to *Paucicostella*. Those under 10 mm in length are concavo-convex, but larger specimens tend toward resupination, a characteristic of *Ingria*. It, therefore, is probable that *Ingria* is represented in the reef by immature or dwarfed individuals.

In his description of *Paucicostella canadensis*, Cooper (1956, p. 712) noted that it was also a resupinate shell with widely spaced major costellae, essentially like those of *Ingria*. Cooper (1956, p. 711) found no specimens that permitted satisfactory preparation of the brachial interior. I suggest the possibility that *Paucicostella* of Quebec and Newfoundland may be congeneric with *Ingria* of Nevada.

Ingria cloudi Ulrich and Cooper

Plate 9, figures 8–19; plate 10, figures 1–4, 8, 9

Ingria cloudi Ulrich and Cooper, 1938, Geol. Soc. America Spec. Paper 13, p. 185–186, pl. 38B, figs. 4–8; pl. 57C, figs. 17, 18, 20, 21, 23. 24.

Ingria cloudi Ulrich and Cooper. Cooper, 1956, Smithsonian Misc. Colln., v. 127, pl. 163B.

Several topotypic silicified specimens from the Nevada Test Site are illustrated for comparison with calcareous shells in the bioherm at Meiklejohn Peak. The calcareous shells (pl. 10, figs, 5–7, 10–13, 17) are much smaller than silicified adults and may be referable to *Paucicostella*.

The variability of *Ingria cloudi* has been noted by Cooper (1956, p. 700). There seem to be two main varieties in the collections from south of Frenchman Flat. One of these is quadrate (pl. 9, figs. 8–15) in outline and the other alate (pl. 9, figs. 16–19; pl. 10, figs. 1–4, 8–9). It is doubtful if these two should be given rank of subspecies unless future statistical study shows significant differences, both morphologically and stratigraphically.

Figured specimens.—USNM 167194a–d, 167195a–c, 167196a–b.

Occurrence.—Antelope Valley Limestone, Ranger Mountains Member, along side of broad wash at exit from range, Ranger Mountains. Nevada coordinates, central zone: E. 726,700 feet, N. 740,700 feet, Frenchman Lake quadrangle, Nevada. USGS collection D719e CO, 100 feet below top of member. USGS collection D719h CO, 70 feet below top of member. USGS collection D719i CO, 60 feet below top of member (Ross, 1964, p. C20; Byers and others, 1961) Nevada Test Site.

Antelope Valley Limestone, lower member, Nevada coordinates, central zone: E. 500,100 feet, N. 775,600 feet, Bare Mountain quadrangle, Nevada. USGS collection D1975 CO, 420 feet above base of member. D1993 CO, 415 feet above base of formation in rubbly beds above bioherm. D1968 CO, in bioherm, 168 feet above its base. D1973 CO, in bioherm 60–65 feet above its base. D1990 CO, in biohorm 45 feet above its base, Meiklejohn Peak.

Discussion.—Small specimens from the bioherm at Meiklejohn Peak resemble *Paucicostella canadensis* Cooper (1956, p. 712, pl. 172A, 173D). However, these specimens are virtually identical to immature stages of *Ingria cloudi* which occurs silicified in muddy, silty strata flanking the bioherm. No satisfactory brachial interiors of the small calcareous specimens in the bioherm have been obtained.

Genus ISOPHRAGHMA Cooper, 1956

Isophragma? sp.

Plate 10, figures 18, 20

A single incomplete silicified pedicle valve has been obtained from beds overlapping the great bioherm and this valve seems to be an immature specimen of *Isophragma* or *Taphrodonta*. The valve is only a little more than 4 mm long; inasmuch as resupination of most species of *Isophragma* takes place beyond a radius of 4 mm, that characteristic cannot be used to determine whether the little shell belongs to *Isophragma* or to *Taphrodonta*.

Dental lamellae poorly developed. Deltidium present. Callosities subperipheral, forming sharp ridges steepest on distal side; ridge interrupted medially by double-pronged depression. This depression seemingly accommodated double septum of brachial valve.

Costellae subequal except for three that are more prominent, one median and a pair enclosing an angle of 50°. These three costellae appear in reverse as grooves on inside of valve.

Figured specimen.—USNM 167199.

Occurrence.—USGS collection D1975 CO, near top of lower member, in beds overlying bioherm, 420 feet above base of formation, Antelope Valley Limestone, Meiklejohn Peak, Nev.

Discussion.—Only after additional collections are made can the correct relationships of this shell be determined. Whether *Isophragma* or *Taphrodonta* is represented, the occurrence of either is unexpected in the *Orthidiella* zone. The latter would provide one more tie between the *Rhysostrophia* zone of the Toquima Range and the *Orthidiella* zone.

Genus PETRORIA Wilson, 1926

Petroria Wilson, 1926, Canada Dept. Mines, Geol. Survey Bull. 44, Contr. Canadian Paleontology, p. 27–28.

Petroria Wilson. Cooper, 1956, Smithsonian Misc. Colln., v. 127, p. 746–747.

The peculiar concentrically rugose surface described in *Petroria rugosa* Wilson (Wilson, 1926, p. 28) is shown in a far less pronounced fashion by shells from Meiklejohn Peak. The shell substance of the Nevada specimens seems to be fibrous and in shingled layers. Irregular silicification probably can produce the effect described in *P. rugosa*. I have not been able to observe any pseudopunctae. No interiors are available for the Nevada species; therefore, generic assignment cannot be final.

It is now known that the original stratigraphic position assigned to this genus by Wilson (1926, p. 29) was incorrect. Cooper (1956, p. 746) called attention to the probable mixing of collections from several horizons and to the association of *Orthis marshalli* Wilson and *Plectorthis? sinuatis* Wilson. He thought that *O. marshalli* should be assigned to *Orthambonites* and that *Plectorthis? sinuatis* looked very much like an *Orthidiella*. Aitken and Norford (1967, p. 188, 203) have shown that *Petroria rugosa* Wilson is indeed associated with *Orthambonites marshalli* (Wilson) in the Skoki and Outram Formations; and, although they have not reassigned associated *P.? sinuatis* to *Orthidiella*, such a reassignment is probably advisable.

At Meiklejohn Peak, *Petroria* seems to be present in the large bioherm. There it is included in the *Orthidiella* zone. *Orthambonites marshalli* (Wilson), although not found in the bioherm, has been found to be a useful index to the *Orthidiella* zone in much of neighboring Nevada and California, as well as in Alberta and British Columbia.

Petroria? austrina Ross, n. sp.

Plate 11, figures 1–5

Shell semielliptical in outline. Concavo-convex in lateral and anterior profiles. Hinge forming widest part of shell; cardinal angles acute in well-preserved shells, somewhat rounded in old or abraded specimens. Anterior commissure flexed centrally slightly near midline. Surface marked by very fine distant costellae; spacing averages about one per millimeter with much wider smooth interspaces.

Pedicle valve strongly convex in lateral profile with greatest convexity between midpoint and umbo. Umbo somewhat swollen. Posterolateral flanks convex in lateral view but somewhat concave in anterior profile. Anterior profile moderately convex; greatest convexity along midline. Cardinal area anacline, concave, wide and long (transversely). Deltidium arched.

Brachial valve markedly concave, particularly along midline posterior to midpoint. Posterolateral "ears" concave. Cardinal area hypercline, wide near notothyrium. Chilidial plates large, completely filling gap in delthyrium above arched deltidium.

Measurements of figured specimens are as follows.

USNM	Type	Valve	Length (mm)	Hinge width (mm)	Thickness (mm)	Measured—
167200	Holotype	Complete	6.3	13.3	4.5	On midline.
					5.3	Transversely.
167200a	Paratype	Pedicle	10.8	13.7+	4.6	On midline.
					5.7	Transversely.

Occurrence.—USGS collection D1973 CO, 60–65 feet above base of bioherm, Antelope Valley Limestone, Meiklejohn Peak.

Discussion.—Despite our inability to demonstrate internal features of this species, the species is assigned with fair confidence to *Petroria* rather than to *Leptella.* Although not possessing the strongly rugose surface of *P. rugosa* Wilson, it does have a similar "shingled" layering of the shell. Externally, both *P. rugosa* and *P.? austrina* resemble *Leptella* very closely. Cooper (1956, p. 188–189) states that *Leptella nevadensis* has a pseudopunctate shell; no pseudopunctae are known in *Petroria* although that lack may be the result of preservation.

Petroria? austrina is a larger and wider shell than *P. rugosa;* the pedicle valve is probably a little more convex.

Genus PAUCICOSTELLA Cooper, 1956

Paucicostella Cooper, 1956, Smithsonian Misc. Colln., v. 127, p. 711–712.

According to the original description, no adequate brachial interiors of this monotypic genus have ever been obtained. In Nevada the bioherm at Meiklejohn Peak has yielded small shells (pl. 10, figs. 5–7, 10–13, 17) that externally resemble *Paucicostella canadensis.* No brachial interiors can be developed on these specimens which also are identical to immature specimens of *Ingria cloudi. Paucicostella* is known from the Mystic Conglomerate of Quebec and the Table Head Formation of Newfoundland in strata correlative to the bioherm at Meiklejohn Peak. The possibility exists that *Paucicostella* of eastern North America is synonymous with *Ingria* of Nevada. The shells in question are figured as *Ingria?* sp.

Genus CUPARIUS Ross, 1971

Cuparius Ross, 1971, Smithsonian Contr. Paleobiology no. 3 p. 125.

The *Parambonites*-like syntrophopsid genus *Cuparis* is represented in the bioherm at Meiklejohn Peak by the type species, *Cuparius cardilatus* Ross. The genus seems to be limited stratigraphically to the equivalents of the *Orthidiella* zone and possibly to the lowermost *Anomalorthis* zone.

Cuparius cardilatus Ross

Plate 11, figures 6–9

Cuparius cardilatus Ross, 1971, Smithsonian Contribut. Paleobiology No. 3, p. 125–128, pl. 1, figs. 1–8.

Figured specimen.—USNM 167201.

Occurrence.—USGS collection D1973 CO, 60–65 feet above base of bioherm, Antelope Valley Limestone, Meiklejohn Peak, Nev.

Discussion.—A few specimens—most of them fragmentary—have been obtained now in the bioherm at Meiklejohn Peak. One of these (pl. 11, figs. 6–9) shares proportions of the types, but is a little larger than previously described specimens. It has also a slightly less convex pedicle valve. As would be expected in a large individual, the fold and sulcus originate behind the midpoint of each valve. Other features are the same as in the original types.

Cuparius sp.

Plate 11, figure 17

A small pedicle valve was found in the bioherm at Meiklejohn Peak within the range of *Cuparius cardilatus.* It possesses a less transverse outline than that species but is a smaller, possibly an immature, shell. The pitting of the surface of the shell is not discernible in the inner layers.

Figured specimen.—USNM 167202.

Occurrence.—USGS collection D1966 CO, 50 feet above base of bioherm, Antelope Valley Limestone, Meiklejohn Peak, Nev.

Phylum ARTHROPODA
Class TRILOBITA

Genus TRINODUS McCoy, 1846

Trinodus McCoy. Ross, 1967, U.S. Geol. Survey Prof. Paper 523–D, p. D8.

Trinodus sp. 1

Plate 11, figures 15, 16

Trinodus? sp. Ross, 1958, Jour. Paleontology, v. 32, no. 3, p. 564, pl. 83, figs. 5, 8.
Trinodus sp. 1. Ross, 1967, U.S. Geol. Survey Prof. Paper 523–D, p. D9, pl. 3, figs. 19, 20.

This species is rare. It is characterized by the much-expanded third, or terminal, lobe of the pygidial axis.

Cephalic length and width about equal. Convex border bounded proximally by deep furrow. Strongly convex cheeks surmounted by glabella. Glabella lacks anterior transverse furrow and median pustule. Length of glabella two-thirds that of cephalon; its width one-half that of cephalon and two-thirds its own length. Width of glabella across basal nodes almost six-tenths the cephalic width.

Pygidium as wide as or somewhat wider than long. Border bearing posterolateral spines. Median node, partly accidently removed during preparation on the illustrated specimen (pl. 11, fig. 16), lies along crest of second axial ring. Axis narrowest between second ring and terminal piece; axis widest at first segment, which is composed of two anterolateral nodes. Terminal piece almost circular in outline. Length of axis, including articulating half ring, between two-thirds and three-fourths the pygidial length. Width of axis at anterior nodes about half pygidial width; width of terminal piece about four-tenths pygidial width.

Figured specimens.—USNM 167203a, b.

Occurrence.—USGS collection D1973 CO, 60–65 feet above base of bioherm, Antelope Valley Limestone, Meiklejohn Peak, Nev.

Discussion.—This species, if it is a true species, seems to be represented by small specimens; therefore it may prove to be the immature stage of some other species. However, its stratigraphic position seems to be consistently low in the Antelope Valley Limestone in the *Orthidiella* zone.

Trinodus sp. 1 differs from *T. clusus* (Whittington) in possessing a narrower glabella and narrower pygidial axis. *T. valmyensis* has a shorter glabella and pygidial axis.

Genus SHUMARDIA Billings, 1862

Shumardia sp.

Plate 11, figure 10

Cephalon semicircular in outline. Glabella broadly rounded in front; its maximum width (trans.) at anterolateral lobes equals nine-tenths cranidial length (sagittal) and six-tenths its width (trans.). Posterior part of glabella semicylindrical. Combined length (sag.) of glabella and occipital ring equals nine-tenths length of cranidium. Anterolateral lobes, shaped like "teardrops," extending backward to point seven-tenths glabellar length from front. Occipital furrow straight; length of occipital ring equals less than four-tenths glabellar length (sag.). Axial furrows deep beside occipital ring and posterior part of glabella, shallowing after curving sharply around rears of anterolateral lobes; very faint at confluence with equally faint preglabellar furrow.

Figured specimen.—USNM 167204.

Occurrence.—USGS collection D1994 CO, in beds flanking bioherm, 173 feet above base of bioherm and 241 feet above base of formation, Antelope Valley Limestone, Meiklejohn Peak, Nev.

Discussion.—This species lacks the preglabellar sagittal furrow and obtusely pointed glabella found in *Shumardia granulosa* Billings and in *S. exopthalma* Ross. There seem to be no small basal glabellar lobes; the posterior part of the glabella not flanked by anterolateral lobes is short for the genus. No pygidium has been identified to date and formal designation of the species is considered unwise.

Genus CARRICKIA Tripp, 1965

Goniophrys Ross. Whittington, 1965, Harvard Univ. Mus. Comp. Zoology Bull., v. 132, no. 4, p. 371.

Carrickia Tripp, 1965, Palaeontology, v. 8, pt. 4, p. 579–580. Shaw, 1968, New York State Mus. and Sci. Service Mem. 17, p. 31.

This komaspid genus is far more widespread in Middle Ordovician deposits than was originally supposed. Although not common, it is here reported for the first time in southern Nevada—in the beds flanking bioherms at Meiklejohn Peak. Whittington (1965, p. 371–372) has reported two species from the Table Head Formation in Newfoundland. Tripp has described species of *Carrickia* from the Albany Mudstone and from the Stinchar Limestone of the Girvan district in southern Scotland.

Carrickia sp. 1

Plate 10, figure 19

This species closely resembles *Carrickia breviceps* (Billings) (Whittington, 1965, pl. 38, figs. 12, 15, 16; pl. 39, figs. 1, 2) in outline and convexity of the glabella and in the outline of the palpebral rims. The fixed cheeks are markedly wider than in C. *breviceps* or *Goniophrys prima*. The outline of the glabella in *Goniophrys prima* tapers more noticeably.

Only a single cranidium of this species has been collected from the flanking beds near the bioherm.

Figured specimen.—USNM 167205.

Occurrence.—USGS collection D1994 CO, lower member of Antelope Valley Limestone, 241 feet above base of formation, and 173 feet above base of bioherm, in flanking beds, Meiklejohn Peak, Nev.

Genus CAROLINITES Kobayashi, 1940

Dimastocephalus Stubblefield, 1950, Annals and Mag. Nat. History, ser. 12, v. 3, p. 344–345.

Carolinites Kobayashi. Stubblefield, 1950, Annals and Mag. Nat. History, ser. 12, v. 3, p. 451–452.

In his discussion of ill-fated *Dimastocephalus*, synonym *Carolinites*, Stubblefield (1950a, p. 341–344) noted the great geographic spread of the genus from Tasmania through Utah to northern Ireland. Since then *Carolinites* has been reported in the Leningrad district by Balashova (1961, p. 130–131), in northeastern USSR by Chugaeva, Rozman, and Ivanova (1964, p. 11–13), in Newfoundland by Whittington (1965, p. 373), in Spitsbergen by Vallance and Fortey (1968), and in Argentina by Harrington and Leanza (1957, p. 141–142). W. T. Dean (written commun., May 8, 1970) stated that *Carolinites* occurs in Arenigian strata in Turkey.

Stubblefield's (1950a, p. 341–344) discussion of the stratigraphic occurrence of *Carolinites killaryensis* revealed that the species was associated in Ireland with *Ectenonotus*, *Nileus*, *Illaenus*, and other genera typical of the Table Head-Lower Head assemblages of Newfoundland and of the *Orthidiella* zone in Nevada. Furthermore, the occurrence in Ireland was in peculiar lenses of brecciated limestone within a sequence of conglomerates and graptolitic shales. These limestone lenses may be related in origin to somewhat similar limestone bodies north of Elko, Nev., as well as to biohermal masses like that at Meiklejohn Peak.

Carolinites ranges from the *Pseudocybele* zone into the *Orthidiella* zone in the Utah-Nevada area. Hintze (1952, p. 145) has reported *C. killaryensis utahensis* in the lowest *Anomalorthis* zone of western Utah. I have never found the genus in beds I considered younger than those of the *Orthidiella* zone in Nevada, and I have found *C. killaryensis* in the area west of the Nevada Test Site, Nev., in the *Orthidiella* zone or highest *Pseudocybele* zone (USGS Colln. D1458 Co.) (Ross, 1967, p. D11).

Known species include:

Carolinites bulbosus Kobayashi
Carolinites killaryensis (Stubblefield)
Carolinites genacinaca Ross
Carolinites killaryensis var. *utahensis* Hintze
Carolinites sibiricus Chugaeva
Carolinites angustagena Ross
Carolinites indentus Ross
Carolinites sp. indet. 1 (Whittington, 1965, p. 373, pl. 39, figs. 3, 4, 11)
Carolinites sp. indet. 2 (Whittington, 1965, p. 373–374, pl. 39, figs. 7, 12, 13)
Carolinites popovkiensis Balashova, 1961
Carolinites macropthalma (Harrington and Leanza)

C. macropthalma (Harrington and Leanza, 1957, p. 141–142) is believed to be of Caradoc age. Although Balashova (1961, p. 130) considered *Carolinites popovkiensis* to be Tremadocian, such an early age is highly unlikely (Valdar Jaanusson, written commun., May 25, 1970).

Carolinites cf. C. killaryensis (Stubblefield)

Plate 11, figs. 11, 14; plate 12, figures 1–6

One of the most abundant species in the Meiklejohn bioherm is well represented by cranidia and free cheeks; only one pygidium is available.

Surface smooth, not pustulose.

Cranidium approximately twice as wide at posterior margin as sagittal length. Glabella widest (trans.) immediately in front of preoccipital nodes and slightly behind midpoint of glabella excluding occipital ring. Width of glabella almost 1.5 times its length (sag.), exclusive of occipital ring. Length (sag.) of occipital ring about one-fourth length of glabella in front of occipital furow. Axial furrows barely impressed except where they separate preoccipital nodes from glabella. Preoccipital nodes positioned between occipital furrow and a point one-fourth glabellar length from occipital furrow. Eyes very large and bulbous. Genal spines flattened, of moderate length.

Pygidium semicircular in outline, strongly convex, dominated by robust axis of four distinct rings, terminal piece, and articulating half ring. Each ring and terminal piece impressed transversely by interpleural furrow. Terminal piece must have borne stout fairly upright spine, as indicated by round stump on solitary specimen. Terminal piece composed of fused axial ring and quarter sphere; posterior face very steep and flattened. Axis consumes one-half total anterior width (trans.) of pygidium. Pleurae prominent, bent steeply down distally to concave border. Front half of each pleura raised and bearing sharp node at flexure above border.

Figured specimens.—USNM 167206a–e.

Occurrence.—USGS collection D1966 CO, 50 feet above base of bioherm, D1973 CO, 60–65 feet above base of bioherm, Antelope Valley Limestone, Meiklejohn Peak, Nev.

Discussion.—The species represented in the Meiklejohn bioherm most closely resembles *Carolinites killaryensis* (Stubblefield). Like that species it possesses wide fixed cheeks on the cranidium, wider than those of *C. killaryensis utahensis* Hintze. Like both Hintze's variety and Stubblefield's Irish species it has a stout spine on the terminal piece of the pygidium, but exact dimensions of this spine are unknown.

From *Carolinites genacinaca* Ross, *C. angustagena* Ross, *C. indentus* Ross, *C. sibiricus* Chugaeva, and *C. bulbosus* Kobayashi, the Meiklejohn form differs in its greater width of fixed cheeks. Only the two indeterminate Newfoundland species illustrated by Whittington (1965, pl. 39, figs. 3, 4, 11 and 7, 12, 13) rival the Nevada and Irish specimens in this regard; both the Table Head species have pustulose surfaces. The pygidium of neither is known with certainty.

