Some Middle Ordovician Brachiopods and Trilobites From the Basin Ranges, Western United States

GEOLOGICAL SURVEY PROFESSIONAL PAPER 523-D

Some Middle Ordovician Brachiopods and Trilobites From the Basin Ranges, Western United States

By REUBEN JAMES ROSS, JR.

With stratigraphic sections A, north of Pyramid Peak, Calif., *by* R. J. ROSS, JR., *and* B, in Specter Range, Nev., *by* HARLEY BARNES

CONTRIBUTIONS TO PALEONTOLOGY

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Species of 14 genera of brachiopods and 32 genera of trilobites are described to support stratigraphic conclusions presented in Geological Survey Bulletin 1180-C

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SOME MIDDLE ORDOVICIAN BRACHIOPODS AND TRILOBITES FROM THE BASIN RANGES WESTERN UNITED STATES

By Reuben James Ross, Jr.

ABSTRACT

Although not encompassing the entire available fossil assemblage reported in U.S. Geological Survey Bulletin 1180–C, 14 genera of brachiopods and 32 genera of trilobites described here support stratigraphic conclusions presented in that bulletin. Those conclusions call for a revision of the Middle Ordovician Whiterock, Marmor, and Ashby Stages of Cooper (1956). Ecologic factors, rather than age, may account for differences between certain zonal assemblages of fossils from the Antelope Valley Limestone (Pogonip Group) across southern Nevada. For example, ecologic control may explain the westerly substitution of the ***Rhysostrophia*** zone assemblage in the stratigraphic position of the ***Anomalorthis*** zone assemblage found farther east.

Stratigraphic sections measured at Pyramid Peak, Calif., and in the Specter Range, Nev., supplement those sections already published to show distribution of fossils stratigraphically.

INTRODUCTION

PURPOSE AND SCOPE OF REPORT

This report presents descriptions of fossils that support conclusions of a preliminary study of Middle Ordovician stratigraphy in southern Nevada and adjacent California (Ross, 1964b, U.S. Geol. Survey Bull. 1180–C). As a result of that study, revisions were suggested for the Middle Ordovician stages of Cooper (1956, p. 6–9). Fossil brachiopods and trilobites that are critical to my conclusions, particularly species that are new, are described. Many genera and species—such as *Orthidiella* and *Anomalorthis*—have been fully described and illustrated by Ulrich and Cooper (1938) and by Cooper (1956), and their descriptions are not repeated here.

Subsequent to completion of the manuscript for U.S. Geological Survey Bulletin 1180–C, more than a dozen additional stratigraphic sections were measured. Because two very interesting trilobite assemblages were obtained from the north side of Pyramid Peak in the Ryan quadrangle, California, that section is presented in this report and is intended for use in conjunction with sections included in Ross (1964b). Similarly, the spacing of both the lithologic units and the fossil assemblages in the Specter Range, Nev., is so like that at Pyramid Peak that a section recorded by Harley Barnes is also included for comparison.

With the exception of fossils from Pyramid Peak, Calif., and Specter Range, Nev., no effort is made to give detailed locality data for each species. Instead, reference is made to U.S. Geological Survey collections and pertinent pages in Ross (1964b); however, relative positions of collections are indicated on plate 11.

TREATMENT OF PALEONTOLOGICAL MATERIAL

Formal classification of brachiopods and trilobites is not repeated here. The classification used by Cooper (1956) is followed, and the reader is referred to it for suprageneric details.

Similarly, the classification of trilobites follows that of the "Treatise on Invertebrate Paleontology" (Geol. Soc. America, 1959, p. 160–167). Terminology used in descriptions of trilobites also follows usage of the treatise (p. 117–126), except that the occipital ring is considered part of the glabella in all trilobites.

ACKNOWLEDGMENTS

Early in the study of brachiopods for this report, G. A. Cooper examined most of the collections, checking on identifications; I am grateful to him not only for corroborating most of the identifications, but also particularly for calling my attention to those that were incorrect. H. B. Whittington gave similar assistance on a few selected trilobites.

Type specimens of Phleger's (1933) brachiopods and trilobites from the Ordovician of the northern Inyo Mountains were loaned by Dr. Theodore Downs of the Los Angeles County Museum.

The stratigraphic section of the Pogonip Group in the Ryan quadrangle was located by J. F. McAllister on the north side of Pyramid Peak. McAllister conferred

with me on the position of formation boundaries in this area. L. A. Wilson has given me continued assistance with fieldwork and has prepared and photographed much of the fauna studied.

In 1964, Wilfrid Davis of San Jose State College made available, through D. C. Ross, several collections from the Barrel Spring Formation of the northern Inyo Mountains. These have yielded two species of brachiopods, a large species of *Hesperorthis* (p. D4), and a single specimen questionably referred to *Plaesiomys* (p. D4).

Dr. W. T. Dean of the British Museum examined stereophotographs of a species of trilobite here assigned to *Protocalymene* and advised me that he knew of no previously described genus to which the species might be readily assigned.

Harley Barnes made available for publication in this report the stratigraphic section in the Specter Range, even though he had originally intended to include it in a more general work on the stratigraphy of the Nevada Test Site.

STRATIGRAPHIC SUMMARY

The evidence of measured stratigraphic sections and ranges of fossils collected therefrom is summarized on plate 11. This plate is virtually the same as plate 1 of U.S. Geological Survey Bulletin 1180–C except that two fossiliferous sections have been added and one poorly fossiliferous section (Sheep Range) has been deleted. (See pl. 11.) In addition, fossil ranges are shown so that the reader will not have to delve through numbered collection lists to ascertain them.

Because I have already discussed the problem of relations among the *Orthidiella*, *Anomalorthis*, and *Rhysostrophia* zones at some length (Ross, 1964a, p. 1534–1540; 1964b, p. C72–C84), there is no need to belabor the subject here. Plate 11 shows rather clearly the astonishing change in composition of brachiopod faunas in the upper thin-bedded part of the Antelope Valley Limestone from the Nevada Test Site on the east to Meiklejohn Peak on the west.

Also striking is the dissimilarity of faunas in the northern Inyo Mountains with those to the east, a fact that I attribute to environmental change. The rocks of the northern Inyo Mountains section and the upper strata of the Pogonip Group farther north at Ikes Canyon, Toquima Range, Nev., are excessively muddy and silty. It does not seem strange to me that brachiopod assemblages that existed on the muddy bottom to the west were different from those that lived on the purer carbonate bottoms to the east and southeast.

In this connection one may note the occurrence of *Orthidium*, a guide to the western *Rhysostrophia* zone, in the *Orthidiella* zone of the Specter Range (USGS colln. D1441 CO). From sections outside the area covered by this report there are additional indications that support correlation of the *Anomalorthis* and *Rhysostrophia* zones.

Shortly before the manuscript for this report was completed, Whittington (1965) published his second work on the Middle Ordovician trilobites of Newfoundland. There can be no denying the similarities between the Basin Range trilobites and those so well described and illustrated by him from both Lower Head (1963) and the Table Head Formation. As a result of this latest work, I have been able to update several identifications of Nevada specimens (Ross, 1964b).

In the Spotted Range, a collection 35 feet below the top of the Antelope Valley Limestone (USGS colln. D990 CO) included *Stegnopsis sp.*, not *Isotelus*? as reported (Ross, 1964b, p. C49–C50) and *Miracybele* cf. *M. Mira* (Billings), not *Ceraurinella*? sp. These beds can be correlated with considerable confidence with the upper part of the Antelope Valley at Meiklejohn Peak to the west where *Stegnopsis* (not *Isotelus*) is also present (Ross, 1964b, p. C30–C31, colln. D830 CO, D825 CO. D829 CO); brachiopods seem to indicate that the age of these beds at Meiklejohn Peak is at least as young as the Marmor Stage and probably as young as the Porterfield Stage of Cooper (1956).

SYSTEMATIC PALEONTOLOGY

Phylum BRACHIOPODA
Class ARTICULATA

Genus ORTHAMBONITES Pander, 1830

Orthambonites Pander. Cooper, 1956, Smithsonian Misc. Colln., v. 127, pt. 1, p. 294.

Orthambonites decipiens (Phleger)

Plate 1, figures 31–36

Orthis decipiens Phleger, 1933, Southern California Acad. Sci. Bull., v. 32, pt. 1, p. 17, pl. 1, fig. 2.