Genus GLAPHURUS Raymond, 1905

Glaphurus Raymond, 1905, Carnegie Mus. Annals, v. 3, p. 357–359.

Glaphurus Raymond. Ulrich, 1929, U.S. Natl. Mus. Proc., v. 76, art. 21, p. 42–46.

Glaphurus Raymond. Shaw, 1968, New York State Mus. and Sci. Service Mem. 17, p. 26.

Glaphurus sp.

Plate 12, figures 7–9

The genus *Glaphurus* is represented in the present collection by a single incomplete cranidium, which lacks anterior border and most of both fixed cheeks.

Surface of cranidium pustulose. Glabella broadly oval in outline, its width equaling more than nine-tenths of its length exclusive of occipital ring. Widest part opposite glabellar midlength exclusive of occipital ring. Its height five-tenths of the glabellar width. Occipital ring strongly convex in lateral profile; its sagittal length equals one-fourth of its length (sag.) of glabella exclusive of ring. Occipital furrow virtually straight in plan view, evenly deep. Glabellar furrows 1*p* parallel axial furrows; front ends of this pair of furrows located opposite glabellar midpoint; back ends of furrows approach but do not reach occipital furrow. Median lobe of glabella between lateral furrows 1*p* constitutes two-thirds of glabella width. Lateral furrows 2*p* reduced to a pair of pits, each connected by shallow sill-like furrow to axial furrow. Furrows 2*p* located opposite point almost four-tenths of glabellar length (sag.) from front. Only one pair of spine bases readily distinguished on glabella almost halfway from occipital furrow to glabellar midpoint. Axial furrows deep, confluent around front of glabella. Preglabellar field not completely preserved; seemingly gently sloping and probably short (sag.) for the genus.

Figured specimen.—USNM 167207.

Occurrence.—USGS collection D1968 CO, 168 feet above base of bioherm, Antelope Valley Limestone, Meiklejohn Peak, Nev.

Discussion.—Many of the interspecific distinguishing features are not preserved on this single cranidium, so that species' identity cannot be established until further collections are made. However, the outline of the glabella is more like that of *Glaphurus pustulatus* (Walcott) than like *G. divisus* Whittington. The anterior pair of glabellar furrows in *G. divisus* are openly connected to the axial furrows but they are reduced to pits in both this specimen and in *G. pustulatus*.

Stratigraphically, the occurrence of *Glaphurus* in the bioherm at Meiklejohn Peak is important in fortifying a link with the similar faunas at Lower Head, Newfoundland (Whittington, 1963), and in calling attention to a similar species in the Chazy Limestone of New York (Shaw, 1968, p. 26–28). Dr. Valdar Jaanusson (written commun., May 25, 1970) has noted that the oldest species "of *Glaphurus* hitherto described is *G. coronatus* Maximova from the Uskut Stage (generally correlated with the Tremadocian) of the Siberian Platform" (Maximova, 1962).

Genus NILEUS Dalman, 1827

Nileus aff. N. scrutator Billings

Plate 12, figures 10–16

Nileus sp. Ross, 1967, U.S. Geol. Survey Prof. Paper 523–D, p. D14, pl. 4, figs. 14, 15.

Cranidium of this species closely resembles that of *N. scrutator* Billings (Whittington, 1965, pl. 32, figs. 1, 3) in course of facial sutures, position of median pustule, and convexity. Palpebral lobes separated from glabella by shallow, almost straight furrows. Width (trans.) of glabella between palpebral lobes eight-tenths of cranidial length (sag.). Length (exsag.) of palpebral lobes one-third of cranidial length (sag.).

Pygidial length, six-tenths its width. Axis can be distinguished only, under optimum lighting, as low triangular rise; undefined by furrows or distinct break in slope. Border defined by very shallow furrow; furrow deeper laterally than medially.

Figured specimens.—USNM 167208a–e.

Occurrence.—USGS collection D1971 CO, in flanking beds 207 feet above base of bioherm, D1973 CO, from bioherm 60–65 feet above its base, Antelope Valley Limestone, Meiklejohn Peak, Nev.

Discussion.—This species differs from *Nileus scrutator* Billings in the lesser exsagittal length of its palpebral lobes; in Billings' species their length is between four-tenths and five-tenths that of the cranidium. Convexity of palpebral lobes and position of the eyes relative to the midlength (sag.) of the cranidium is the same. Width (trans.) of the glabella between the palpebral lobes relative to cranidial length is almost the same. The pygidium of the Nevada species is somewhat narrower.

Genus PERASPIS Whittington, 1965

Peraspis? sp.

Plate 12, figure 17, 18

Pygidium almost semicircular, of low convexity. Axis tapering to narrowly rounded terminal piece; axial segmentation very faint, seemingly seven rings plus terminal piece. Anterior width (trans.) of axis equals one-third pygidial width and almost three-quarters length (sag.) of axis. Pleural region evenly convex, bounded by shallow border furrow and convex border. Five pairs of interpleural furrows barely discernible. Width (exsag.) of border about one-sixteenth length (sag.) of pygidium.

Figured specimen.—USNM 167209.

Occurrence.—USGS collection D1991 CO, Meiklejohn Peak, Nev.

Discussion.—This pygidium closely simulates that of *Peraspis lineolata* (Raymond) (Whittington, 1965, pl. 34, figs. 1, 6, 7, 10) and that of *P. erugata* Ross (1970, pl. 14, figs. 21, 22) in general outline and proportion. The border is markedly wider (exsag.) than in *P. lineolata* and is slightly wider than in *P. erugata*. Segmentation is fainter than in *P. lineolata* but about the same as in undecorticated specimens of *P. erugata*.

Genus ILLAENUS Dalman, 1827

Illaenus cf. I. auriculatus Ross

Plate 12, figures 19–26; plate 13, figures 1–13; plate 14, figures 23–25

In dorsal view, cephalon broadly crescentic in outline; its sagittal length a little less than half its width (trans.). Sagittal profile of cephalon an even curve, in effect the arc between radii bounding 160° angle. Smooth margin without raised border. Transverse profile between eye centers of low convexity, but steeply sloping (approximately 65°) below eyes. Glabella defined by shallow axial furrows of openly S-shaped outline; posterior part broadly convex outward with greatest width between greatest width of palpebral lobes; anterior part of furrows convex inward between front ends of palpebral lobes. Axial furrows terminate immediately in front of palpebral lobes. Defined length (exsag.) of glabella about seven-tenths its greatest width (trans.). One line through eye centers, width of each fixed cheek equals six-tenths width of glabella.

Facial sutures run backward with only slight divergence from palpebral lobes to cut posterior margin; cranidium wider at palpebral lobes than at posterior margin. In front of eyes, sutures run forward with very slight initial divergence, then curve more tightly inward before reaching transverse rostral suture. Features of rostrum and anterior doublure not known. Free cheeks steep sided with prominent posterolaterally directed lappets.

Thorax not known.

Pygidium transversely semielliptical in outline with pronounced anterolateral facets. Length (sag.) about four-tenths greatest width. Axis low, broadly triangular, defined by shallow axial furrows. Anterior width (trans.) of axis about one-third that of pygidium. Length (sag.) of axis about one-half that of pygidium. Doublure as in *I. auriculatus*.

Figured specimens.—USNM 167210a–i.

Occurrence.—USGS collection D1973 CO, 60–65 feet above base of bioherm; and D2058 CO, 130 feet above base of bioherm, Meiklejohn Peak, Nev.

Discussion.—The cephalon and cranidia of this species resembles those of *Illaenus consobrinus* Whittington and *Illaenus bucculentus* Whittington. The lappets on the free cheeks of both those species are slenderer and extend backward farther to give the cephalon a more narrowly crescentic outline than that of this Nevada form.

The sigmoid curvature of the axial furrows on the cranidium is more pronounced in *I. consobrinus* but very similar in *I. bucculentus*. *I. fraternus* Billings has somewhat similar axial furrows but a different lateral profile of the cranidium. *I. marginalis* Raymond and *I. alveatus* Raymond possess thickened borders on the anterior of the cranidium, as does *I. consimilis* Billings.

An associated hypostome (pl. 13, fig. 4) is damaged, but otherwise can hardly be distinguished from that of *I. consobrinus* (Whittington, 1963, pl. 18, fig. 4); it possesses a shorter (sag.) posterior lobe than a smaller specimen assigned to *Illanenus auriculatus* (Ross) (Ross, 1967, pl. 5, fig. 15), a difference possibly attributable to stage of growth.

Although two kinds of pygidia are associated (pl. 14, figs. 13–15 and pl. 13, figs. 5–8), the more transverse specimens which have pronounced anterolateral facets probably should be assigned to this species. These pygidia are almost identical to those of *Illaenus auriculatus* Ross in dorsal features and in shape of doublure (pl. 13, figs. 5–8). The pygidium of *I. consobrinus* is relatively longer (sag.) than these and has less conspicuous facets.

The correlative sample on which the description of the species *Illanenus auriculatus* Ross (Ross, 1967, p. D16, pl. 5, figs. 1–32, 36, 40)) was based may be composed of immature individuals of the species described here.

Illaenus sp. b

Plate 13, figures 14–19; plate 14, figures 1–6

Illaenus sp. ind. 2 of Whittington, 1963, Harvard Coll. Mus. Comp. Zoology Bull., v. 129, no. 1, p. 73–74, pl. 19, figs. 5, 6, 8, 9.

Three cranidia, all damaged, bear a very close resemblance to an indeterminate species described by Whittington (1963, p. 73–74, pl. 19, figs. 5, 6, 8, 9) as *Illaenus* sp. ind. 2 from Newfoundland. The Nevada and Newfoundland specimens share similar axial furrows, similarly narrow steeply sloping preglabellar fields, raised bordering rims, and similar lateral profiles. Whittington's specimen bears a median glabellar node and palpebral rims; evidence is lacking for palpebral rims on the present cranidia; a faint median node is present on the smallest cranidium (pl. 13, figs. 14–16).

Free cheek assigned to this species bears small eye, steep evenly rounded slopes, and a distinct border; border beveled to slope posteroventrally. Genal angles broadly rounded.

Figured specimens.—USNM 167211a–d.

Occurrence.—USGS collection D1968 CO, Meiklejohn Peak, Nev.

Discussion.—Free cheeks of this species seem to lack the thin, sharp edged lappet found in *Illaenus* cf. *I. auriculatus* Ross or the blunt genal protrusion of *Illaenus* sp. f. In these regards it is probably similar to *Illaenus* sp. ind. 2 of Whittington (1963, pl. 19, figs. 5, 6, 8, 9).

Ilaenus sp. c

Plate 14, figures 7–12

Two fairly large decorticated cranidia bear resemblances to those of *Illaenus consobrinis* Whittington and *Illaenus* sp. a, described above. They differ from both species in a more forward position of palpebral lobes, smaller palpebral lobes, more divergent posterior course of facial suture, and convexity of lateral profile. The profile (sag.) is virtually the arc of an 108° sector of a circle with radius approximating 15 mm.

Figured specimens.—USNM 167212a, b.

Occurrence.—USGS collection D1991 CO, Meiklejohn Peak, Nev.

Discussion.—No coeval species from Newfoundland or Nevada possesses a less convex lateral cranidial profile. There is some indication that convexity decreases with increase in size in several species of *Illaenus*, but this is clearly not true of all species. No identifiable pygidia were found associated with the cranidia of *Illaenus* sp. c.

Two specimens, one very large and one very small, of *Illaenus consimilis* (Whittington, 1965, pl. 51, figs. 1, 2, 5; pl. 50, figs. 2, 7, 9) have a similar low convexity of profile. In convexity they differ from other specimens of *I. consimilis* illustrated by Whittington (1965, pls. 50 and 51). *I. consimilis* possesses an anterior marginal rim on the cranidium and converging anterior facial sutures. The two cranidia of *Illaenus* sp. c differ in these two respects.

Illaenus sp. d

Plate 14, figures 13–15

Pygidium almost twice as wide as long, parabolic in outline. In profile, convexity of upper surfaces low, steepening strongly past vertical toward periphery. Margin lacking furrow or rim. Triangular outline of axis delineated by faint axial furrows. Anterior width (trans.) of axis equals its length (sag.).

Figured specimen.—USNM 167213.

Occurrence.—USGS collection D1973 CO, D1968 CO, Meiklejohn Peak, Nev.

Discussion.—Two pygidia similar to that of *Illaenus tumidifrons* Billings (Whittington, 1963, pl. 15, fig. 13) have been found in USGS collection D1973 CO where they are associated with *Illaenus* cf. *I. auriculatus* Ross, described above, for which the pygidial association is fairly certain. To date only one kind of cranidium has been recognized in this collection. There are only two pygidia of *Illaenus* sp. d as opposed to seven assigned to *I.* cf. *I. auriculatus* Ross.

Illaenus sp. e

Plate 14, figure 16

Pygidium markedly transverse in outline, length (sag.) about one-third greatest width (trans.). Axis sharply triangular in outline, its anterior width (trans.) equaling its length (sag.). Convexity of axis very low. Convexity of pygidium increasing peripherally.

Figured specimen.—USNM 167214.

Occurrence.—USGS collection D1968 CO, Meiklejohn Peak, Nev.

Discussion.—This pygidium resembles the pygidia of *Illaenus alveatus* Raymond, but it is presently impossible to assign it to an associated cranidium with any assurance. Associated are *Harpillaenus* sp., *Illaenus* cf. *I. auriculatus* Ross, and *Illaenus* sp. b.

Illaenus? sp. f

Plate 14, figures 17–22

Two free cheeks bear prominent eyes and long stout genal spines directed laterally. Close to its base each genal spine curves forward. In smaller specimen, spine then curves backward slightly.

Figured specimens.—USNM 167215a, b.

Occurrence.—USGS collection D1968 CO, Meiklejohn Peak, Nev.

Discussion.—Because these cheeks have a very short radius of curvature in lateral profile they were thought to belong to *Harpillaenus*. However, they seem to lack the thin anterior border found in cranidia of *Harpillaenus*, and other associated free cheeks have this feature. Also associated are cranidia tentatively identified as *Illaenus* cf. *I. auriculatus* Ross (pl. 14, figs. 23–25). Although not differing significantly from those of *Illaenus* cf. *I. auriculatus*, such cranidia in collection D1968 CO may represent a distinct species characterized by the peculiar free cheeks described here.

Genus HARPILLAENUS Whittington, 1963

This trilobite genus is represented by two very poorly preserved cranidia from the bioherm at Meiklejohn Peak. No pygidia have been found to ensure correct identification. The great width (trans.) of cranidium as compared with its shortness (sag.) is unequaled in other illaenids?.

Although species identity cannot be ascertained, the significance of the discovery is the provision of another paleontologic link between the biohermal deposit of southern Nevada and the "white limestone boulder at Lower Head," Newfoundland, from which Whittington (1963) described an extensive fauna. To date, the genus is known from no other lithologic type.

Harpillaenus sp.

Plate 15, figures 1–9

Outline of complete cephalon not known. Cranidium almost semicircular in lateral profile. Greatest width of cranidium at palpebral lobes equals about 2.5 times diameter of lateral profile. Width of cranidium at posterior margin narrower than width at palpebral lobes by width (trans.) of palpebral lobes. Glabella defined by exceedingly faint axial furrows that fade out opposite fronts of palpebral lobes. Axial furrows better defined in decorticated specimens than on exterior of carapace. Glabella widest at posterior margin, narrows anteriorly. Width (trans.) of glabella at front equals eight-tenths of its width at posterior margin. Width of glabella between eye centers slightly less than four-tenths of greatest width (trans.) of cranidium.

In decorticated specimen shallow, transverse groove crosses glabella adjacent to posterior margin; this groove not a true occipital furrow. Median tubercle positioned between posterior ends of palpebral lobes.

Facial sutures extend forward in curving converging courses to cross anterior margin and intersect rostral suture obliquely.

Shallow marginal furrow parallels rostral suture and bounds very narrow, faintly raised border. Courses of facial suture behind eye straight and diverging only slightly before crossing posterior margin.

Free cheeks bear long (exsag.) low eyes. Anterolateral surface curves steeply downward past vertical to narrow marginal furrow and narrow border like that on cranidium. Although no complete cephala are known, free cheeks must have provided bluntly pointed genal "horns."

Surface of cranidial carapace and free cheeks marked by strong, transverse, widely spaced Bertillon lines.

No thoracic or pygidial parts known.

Figured specimens.—USNM 167216a–c.

Occurrence.—USGS collection D1968 CO, in bioherm 168 feet above its base, lower member, Antelope Valley Limestone, Meiklejohn Peak, Nev.

Discussion.—According to Whittington (1963, p. 79), the surface of most of the median part of the cephalon of *Harpillaenus arcuatus* (Billings) is smooth. The subparallel transverse pattern marking the entire cranidial surface differentiates the Nevada species described here. In *H. arcuatus* the glabella is parallel sided and seems to carry a fairly distinct occipital ring; the Nevada species has an anteriorly narrowing glabella which has only a suggestion of occipital ring. The palpebral lobes appear to be closer to the posterior margin in the western specimens than in *H. arcuatus.* The outstanding difference is in shape of free cheeks which in *H. arcuatus* form enormous "horns." In the present species the "horns" are blunt and short.

It should be noted that two very different free cheeks (pl. 14, figs. 17–22) were also found associated and were thought to belong to this species of *Harpillaenus* because of the remarkable development of genal spines. These cheeks seem to lack a raised anterior border and therefore probably do not belong with the cranidia of *Harpillaenus.*

Genus BATHYURELLUS Billings, 1865

This genus is represented in the present collections by two cranidia and two pygidia. These four specimens come from three separate collections and represent three different species.

Bathyurellus feitleri (Holliday) was originally decribed on the basis of a pygidium from Meiklejohn Peak (Holliday, 1942); so far I have been no more successful than Holliday at establishing the correct cephalic parts.

Bathyurellus sp. 3 closely resembles a cranidium described as *B. pogonipensis* by Hintze (1952, p. 138, pl. 10, fig. 14); unfortunately Hintze chose as his holotype a pygidium (pl. 10, figs. 11a, b) which belongs to *Uromystrum.* The remaining specimens (Hintze, 1952, pl. 10, figs. 1–19) probably all belong to a single species of *Bathyurellus*, and I suggest that future collections may show this species to be a synonym of *B. feitleri* (Holliday).

Bathyurellus feitleri (Holliday)

Plate 15, figures 10–12

Niobe? feitleri Holliday, 1942, Jour. Paleontology, v. 16, p. 473, pl. 74, fig. 7.

This species is represented by a single pygidium in the beds flanking the bioherm. No cranidium was found associated.

Figured specimen.—USNM 167217.

Occurrence.—USGS collection D1994 CO, from flanking beds 173 feet above base of bioherm, Antelope Valley Limestone, Meiklejohn Peak, Nev.

Discussion.—This pygidium and that illustrated by Holliday closely resemble the specimen shown by Hintze (1952, pl. 10, fig. 17).

Bathyurellus sp. 3

Plate 15, figures 17–19

A single cranidium closely resembles that illustrated by Hintze (1952, pl. 10, figs. 14a, b). It is similar in virtual lack of occipital furrow. It differs in having a longer (sag.) preglabellar field and narrower (sag.) anterior border.

Figured specimen.—USNM 167218.

Occurrence.—USGS collection D1966 CO, 50 feet above base of bioherm, Meiklejohn Peak, Nev. USGS collection D2058 CO, 130 feet above base of bioherm.

Discussion.—This species occurs below *Orthidiella* at Meiklejohn Peak and yet its closest obvious relative is the species recorded by Hintze (1964, pl. 10, fig. 14) from his zone M. Zone M has been correlated with the *Anomalorthis* zone.

Bathyurellus sp. 4

Plate 15, figures 13–16, 20

One cranidium and one pygidium are the basis for this description, hardly a large enough sample on which to base a species description. Both specimens are damaged.

Much of the cranidial surface bears myriad small irregular to subcircular pits between well-developed Bertillon markings. Glabella almost semiovoid, sharply pointed in front, widest between fronts of eyes, somewhat constricted between rear ends of eyes, and widening immediately in front of occipital furrow. Width of glabella two-thirds its length. Preglabellar field long (sag.) for the genus, its length one-third that of glabella; field slopes at about 55° downward from glabellar base; preglabellar field broad, evenly convex, bounded anteriorly by shallow marginal furrow and border. Width (sag.) of anterior border not known.

Fixed cheeks virtually horizontal between eyes. Palpebral lobes semicircular, of length (exsag.) equaling four-tenths length (sag.) of glabella. Eye centers positioned a little behind midpoint of glabella. Fixed cheek behind palpebral lobes forming narrow (exsag.) descending triangle bounded posteriorly by narrow border furrow and narrow convex posterior border. Width (trans.) of cranidium at posterior border approximately twice sagittal length of glabella plus occipital ring.

Pygidium almost perfectly semicircular, its length (sag.) very slightly exceeding half its width. Length of axis a little more than seven-tenths sagittal length of pygidium; its anterior width slightly less than three-tenths pygidial width. Width (trans.) of axis equals two-thirds length of axis. Axis composed of three rings and bluntly rounded terminal piece. Radius of pleural field equals axial length posteriorly but increases toward anterolateral corners of pygidium. True marginal furrow lacking; border concave proximally and slightly convex distally. Proximal side of border slightly increased by distal ends of pleural and interpleural furrows.