Two specimens, a brachial valve and a pedicle valve, are on the piece marked as holotype (LAM 55/5.527). The brachial valve is 10.3 mm wide and 5.9 mm long. Gently convex in lateral profile. Median septum well developed. Costae simple, total 30, spaced seven in 5 mm at front of valve. Cardinal extremities acute, alate. Length to width ratio is 0.58. The pedicle valve is a larger specimen but is broken so that the width can only be estimated. It possesses bilobed pedicle muscle field with very thin median ridge extending forward of the main field as in *Desmorthis*.

Much topotype material in present collections indicates that Phleger's type specimen is immature and not entirely typical. Larger specimens are not so markedly alate in outline and most are a little longer relative to the width. The length to width ratio ranges from 0.56 to 0.68. The total number of costae, which is seemingly a very important characteristic for distinguishing this species, ranges from 28 to 32. Spacing very variable, ranging from five to nine in 5 mm at the front of a valve. This spacing is not clearly related to size of valve.

Two transverse specimens agreeing in other respects have 36 and 38 costae. Whether these specimens are of varietal rank is not known.

Figured specimens: USNM 145656–145661.

Occurrence: Barrel Spring Formation: USGS colln. D1005 CO, 75 ft below top; D1017CO, 60 ft below top. Northern Inyo Mountains, Calif. (Ross, 1964b, p. C40; pl. 1, locs. 2 and 8).

Discussion.—Although Cooper (1956, p. 351) assigned this species questionably to *Hesperorthis*, the convexity of the brachial valve suggests that it should be placed in *Orthambonites*. However, some specimens here included in *Orthambonites decipiens* may be immature specimens of *Hesperorthis* (compare figs. 19 and 32, of pl. 1), but lack of adequate interiors makes any differentiation impossible. This species closely resembles *O. friendsvillensis* (Cooper, 1956, p. 303) in size and costation but is wider in outline. Though different in size, it bears a strong resemblance to *O. occidentalis* (Cooper, 1956, p. 308) and *O. minus* (Cooper, 1956, p. 304). It lacks the pronounced pedicle fold of *O. minus*.

Orthambonites michaelis (Clark)

Plate 1, figures 1, 2

Orthis michaelis Clark, 1935, Jour. Paleontology, v. 9, p. 242.
Ulrich and Cooper, 1938, Geol. Soc. America Spec. Paper 13, p. 101, pl. 14C, figs. 11, 12, 21, 23, 24 (but not figs. 25–29).

Orthambonites michaelis (Clark). Cooper, 1956, Smithsonian Misc. Colln., v. 127, pt. 1, p. 304.

Clark's original description of this species gave no information concerning muscle scars but specified that shells bore 30–34 costae and were about 20 mm wide and 15 mm long.

Ulrich and Cooper amplified this description; in doing so they based their observations on specimens from the Confusion Range rather than from the type area at Logan, Utah. I have examined numerous specimens from the type area and find none with the exaggerated tripartite pedicle muscle scars that Ulrich and Cooper (1938, pl. 14C, fig. 27) illustrated in one specimen. I believe that this specimen may represent a distinct species in the Confusion Range although better preservation of the Confusion Range specimen may account for this muscle pattern.

The typical specimens show an elliptical scar area with the adductors narrowing anteriorly. This scar is the type illustrated by Ulrich and Cooper (1938) on their plate 14C, figure 11.

Figured specimens: USNM 145662, 145663.

Occurrence: Swan Peak Formation: USGS colln. D629 CO. East side of Beaver Creek, immediately south of Utah-Idaho State boundary, E½ sec. 35, T. 15 N., R. 4 E., Logan quad., Utah (Ross, 1964b, p. 70)

Discussion.—*Orthambonites michaelis* occurs with and closely resembles *O. swanensis* (pl. 1, fig. 8) from which it differs in total number of costae, 22–25 adorning *O. swanensis*. Costae are spaced three to five in 5 mm in *O. swanensis* as against four to five in 5 mm in *O. michaelis*. Representative specimens from the type area of both species in Utah are illustrated here for comparison with specimens found farther west.

Orthambonites perplexus n. sp.

Plate 1, figures 20–29

This species is an intermediate in a complex including *O. swanensis*, *O. michaelis*, *O. occidentalis*, and *O. dinorthoides*, each one of which it resembles in some respect.

Its outline is broadly elliptical, the hinge being narrower than the greatest width. Brachial valve gently convex with very shallow sulcus involving four costae. Pedicle valve only slightly more convex than brachial. Surface costate, costae numbering 21–25 and spaced from three to five in 5 mm at front margin. In many specimens there is single fine raised line between costae; in some no line discernible.

Inside brachial valve the brachiophores short and stout. Cardinal process variable in development. In some specimens (pl. 1, fig. 22), a mere suggestion of a ridge is present. In others (pl. 1, fig. 20), a rudimentary myophore is formed.

In pedicle valve the muscle field is bilobed, although indentation of front edge varies considerably. Some specimens (pl. 1, figs. 28, 29) resemble *O. dinorthoides*, whereas others (pl. 1, figs. 24–27) are closely comparable with *O. swanensis* and *O. michaelis*.

Dimensions (millimeters) and costal features of 16 type specimens of *O. perplexus*, n. sp. are as follows:

USNM	Length	Width	Hinge width	Total costae	Costae in 5 mm
145665	9.1	11.8	8.1	24	4.5
666	9.2	11.4	8.6	25	4.5
667	9.3	10.4	7.8	24	4
668	8.5	11.5	7.6	22	4.5
669	8.1	10.1	6.7	21	4
670	8.3	9.9	5.8	20	5
671	9.4	11.5	8.5	23	4
672	8.6	10.3	7.8	23	4
673	(?)	10	7.8	23	(?)
674	8.4	9.3	6.3	22	4.5
675	10.3	(?)	7.4	21	3
676	9.9	10.2	7.2	20–21	4.5
677	8.3	9.8	7.2	(?)	4.5
678	9.3	11.5	(?)	21	3
679	6.9	8.5	6.4	24	5
680	9.1	10	6.6	21–23	4.5

Holotype: USNM 145668.
Paratypes: 145665–145667, 145669–145680.
Occurrence: Antelope Valley Limestone: USGS colln. D709 CO, D710 CO, D712 CO, upper part of formation, approximately 30 ft below base of Eureka Quartzite. Ranger Mountains, Nevada Test Site (Ross, 1964b, p. C18–C19; pl. 1, loc. 50); USGS colln. D835 CO, approximately 160 ft below black shale at base of Eureka Quartzite. Rawhide Mountain, Nev. (Ross, 1964b, p. C66, C68, text fig. 5).

Discussion.—This species is very similar to *Orthambonites swanensis* from which it differs by its smaller size and by lack of multiple striae between costae. Previously I have referred this species to *O.* cf. *O. swanensis* (Ross, 1964b, p. C18, C19, C68). *O. minusculus* Phleger possesses a more auriculate outline and more angular costae and interspaces. Although *O. paucicostatus* has a similar outline and about the same number of costae, it is a much larger species with only two to three costae in a space of 5 mm at the front of the shell. *O. dinorthoides* is a large form like *O. paucicostatus* in outline and costal spacing, but it has costae and interspaces of about equal width.

Genus PLAESIOMYS Hall and Clarke, 1892

Plaesiomys? sp.

Plate 1, figure 30

Plaesiomys is questionably represented in collections from the Barrel Spring Formation by a single specimen, a mold of the interior of a brachial valve. Without an exterior of either valve and without a pedicle interior, the generic assignment is uncertain. If *Plaesiomys* is present, this specimen may be one of its oldest occurrences. The specimen is figured as a matter of record.

Figured specimen: USNM 145681.
Occurrence: Barrel Spring Formation: USGS colln. D1477 CO. On west side of headward part of Mazourka Canyon, altitude 8,320 ft, California coordinates, zone 4: E. 2,267,900 ft, N. 590,600 ft, Independence quad., California. Collected by Wilfrid Davis.

Genus HESPERORTHIS Schuchert and Cooper, 1931

Hesperorthis Schuchert and Cooper. Cooper, 1956, Smithsonian Misc. Colln., v. 127, pt. 1, p. 343–344.

Hesperorthis cf. H. dubia Cooper

Plate 1, figures 16–19

This species is represented only by molds in the argillite of the Barrel Spring Formation. It is not well-enough known for positive identification or for formal description.

Brachial valve nearly flat and faintly sulcate. Pedicle valve less convex than in most species of genus. Exterior bears 32–38 costae. In interior of pedicle valve the muscle field markedly bilobed.