Figured specimens.—USNM 167219a, b.

Occurrence.—USGS collection D1991 CO, 10 feet above base of bioherm, Antelope Valley Limestone, Meiklejohn Peak, Nev.

Discussion.—This species seems to differ from all others in the peculiar pitted texture of the outside of the cranidial carapace. The preglabellar field is longer sagittally than in any other known species. Unfortunately, the exact shape of the anterior border and of the occipital ring cannot be told from the available specimen. The pygidium has a longer axis and wider pleural field than in *Bathyurellus nitidus*; conversely the border of *B. nitidus* is much wider as is also that of *B. teicherti.* In fact, the pygidium of *Bathyurellus* sp. 4 approaches pygidia of *Bathyurus* in proportions. The pygidia of *B. feitleri* and the unnamed species illustrated by Hintze (1952, pl. 10, figs. 12, 17, 19) are semiellipitical rather than semicircular in outline.

Genus RAYMONDITES Sinclair, 1944

Raymondites Sinclair. Whittington, 1953, Jour. Paleontology, v. 27, no. 5, p. 654–655.

Raymondites? sp.

Plate 16, figures 1–6

This species is represented by two pygidia in the present collections.

Outline of pygidium nearly semicircular. Axis bearing an enormous spine based on anterior four rings of the axis. Length (sag.) of pygidium about six-tenths its width (trans.). Length (sag.) of axis about three-fourths length (sag.) of pygidium. Width (trans.) of axis equals about eight-tenths its length (sag.) and about one-third pygidial width (trans.). Axial segmentation indicated by furrows along sides of axis adjacent to axial furrows; only terminal piece defined by furrow completely across crest of axis. Axial furrows shallow but distinct, confluent and weak around broadly rounded posterior outline of axis.

Exact shape and height of axial spine not known; minimum height of axial spine equals twice height of axis itself. Pleural fields of moderate convexity, crossed by four distinct pleural furrows which enter border but do not attain margin. Pleural furrow very faint, only anterior three discernible. Border of pygidium concave.

Proximally from border and almost parallel to it series of short furrows extends backward from each pleural furrow. A very short faint similar furrow also present on anterior pleural band of first pygidial segment. Furrow from fourth pleural furrow extends upward toward tip of axis rather than parallel to border. These peculiar furrows seem to correspond to ventral inner edge of doublure.

Figured specimens.—USNM 167220a, b.

Occurrence.—USGS collection D2052 CO, Meiklejohn Peak, Nev.

Discussion.—The lack of cephalic parts prevents positive identification of these pygidia. *Raymondites ingalli* Raymond bears a long stout spine on the pygidium (Wilson, 1947, pl. II, figs. 15, 16; Whittington, 1953, pl. 69, figs. 16, 17, 21) which interrupts only the posterior axial segments. Whittington's illustration (1953, pl. 69, fig. 21) shows suggestion of furrow corresponding to inner edge of doublure. *Raymondites trispinosus* Wilson (1947, pl. II, fig. 8) also bears a spine on the pygidial axis. But both these species of *Raymondites* have narrow, strongly convex pygidial axes with prominent terminations, whereas the present species has a wide, terminal piece of low relief.

I have found no reference to a bathyurid with a comparable pygidium.

Proetid pygidium

Plate 16, figure 16

A small, probably transitory, pygidium of proetid character was found in beds above the bioherm but it has no assignable cephalic parts. Its outline semielliptical; length (sag.) about six-tenths its width (trans.). Axis composed of three rings plus sharply rounded terminal piece; terminal piece bears trace of anterior segment at crestline. Axial outline tapering posteriorly. Axial furrows shallow but distinct, confluent around posterior of axis. Pleural platforms gently convex, crossed by three pairs of pleural and interpleural furrows. No distinct border.

Figured specimen.—USNM 167222.

Occurrence.—USGS collection D2052 CO, Meiklejohn Peak, Nev.

Genus SELENOHARPES Whittington, 1950

Selenoharpes Whittington, 1950, monograph of the British trilobites of the family Harpidae: Palaeontographical Soc., p. 10.

Selenoharpes sp.

Plate 16, figures 7, 8

Two fragmentary cephalons of *Selenoharpes* were obtained high in the bioherm at Meiklejohn Peak; they are not adequate for species identification.

Cephalon semielliptical in outline. Its greatest width opposite occipital furrow equals 1.6 times the cephalic length (sag.). Length of prolongations not known. Glabella narrow, its length (sag.) about forty-eight one-hundredths that of cephalon (sag.). Glabellar width at lobes 1*p* equals six-tenth glabellar length (sag.). Eyes located opposite front eight-tenths of glabella, distant from axial furrow more than half way to the proximal edge of cheek roll. Inconspicuous alae of the same length (exsag.) as glabellar lobes 1*p*; the width (trans.) of each ala about three-tenths total width glabella.

Outline of proximal edge of cheek roll almost straight across in front of preglabellar field, curving fairly sharply to rear in front of eyes. Course of girder evenly curved across front; course not known on prolongations. Brim concave, its width (sag.) equaling one-third length (sag.) of cephalon.

Figured specimens.—USNM 167221a, b.

Occurrence.—USGS collection D1968 CO, 168 feet above base of bioherm, Antelope Valley Limestone, Meiklejohn Peak, Nev. USGS collection D2054 CO.

Discussion—The fragmentary nature of the two available specimens obviously prevents formal identification or complete description of this species. The glabella is narrower than in *Selenoharpes vitilis* Whittington (1963, pl. 2, fig. 7), yet wider than in *S. singularis* Whittington (1965, pl. 8). The outline of the proximal edge of the cheek roll is like that in *S. singularis*—not the evenly rounded curve of *S. vitilis*. The sagittal length of the glabella relative to the overall sagittal length of cephalon is longer than in *S. vitilis* and *S. fragilis* (Raymond) but shorter than in *S. singularis*. The critical course of the girder relative to the prolongations cannot be observed. The eyes appear to be farther from the glabella than in either *S. vitilis* or *S. singularis*.

Although this Nevada species seems to differ from the three Table Head species, it is obviously very similar to all of them. It is in the similarity of Table Head species, shared by a high percentage of the fauna, that the stratigraphic importance of the Meiklejohn specimens lies.

Genus ENDYMIONIA Billings, 1865

Endymionia cf. E. meeki (Billings)

Plate 16, figures 9–15, 18

This species is represented by three fairly mature and one immature cranidia in present collections.

Figured specimens.—USNM 167223a–c 167225.

Occurrence.—USGS collection D1968 CO, 168 feet above base of bioherm, Antelope Valley Limestone, Meiklejohn Peak, Nev. One immature cranidium from USGS collection D1973 CO, 60–65 feet above the base of bioherm, same locality.

Discussion.—The Nevada specimens resemble most closely the type of *Endymionia meeki*, illustrated by Whittington (1965, pl. 15, figs. 19, 23, 24). However, no median glabellar tubercle is present. *Endymionia raymondi* (Whittington, 1965, pl. 15, figs. 21, 22, 25) differs markedly in greater cranidial width (trans.), steepened preglabellar field, and virtual lack of flattened border on the cranidium.

I have found it almost impossible to distinguish *E. meeki* from *E. schucherti* Raymond except for the difference in position of the glabellar tubercle. The tubercle is immediately in front of the occipital furrow in *E. schucherti* and near the midlength of the glabella in *E. meeki.* It is possible that the tubercle can be seen only in decorticated specimens.

The importance of the Nevada specimens is the provision of another link with the "Whiterock" provincial faunas of Quebec and western Newfoundland.

Genus LEHUA Barton, 1916

Lehua aff. L. argus Whittington

Plate 16, figure 17

Single incomplete cephalon in present collections closely resembles that of *Lehua argus* Whittington (1963, p. 84–86, pl. 23, figs. 1–4, 6, 8, 9). Glabella of Nevada specimen almost parallel-sided. Lateral glabellar furrows 3*p* sigmoid, running inward then backward, then posteroproximally.

Figured specimen.—USNM 167224.

Occurrence.—USGS collection D1991 CO, 10 feet above base of bioherm, Antelope Valley Limestone, Meiklejohn Peak, Nev.

Discussion.—The single cranidium of *Lehua* differs from that of *L. argus* in the sigmoid trace of glabellar furrows 3*p* and in the uniform width of the glabella. In other respects it is virtually indistinguishable from *L. argus.*

The stratigraphic importance of *Lehua* lies in establishing the presence in the bioherm at Meiklejohn Peak of yet another species very similar to one from the biohermal limestone of Lower Head, Newfoundland (Whittington, 1963, p. 84–86).

Genus PLIOMEROPS Raymond, 1905

Pliomerops is represented in the beds above the bioherm (USGS colln. D2051 CO) by a cranidium and partial thorax, two cranidia, and two pygidia and in the bioherm by one pygidium (USGS colln. D1968 CO). *Pliomerops* is generally considered to be a guide to strata of Chazy or younger age in the Appalachian region (Shaw, 1968, p. 88–89).

As noted by Whittington (1961, p. 917), *Pliomerops* differs from *Pseudomera*

> in the absence of a median pit in the preglabellar furrow, the shallow lateral glabellar furrow 3p that commences in the preglabellar furrow, the more rounded outline of the anterior margin of the glabella, the presence of 18 thoracic segments, and the absence of pits or a U-shaped furrow in the triangular terminal piece of the pygidial axis.

Valdar Jaanusson (written commun., May 25, 1970) has collected specimens of *Pliomerops* from the Mountain Lake Member of Cooper (1956) of the Bromide Formation in the Arbuckle Mountains (along Oklahoma Highway 99, 3 miles south of Fittstown, Okla., top of Harris' zone 49).

As noted by Shaw (1968, p. 89), *P. senilis* (Barrande) occurs in strata of Llanvirn age in Bohemia. Dean (1966, p. 284–287) has redescribed *Pliomerops escoti* (Bergeron), an Arenigian species from France. This last species bears considerable resemblance to Canadian (Arenig) pliomerids of Utah.

The stratigraphic range of *Pliomerops* s.s. probably is not as restricted in North America as it seems to be in the Appalachian region.

Pliomerops sp.

Plate 16, figures 19–24

Specimens are poorly preserved in compact silty limestone which defies proper preparation.

Glabella semicircular in anterior outline, widest at front. Occipital ring of same width sagittally and exsagittally; curved forward medianly. Occipital furrow continuous across glabella, curving forward medianly. Lateral glabellar furrows 1*p* cross almost one-third of glabella; proximally, ends curve backward very slightly. Lateral furrows 2*p* oriented transversely straight, crossing a little more than one-third glabella. Lateral glabellar furrows 3*p* originate in front of fossulae and run somewhat posteroproximally so that proximal ends are alined with ends of furrows 1*p* and 2*p*. Axial furrows deep, intersecting preglabellar furrow at fossulae. Preglabellar furrow deepest at fossulae, shallowing medially. No median pit in preglabellar furrow, but a faint median muscle scar seems to produce indentation on front of decorticated glabella.

On cranidium, each palpebral rim, bounded proximally by distinct furrow, extends along facial suture from point slightly in front of lateral glabellar furrow 1*p* forward to point opposite middle of lateral glabellar lobe 3*p*. Posterior course of facial suture fairly straight, runs laterally and slightly posteriorly to cross border furrow and border in front of genal angle and opposite front half of lateral glabellar lobe 1*p*. Fixed cheeks coarsely pitted.

Single incomplete specimen retains cranidium, parts of free cheeks, and most of thorax. Posterior part of thorax badly damaged. Remaining thoracic segments number 16, possibly 17.

Pygidium composed of five axial rings and five pairs of digitate pleurae. Posterior triangular terminal piece of axis completely enclosed by proximal part of posterior pair of pleurae. Pleurae flexed abruptly downward so that distal ends approach the vertical.

Figured specimens.—USNM 167226a, b.

Occurrence.—USGS collection D2051 CO, Meiklejohn Peak, Nev.

Discussion.—*Pseudomera* and *Ectenonotus* have previously been reported from beds flanking and immediately above the bioherm at Meiklejohn Peak. The discovery of *Pliomerops* in these beds was unexpected and adds support to the belief that "Whiterock" beds are at least partly of Chazy or Marmor age.

The specimens described here probably belong to a new species of *Pliomerops*. In *P. canadensis* (Billings) the palpebral furrow extends farther backward, lateral glabellar furrows 3*p* are not as deeply cleft, and lateral furrows 1*p* are shorter (exsag.). In all these respects the Nevada specimens more closely resemble *P. senilis* (Barrande). On the pygidia of *P. canadensis* and *P. senilis*, the fifth axial ring is separated from its pleurae by axial furrows; lack of separation in the pygidia from Meiklejohn Peak may be due to a different degree of decortication.

Pliomerops sp.

Plate 16, figure 25

A single poorly preserved pygidium is illustrated as a matter of record. Lacking cephalic parts, no generic assignment can be made with confidence. Although similar in form to pygidia of *Pseudomera*, this pygidium lacks the U-shaped furrow on the terminal piece of the axis. It therefore resembles *Pliomerops* more than *Pseudomera.*

Figured specimen.—USNM 167227.

Occurrence.—USGS collection D1968 CO, 168 feet above base of bioherm, Antelope Valley Limestone, Meiklejohn Peak, Nev.

Genus KAWINA Barton, 1916

Kawina wilsoni Ross, n. sp.

Plate 17, figures 1–16

Surface very finely granular with widely scattered large pustules. Glabella strongly convex, widest at lateral lobes 1*p*. Greatest width (trans.) nearly equals glabellar length (sag.), exclusive of occipital ring. In lateral view anterior of glabella slightly overhangs preglabellar furrow; median lobe highest between backs of lateral lobes 2*p*, sloping backward steeply into occipital furrow. Lateral glabellar furrow 1*p* S-shaped, but curvature of S adjacent to axial furrow not pronounced and somewhat variable; proximal ends of furrows not reaching occipital furrow. Furrows 2*p* and 3*p* evenly spaced at sides, joining axial furrows at right angle, running inward with gentle backward curve very nearly parallel to each other. Furrow 3*p* the shortest. Occipital furrow almost straight or very slightly concave on forward side at midline of glabella; laterally curving backward the slightest amount to accommodate posterior of lateral glabella lobes 1*p*. Occipital ring low, of slight convexity, widest (sag.) near middle, narrowing laterally. Axial furrow not so deep as occipital furrow but deeper than preglabellar furrow. Border in front of preglabellar field exceptionally narrow. Palpebral lobe located close to axial furrow and opposite anterior "corner" of lateral glabellar lobe 1*p*. Anteriorly, facial suture closely parallels axial furrow, crosses border furrow opposite lateral glabellar furrow 3*p*, and turns abruptly along outer edge of border. Posteriorly, facial suture runs laterally almost parallel to posterior border furrow before turning sharply to cross posterior border at right angle. Width (trans.) of posterior fixed cheek equals one-half width (trans.) of occipital ring. Posterior border narrow (exsag.) adjacent to axial furrow, doubling in width (exsag.) where crossed by facial suture.

Pygidium with low broadly triangular axis, composed of articulating half ring, three rings, and a minute triangular terminal piece. Apical angle of "axial triangle" approximately 60°. Articulating furrow straight across; first ring furrow very gently convex forward; second ring furrow slightly convex backward. Pleurae paddle shaped, outlined by interpleural furrows; tips bluntly rounded. Posterior pair fused to enclose axis.

Holotype.—USNM 167228a.

Paratypes.—USNM 167228b–h.

Occurrence.—USGS collection D1973 CO, 60–65 feet above base of bioherm, D1966 CO, 50 feet above base of bioherm, D1968 CO, 168 feet above base of bioherm, Antelope Valley Limestone, Meiklejohn Peak, Nev.

Discussion.—The sharp convexity of the glabella in anterior profile distinguishes this species from *Kawina limbata* Whittington, *K. arnoldi* Whittington, *Cydonocephalus griphus* Whittington, *C. prolificus* (Billings), *C. mercurius* (Billings), *C. prominulus* Whittington, *C. torulus* Whittington, and *C. scrobiculus* Whittington. In this respect, it most closely resembles *Kawina vulcanus* (Billings). In lateral profile the greater convexity of the glabella separates *K. wilsoni* from *K. arnoldi* Whittington and all species of *Cydonocephalus;* in side view *K. vulcanus* and *K.? chazyensis* (Raymond) are more sharply convex at the rear of the glabella.

The spacing of lateral glabellar furrows is virtually the same as in *Kawina arnoldi* and *K.? chazyensis* but differs from all other described species of *Kawina* or *Cydonocephalus.* The pygidium is almost identical to that described by Whittington (1963, p. 95, pl. 31, figs. 2, 3, 6, 7) as *Kawina?* sp. It differs markedly from the pygidium of *K. arnoldi* in the size and shape of the terminal piece.

Genus XYSTOCRANIA Whittington, 1965

Xystocrania Whittington, 1965, Harvard Univ. Mus. Comp. Zoology Bull., v. 132, no. 4, p. 412.

Nieszkowskia Schmidt. Shaw, 1968, New York State Mus. and Sci. Service Mem. 17, p. 81.

Xystocrania is probably divisible into two groups of species. One of these groups is characterized by very weak, almost obsolete, lateral glabellar furrows 2*p* and 3*p* and an erect midglabellar spine. The included species are *X. perforator* (Billings) (Whittington, 1965, p. 412, pl. 61), *X.* cf. *X. perforator* (Billings) (Ross, 1970, p. 89, pl. 17, figs. 3–7, 10) and *X. unicornica* (Hintze, 1952).

The second group of species has lateral glabellar furrows 2*p* and 3 *p* well defined and rising from the axial furrows virtually at right angles; the crest of the glabella is considerably involved in the base of the median spine. The base of the spine is located in front of the proximal ends of furrows 1*p* and approximately between the proximal ends of furrows 2*p*. This group includes *Xystocrania glaucus* (Billings) and *X.* cf. *X. glaucus* (Billings) (Whittington, 1965, p. 414–415, pl. 62, figs, 1–4, 6, 8, 9), *X. pyriformis* Ross, n. sp., and *X. satyrus* (Billings) (Shaw, 1968, p. 81–82, pl. 13, figs, 1, 5, 6, 10, 12, 13, 15–17). No pygidia are known for any of these species.

The stratigraphic ranges of these two groups of species are very similar. The first seems to occur in muddy limestones and calcareous mudstones, whereas the occurrences of the second may be related to purer limestones of a biohermal facies. This suggestion as it relates to *X. glaucus* needs further testing.

Xystocrania pyriformis Ross, n. sp.

Plate 17, figures 17–20

Glabella almost pear shaped in lateral view, its crest drawn out to form subconical base of median spine. Exact length of stout spine not known. Glabellar width (trans.) greatest across lateral lobes 1*p*, narrowing rapidly. Base of median spine centered between proximal ends of furrows 2*p*. Front of glabella overhanging preglabellar furrow. Lateral glabellar furrows start very slightly above axial furrows. Furrows 1*p*, S-shaped, proximal ends not reaching occipital furrow. Furrows 2*p* and 3*p* gently curved, 3*p*, the shorter. Distance along axial furrow from occipital furrow to 1*p* longer than from 1*p* to 2*p*; distance from 2*p* to 3*p* still shorter. Occipital ring widest sagittally. Eye located opposite back half of lateral glabellar lobe 2*p*.

Holotype.—USNM 167229.

Occrurence.—USGS collection D1968 CO, 168 feet above base of bioherm, D1973 CO 60–65 feet above base of bioherm, Antelope Valley Limestone, Meiklejohn Peak, Nev.

Discussion.—*Xystocrania pyriformis*, as noted under the generic description, differs from *X. perforator* in stronger development of the lateral glabellar furrows 2*p* and 3*p*. It more closely resembles *X. glaucus* (Billings) from the lower Table Head Formation and *X. satyrus* (Billings) from the reef limestones of the Chazy Limestone (Shaw, 1968, p. 81, table 5) in the strength of all glabellar furrows and in the peculiar modification of the glabellar crest to form a base for the great median spine. In *X. satyrus* the spine must have been raked backward to some extent; in *X. pyriformis* it is more erect. In *X. glaucus* from the Mystic Conglomerate (Whittington, 1965, pl. 62, figs. 4, 8, 9), the spine seems to have been raked a little less than in *X. satyrus*, whereas in *X.* cf. *X. glaucus* from the Lower Table Head Formation (Whittington, 1965, pl. 62, figs. 1–3, 6) it is directed as in *X. pyriformis.* The glabellar crest of this Lower Table Head species is not so much involved in the spine base as it is in *X. pyriformis.*

Genus HELIOMERA Raymond, 1905

Heliomera Raymond Whittington, 1965, Harvard Univ. Mus. Comp. Zoology Bull., v. 132, no. 4, p. 416–417.

Two incomplete cranidia represent *Heliomera* in the collections from Meiklejohn Peak. Neither is worthy of unquestioned species designation. *Heliomera* has not previously been reported in western North America; it joins several genera from the great bioherm that have been known for many years from biohermal limestones of western Newfoundland and southern Quebec.

Heliomera cf. H. albata Whittington

Plate 17, figures 21–25

The incomplete larger cranidium was unfortunately further damaged in preparation so that the critical lateral glabellar lobe 3*p* was partly ground away at the distal end; this lobe was originally distinctly L-shaped and is still faintly L-shaped, as described in *Heliomera albata* by Whittington (1963, p. 86). However, the L-shape is not as pronounced as in the Newfoundland specimens.

The second and smaller cranidium may not belong to the same species, because it seems to lack the L-shape in lateral glabellar lobe 3*p*. However, Whittington (1963, pl. 24, figs. 1–13) has shown that in immature cranidia this feature is not developed so well as in larger specimens. Inasmuch as the two cranidia were taken from the same piece of limestone, one probably is an immature specimen and the other a more mature example of the same species.

Figured specimens.—USNM 167230a, b.

Occurrence.—USGS collection D1968 CO, 168 feet above base of bioherm Antelope Valley Limestone, Meiklejohn Peak, Nev.

Genus MIRACYBELE Whittington, 1965

The specimen illustrated here is possibly assignable to *Cybelurus* Levitskii 1960. However, no pygidia of the type distinguishing *Cybelurus* have been found in any Nevada strata.

Miracybele and *Cybelurus* are closely related and lived at about the same time. However, species assigned to *Cybelurus* by Levitskii (1962) have 18–24 axial rings on the pygidium, as compared with the 14–15 in *Miracybele mira* (Billings). Further, pygidial pleurae in *Cybelurus planifrons* Semenova, type species, are flattened and divided by pleural furrows in a manner reminiscent of *Pilekia.* Pleurae in *Miracybele mira* are slender and graceful.

Pygidia similar to those of *Miracybele mira* have previously been reported from strata correlative with those of the bioherm at Meiklejohn Peak (Ross, 1967, pl. 8, figs. 23–25).

Whether differences in pygidia should be given generic rank is a question that may not be resolved until Spitsbergen faunas have been studied by Richard Fortey and until the trilobites of the Albany Mudstone of Ayrshire, Scotland (Ross and Ingham, 1970, p. 395–396), have been described by Ingham and this author.

Miracybele sp. 1

Plate 17, figure 26

Miracybele? sp. 1. Ross, 1967, U.S. Geol. Survey Prof. Paper 523–D, p. D25 pl. 8, fig. 23.

Aff. *Miracybele* sp. 1. Ross, 1970, U.S. Geol. Survey Prof. Paper 639, p. 92, pl. 18, fig. 6.

A fairly complete cranidium from beds flanking the great bioherm at Meiklejohn Peak bears a remarkable resemblance to a species found in Spitsbergen (Richard Fortey, written commun., Apr. 4, 1969).

Cranidium 2.5 times as wide as long (sag.). Posterior margin of cranidium curved backwards laterally. Fixigenal spines stout. Glabella expanding forward from occipital furrow to frontal lobe, but slightly constricted opposite lateral furrows 4*p*. Glabella width at frontal lobe almost 1.5 times its width at occipital furrow and 1.25 times width (trans.) of occipital ring. Occipital ring longest (sag.) at midline and bearing a faint median tubercle. Lateral glabellar furrows 1*p* deepest proximally, oriented transversely and connected to axial furrows. Glabellar furrows 2*p* and 3*p* reduced to elongate transverse pits not connected to axial furrow. Furrows 1*p*, 2*p*, and 3*p* equally spaced forward from occipital furrow. Glabellar furrow 4*p* oriented anteroproximally to posterodistally, also reduced to elongate pit without obvious connection to axial furrow. In decorticated specimens furrows 2*p* may show a shallow connection with axial furrow, and furrows 3*p* and 4*p* may be connected at their distal ends with shallow furrow in form of Y connected to axial furrow. Frontal lobe of glabella poorly defined on exterior of carapace; its anterolateral bounds indicated by narrow creaselike intersection of preglabellar furrow and axial furrow. Preglabellar furrow extremely faint; in decorticated specimens transverse median pit lies in furrow and is joined by faint sagittal median furrow creasing front of glabella. Unlike other species of *Miracybele* this species bears only a flattened transverse depression in place of median pit and no trace of sagittal crease on exterior of carapace. Anterior border, possibly analogous to preglabellar field, broad (exsag.), gently convex, barely differentiated from frontal lobe of glabella, on cranidium bounded laterally by axial furrows.

Posterior border of cranidium bounded proximally by deep, narrow furrow confluent with occipital furrow. Border rounded subtubular, continuous with stout fixigenal spines. Fixed cheeks slope steeply away from eye lobes, which stand much higher than glabella and opposite glabellar furrows 2*p*. Eye ridges run inward and forward to intersect axial furrows opposite lateral glabellar furrows 3*p*. Surface of fixed cheeks finely pitted, except for eye ridges.

Figured specimen.—USNM 167231.

Occurrence.—USGS collection D1971 CO, in beds flanking bioherm 207 feet above base of bioherm, Antelope Valley Limestone, Meiklejohn Peak, Nev. This species has also been found in USGS collection D727 CO (Ross, 1967, p. D25, pl. 8, fig. 23) and in USGS collection D1603 CO (Ross, 1970, p. 92, pl. 18, fig. 6).

Discussion.—This species differs from *Miracybele mira* (Billings) in reduction of its lateral glabellar furrows 2*p*, 3*p*, and 4*p* to elongate pits and in the poor definition of the preglabellar furrow. It differs from a new undescribed species found in the Albany Mudstone of the Girvan district, Scotland, and from a species figured as *Pliomerops* by Nikolaisen (1961, pl. 2, fig. 4) for the same reasons.

These Nevada specimens from the *Orthidiella* zone are similar to forms discovered in the Middle Ordovician of western Spitsbergen (Richard Fortey, written commun., Apr. 4, 1969) and listed from the Upper Limestone Division of the Valhallfonna Formation by Vallance and Fortey (1968).

Genus **APATOLICHAS** Whittington, 1963

Apatolichas Whittington, 1963, Harvard Coll. Mus. Comp. Zoology Bull., v. 129, no. 1, p. 104–106.

Apatolichas cf. A. jukesi (Billings)

Plate 18, figures 1–8

Cranidial proportions virtually same as in *A. jukesi* (Billings); however, differences seem to exist in definition of furrows on glabella.

Lateral glabellar furrows 1*p* faintly defined on outer surface of carapace. Axial furrow behind eye lobe indicated by break in slope rather than by smooth crease, running almost straight back from eye lobe to occipital furrow. Similarly defined furrow delineates front side of occipital lobe; this furrow originates at intersection of longitudinal and occipital furrows, running outward and very slightly forward almost parallel to lateral glabellar furrow 1*p*, resulting in triangular occipital lobe.

Figured specimens.—USNM 167232a–c.

Occurrence.—USGS collection D1968 CO, 168 feet above base of bioherm, Antelope Valley Limestone, Meiklejohn Peak, Nev.

Discussion.—Whittington (1963, pls. 32, 34) has shown clearly that definition of various furrows on the glabellae of *Apatolichas jukesi* is a function of maturity of the individual as well as of mode of preservation. The smaller the specimen the better defined are the glabellar lobes. And in decorticated cranidia the inner molds show furrows much more clearly than those on the outside of the carapace.

None of the Nevada specimens are well preserved. Eyes are broken from them all. Partly decorticated specimens show the furrows well (pl. 18, figs. 3–5), but large specimens still bearing the outer carapace seem to show traces of furrows better than examples from Newfoundland. The difference is so slight and inconsistent that it cannot be used with confidence to differentiate the Nevada and Newfoundland specimens. When pygidia are found for the Nevada material they may provide the means of distinction.

The genus is so far known only in biohermal limestone at Lower Head, Newfoundland (Whittington, 1963) and in the bioherm at Meiklejohn Peak, Nev.

PYGIDIA OF UNCERTAIN AFFINITY

Undetermined pygidium 1

Plate 18, figure 9

Pygidium transversely subelliptical in outline, of moderate convexity; its length (sag.) equals six-tenths its width (trans.). Axis short, poorly defined posteriorly. Length of axis (sag.) a little more than six-tenths that of pygidium. Width of axis (trans.) one-quarter that of pygidium and two-thirds length (sag.) of axis. Three very faintly defined axial rings plus terminal portion. Axial furrows very distinct along sides of axis. Pleural regions bounded by shallow border furrow and border of very low convexity. Width of border (sag.) about one-fifth length of pygidium.

Figured specimen.—USNM 167233.

Occurrence.—USGS collection D1973 CO, Meiklejohn Peak, Nev.

Discussion.—This pygidium is associated with *Illaenus*, *Nileus*, *Carolinites*, *Kawina*, and *Xystocrania*. It is unlikely that it could be assigned to any of them; its general form is vaguely similar to pygidia of the nileid *Peraspis*.

Undetermined pygidium 2

Plate 18, figures 10–12

Pygidium semicircular, evenly convex, bearing short bluntly rounded axis. Length (sag.) of pygidium about six-tenths its width (trans.). Length of axis about seven-tenths length of pygidium (sag.); width (trans.) of axis three-tenths that of pygidium and 2/3–3/4 its own length (sag.). In decorticated specimens axial rings faintly defined; four rings plus terminal piece. Pleural regions evenly convex, curving downward more steeply toward margin; lacking furrow and border. Surface marked by concentric Bertillion lines.

Figured specimens.—USNM 167234a–c.

Occurrenc.—USGS collection D1973 CO, Meiklejohn Peak, Nev.

Discussion.—No cranidium to which this pygidium can be assigned has been found associated with it. The pygidium bears close resemblance to other unassigned forms illustrated by Ross (1951, pl. 30, figs. 12, 13, 16) and by Hintze (1952, pl. XV, figs. 18a, b).

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PLATES 1–18

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

PLATE 1

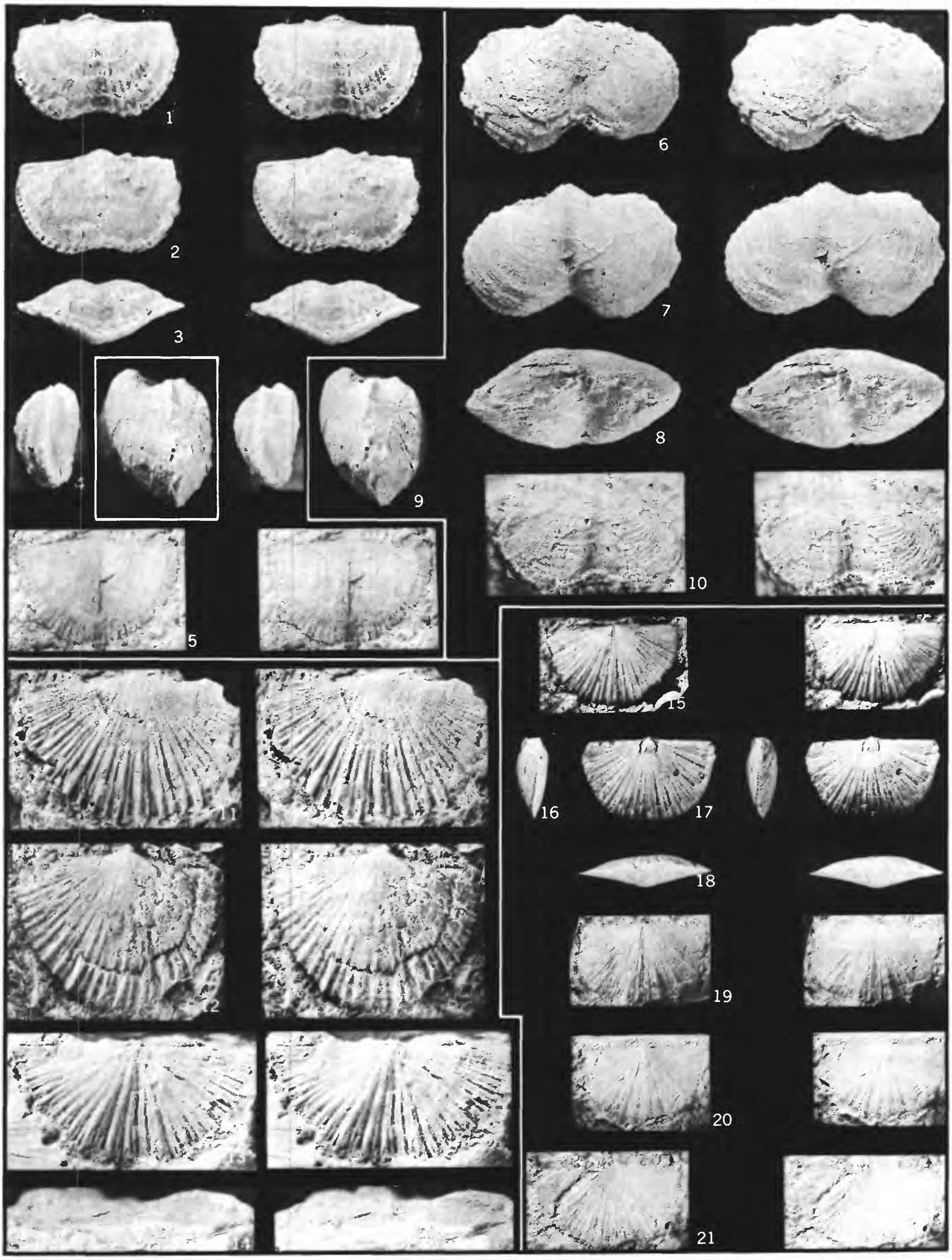
[All illustrations are stereophotographs]

FIGURES 1–5. *Orthidium bellulum* Ulrich and Cooper (p. 17).
USGS colln. D1973 CO × 6.
1–4. Complete shell; views of exterior of brachial valve, exterior of pedicle valve, anterior both valves, and left side of both valves. USNM 167177a.
5. Brachial valve, decorticated. USNM 167177b.

6–10. *Orthidium*? aff. *O. fimbriatum* Cooper (p. 17).
USGS colln. D1991 CO.
6–9. Complete shell; views of exterior of brachial valve, exterior of pedicle valve, anterior of both valves, and right side of both valves, × 3. USNM 167178a.
10. Pedicle valve, × 4. USNM 167178b.

11–14. *Trematorthis* sp. (p. 20).
USGS colln. D1973 CO.
11. Pedicle valve, × 3. USNM 167179b.
12. Pedicle valve, × 3. USNM 167179c.
This valve may belong to a different species.
13, 14. Complete shell; views of exterior of brachial valve and of posterior, showing deltidium, × 5. USNM 167179a.

15–21. *Pleurorthis beattyensis* Ross, n. sp. (p. 20).
USGS colln. D1973 CO, × 1.
15–18. Complete shell, holotype; views of exterior of brachial valve, right side of both valves, exterior of pedicle valve, and anterior of both valves. USNM 167180. The exterior has been excavated to show muscle scars in fig. 17.
19. Brachial valve, paratype; exterior. USNM 167181a.
20. Brachial valve, paratype. USNM 167181b.
21. Pedicle valve, paratype; external mould. USNM 167181c.



ORTHIDIUM, *ORTHIDIUM*?, *TREMATORTHIS*, AND *PLEURORTHIS*

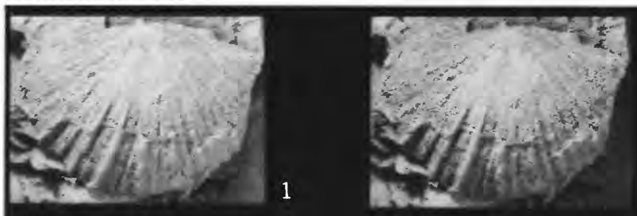
PLATE 2

[All illustrations are stereophotographs]

FIGURE 1. *Pleurorthis*? sp. (p. 21).
USGS colln. D1990 CO, pedicle valve, × 2. USNM 167182.

2–6. *Cyrtonotella*? aff. *C. fasciculata* Cooper (p. 21).
USGS colln. D1973 CO.
- 2. Brachial valve; latex cast of interior excavated in attempt to unearth cardinalia, × 2. USNM 167183a.
- 3. Brachial valve; exterior partly excavated to show position and proportions of notothyrial platform and median septum, × 2. USNM 167183b.
- 4. Brachial valve; exterior, × 3. USNM 167183c.
- 5. Pedicle valve; exterior, × 2. USNM 167183e.
- 6. Brachial valve; exterior, × 2. USNM 167183d.

7–18. *Phragmorthis antiqua* Ross, n. sp. (p. 22).
USGS colln. D2052 CO.
- 7–9. Brachial valve, holotype; exterior, and anterior views, × 6. USNM 167184.
- 10–12. Brachial valve, paratype; exterior, interior, and anterior views, × 6. USNM 167185a.
- 13, 14, 16. Pedicle valve, paratype; exterior, interior, and anterior views × 10. USNM 167185b.
- 15, 17, 18. Pedicle valve, paratype, damaged; exterior, interior, and anterior views, X 10, USNM 167185c. Interior view shows pallial trunks.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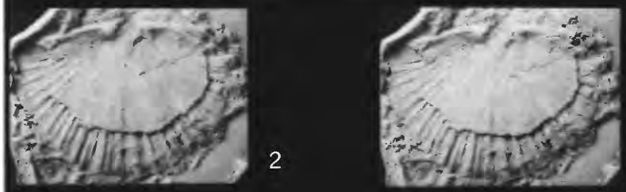
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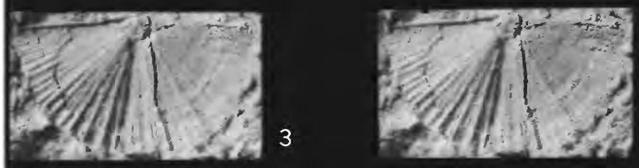
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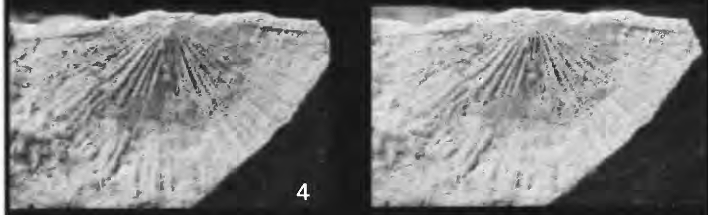
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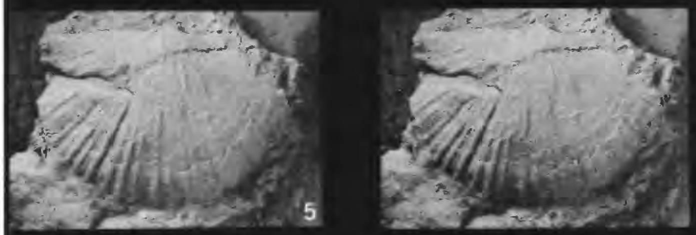
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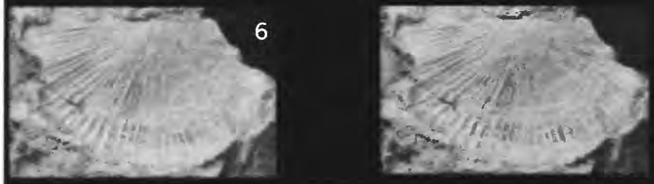
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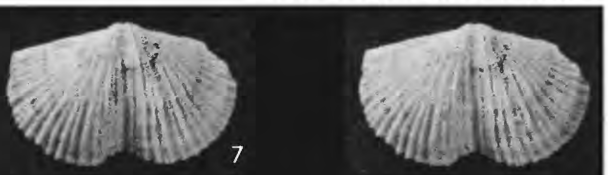
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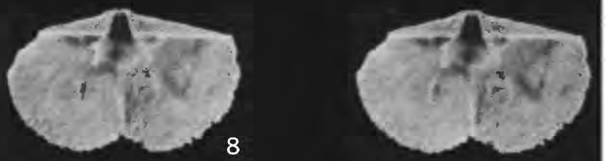
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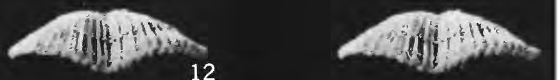
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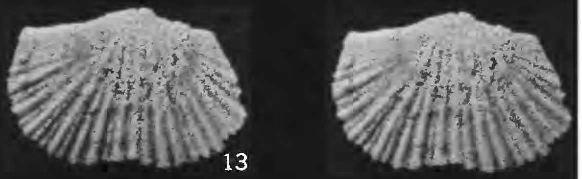
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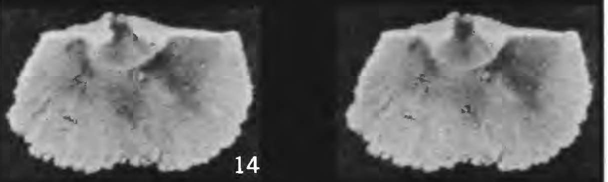
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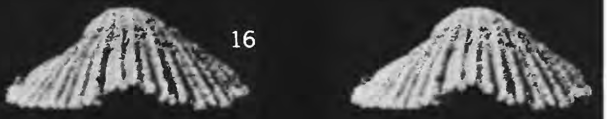
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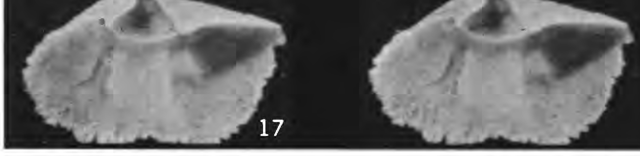
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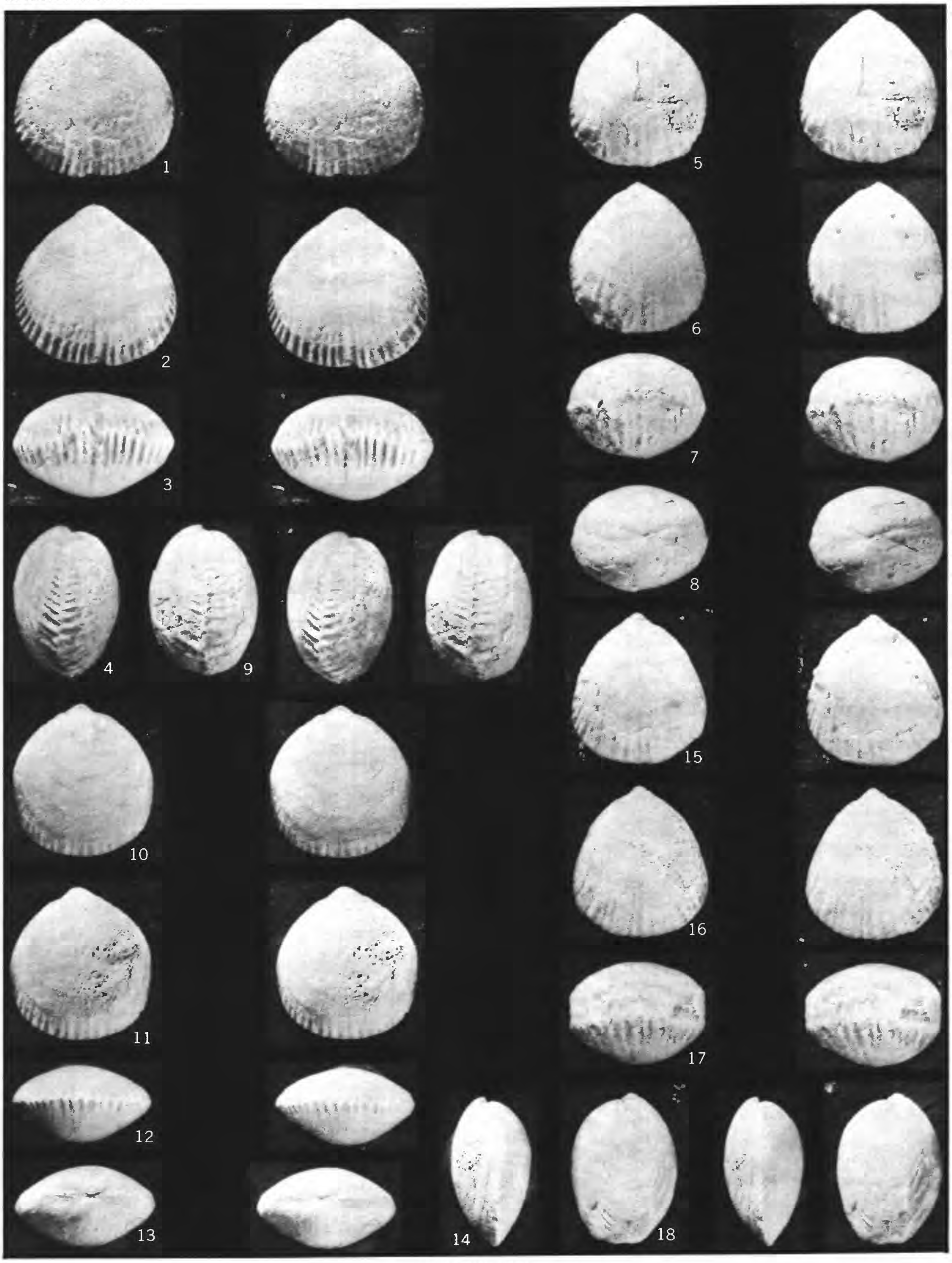
18