Figured specimens: USNM 145682–145685.
Occurrence: Barrel Spring Formation: USGS colln. D1475 CO, east side of Al Rose Canyon, altitude 8,400 ft, California coordinate, zone 4: E. 2,267,100 ft, N. 591,750 ft, Independence quad., California; USGS colln. D1476 CO, east side of Al Rose Canyon, altitude 8,440 ft, California coordinates, zone 4: E. 2,267,500 ft, N. 591,200 ft, Independence quad., California; USGS colln. D1477 CO, on west side of headward part of Mazourka Canyon, altitude 8,320 ft, California coordinates, zone 4: E. 2,267,900 ft, N. 590,600 ft, Independence quad., California. Collected by Wilfrid Davis.

Discussion.—This species adds to the faunal assemblage of Porterfield aspect in the Barrel Spring Formation, although the genus *Hesperorthis* is known in beds as young as Trenton.

Genus PTYCHOPLEURELLA Schuchert and Cooper, 1931

Ptychopleurella Schuchert and Cooper. Cooper, 1956, Smithsonian Misc. Colln., v. 127, pt. 1, p. 385.

Ptychopleurella kleinhamplei, n. sp.

Plate 1, figures 9–15

This species of average size for the genus. Its length about three-fourths its width. Cardinal extremities, obtuse. Greatest width behind midlength. Outline of sides rounded with sharper curvature than that of front margin. Surface costate. Costae acutely rounded to narrowly angular. Interspaces V-shaped, of about the same width as costae. Approximately 18–19 costae on a valve. Surface lamellose or imbricate, particularly in distal half. Imbrications spaced four to five in 2 mm. Anterior commissure faintly sulcate. Pedicle interarea apsacline, almost catacline. In lateral profile, the two valves are of approximately equal convexity; in anterior profile, pedicle valve is the more convex and brachial valve is gently sulcate.

Although brachial valve is very slightly sulcate, pedicle valve is evenly convex in anterior profile. There is suggestion that central seven costae are of about same height, but this height is affected by stage of growth of shell. Posterolateral slopes of valve very slightly concave. Length of interarea three-tenths hinge width. No specimens show interior of pedicle valve.

On brachial valve, there may be as many as seven or eight costae involved in very gentle sulcus. Posterolateral corners almost flat or very slightly concave. In interior, brachiophores short and stout. Cardinal process shows suggestion of thickening to form small but obvious myophore on one specimen but no thickening at all on another.

Holotype: USNM 145686.
Paratype: USNM 145687.
Occurrence: Antelope Valley Limestone: USGS colln. D819 CO, from float 100–210 ft below top. Meiklejohn Peak, Nev., southwest side (Ross, 1964b, p. C25, C27; pl. 1, loc. 32).

Discussion.—In outline this species probably resembles most closely *Ptychopleurella rectangulata* Cooper; that Virginia species is somewhat smaller, has fewer total costae, and has fewer costae in the brachial sulcus. The size range of *P. glypta* Cooper includes that of the present species, but *P. glypta* is considerably more convex and possesses a much narrower brachial sulcus.

Genus VALCOUREA Raymond, 1911

Valcourea Raymond. Cooper, 1956, Smithsonian Misc. Colln., v. 127, no. 1, p. 404–405.

Valcourea sp. 1

Plate 3, figures 17, 18

All specimens are small and presumably immature. Although little doubt exists concerning their generic assignment, any firm conclusions concerning specific identity are difficult to reach.

The cardinal process, seemingly because of immaturity, lacks a strong myophore. A brachial valve 5 mm long shows characteristic gentle convexity, but one 2.5 mm long is nearly flat. Approximately 20 costellae in 5 mm along margin of shell 5 mm long.

Figured specimens: USNM 145688, 145689.

Occurrence: Antelope Valley Limestone: USGS colln. D819 CO, from float 100–210 ft below base of Eureka Quartzite. Meiklejohn Peak, Nev., southwest side (Ross, 1964b, p. C25, C27; pl. 1, loc. 32).

Valcourea sp. 2

Plate 3, figure 16

Outline semielliptical, about twice as wide as long. Median sulcus narrow and more clearly defined near umbo than at anterior margin where it is very shallow and on this specimen about 5 mm wide. Costellae spaced 16 in a width of 5 mm at margin. Hinge width, 17 mm; length, 9 mm.

Figured specimen: USNM 145690.

Occurrence: Eureka Quartzite: USGS colln. D680 CO, in sandy limestone, 60–90 ft above base. Ranger Mountains, Nevada Test Site (Ross, 1964b, p. C18; pl. 1, loc. 50).

Discussion.—A single specimen from collection D680 CO is assigned without much question to *Valcourea* although it is a brachial exterior. This specimen is practically indistinguishable from *Valcourea angulata* (Phleger) from the Barrell Spring Formation. It may also represent adult stages of the small specimens referred to *Valcourea* sp. 1, above.

Genus DESMORTHIS Ulrich and Cooper, 1936

Desmorthis Ulrich and Cooper, 1938, Geol. Soc. America Sp. Paper 13, p. 158.

Desmorthis planus, n. sp.

Plate 1, figures 3–7

All specimens of this species in the present collection are small, possibly immature.

Valves unequally biconvex, brachial gently convex in lateral profile and sulcate in anterior view, pedicle evenly convex in both anterior and lateral profile. Outline wider than long; hinge width narrower than midwidth. About 30 costae. Increases in number of costae during growth mainly by implantation but a few by bifurcation. Four costae in space of 1.0 mm in valve 5 mm long. Brachial sulcus very shallow yet distinct, occupied by about five to seven costae.

In interior of brachial valve, cardinal process is a thin blade. Brachiophores rodlike and supported by lamellae bounding the notothyrial cavity. Fulcral plates present. Median septum poorly developed; most of median ridge caused by brachial sulcus.

Interior of pedicle valve has receding dental lamellae. Diductor scars bilobed, separated by linear adductor scar extending in front of them. Cardinal area short, apsacline.

Holotype: USNM 145691.

Paratypes: USNM 145692–145694.

Occurrence: Antelope Valley Limestone: USGS colln. D829 CO, 530–550 ft below top. Meiklejohn Peak, Nev., north side (Ross, 1964b, p. C29, C31; pl. 1, loc. 32).

Discussion.—This species is smaller than *Desmorthis nevadensis* Ulrich and Cooper and bears fewer costae. In *D. nevadensis* there are two to three costae per mm as compared with four per mm in this species, and yet *D. nevadensis* has a total of 50 as against 30 in this species. The brachial valve is flatter and more pronouncedly sulcate in this species than in immature specimens of *D. nevadensis* of comparable size.

Genus SKENIDIOIDES Schuchert and Cooper, 1931

Skenidioides Schuchert and Cooper, 1932, Peabody Mus. Nat. History Mem., v. 4, p. 71

Skenidioides oklahomensis Cooper

Plate 2, figures 1–7

Skenidioides oklahomensis Cooper, 1956, Smithsonian Misc. Colln., v. 127, pt. 1, p. 498–499, pl. 97A, figs. 1–12; pl. 98E. figs. 24–27.

The present specimens agree so closely with the type specimen in size, proportion, and ornamentation that there seems little doubt that they are conspecific. Several specimens from Nevada are illustrated here as a matter of record and because their occurrence is significant stratigraphically.

Figured specimens: USNM 145695–145697.

Occurrence: Antelope Valley Limestone: USGS colln. D829 CO, 530–550 ft below top. Meiklejohn Peak, Nev., north side (Ross, 1964b, p. C24, C29, C31; pl. 1, loc. 32).

Discussion.—This species, reported previously from rocks of Porterfield age, is one of several that can be interpreted to indicate a post-Whiterock age for strata that on lithology and position would be considered correlative with beds of the *Anomalorthis* zone farther east.

Genus ATELELASMA Cooper, 1956

Atelelasma Cooper, 1956, Smithsonian Misc. Colln., v. 127, pt. 1, p. 517.

Unfortunately all the specimens of the species described below, the first representative of the genus *Atelelasma* reported from the Western United States, are damaged. They are silicified and are from rocks that are fractured too badly to permit obtaining a single complete shell; however, it seems possible to distinguish this species as a separate one.

Atelelasma primotica, n. sp.