PLEURORTHIS?, *CYRTONOTELLA*?, AND *PHRAGMORTHIS*

PLATE 3

[All illustrations are stereophotographs]

FIGURES 1–18. *Camerella* sp. 1 (p. 23).
USGS colln. D1973 Co, × 4.
1–4. Complete shell; views of brachial exterior, pedicle exterior, anterior, and right side. USNM 167186a.
5–9. Complete shell, tumid form, with posterolateral sides somewhat flattened; views of pedicle exterior, brachial exterior, anterior, posterior, and right side, USNM 167186b.
10–14. Complete shell, depressed, subcircular form; views of brachial exterior, pedicle exterior, anterior, posterior, and right side. USNM 167186c.
15–18. Complete shell, with flattened periphery; views of brachial, pedicle, anterior, and left side. USNM 167186d.



CAMERELLA

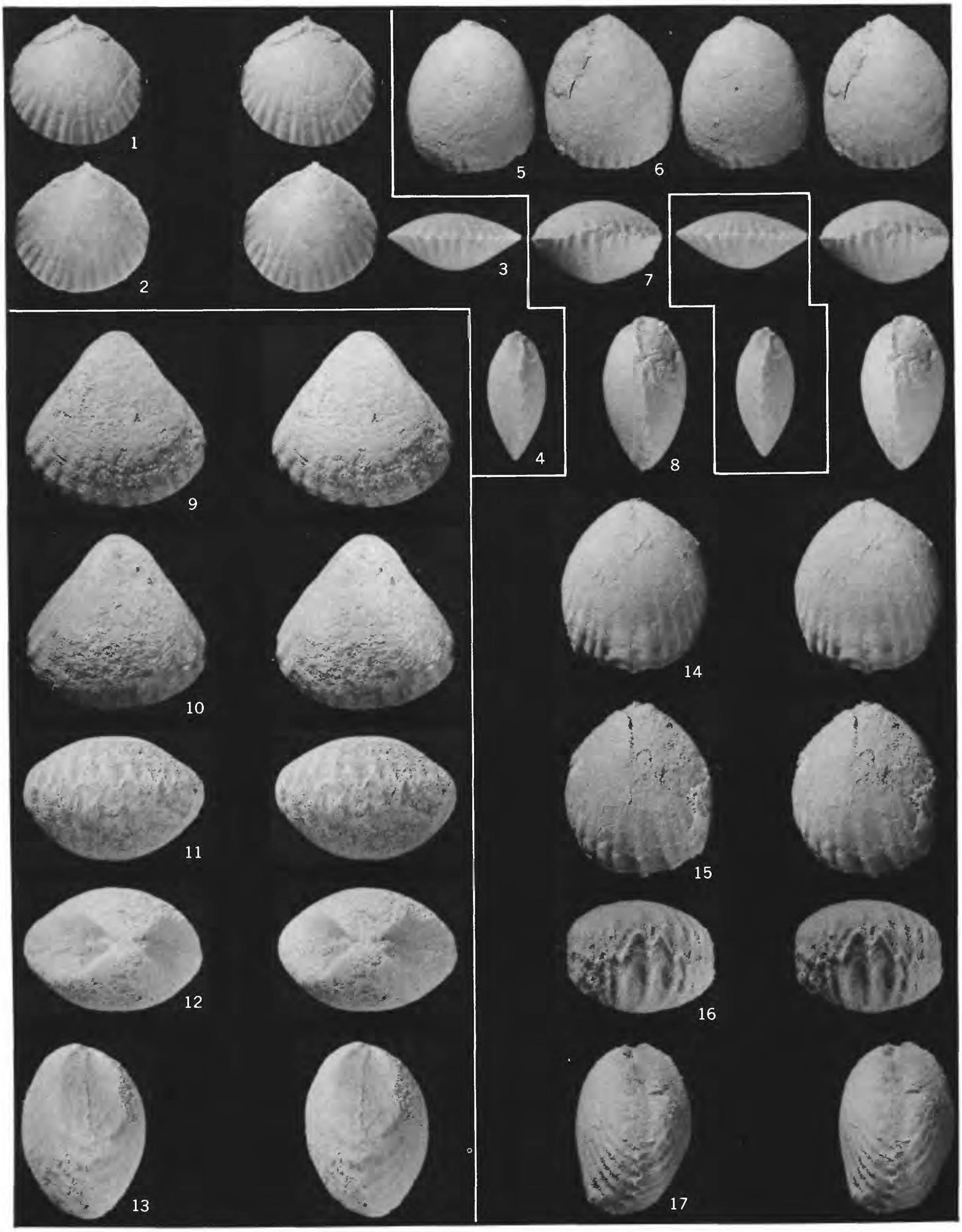
PLATE 4

[All illustrations are stereophotographs]

FIGURES 1–4. *Camerella* cf. *C.* sp. 1 (p. 23).
USGS colln. D1991 CO, views of exterior of brachial valve, exterior of pedicle valve, anterior, and right side, × 5, USNM 167187.

5–8, 14–17. *Camerella* sp. 2 (p. 23).
USGS colln. D1966 CO, × 5.
5–8. Complete shell; views of brachial valve, pedicle valve, anterior, and left side. USNM 167188a.
14–17. Complete shell; views of brachial valve, pedicle valve, anterior, and left side, USNM 167188b.

9–13. *Idiostrophia* n. sp. A (p. 24).
Asaphus shale, Töyen district, Oslo, Norway. Stage 3cβ; views of exterior of brachial valve, exterior of pedicle valve, anterior, posterior, and right side, × 4, Paleontologisk Mus. (Oslo) No. 47089.



CAMERELLA AND *IDIOSTROPHIA*

PLATE 5

[All illustrations are stereophotographs]

Figures 1–25. *Idiostrophia lenticularis* Ross, n. sp. (p. 24).
USGS colln. D1968 CO.

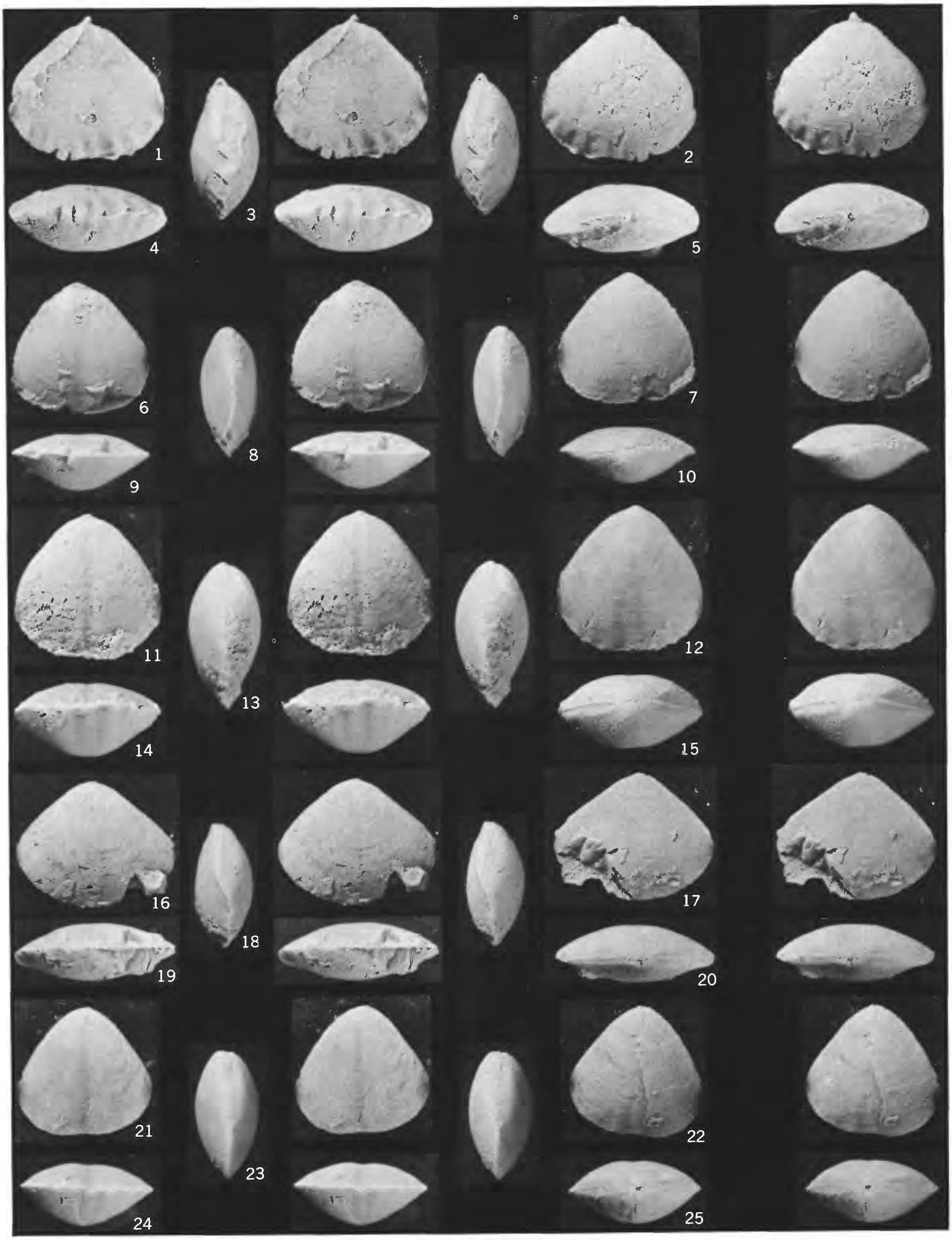
1–5. Complete shell, holotype and largest specimen discovered; views of pedicle exterior, brachial exterior, right side, anterior (upside down) and posterior (upside down), × 4, USNM 167189.

6–10. Complete shell, paratype and smallest specimen discovered; views of brachial exterior, pedicle exterior, right side, anterior, and posterior, × 7, USNM 167190a.

11–15. Complete shell, paratype; views of brachial exterior, pedicle exterior, right side, anterior, and posterior, × 6, USNM 167190b.

16–20. Complete shell, paratype, large specimen almost lacking costae; views of brachial exterior, pedicle exterior, right side, anterior, and posterior, × 4, USNM 167190c.

21–25. Complete shells, paratype, small specimen bearing few faint costae; views of brachial exterior, pedicle exterior, right side, anterior, and posterior, × 6, USNM 167190d.



IDIOSTROPHIA

PLATE 6

[All illustrations are stereophotographs]

FIGURES 1–20. *Idiostrophia valdari* Ross, n. sp. (p. 25).

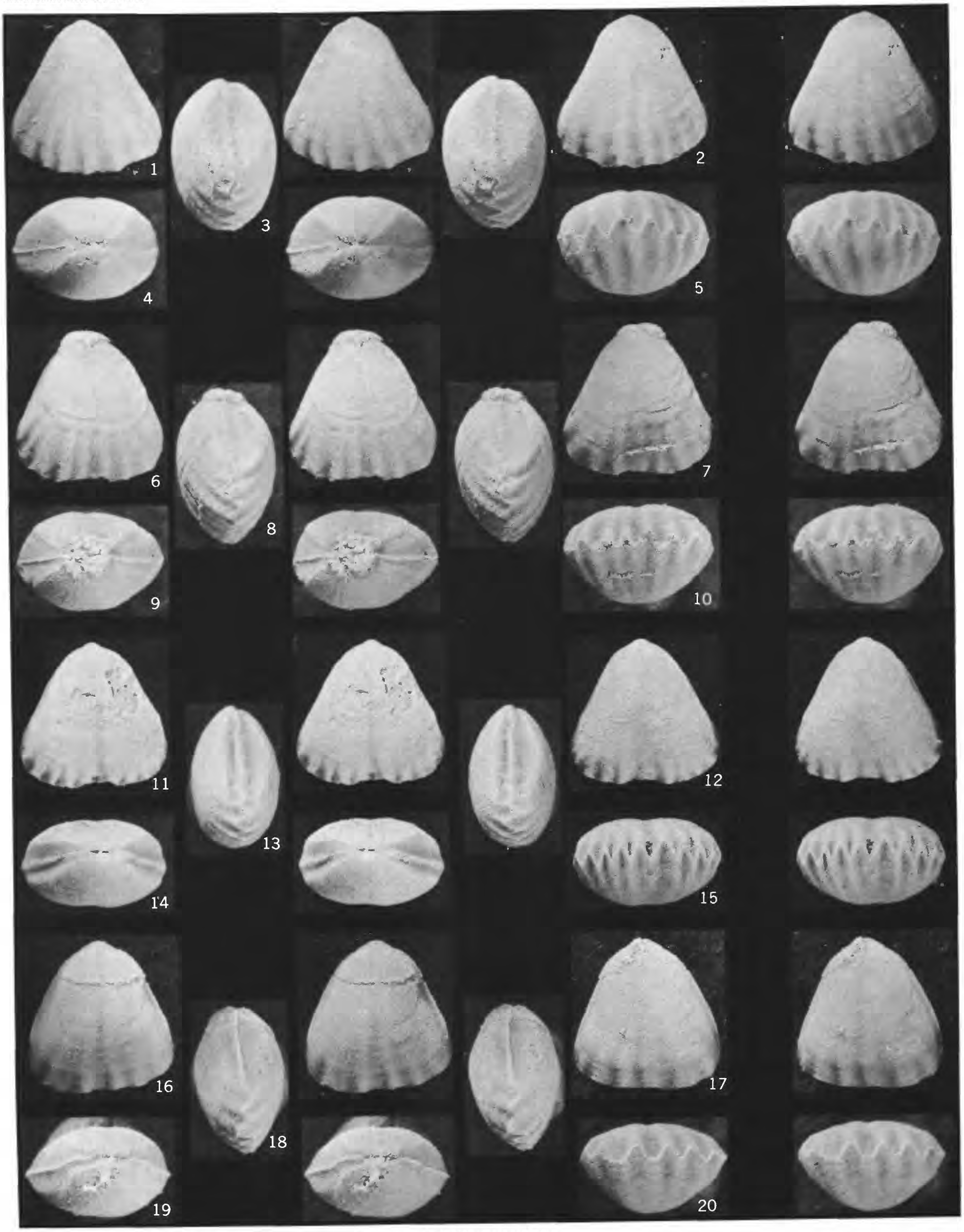
USGS colln. D1968 CO. All specimens on this plate are of the narrow variety.

1–5. Paratype; views of pedicle valve exterior, brachial valve exterior, right side, posterior, and anterior, × 5. USNM 167192a. Costae are relatively coarse in this specimen.

6–10. Paratype; views of brachial valve exterior, pedicle valve exterior, right side, posterior, and anterior, × 6. USNM 167192b.

11–15. Paratype; views of brachial valve exterior, pedicle valve exterior, right side, posterior, and anterior, × 5. USNM 167192c. Costae are relatively fine and limited to front of shell.

16–20. Paratype; views of brachial valve exterior, pedicle valve exterior, right side, posterior, and anterior, × 7. USNM 167192d. A fairly small specimen.



IDIOSTROPHIA

PLATE 7

[All illustrations are stereophotographs]

FIGURES 1–20. *Idiostrophia valdari* Ross, n. sp. (p. 25).

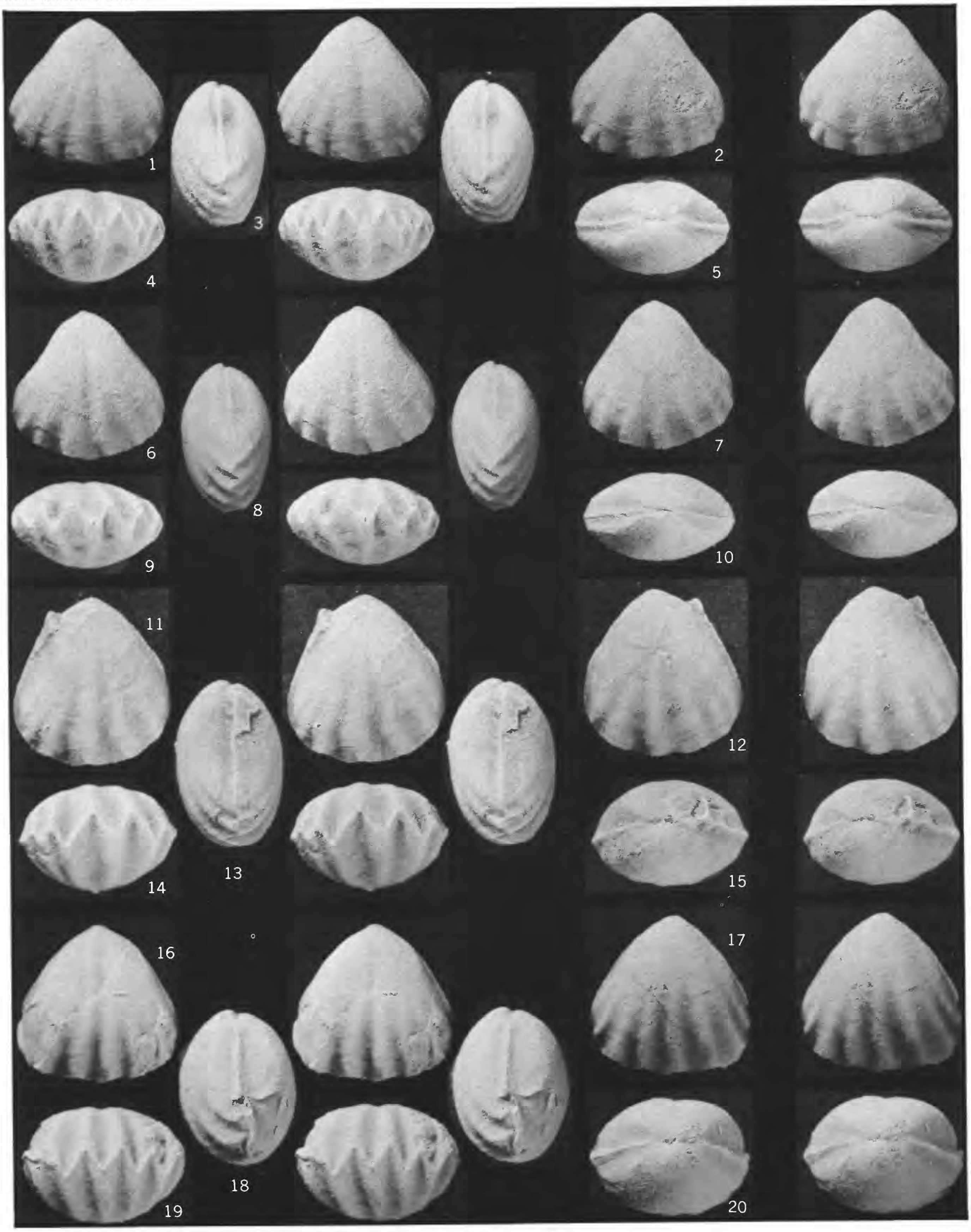
USGS colln. D1968 CO. Most specimens illustrated on this plate are somewhat wider than average with fewer than average number of costae.

1–5. Paratype, a large specimen; views of exterior of brachial valve, exterior of pedicle valve, right side, anterior, and posterior, × 5. USNM 167192e.

6–10. Paratype; views of exterior of brachial valve, exterior of pedicle valve, right side, anterior, and posterior, × 5. USNM 167192f.

11–15. Paratype, a relatively small specimen; views of exterior of brachial valve, exterior of pedicle valve, right side, anterior, and posterior, × 7. USNM 167192g.

16–20. Paratype; views of exterior of brachial valve, exterior of pedicle valve, right side, anterior, and posterior, × 6. USNM 167192h.

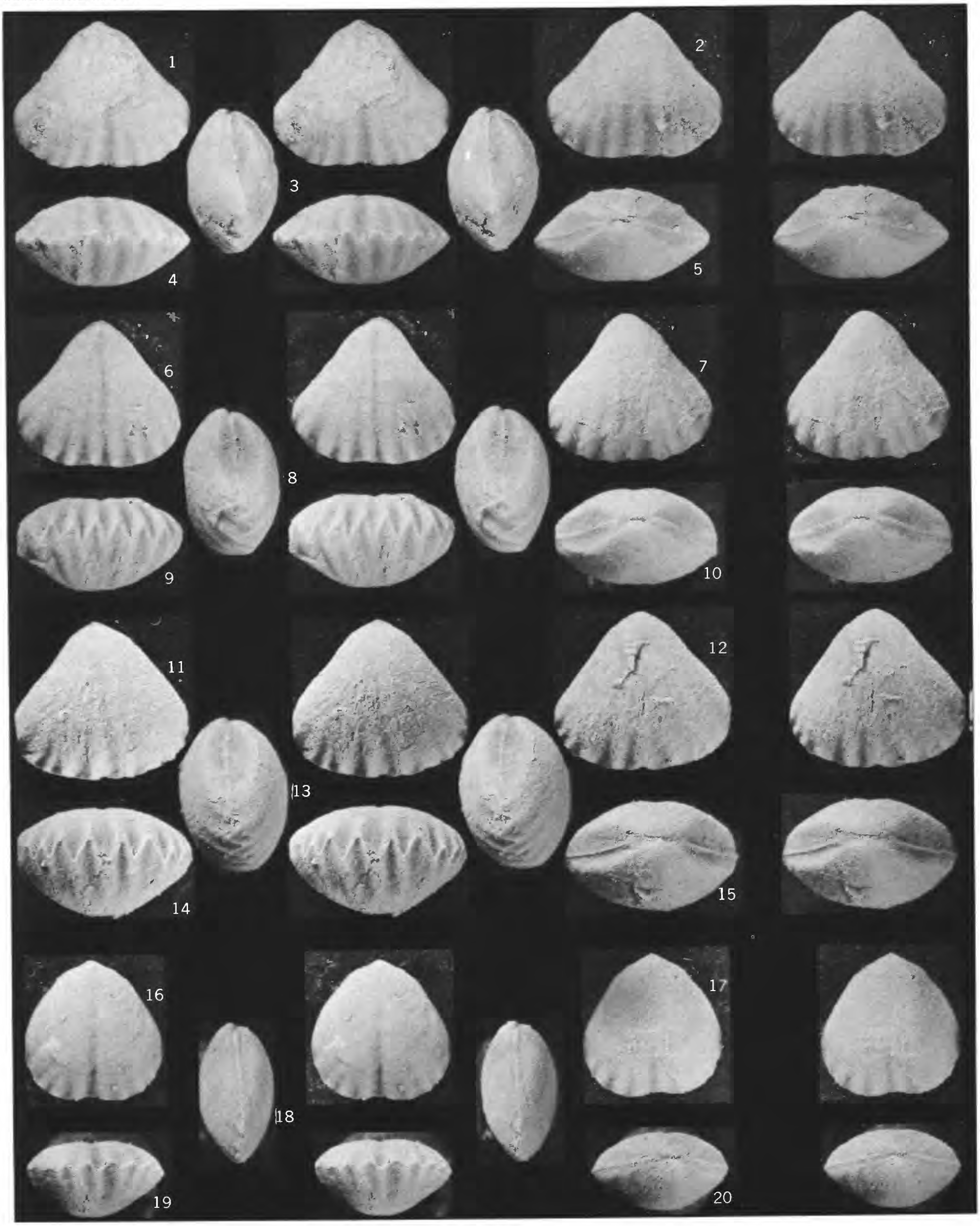


IDIOSTROPHIA

PLATE 8

[All illustrations are stereophotographs]

FIGURES 1–20. *Idiostrophia valdari* Ross, n. sp. (p. 25).
USGS colln. D1968 CO, paratypes.
1–5. Complete specimen with strongly flared outline; views of exterior of brachial valve, exterior of pedicle valve, right side, anterior, and posterior, × 5. USNM 167192i.
6–10. Complete specimen, with moderately flared outline; views of exterior of brachial valve, exterior of pedicle valve, right side, anterior, and posterior, × 5. USNM 167192j.
11–14. Complete specimen, with flared outline; views of exterior of brachial valve, exterior of pedicle valve, right side, anterior, and posterior, × 5. USNM 167192k.
16–20. Complete specimen, immature; views of exterior of brachial valve, exterior of pedicle valve, right side, anterior, and posterior, × 7 USNM 167192l.



IDIOSTROPHIA

PLATE 9

[All illustrations are stereophotographs]

FIGURES 1–7. *Idiostrophia conciliata* Ross, n. sp. (p. 26).

USGS colln. D1991 CO.

1–4. Holotype, complete specimen; views of exterior of brachial valve, exterior of pedicle valve, anterior, and left side, × 3. USNM 161793.

5–7. Paratype, large brachial valve with numerous costae; views of exterior, anterior, and right side, × 2. USNM 167193a. This shell is split close to beak.

8–19. *Ingria cloudi* Ulrich and Cooper (p. 26).

From lower member of Antelope Valley Limestone, along wash south of Frenchman Flat. Nevada coordinates, central zone: E. 726,700 ft; N. 740,700 ft, Frenchman Lake quadrangle, × 1.5.

8, 9. Brachial valve; exterior and interior. USNM 167194d. USGS colln. D719e CO, 100 feet below top of lower member. Cardinal process is broken in this specimen.

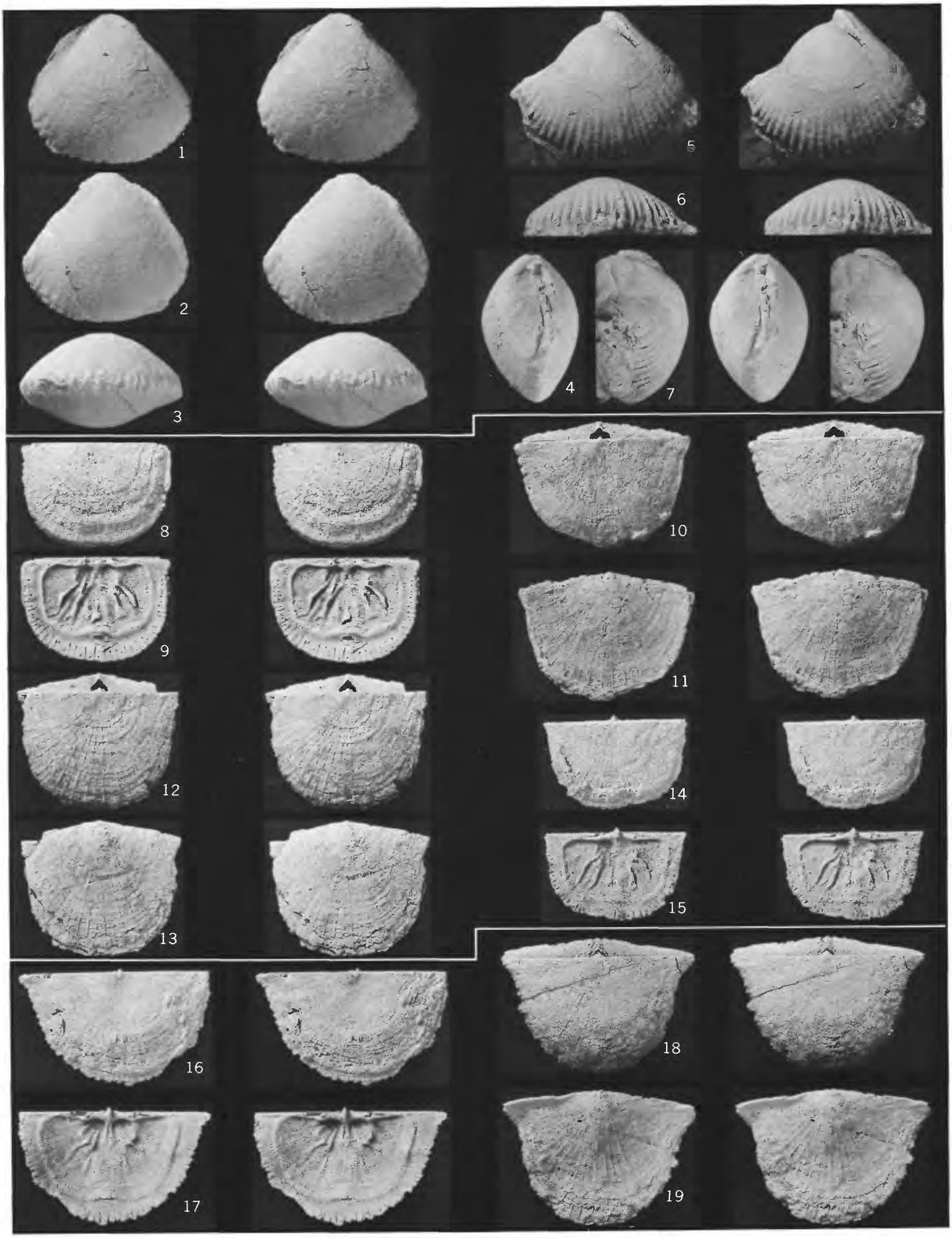
10, 11. Complete specimen, with wide outline; views of brachial and pedicle valves. USNM 167194a. USGS colln. D719e CO.

12, 13. Complete specimen with subquadrate outline; views of brachial and pedicle valves. USNM 167194b. USGS colln. D719e CO.

14, 15. Brachial valve; exterior and interior views. USNM 167194c. USGS colln. D719e CO.

16, 17. Brachial valve of alate outline; exterior and interior views. USNM 167195c. USGS colln. D719i CO, 60 feet below top of lower member.

18, 19. Complete shell of alate outline; views of exterior of brachial and pedicle valves. USNM 167195a. USGS colln. D719i CO.



IDIOSTROPHIA AND *INGRIA*

PLATE 10

[All illustrations are stereophotographs]

FIGURES 1–4, 8, 9. *Ingria cloudi* Ulrich and Cooper (p. 26).

Lower member of Antelope Valley Limestone, south of Frenchman Flat. (Ross, 1964, p. C20, pl. 1)

1, 2. Complete specimen; views of exterior of brachial and pedicle valves, × 1.5, USNM 167195b. USGS colln. D719i CO, 60 feet below top of lower member.

3, 4. Broken specimen, transverse outline; views of exterior of brachial and pedicle valves, × 3, USNM 167196b. USGS colln. D719h, 70 feet below top of lower member.

8, 9. Badly damaged specimen showing extremely alate outline; views of brachial and pedicle valves, × 3, USNM 167196a. USGS colln. D719h CO, 70 feet below top of lower member

5–7, 10–13, 17. *Ingria?* sp. (p. 28).

Main mass of bioherm, Antelope Valley Limestone, at Meiklejohn Peak. These specimens may be assignable to *Paucicostella*.

5. Pedicle valve, × 3, USNM 167197a. USGS colln. D1973 CO.
6. Pedicle valve, × 3, USNM 167197b. USGS colln. D1973 CO.
7. Pedicle valve, × 2, USNM 167197c. USGS colln. D1973 CO.
10, 12. Pedicle valve; exterior and posterior views, × 4, USNM 167197d. USGS colln. D1990 CO.
11. Brachial valve, × 2, USNM 167197e. USGS colln. D1990 CO.
13. Pedicle valve, × 3, USNM 167197f. USGS colln. D1990 CO.
17. Pedicle valve, × 6, USNM 167197g. USGS colln. D1968 CO.

14–16. *Leptellina?* sp. or *Taphrodonta?* sp. (not described).

USGS colln. D2052 CO. Views of exterior of brachial valve, exterior of pedicle valve, and anterior, × 4, USNM 167198.

18, 20. *Isophragma?* sp. (p. 27).

USGS colln. D1975 CO. Exterior and interior of pedicle valve, × 5, USNM 167199. This specimen may belong to *Taphrodonta*.

19. *Carrickia* sp. 1 (p. 29).

USGS colln. D1994 CO. Cranidium; dorsal view, × 10, USNM 167205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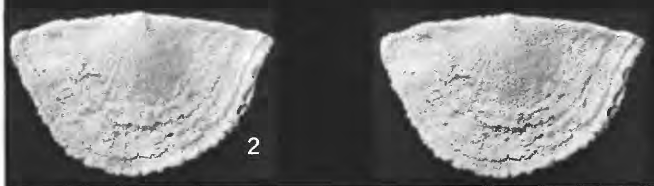
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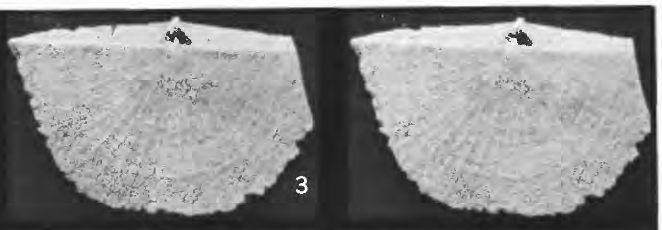
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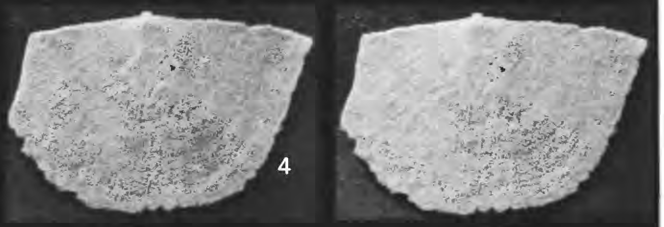
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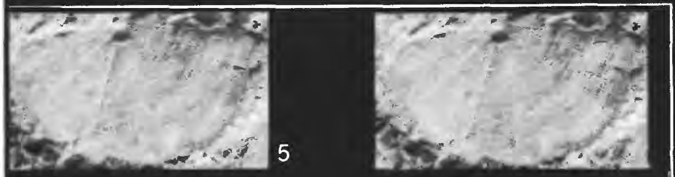
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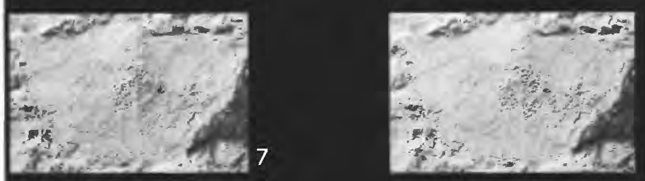
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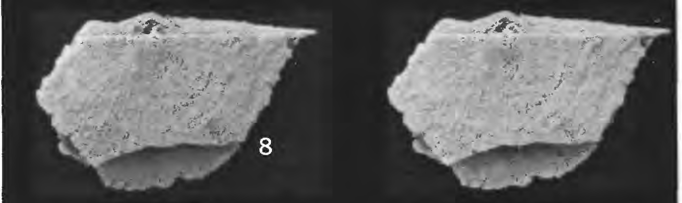
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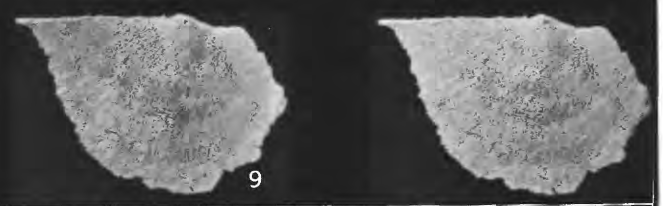
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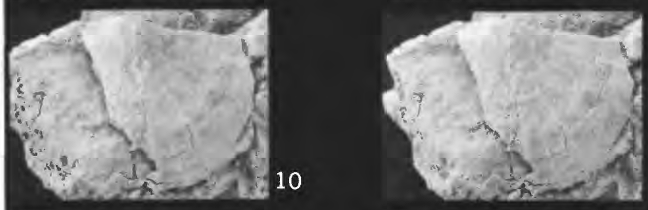
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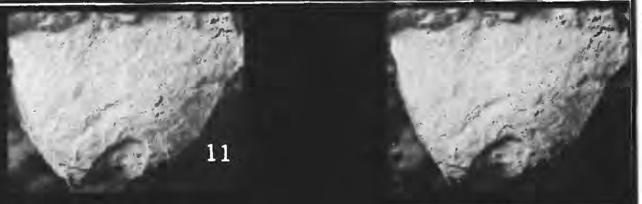
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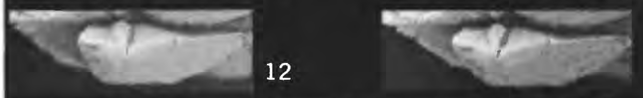
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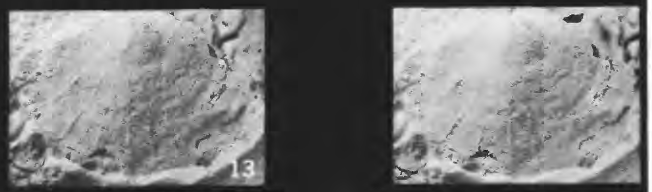
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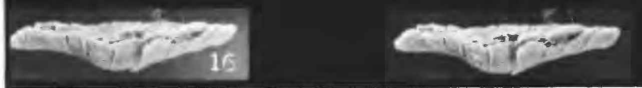
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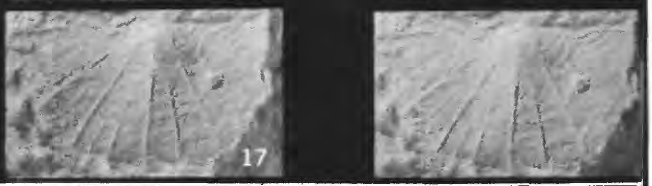
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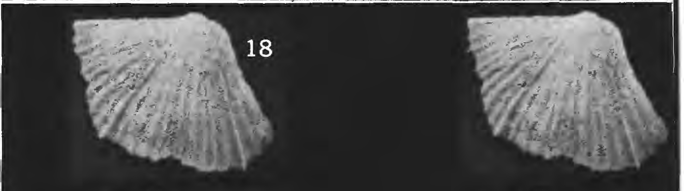
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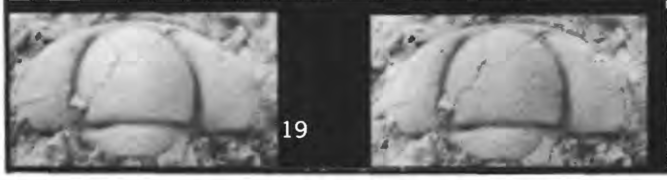
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20

INGRIA, *INGRIA*?, *LEPTELLINA*? OR *TAPHRODONTA*?,
ISOPHRAGMA?, AND *CARRICKIA*

PLATE 11

[All illustrations are stereophotographs]

FIGURES 1–5. *Petroria austrina* Ross, n. sp. (p. 27).
USGS colln. D1973 CO. × 3.
1, 2. Holotype, complete shell; views of exteriors of brachial and pedicle valves. USNM 167200.
3–5. Paratype, pedicle valve; views of exterior, anterior, and right side. USNM 167200a.