Plate 2, figures 8–14

Brachial valve gently convex and has distinct but shallow median sulcus. Sulcus originates at umbo and widens rapidly. Interarea anacline. Posterolateral surfaces slightly concave.

Pedicle valve strongly convex in anterior profile and semiconical in lateral profile. Interarea procline to catacline, having apical angle of approximately 110°. Delthyrium bounded by narrow deltidial plates. Cardinal angles barely acute to normal although greatest width of shell may have been slightly forward of hinge line.

Costellae increase in number by implantation and are spaced 13–15 in 5 mm along front of mature valve.

Holotype: USNM 145698.

Paratypes: USNM 145699, 145700.

Occurrence: Antelope Valley Limestone: USGS colln. D819 CO, from float 100–200 ft below base of Eureka Quartzite, Meiklejohn Peak, Nev., southwest side (Ross, 1964b, p. C25, C27; pl. 1, loc. 32); USGS colln. D831 CO, 350 ft below base of Eureka Quartzite. Approximately half a mile north of Meiklejohn Peak, Nev., north side (Ross, 1964b, p. C29–C30; pl. 1, loc. 32).

Discussion.—In the proportions of the interarea of the pedicle valve this species is very similar to *Atelelasma perfectum* Cooper, from which it differs in having closer spacing of the costellae and in having somewhat less elongate outline. It differs from all other described species in the closeness of the spacing of costellae, with the possible exception of *A. sulcatum* Cooper which has a far less convex pedicle valve and *A.? multicostum* (Hudson) which has a procline pedicle interarea.

Genus OXOPLECIA Wilson, 1913

Oxoplecia Wilson. Ulrich and Cooper, 1936, Jour. Paleontology, v. 10, no. 5, p. 337–338.

Oxoplecia monitorensis Cooper

Plate 2, figures 25–29

Oxoplecia monitorensis Cooper, 1956, Smithsonian Misc. Colln., v. 127, pt. 1, p. 548, pl. 102D, figs. 33–37.

The original illustrations of this species showed no costae on the fold of the brachial valve, a lack probably caused by abrasion or weathering. The present specimen, although partly decorticated, shows the predictable six costae. It also shows that the costae are of very unequal strengths and have no symmetrical arrangement according to strength.

Figured specimen: USNM 145701.

Occurrence: Antelope Valley Limestone: USGS colln. D824 CO, topmost 13 ft. Meiklejohn Peak, Nev., north side (Ross, 1964b, p. C24, C29, C30; pl. 1, loc. 32).

Discussion.—This species is of particular significance stratigraphically. Its occurrence with *Laticrura* cf. *L. heteropleura* Cooper and *Sowerbyella* cf. *S. perplexa* Cooper indicates equivalence to Cooper's Porterfield Stage and correlation with the lower part of the Copenhagen Formation.

Genus STENOCAMARA Cooper, 1956

Stenocamara Cooper, 1956, Smithsonian Misc. Colln., v. 127, pt. 1, p. 602–603.

Stenocamara? sp.

Plate 2, figures 15, 16

Only fragmentary specimens of this species have been obtained. They all have smooth exteriors. None of the fragments is large enough to indicate with certainty the shape of the whole shell.

In interior of brachial valve, brachiophore bases converge to form sharply angular cruralium supported by long median septum. In pedicle valve exceptionally long subparallel lamellae support hinge teeth; these lamellae reach floor of valve in advance of teeth.

Figured specimens: USNM 145702, 145703.

Occurrence: Antelope Valley Limestone: USGS colln. D713 CO, top 10 ft. Ranger Mountains, Nevada Test Site (Ross, 1964b, p. C18; pl. 1, loc. 50).

Discussion.—Although this species cannot be described fully because of fragmentary nature of the specimens, the interiors alone show clearly that it is a stenocamarinid. Previously only the Marmor genus *Stenocamara* was assigned to this subfamily. Better collections will be needed to show whether this species belongs to *Stenocamara* or to a closely related genus.

Genus LEPTELLINA Ulrich and Cooper, 1936

Leptellina Ulrich and Cooper, 1938, Geol. Soc. America Spec. Paper 13, pt. 1, p. 190–191.

Leptellina occidentalis Ulrich and Cooper

Plate 3, figures 1–10

Leptellina occidentalis Ulrich and Cooper, 1938, Geol. Soc. America Spec. Paper 13, p. 191, 192, pl. 39B, figs 3, 7.

Cooper, 1956, Smithsonian Misc. Colln., v. 127, pt. 1, p. 751, pl. 189C, figs. 30–37.

Nothing is added here to the original description of this species.

Figured specimens: USNM 145704–145710.

Occurrence: Antelope Valley Limestone: USGS colln. D819 CO, float, 100–210 ft below top. Meiklejohn Peak, Nev., southwest side. D829 CO, 530–550 ft below top; D831 CO, 400 ft below top. Meiklejohn Peak, Nev., north side (Ross, 1964b, p. C24, C25, C27, C29–31; pl. 1, loc. 32).

Discussion.—Specimens here identified as *Leptellina occidentalis* resemble *L. llandeiloensis* (Davidson) (Williams, 1962, p. 164–166, pl. 15, figs. 27, 32) in outline, size, relative size of the brachial diaphragm and ornamentation. In *L. llandeiloensis*, the length of the brachial diaphragm is 0.46 its width; in *L. occidentalis* it is 0.4–0.5. Williams's illustrated specimen (1962, pl. 15, fig. 28) shows well-developed pallial markings, with two main trunks originating at the tips of the bilobed pedicle muscle scar. In two specimens of *L. occidentalis* (pl. 3, figs. 7, 8), the positions are suggested of a similar pair of trunks, ramifications of which are not preserved.

Genus SOWERBYELLA Jones, 1928

Sowerbyella cf. S. perplexa Cooper

Plate 3, figures 11–15

Sowerbyella perplexa Cooper, 1956, Smithsonian Misc. Colln., v. 127, pt. 1, p. 790, pl. 196F, figs. 41, 40.

The specimens at hand agree with *S. perplexa* in size, outline, and spacing of costellation. Where the posterolateral flanks of the pedicle valve are slightly concave in *S. perplexa*, they are flat or very slightly convex in this form. The anterior parts of the interiors of both valves are strongly spinose as in *S. aequicostellata* Cooper.

Figured specimens: USNM 145711–145713, 146507.

Occurrence: Antelope Valley Limestone: USGS colln. D820 CO, upper 6 ft, Meiklejohn Peak, southwest side; USGS colln. D824 CO, 35 ft below top. Meiklejohn Peak, Nev., north side (Ross, 1964b, p. C24, C25, C27, C29, C30; pl. 1, loc. 32).

Genus MACROCOELIA Cooper, 1956

Macrocoelia Cooper, 1956, Smithsonian Misc. Colln., v. 127, pt. 1, p. 890–891.

Macrocoelia? sp. 1

Plate 2, figure 17

Large, gently concavo-convex shells, with even curvature in lateral profile. In outline somewhat wider than long with squared cardinal angles, straight sides, and broadly rounded anterior. In anterior profile an extremely obscure fold at anterior of pedicle valve. Lateral slopes toward the cardinal angles almost flat, with very slight concavity. Ornamentation very delicate. At front of shell, three sizes of costellae present; coarsest size spaced about six in 5 mm. Between every two of these there tends to be a smaller costella. Between each coarse and less coarse costella is a third smaller size. All these are crossed by much finer concentric ornamentation.

Figured specimen: USNM 145714.

Dimensions of figured specimen: Length 28 mm, median width 32 mm, hinge width 31 mm.

Occurrence: Antelope Valley Limestone: USGS colln. D713 Co, upper 10 ft. Ranger Mountains, Nevada Test Site (Ross, 1964b, p. C18; pl. 1, loc. 50).

Discussion.—No interiors are known for this species. Generic assignment is therefore impossible. Delicacy of external ornamentation suggests that the species may be assignable to *Glyptomena*, but most species of that genus are markedly smaller. Stratigraphic significance is identical because both *Macrocoelia* and *Glyptomena* range in age from Marmor to Porterfield.

Macrocoelia? sp. 2

Plate 2, figures 18, 19

Gently concavo-convex with even curvature in lateral profile. Outline almost square with rounded front, hinge width equal to or slightly exceeding midwidth. Cardinal extremities may be very slightly alate. Sides subparallel. Costellae of two sizes, larger ones predominating with smaller costellae interspersed irregularly, two to three in space of 1.0 mm at front of valve.

Figured specimen: USNM 145715.

Dimensions of figured specimen: Length 32 mm, midwidth 32.5 mm, hinge width 37 mm, approximately.

Occurrence: Antelope Valley Limestone: USGS colln. D731 CO, 5 ft below top. South of Aysees Peak, Nevada Test Site (Ross, 1964b, p. C18; pl. 1, loc. 50).

Discussion.—All available specimens are rather crudely silicified. No interiors are present and exteriors do not show the ornamentation well.

This species is smaller and less alate than *Macrocoelia occidentalis* Cooper from the Copenhagen Formation and lacks the wrinkled surfaces of *M. occidentalis* in the cardinal extremities. In size and ornamentation it seems to be similar to *M. elegantula* Cooper from the Ashby of Virginia, some shells of which it also resembles in outline (Cooper, 1956; pl. 235C, fig. 8); it is less convex, however, than the Virginia species.

Genus LATICRURA Cooper, 1956

Laticrura Cooper, 1956, Smithsonian Misc. Colln., v. 127, pt. 1, p. 979–980.

Previously this genus was known only in the Appalachian region and in the British Isles (Williams, 1962, p. 144). Its age range is Porterfield to Trenton.

Laticrura cf. L. heteropleura Cooper

Plate 2, figures 20–24

Two specimens, one a silicified shell, broken but showing the interior structures, the other a poor but complete individual, have been found in southern Nevada. These hardly warrant description, but are extremely important stratigraphically.

On the basis of general outline and form they seem to resemble *L. heteropleura* Cooper very closely, but are too poorly preserved to be sure of identity.

Figured specimens: USNM 145716, 145717.

Occurrence: USGS colln. D824 CO. Antelope Valley Limestone, approximately 25 ft below top. Meiklejohn Peak, Nev., north side (Ross, 1964b, p. C24, C29, C30; pl. 1, loc. 32).

Phylum ARTHROPODA
Class TRILOBITA

Genus TRINODUS M'Coy, 1846

Confusion currently exists concerning the identifying characteristics of *Trinodus*, particularly those that distinguish it from *Geragnostus*. Both *Trinodus* and *Geragnostus* have many more similarities than differences.

The main difference emphasized by Howell (1935, p. 231, 233–234) in erecting *Geragnostus* was the presence of a transverse furrow on its glabella and the lack or near lack of such a furrow in *Trinodus*. He stated that the glabella of *Trinodus* might bear faint traces of a transverse furrow but would never be truly bilobed; this statement describes the condition of one species, *G. occitanus*, which he placed in *Geragnostus*. And it was on the same basis that I (Ross, 1958, p. 562–564) assigned the species *valmyensis* to *Trinodus*. In *T. valmyensis*, no transverse glabellar furrow exists; the sides are constricted slightly. My supposition that the constrictions in the glabella of *T. valmyensis* might be relicts of the transverse furrow in *Geragnostus* was probably erroneous. Tjernvik (1956, p. 188–193) had previously described four species of *Geragnostus*, and also redescribed the type species *G. sidenbladhi;* four of these species have a transglabellar furrow and glabellar constrictions. The constrictions are behind the furrow and are shown to be discrete from the furrow. In *G. sidenbladhi*, glabellar constrictions are absent (Tjernvik, 1956, p. 189).

In redescribing *T. agnostiformis* M'Coy, Whittington (1950, p. 533–535) made no mention of glabellar constrictions. Whittington (1963, p. 28) stated that one of three characteristics distinguishing *Trinodus* from *Geragnostus* is the absence of the lateral furrows from the glabella. He then placed in *Geragnostus* the species *G. clusus*, which lacks a transglabellar furrow but possesses faint glabellar constrictions.

Is the shift in emphasis justified, the shift that rejects Howell's original prime criterion, the presence of transglabellar furrow in *Geragnostus* and its absence in *Trinodus*, the shift that substitutes the presence or absence of faint constrictions close to the axial furrows? Such constrictions are known in a great variety of trilobites and generally indicate the positions of appendifers beneath glabellae that are otherwise unfurrowed, but as noted above they may not be related directly to the transglabellar furrow of *Geragnostus*.

In this regard, Howell's assignment of *G. occitanus* seems to indicate that he, himself, considered the glabellar constrictions characteristic of *Geragnostus*.

Whittington's (1963, p. 28) further restriction of *Trinodus* to forms that lack the median glabellar tubercle must be an oversight, because *T. tardus* (Barrande), (see Kielan, 1959, p. 60–62, pl. 1, figs. 7, 8) possesses such a tubercle.

Howell (1935, p. 234) stated that *Trinodus* is characterized by a short pygidial axis, a feature he (p. 231) also ascribed to *Geragnostus*. A review of Howell's illustrations shows that in the species he assigned to *Geragnostus* the length of pygidial axis is about six-tenths or a little more of the pygidial length; the length of the axis in *Trinodus* seems to be closer to five-tenths or less. Whittington (1963, p. 28) emphasized this difference in length of the pygidial axis, and in assigning to *Geragnostus* the two species *G. clusus* Whittington (1963, p. 28; pl. 1, figs. 4, 10, 11, 14) and *G. longicollis* (Raymond) (Whittington, 1965, p. 301, pl. 1, figs. 1, 7, 16) he has considered the length of the axis paramount to the absence of transglabellar furrow.

The group of species comprising *Trinodus* and *Geragnostus* obviously can be divided into three parts, which show the following characteristics:

1. Transglabellar furrow and long pygidial axis exceeding six-tenths total pygidial length. Species displaying these characteristics are definitely *Geragnostus*.
2. No transglabellar furrow but a long pygidial axis exceeding six-tenths pygidial length. Species showing these characteristics are intermediate between *Geragnostus* and *Trinodus*.
3. No transglabellar furrow and short pygidial axis equalling five-tenths or less the total pygidial length. Species showing these characteristics are definitely *Trinodus*.

Of these groups, the first (*Geragnostus* s.s.) ranges from Late Cambrian to middle Early Ordovician, the second (*Trinodus* s.l.) ranges from early Early to early Middle and possibly to Late Ordovician, and the third (*Trinodus* s.s.) ranges from Early to Late Ordovician. There is therefore no stratigraphic value in separating the second and third groups, both of which I regard as belonging to *Trinodus*, a genus not known earlier than Ordovician.

To me it seems that the transglabellar furrow is an essential feature of *Geragnostus*, that lateral glabellar constrictions close to axial furrows may be present or absent in both *Geragnostus* and *Trinodus*, and that the median glabellar node is absent in some but not in all species of *Trinodus*.

T. valmyensis Ross, *G. clusus* Whittington, and *G. longicollis* (Raymond) are surely congeneric. None of these species is precisely like *G. sidenbladhi* or *T. agnostiformis*, but the absence of a transglabellar furrow like that of *G. sidenbladhi* (see Tjernvik, 1956, pl. 1, fig. 5) favors assignment of all three species to *Trinodus*.

The two species described below lack a glabellar tubercle and a transglabellar furrow and seem to lack glabellar constrictions. They are assigned to *Trinodus*.

Trinodus cf. T. clusus (Whittington)

Plate 3, figures 21–25

Geragnostus clusus Whittington, 1963, p. 28–30, pl. 1, figs. 1–17.

This species is represented by two specimens in the present collection—a cephalon and a pygidium. Both are coarsely silicified and covered with siliceous silt particles that cannot be removed. Details of the carapace are partly masked.

It is obvious that the proportions of length to width of the cephalon and its glabella and of the pygidium and its axis are very nearly the same as in *T. clusus* (Whittington) and *T. longicollis* (Raymond) (Whittington, 1965, p. 301–302, pl. 1, figs. 1–12, 14, 16, 17). Whittington stated that the posterior part of the pygidial axis is longer in *T. longicollis* than in *T. clusus;* however, his illustrations show that the length of the posterior part compared with the total length of the axis ranges from 0.46 to 0.49 in *T. longicollis* and from 0.42 to 0.50 in *T. clusus*. This difference is far from distinctive. Proportions of the pygidial axis relative to the pygidium show similar overlaps. It is possible that the differences between the two are of varietal or subspecific rank.

The two specimens from California illustrate the difficulty in differentiating *T. clusus* and *T. longicollis* on the basis of the angularity of the anterolateral and posterolateral "corners" of the cephalic and pygidial borders. These specimens seem to resemble more nearly *T. clusus* in this regard (compare Whittington, 1963, pl. 1, fig. 7, with Whittington, 1965, pl. 1, fig. 11). Because of poor preservation it is not possible to ascertain whether a glabellar tubercle is present or whether the glabella is laterally constricted. Additional material is needed for study.