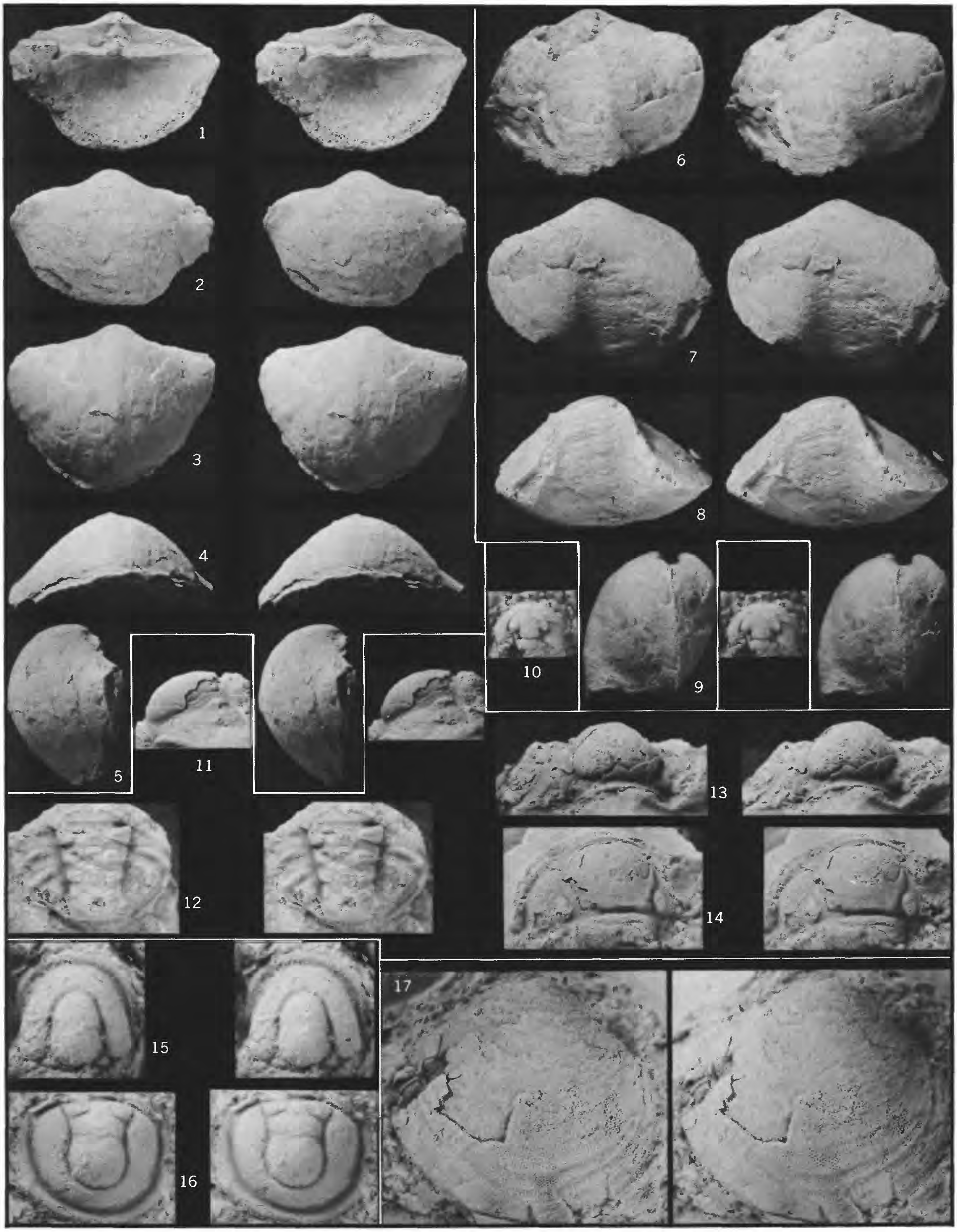
6–9. *Cuparius cardilatus* Ross (p. 28).
USGS colln. D1973 CO. Large complete shell; views of exterior of brachial valve, exterior of pedicle valve, anterior, and left side, × 2. USNM 167201.

10. *Shumardia* sp. (p. 29).
USGS colln. D1994 CO. Cranidium; dorsal view, × 10. USNM 167204.

11–14. *Carolinites* cf. *C. killaryensis* (Stubblefield) (p. 30).
11, 13, 14. Cranidium; left lateral, anterior, and dorsal views, × 3. USNM 167206a. USGS colln. D1966 CO.
12. Pygidium; dorsal view, × 6. USNM 167206b.
USGS colln. D1973 CO. Note base of upright spine on combined crests of fourth axial segment and terminal piece.

15, 16. *Trinodus* sp. 1 (p. 28).
USGS colln. D1973 CO, × 10.
15. Cephalon; dorsal view. USNM 167203a.
16. Pygidium; dorsal view. USNM 167203b.

17. *Cuparius* sp. (p. 28).
USGS colln. D1966 CO. Pedicle valve, showing pitted exterior of shell, × 4. USNM 167202.



PETRORIA?, *CUPARIUS*, *SHUMARDIA*, *CAROLINITES*, AND *TRINODUS*

PLATE 12

[All illustrations are stereophotographs]

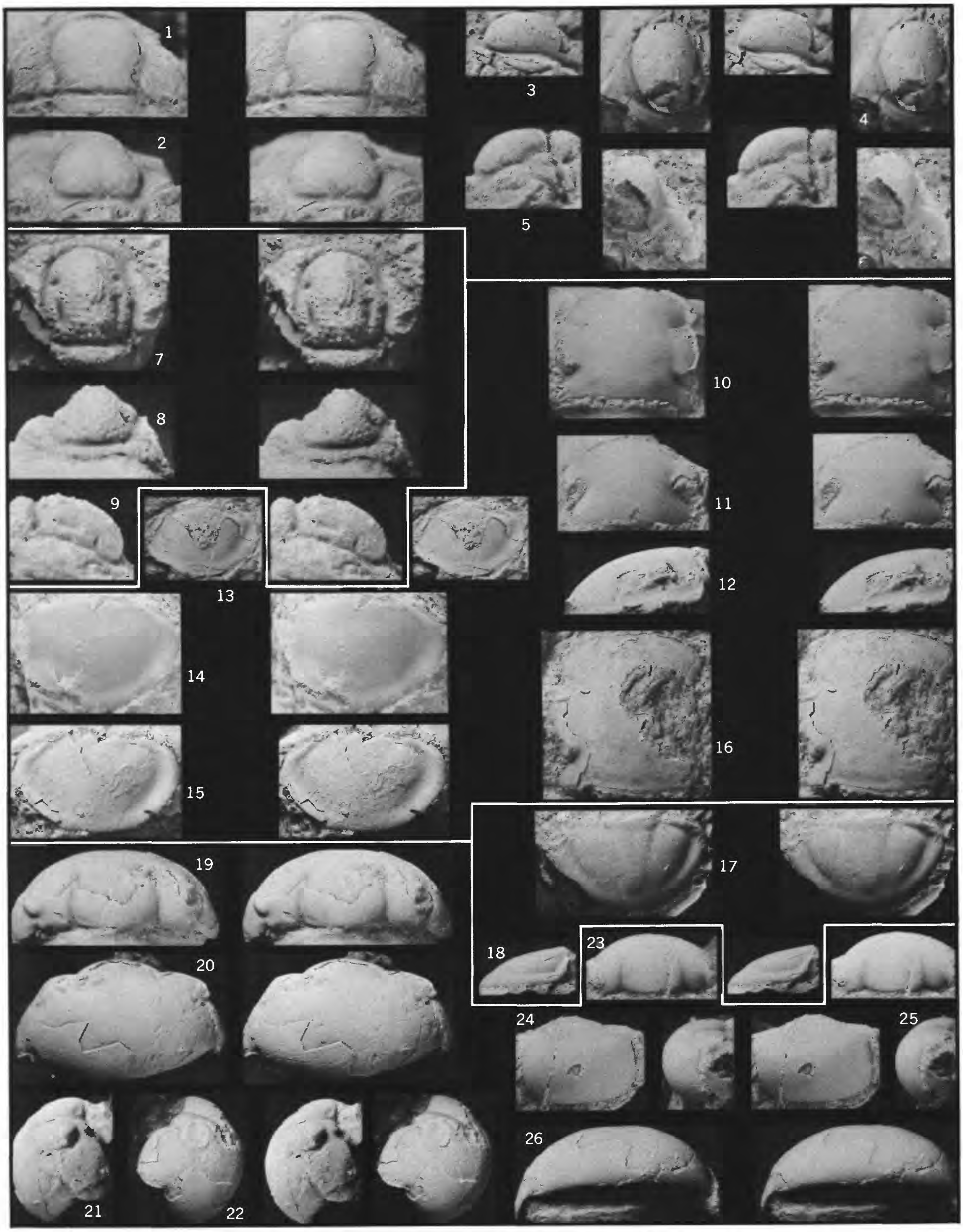
FIGURES 1–6. *Carolinites* cf. *C. killaryensis* (Stubblefield) (p. 30). USGS colln. D1973 CO, × 4.
- 1, 2, 5. Cranidium; dorsal, anterior, and left lateral views, USNM 167206c.
- 3, 4. Free cheek, left (genal spine broken off); lateral and dorsal views, USNM 167206d.
- 6. Free cheek, right (part of genal spine preserved); dorsal view, USNM 167206e.

7–9. *Glaphurus* sp. (p. 31).
USGS colln. D1968 CO. Cranidium; dorsal, anterior, and lateral views, × 7, USNM 167207.

10–16. *Nileus* aff. *N. scrutator* Billings (p. 31).
All from USGS colln. D1973 CO except fig. 15.
- 10–12. Cranidium; dorsal, anterodorsal, and lateral views, × 2, USNM 167208a.
- 13. Pygidium; dorsal view, × 2, USNM 167208b.
- 14. Pygidium; dorsal view, × 4, USNM 167208c.
- 15. Pygidium; dorsal view, × 1.5, USNM 167208d. USGS colln. D1971 CO.
- 16. Cranidium; dorsal view, × 3, USNM 167208e.

17, 18. *Peraspis*? sp. (p. 31).
USGS colln. D1991 CO. Pygidium; dorsal and lateral views, × 1, USNM 167209.

19–26. *Illaenus* cf. *I. auriculatus* Ross (p. 32).
USGS colln. D1973 CO.
- 19–22, 26. Cephalon; dorsal, anterior, left lateral, right lateral, and anteroventral views, × 2, USNM 167210a.
- 23–25. Cranidium; dorsal, anterior, and lateral views, × 3, USNM 167210b.



CAROLINITES, GLAPHURUS, NILEUS, PERASPIS?, AND *ILLAENUS*

PLATE 13

[All illustrations are stereophotographs]

FIGURES 1–13. *Illaenus* cf. *I. auriculatus* Ross (p. 32).

1–3. Cranidium; dorsal anterior, and lateral views, × 3, USNM 167210c. USGS colln. D1973 CO.

4. Hypostome; ventral view, × 5, USNM 167210d. USGS colln. D1973 CO.

5. Pygidium; dorsal view, excavated to show extent of doublure, × 2, USGS colln. D1973 CO. USNM 167210e.

6–8. Pygidium; dorsal, posterior, and lateral views, × 2, USNM 167210f. USGS colln. D2058 CO.

9, 10. Free cheek; dorsal and lateral views, × 3, USNM 167210g. USGS colln. D1973 CO.

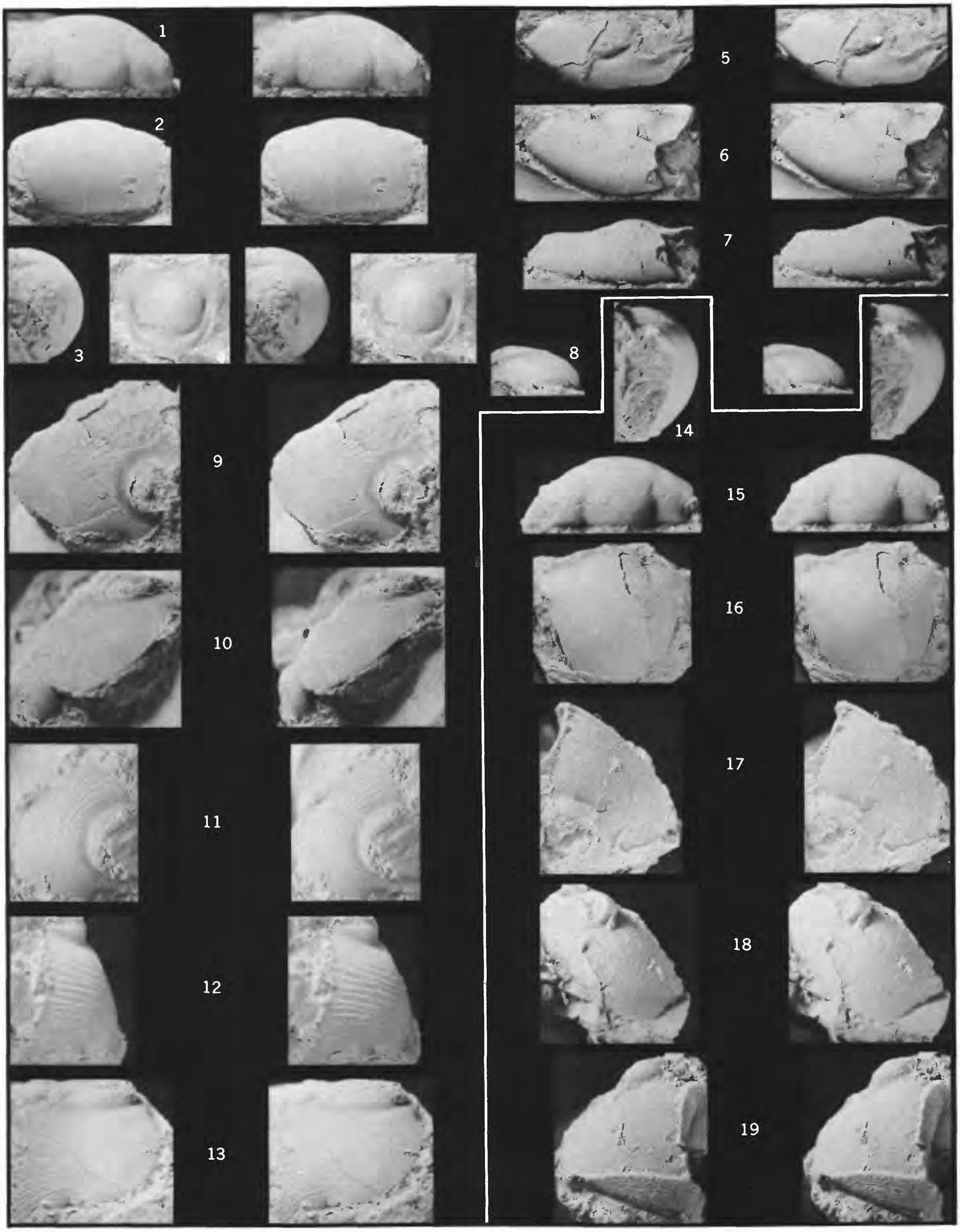
11–13. Free cheek; dorsal, lateral, and anterior views, × 5, USNM 167210h. USGS colln. D2058 CO.

14–19. *Illaenus* sp. b (p. 32).

USGS colln. D1968 CO.

14–16. Cranidium; lateral, dorsal, and anterior views, × 6, USNM 167211a.

17–19. Free cheek; dorsal, lateral, and anterior views, × 4, USNM 167211b.



ILLAENUS

PLATE 14

[All illustrations are stereophotographs]

FIGURES 1–6. *Illaenus* sp. b (p. 32).
USGS colln. D1968 CO.
1–3. Cranidium; lateral, dorsal, and anterior views, × 1, USNM 167211c.
4–6. Cranidium; dorsal, lateral, and anterior views, × 4, USNM 167211d.

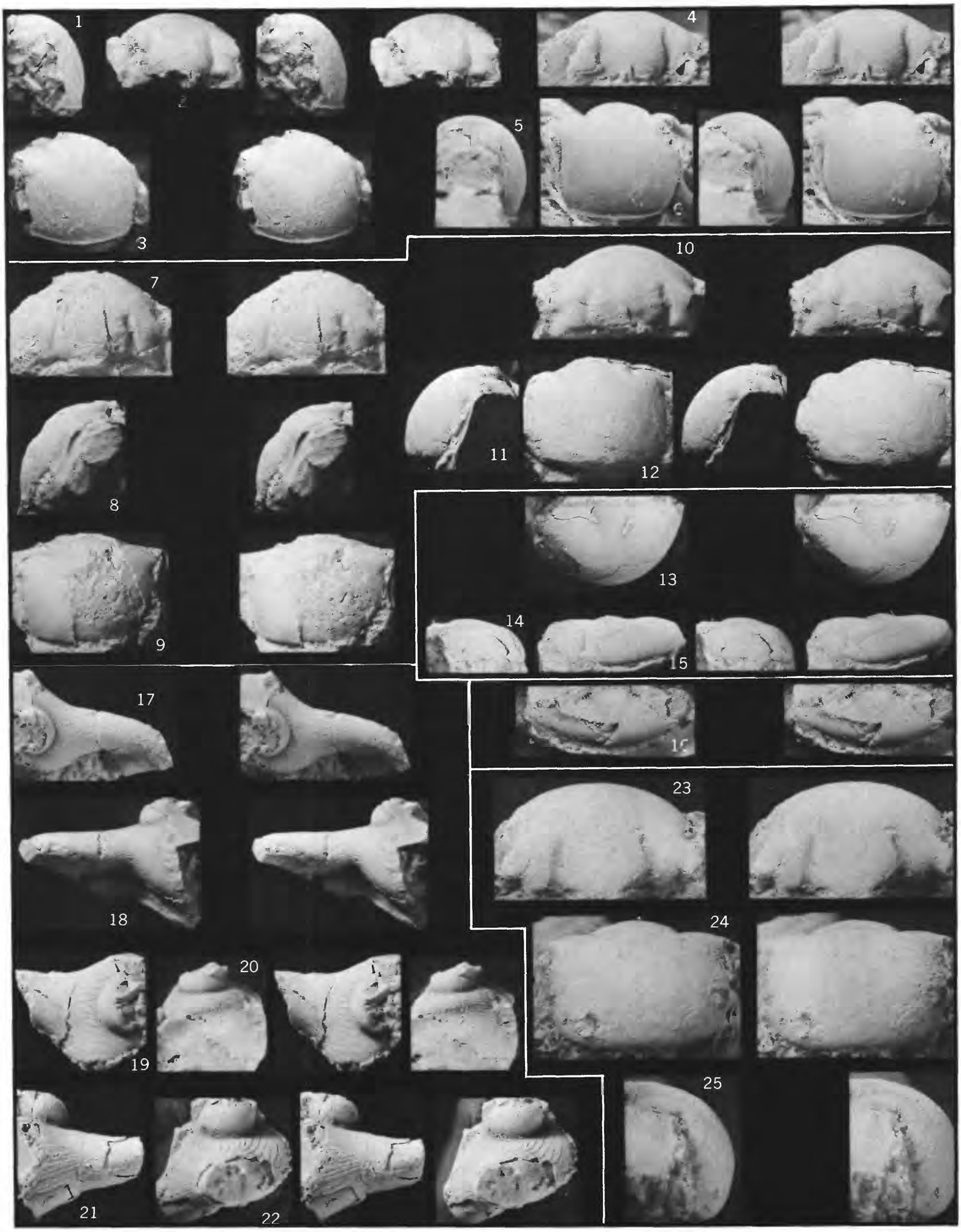
7–12. *Illaenus* sp. c (p. 33).
USGC colln. D1991 CO, × 1.
7–9. Cranidium; dorsal, lateral, and anterior views, USNM 167212a.
10–12. Cranidium; dorsal, lateral, and anterior views, USNM 167212b.

13–15. *Illaenus* sp. d (p. 33).
USGS colln. D1973 CO.
Pygidium; dorsal, lateral, and posterior views, × 1, USNM 167213.

16. *Illaenus* sp. e (p. 33).
USGS colln. D1968 CO.
Pygidium; dorsal view, partially excavated, × 2, USNM 167214.

17–22. *Illaenus* sp. f (p. 33).
USGS colln. D1968 CO, × 4.
17, 18, 20. Free cheek, right; dorsal, anterior, and lateral views, USNM 167215a.
19, 21, 22. Free cheek, badly damaged, left; dorsal, anterior, and lateral views, USNM 167215b.

23–25. *Illaenus* cf. *I. auriculatus* Ross (p. 32).
USGS colln. D1968 CO, Cranidium; dorsal, anterior, and lateral views, × 2, USNM 167210i. This cranidium is associated with free cheeks designated *Illaenus* sp. f.



ILLAENUS AND *ILLAENUS*?