Figured specimens: USNM 145718, 145719.

Occurrence: Antelope Valley Limestone: USGS colln. D1398 CO, 379 ft above base. North of Pyramid Peak, Ryan quad. California.

Trinodus sp. 1

Plate 3, figures 19, 20

Only three specimens of this species—a cephalon and two pygidia—were collected, and all are very small.

Length of cephalon approximately equals its width. Convex border bounded by deep furrow. Cheeks strongly convex, surmounted by narrowly convex glabella. Glabella lacking transverse furrow, lateral constrictions, and median pustule. Length of glabella about two-thirds that of cephalon; its width about one-half that of cephalon and two-thirds its own length. Its width across basal nodes almost six-tenths cephalic width.

Pygidium as wide as long. Border bearing posterolateral spines. Median node rests along full midlength of second axial ring. Axis two-thirds as long as pygidium, narrowest at second ring. Anterior axial ring represented by two anterolateral nodes.

Figured specimens: USNM 145720, 145721.

Occurrence: Antelope Valley Limestone: USGS colln. D728 CO, 35 ft above base of Ranger Mountains Member. Southwest of Aysees Peak, Nevada Test Site (Ross, 1964b, p. C20; pl. 1, loc. 50).

Discussion.—In the species represented here, the glabella and pygidial axis are longer than in *Trinodus valmyensis* Ross and the glabella is wider. The width of the glabella and of the pygidial axis is greater in *T. clusus* (Whittington).

Genus SHUMARDIA Billings, 1862

Shumardia exopthalmus, n. sp.

Plate 10, figures 23–33

This species is characterized by the pointed anterior outline of the glabella and the globular shape of the anterolateral lobes of the glabella. Nearly 600 silicified specimens of cephalons 0.5–1.3 mm in length are included in the present collections, but none has been recognized corresponding to the smallest growth stages described for *S. pusilla* by Stubblefield (1926).

Cephalon approximately semicircular in outline with steeply sloping, almost vertical, lateral and frontal slopes. Genal angles nearly 90° and rounded. In its posterior part, glabella rises only slightly above general cephalic surface, occipital ring forming highest part of cephalon. Length of glabella very nearly equal to length of cephalon in dorsal view. Although glabella does not reach cephalic margin, preglabellar field is nearly vertical; cephalon 1.2 mm long, sagittal length of preglabellar field is 0.2 mm.

Large anterolateral lobes have traditionally been considered part of glabella. In this species each lobe is bounded anterolaterally by a faint furrow running almost straight to the sagittal line, where it meets its mate at angle slightly more than 90°. Inside of each of lobes also defined by faint furrow, almost paralleling outer one and intersecting its counterpart at a little less than 90°. Lobes therefore appear like two "teardrops" con-

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nected across front of and drawn backward along sides of glabella.

Behind large lobes, axial furrows are greatly excavated so that back of glabella seems to be narrowly convex semicylinder bounded on each side by deep valley. Into each of these valleys projects bulbous posterior end of anterolateral glabellar lobes. In many specimens, faint pair of glabellar furrows creases sides of glabella between large lobes and poorly defined occipital furrow, separating two pairs of very small ill-defined lateral glabellar lobes. In other specimens, sides of glabella are deeply impressed in this area, but definition of lateral glabellar lobes is uncertain.

Occipital furrow poorly defined, seemingly represented by pair of deep pits in axial furrows which crease sides of glabella but do not cross its crest. In many specimens, separation of occipital furrow and first preoccipital glabellar furrows virtually impossible. As a result, interior limit of occipital ring not precise.

On each side of posterior margin of cephalon, narrow furrow runs from genal angle inward toward occipital ring, then turns abruptly forward at 90° to run into axial "valley." However, its entry into axial "valley" is as raised lip well above floor of "valley." This furrow at first seems to be both a border furrow and, after its turning, an axial furrow.

Largest available pygidia transversely subelliptical with slight median indentation of posterior margin. Axis low, bluntly semiconical, composed of four rings and terminal piece, and occupying three-fourths of sagittal pygidial length. Narrow convex border limited proximally by very shallow furrow. Three pleural furrows, and possibly a faint fourth, cross each pleural platform. Tiny pustules present on each pygidial segment.

Holotype: USNM 145722.

Paratypes: USNM 145723–145729.

Occurrence: Ninemile Formation: USGS colln. D724 CO, 180–195 ft above base. Southwest of Aysees Peak, Nevada Test Site (Ross, 1964b, p. C22). Antelope Valley Limestone: USGS colln. D1437 CO. Barnes' unit 9, Specter Range, Nevada (p. D36).

Discussion.—During growth when the cephalon is about 0.5 mm long, the glabella of this species is not much different in outline from that of *Shumardia pusilla.* When 0.8 mm long, the cephalon possesses a tapering, bluntly semiconical glabella with anterolateral lobes draped backward along its sides. There is a progressive change to greater width at these lobes and greater constriction of the glabella behind them and in front of the occipital ring.

Although several species possess an anteriorly pointed glabellar outline, including *S. pusilla* (Sars), *S. granulosa* Billings, *S. oelandica* Moberg, and *S. sagittula* Whittington, in all but the last of these the angulation of the point is broadly obtuse. In *S. exopthalmus* it is approximately 90°. In *S. sagittula* (Whittington, 1965, pl. 17, figs. 1, 3, 5–7, 11), the furrows that outline the anterior of the glabella approach each other but never meet, turning anteriorly to run parallel as they do in some species of *Clelandia* (pl. 10, figs. 7, 11). The inner furrows separating the frontal lobes from the rest of the glabella are very similar in *S. granulosa* and *S. exopthalmus* but are considerably shorter in *S. sagittula.*

Genus CAROLINITES Kobayashi, 1940

Carolinites angustagena, n. sp.

Plate 3, figures 29–39

Cranidium subpentagonal in outline; its greatest width between palpebral rims approximately equal to 1½ times its midlength. Anterior border narrow, subtubular.

Glabella encompasses more than nine-tenths the cranidial length. Length of occipital ring (sag.) a little more than one-fourth total glabellar length. Width at occipital ring and at glabellar midpoint equal almost nine-tenths the glabellar length. Axial furrows deep, crossing posterior border to define sides of occipital ring, swinging inward around preoccipital nodes. In front of nodes, axial furrows curve outward and then inward in quarter circular course to define bluntly rounded glabella. At anterior midline, confluent axial furrows and anterior border furrow are essentially tangent; there is almost no preglabellar field.

Fixed cheeks are exceedingly narrow; excluding preoccipital nodes not exceeding palpebral rims in width (trans.) except on the posterior border between facial suture and axial furrow. Palpebral furrow deep, curving gently from posterior to anterior border furrow. Palpebral rim not much wider than furrow delimiting it; in lateral profile each rim is flat topped and has a gentle slope posteriorly and a nearly vertical to overturned slope anteriorly. Distance between outsides of preoccipital nodes exceeds glabellar length. Preoccipital nodes flattened, set off from rest of fixed cheeks by shallow but distinct furrows.

Each free cheek composed of great bulbous eye, surmounting a semicircular subtubular border from which it is separated by distinct furrow. Genal spine about half as long as eye, originates in front of middle of border.

Thorax not known.

Pygidium subtrapezoidal in outline, strongly convex, its height equal to two-thirds its length. Axis composed of four prominent rings and vertically flattened terminal piece creased by very shallow vertical median furrow. Pleural platforms divided by three furrows on sides. Platforms almost horizontal close to axial furrows, rolling distally to become vertical. Height of vertical part equals width of horizontal. Posterior or fourth pair of pleura forming low slanting nodes bounded on posterior face of pygidium by shallow furrows. Border furrow impressed distinctly around vertical part of pleural platform and bounding a narrow subtubular border. Border and border furrow can only be seen in lateral and posterior views, being hidden in dorsal view by overhang of pleural platforms.

Holotype: USNM 145732.

Paratypes: USNM 145733–145738.

Occurrence: Antelope Valley Limestone: USGS colln. D1397 CO, 367 ft above base; USGS colln. D1398 CO, 379 ft above base; USGS colln. D1399 CO, from float derived from 410 to 435 ft above base of formation. North of Pyramid Peak, Ryan quad., California.