PLATE 15

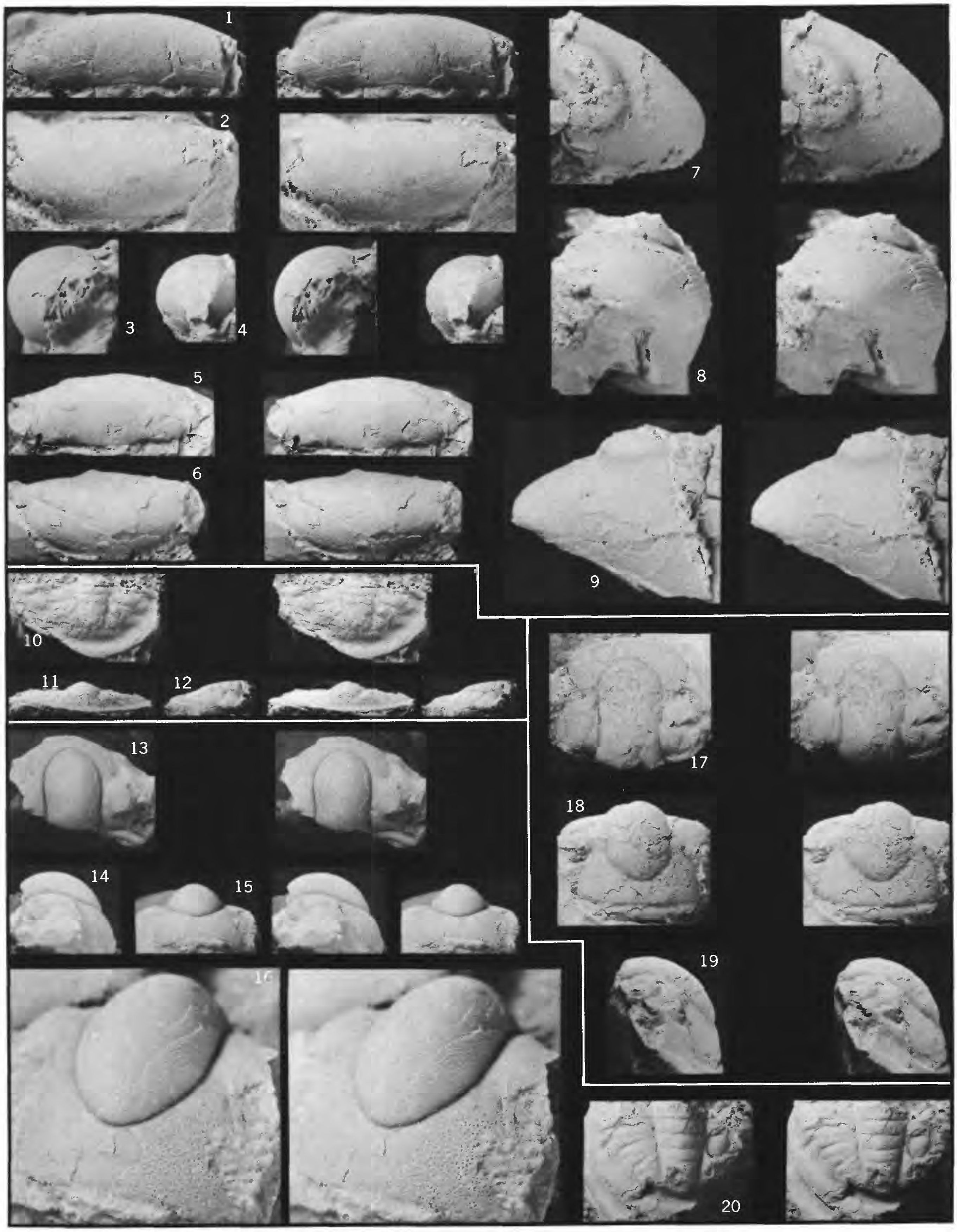
[All illustrations are stereophotographs]

FIGURES 1–9. *Harpillaenus* sp. (p. 34).
USGS colln. D1968 CO.
1–3. Cranidium; dorsal, anterior, and lateral views, × 3, USNM 167216a.
4–6. Cranidium; lateral, dorsal, and anterior views, × 2, USNM 167216b.
7–9. Free cheek; dorsal, lateral, and anterior views, × 5, USNM 167216c.

10–12. *Bathyurellus feitleri* (Holliday) (p. 34).
Pygidium; dorsal, posterior, and lateral views, × 1, USGS colln. D1994 CO. USNM 167217.

13–16, 20. *Bathyurellus* sp. 4 (p. 35).
USGS colln. D1991 CO.
13–15. Cranidium; dorsal, lateral, and anterior views, × 2, USNM 167219a.
16. Same specimen enlarged to show surface ornamentation, × 5, USNM 167219a.
20. Pygidium; dorsal view, × 1, USNM 167219b.

17–19. *Bathyurellus* sp. 3 (p. 35).
USGS colln. D1966 CO.
Cranidium; dorsal, anterior, and lateral views, × 1, USNM 167218.



HARPILLAENUS AND *BATHYURELLUS*

PLATE 16

[All illustrations are stereophotographs]

FIGURES 1–6. *Raymondites?* sp. (p. 35).
USGS colln. D2052 CO.
1–3. Pygidium; dorsal, posterior, and lateral views, × 1, USNM 167220a.
4–6. Pygidium; lateral, dorsal, and posterior views, × 5, USNM 167220b.

7, 8. *Selenoharpes* sp. (p. 36).
USGS colln. D1968 CO.
7. Latex cast of partial cephalon; dorsal view, × 3, USNM 167221b.
8. Cephalon, damaged; left side only, × 4, USNM 167221a.

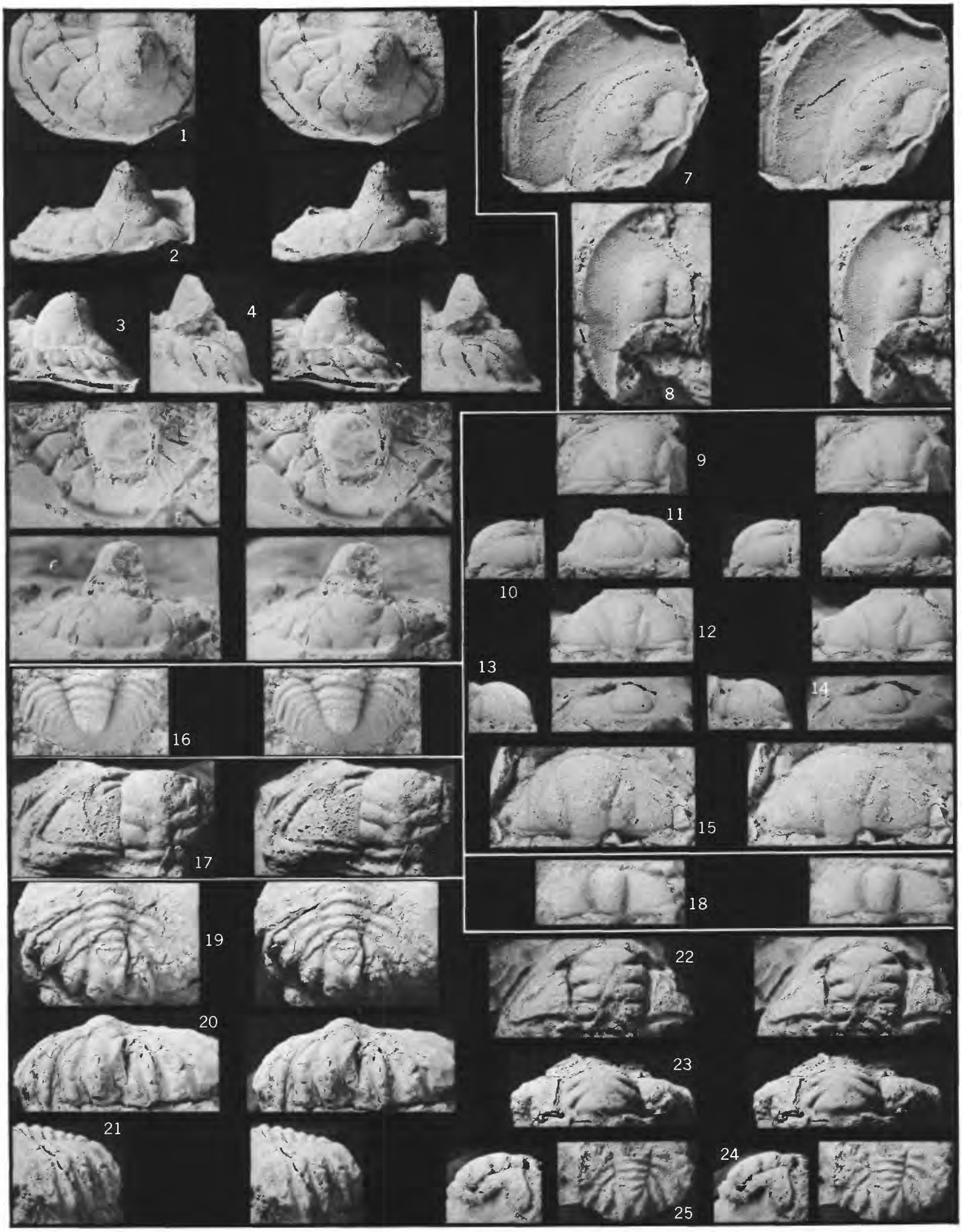
9–15. *Endymionia* cf. *E. meeki* (Billings) (p. 37).
USGS colln. D1968 CO, × 4.
9–11. Cranidium; dorsal, lateral, and anterior views, USNM 167223a.
12–14. Cranidium; dorsal, lateral, and anterior views, USNM 167223b.
15. Cranidium; dorsal view, USNM 167223c.

16. Proetid pygidium (p. 36).
USGS colln. D2052 CO.
Dorsal view, × 10, USNM 167222.

17. *Lehua* aff. *L. argus* Whittington (p. 37).
USGS colln. D1991 CO.
Cephalon, damaged; dorsal view, × 1, USNM 167224.

18. *Endymionia* cf. *E. meeki* (Billings) (p. 37).
USGS colln. D1973 CO.
Cranidium, immature; dorsal view, × 10, USNM 167225.

19–25. *Pliomerops* sp. (p. 37, 38).
19–21. Pygidium; dorsal, posterior, and lateral views, × 1.5, USNM 167226b. USGS colln. D2051 CO.
22–24. Cranidium; dorsal, anterior, and lateral views, × 1.5., USNM 167226a. USGS colln. D2051 CO.
25. Pygidium; dorsal view, × 1, USNM 167227.
USGS colln. D1968 CO.



RAYMONDITES?, *SELENOHARPES*, *ENDYMIONIA*, PROETID, *LEHUA*, AND *PLIOMEROPS*

PLATE 17

[All illustrations are stereophotographs]

FIGURES 1–16. *Kawina wilsoni* Ross, n. sp. (p. 38).

1–3. Cranidium, holotype; dorsal, anterior, and lateral views, × 3, USNM 167228a. USGS colln. D1968 CO.

4. Pygidium, paratype; dorsal view, × 3, USNM 167228b. USGS colln. D1968 CO.

5, 6, 8. Cranidium, paratype; dorsal, lateral, and anterior views, × 2, USNM 167228c. USGS colln. D1968 CO.

7, 9, 10. Cranidium, paratype; anterior, dorsal, and lateral views, × 2, USNM 167228d. USGS colln. D1968 CO.

11. Pygidium, paratype; dorsal view, × 5. Latex cast of damaged specimen. USNM 167228f. USGS colln. D1973 CO.

12, 13, 16. Cranidium, paratype; dorsal, lateral and anterior views, × 1, USNM 167228e. USGS colln. D1968 CO.

14. Pygidium, paratype; dorsal view, × 5, USNM USGS colln. D1973 CO. USNM 167228g.

15. Pygidium, paratype; dorsal view, × 2, USNM 167228h. USGS colln. D1966 CO.

17–20. *Xystocrania pyriformis* Ross, n. sp. (p. 39).

USGS colln. D1968 CO.

Cranidium, holotype; dorsal, anterior, ventral, and lateral views, × 2, USNM 167229.

21–25. *Heliomera* cf. *H. albata* Whittington (p. 40).

USGS colln. D1968 CO. × 5.

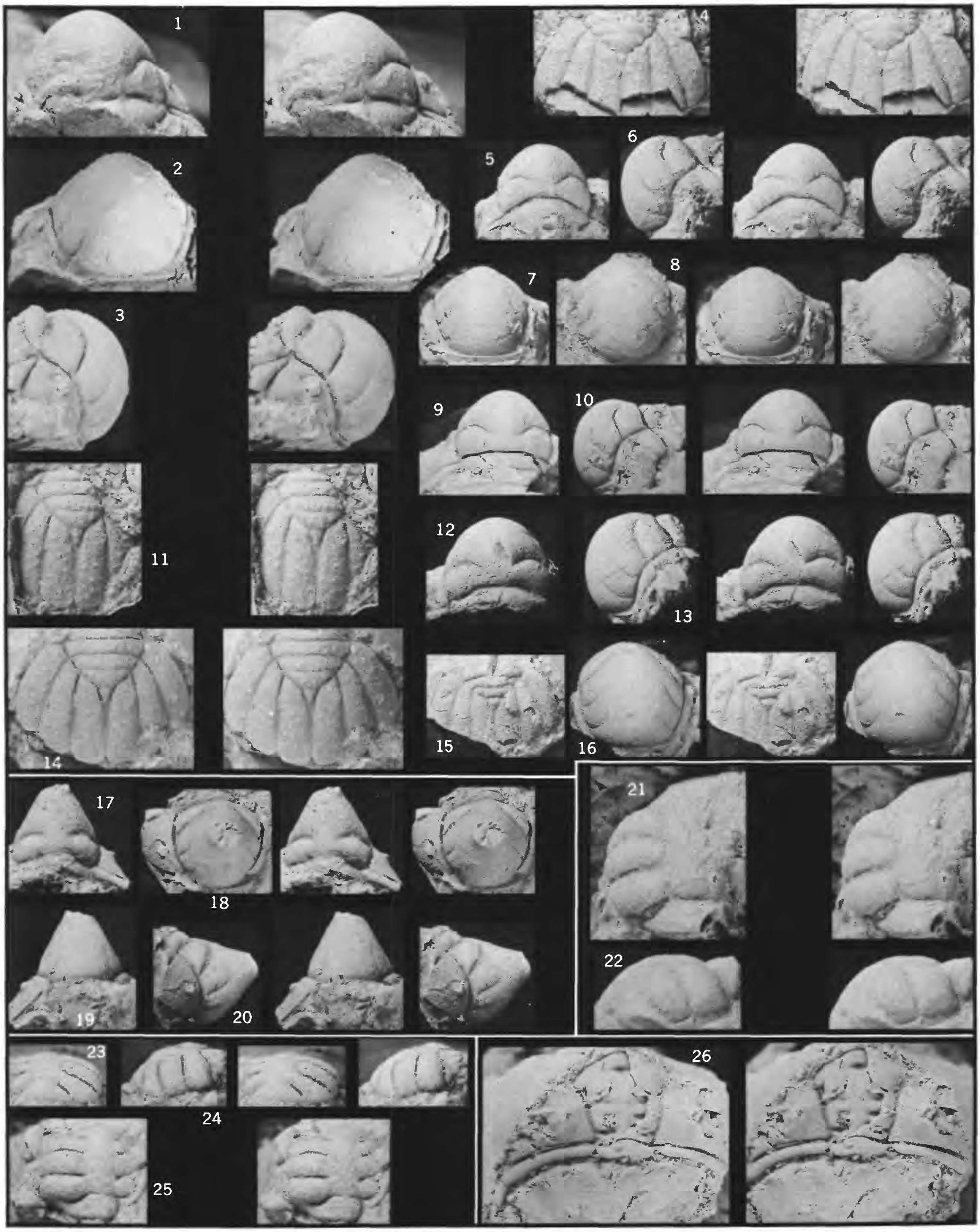
21, 22. Cranidium; dorsal and lateral views, USNM 167230a.

23–25. Cranidium; anterior, lateral, and dorsal views, USNM 167230b.

26. *Miracybele* sp. 1 (p. 40).

USGS colln. D1971 CO.

Cranidium; dorsal view, × 3, USNM 167231.



KAWINA, *XYSTOCRANIA*, *HELIOMERA*, AND *MIRACYBELE*

PLATE 18

[All illustrations are stereophotographs]

FIGURES 1–8. *Apatolichas* cf. *A. jukesi* (Billings) (p. 41).
USGS colln. D1968 CO.
1, 2. Cranidium; dorsal and anterior views, × 4, USNM 167232a.
3–5. Cranidium; dorsal, anterior, and lateral views, × 4, USNM 167232b.
6–8. Cranidium; dorsal, anterior, and lateral views, × 3, USNM 167232c.

9. Undetermined pygidium 1 (p. 41).
USGS colln. D1973 CO.
Dorsal view, × 6, USNM 167233.

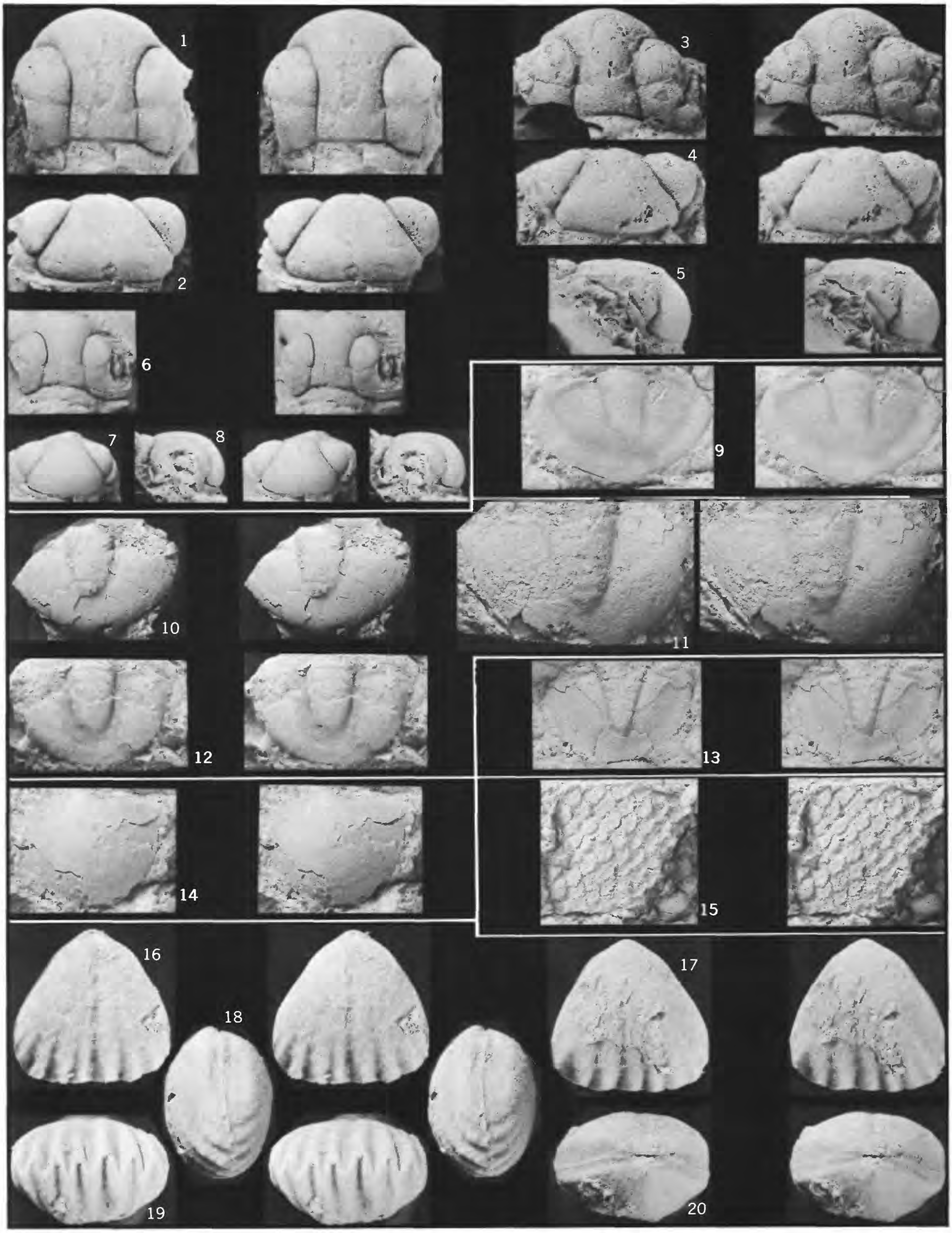
10–12. Undetermined pygidium 2 (p. 41).
USGS colln. D1973 CO.
10. Dorsal view, × 1, USNM 167234a.
11. Dorsal view, × 1, USNM 167234b.
12. Dorsal view, × 4, USNM 167234c.

13. Undetermined pygidium No. 3 (not described).
USGS colln. D1970 CO.
Dorsal view, × 3, USNM 167235.

14. *Eopteria* sp. (not described).
USGS colln. D1990 CO.
Lateral view, × 3, USNM 167236.

15. Undetermined edrioasteroid, × 3, USNM 167237.
USGS Colln. D1990 CO. (not described).

16–20. *Idiostrophia valdari* Ross, n. sp. (p. 25).
USGS colln. D1968 CO.
Complete shell, holotype; views of exterior of brachial valve, exterior of pedicle valve, right side, anterior, and posterior, × 6, USNM 167191.



APATOLICHAS, UNDETERMINED PYGIDIA, *EOPTERIA*,
UNDETERMINED EDRIOASTEROID, AND *IDIOSTROPHIA*