Discussion.—This species differs markedly from *Carolinites genacinaca* Ross by the extreme narrowness of the fixed cheeks, shortness of the genal spines, and convexity of the pygidium. It lacks the indented preglabellar field of *C. indentus*, n. sp. from collection D727 CO (Ross, 1964b, p. C20), as well as the wide fixed cheeks.

The fixed cheeks outside the preoccipital nodes are narrower in this species than in *C. nevadensis* Hintze, *C. killaryensis* Stubblefield, or *C. kyllaryensis utahensis* Hintze. In fact, *C. kyllaryensis* has wider fixed cheeks than any other species whereas *C. kyllaryensis utahensis* has narrower fixed cheeks than any species except *C. angustagena*. *C. angustagena* lacks the terminal pygidial spine of *C. killaryensis* and *C. killaryensis utahensis* and flatness of the posterior face of the pygidium is distinctive. It agrees with all species except *C. genacinaca* in the oversteepening of the pygidial pleural platforms.

This species may be synonymous with the Siberian *Carolinites sibiricus* Chugaeva (Chugaeva and Ivanova, 1964, p. 45–46, pl. 1, figs. 4, 5; text fig. 13), sharing with it narrow fixed cheeks; however, no pygidium is known for the Siberian species, and no final comparison can be made at the present time.

From the middle Table Head Formation of Newfoundland, Whittington (1965, p. 373–374, pl. 39, figs. 3, 4, 7, 11–13) has described two specimens assignable to *Carolinites*. Both are cranidia and both are characterized by exceptionally wide fixed cheeks and pustulose surfaces.

Silicified specimens believed to belong to true *Carolinites killaryensis* Stubblefield have been discovered 8 feet above the base of the Antelope Valley Limestone on the west side of a ridge, center NW¼ sec. 10, T. 15 S., R. 50 E., Nevada coordinates, central zone: E. 597, 100 ft, N. 698, 300 ft, Lathrop Wells quadrangle, Nevada. The associated trilobites include *Ischyrotoma* and *Ptyocephalus* and probably represent the *Pseudocybele nasuta* zone.

Carolinites indentus, n. sp.

Plate 3, figures 26–28

Cranidial outline distinguished by narrow extension of preglabellar field and notched anterior border.

Glabella equals eight-tenths of cranidial length. Width of glabella at its midpoint and at occipital ring equals three-fourths its length. Length of occipital ring (sag.) one-fourth total length of glabella. Axial furrows constrict sides of glabella between preoccipital nodes, diverging to points opposite glabellar midpoint then converging to become confluent around rounded front of glabella, where they are distinct from anterior border furrow. Preglabellar field exceptionally short (sag.) yet discrete. Anterior border furrow broad, shallow, setting off low convex border that is distinctly indented at midline.

Fixed cheeks moderately wide for genus, bearing long evenly curved narrow palpebral rims, delimited proximally by narrow palpebral furrows. In lateral profile, rims flat topped, sloping gently to rear and steeply to front. Preoccipital nodes small, rounded, defined distally by very faint furrow.

Facial suture cuts posterior border so that cranidial width is 1.1 times cranidial length. Sutures run forward in gentle curve to point opposite glabella midpoint, then converge laterally to a point opposite front of glabella, coinciding with front edge of eye. Sutures then run straight forward or slightly anterolaterally to distal side of border furrow, thereafter converging sharply across border to edge of anterior indentation.

Free cheeks equipped with slender genal spines (pl. 3, fig. 26) of medium length for genus.

Hypostome, thorax, and pygidium not known.

Holotype: USNM 145730.

Paratype: USNM 145731.

Occurrence: Antelope Valley Limestone: USGS colln. D727 CO, and D728 CO, 25 and 35 ft above base of Ranger Mountains Member. Southwest of Aysees Peak, Nevada Test Site (Ross, 1964b, p. C20–C21; pl. 1, loc. 50).

Discussion.—This species is described from a few immature specimens; I believe it will prove a valid taxon because its distinguishing features are not likely to be due entirely to stage development. The fact that the glabella is narrower than in other species is probably due to immaturity. The fixed cheeks are narrower than those of *Carolinites genacinaca* Ross, *C. nevadensis* Hintze, or *C. killaryensis* Stubblefield but wider than those of *C. utahensis* Hintze or *C. angustagena*, n. sp. No other species has the preglabellar field or indented anterior border of this species.

Genus REMOPLEURIDES Portlock, 1843

Remopleurides occidens Phleger

Remopleurides occidens Phleger, 1933, Southern California Acad. Sci. Bull., v. 32, pt. 1, p. 18–19, pl. 1, figs. 3, 4.

After examining the types of this species from the Barrel Springs beds, I am convinced that it may be very difficult to identify it elsewhere. The original cranidium (Phleger, 1933, pl. 1, fig. 3) is poorly preserved, and the anterior tongue has not been developed. I have taken the liberty of cleaning out a specimen of the pygidium and the rear part of the thorax which is on the same small slab with the thorax illustrated by Phleger. This specimen shows clearly that the falcate pleurae are much like those of *R. eximius* Whittington in that the posterior four are shorter than those ahead of them. The pygidium, with its two pairs of flattened broad pleural spines, is of the kind exemplified by *R. simulus* Whittington. A very long spine arises from the middle of the fourth thoracic segment from the rear; this spine extends backward several millimeters past the rear of the entire carapace.

Occurrence: "Barrel Springs Canyon, Inyo Mountains, California."

Genus ISOTELUS DeKay, 1824

Isotelus spurius Phleger

Plate 4, figures 6–9

Isotelus spurius Phleger, 1933, Southern California Acad. Sci. Bull., v. 32, pt. 1, p. 20–21.

A small species of *Isotelus;* length of entire specimens about 30 mm.

Cephalon semicircular, without genal spines. Genal angles sharply quadrate. Lacks border furrows. Glabella equals entire length of cephalon, ill defined by faint axial furrows between palpebral lobes. Glabellar width between palpebral lobes about seven-tenths glabellar length; immature specimens a little wider than the mature. In immature specimens only a suggestion of median pustule present between posterior ends of palpebral lobes. Lobes of *I. spurius* small, subtrigonal, slanted upward distally.

Each facial suture runs forward and slightly outward from palpebral lobes, curving sharply almost at right angles to cross front of cephalon to midline very slightly above margin or border, there meeting a median suture. Angle between two facial sutures 130°–140°. Posterolaterally from palpebral lobes each suture runs to border about halfway between genal angle and axial furrow.

Free cheeks, smooth, convex, bearing large eyes which are nearly quarter spheres. Shape and width of doublure not known.

Hypostome associated with these cephalic parts is of forked type. Middle body divided by curving transverse furrow approximately seven-tenths of midlength from front. Posterior part of middle body equipped with large maculae. Posterior deeply notched with gently rounded anterolateral shoulders. Notch one-half as wide as deep, almost parallel sided; its depth about four-tenths entire hypostomal length.

Thorax of eight segments.

Pygidium transversely subelliptical in outline. A very faint suggestion of border furrow hardly delineates a convex border from rest of smooth, almost featureless pygidium. Axis not defined laterally except by rudiments of axial furrows denting anterior edge above anterolateral facets. Posterior tip of axis barely suggested on some specimens seven-tenths of length from front of pygidium. Width of doublure (sag.) about four-tenths length of pygidium.

Figured specimens: USNM 145742–145745.

Occurrence: Eureka Quartzite: USGS colln. D680 CO, sandy limestone 60–90 ft above base. Ranger Mountains, Nevada Test Site (Ross, 1964b, p. C18; pl. 1, loc. 50). Barrel Spring Formation, type section: USGS colln. D924 CO, 60 ft below top; D1017 CO, 15 ft below top. Northern Inyo Mountains, Calif. (Ross, 1964b, p. C37, C40; pl. 1, locs. 2 and 8).

Discussion.—Associated with this species in the Ranger Mountains (USGS colln. D680 CO), but not in the Barrel Spring Formation, are a few free cheeks with genal spines (pl. 4, fig. 11). Although possibly a sexual dimorph of this species, they are assigned tentatively to *Megistaspis*? described on page D13.

Recently *Homotelus bromidensis* was described by Esker (1964, p. 195–198; pl. 1, figs. 5–6) from the Pooleville Member of the Bromide Formtion of Oklahoma. This Oklahoma species may prove to be synonymous with *Isotelus spurius.*

Genus ISOTELOIDES Raymond, 1910

Isoteloides? sp.

Plate 4, figures 31, 32

A single decorticated cranidium referable to *Isoteloides* was obtained.

Glabella almost parallel sided, narrowest opposite its midlength, broadly rounded in anterior outline, and lacking glabellar furrows. Median pustule about one-fifth of glabellar length from rear. Axial furrows very shallow, more a break in slope than furrows. Preglabellar field flat, separated from glabella by break in slope; sagittal length of field one-fifth length of glabella.

Posterior part of fixed cheeks (posterior limbs of old usage) broad (exsag.), short (trans.), almost flat. Size of palpebral lobes not known.

Figured specimens: USNM 145746, 145747.

Occurrence: Antelope Valley Limestone: USGS colln. D725 CO, 170 ft above base of Paiute Ridge Member. Southwest of Aysees Peak, Nevada Test Site (Ross, 1964b, p. C21; pl. 1, loc. 50).

Discussion.—This specimen is described as a matter of record. Associated is a pygidium (pl. 4, fig. 31) that may belong to this species although its axis is short for *Isoteloides.*

Genus MEGISTASPIS Jaanusson, 1956

Megistaspis? sp.

Plate 4, figures 10, 11

A single pygidium without obviously related cephalic parts is preserved in collection D680 CO. Its outline is subtriangular, length approximately 9 mm, and width about 10–11 mm. The tapering axis faintly defined, being 6 mm long and 5 mm wide at the front. Neither axial rings nor pleural furrows present, except for single pair behind anterolateral facets. A border 1 mm wide set off by faint break in slope. Doublure 2–3 mm wide.

Figured specimens: USNM 145748, 145749.

Occurrence: Eureka Quartzite: USGS colln. D680 CO, sandy limestone 60–90 ft above base. Ranger Mountains, Nevada Test Site (Ross, 1964b, p. C18; pl. 1, loc. 50).

Discussion.—This pygidium may belong to the same asaphid as the free cheek with genal spine illustrated on plate 4, figure 11. No cranidium has been found with which to ally either.

Genus NILEUS Dalman, 1827

Nileus hesperaffinis, n. sp.

Plate 4, figures 18–25

Cephalon transversely subelliptical, width twice the length (sag.), lacking axial furrows and border furrow, hence surface of cephalon is evenly curved except for large eyes. Cranidium widest at palpebral lobes. Length (exsag.) of eyes about one-half that (sag.) of cranidium. Posterior ends of eyes close to posterior margin of cephalon, only one-tenth the length of cranidium from posterior margin.

Free cheeks yoked in single unit. Genal spines developed only on immature specimens (pl. 4, fig. 19); genal angles sharp but without spines on adults (pl. 4, fig. 25). Doublure lies close to dorsal surface posteriorly but is bent sharply downward close to an imaginary line through the eye centers. Anteriorly doublure is subhorizontal and fairly wide (sag.), its sagittal width being about one-fourth the cephalic length. Hypostomal suture indents inner margin of doublure shallowly and broadly. Width of indentation equals distance between anterior ends of eyes.

Hypostome wider than long. Middle body subquadrate, not divided clearly into lobes. Maculae close to border furrow midway between front and back of middle body. Border extended into wide rounded shoulders that narrow posteriorly. Posterior border obtusely three pronged.

Thoracic segments evenly arched with very faint suggestion of axial furrows. Articulating condyles developed on ventral side of anterior edge at axial furrows. Doublure forming a sheath on each pleuron distally from articulations.

Pygidium transversely elliptical in outline, almost featureless. Axis not defined. Border suggested by concentric concavity; sagittal width of this border one-eight pygidial length. Doublure pressed close to dorsal surface, covering almost entire ventral side of pygidium. A small triangular area (beneath the axis?) left uncovered; its length two-thirds that of pygidium, its anterior width one-half that of pygidium.

Holotype: USNM 145753.

Paratypes: USNM 145750–145752, 145754, 145755.

Occurrence: Antelope Valley Limestone: USGS colln. D1398 CO, 379 ft above base. North of Pyramid Peak, Ryan quad., California.

Discussion.—This species probably resembles most closely three species from the Table Head Formation of Newfoundland. *Nileus affinis* Billings (Whittington, 1963, p. 53, pl. 9, figs. 7, 9–12; pl. 10, figs. 1–7, 10, 13; 1965, p. 358, pl. 30, figs. 1, 3, 5, 7; pl. 31, figs. 1–6, 8, 10) has shorter eyes located farther forward, a wider anterior doublure, a hypostome without furrows delimiting the sides of the middle body but with longer and more slender anterior wings and a less extensive doublure under the pygidium. Whittington has noted the rounded margin of the cephalon in comparing *N. affinis* with *N. scrutator* Billings. Like *N. scrutator* (Whittington, 1965, p. 360–361, pl. 30, figs. 2, 4, 6, 8–14; pl. 31, figs. 7, 9; pl. 32, figs. 1, 3, 5, 7, 9), *Nileus hesperaffinis* possesses a sharp cephalic margin (pl. 4, fig. 18), along which there runs an exceptionally narrow rim. The eyes of *N. scrutator* are not as long as those of *N. hesperaffinis* nor are they as close to the rear of the cephalon. Beneath the pygidium of the western species the V-shaped axial area left uncovered by the doublure is longer and narrower than that of *N. scrutator* (Whittington, 1965, pl. 31, fig. 10). In *N. macrops* Billings (Whittington, 1965, pl. 32, fig. 6), this uncovered area is as long but is also considerably wider. *N. macrops* also differs from *N. hesperaffinis* in greater convexity of the cephalon and parallel course of the anterior facial sutures.

Nileus hesperaffinis differs from the Swedish Lower Ordovician species *N. limbatus* Brogger, *N. exarmatus*

Tjernvik, and *N. orbiculatus* Tjernvik in the lack of axial and preglabellar furrows and from the first two of these in the three-pronged margin of the hypostome. (See Tjernvik, 1956, pl. 2, figs. 12–23.) *N. symphysuroides* Lu possesses a longer pygidium and axial furrows defining the glabella. (See Lu, 1957, pl. 151, figs. 8–13.) In *N. transversus* Lu (1957, pl. 151, figs. 4–6), axial furrows are also developed; its pygidium is semielliptical rather than subelliptical as in *N. hesperaffinis*. *N. hesperaffinis* bears a strong resemblance to *N. armadilliformis* Lu (1957, pl. 152, figs. 3–6), which possesses a narrow but distinctly concave border on the cephalon. In *N. armadillo* Dalman the glabella is delimited laterally by axial furrows, the cheeks lack genal angles, and the pygidium bears a well-differentiated convex border.

The proportions of the hypostome are quite different from those of *Nileus* sp. collected in essentially correlative beds on the Nevada Test Site (pl. 4, fig. 12). The anterior margin is more nearly straight than in that species. (Compare pl. 4, figs. 17 and 25.)

Examination of the underside of the yoked free cheeks (pl. 4, fig. 25) suggests that the tips of pleura that shingled over one another during enrollment probably fitted against the part of the doublure which is close against the dorsal shell. Their forward travel would have been limited by the bulge in the doublure beneath the eyes.

Nileus sp.

Plate 4, figures 12–17

This species is represented by fragmentary material, some calcareous and some silicified. It is not adequate for a complete description of the species. Enough information can be obtained to differentiate this form from *Nileus hesperaffinis*, n. sp.

Cephalon semicircular in outline. Glabella poorly defined; in decorticated specimens axial furrows faint across bases of palpebral lobes but absent on exterior surface. Similarly, occipital furrow present in decorticated specimens but not showing on dorsal surface. Posterior margin indented at axial furrow, marking posterolateral corners of glabella. These indentations may only show on decorticated specimens, as does median tubercle on glabella between posterior halves of palpebral lobes. Length of palpebral lobes less than half that of cephalon. Posterior ends close to real margin of cranidium.

Free cheeks with long genal spines in immature individuals. No complete specimens show whether there were genal spines on full-grown animals. Front margin of yoked cheeks evenly rounded curve. Anterior doublure wide; its width (sag.) estimated as equal to one-third the length of cephalon. Its margin broadly notched to receive hypostome.

Hypostome about as long as wide. Anterior wings long. Middle body marked only by maculae opposite its midpoint. Border produced into narrow shoulders anterolaterally; posterior obtusely three pointed.

Pygidium about three-fourths as long as wide. Axis not defined. Border gently convex, delimited by very shallow border furrow.

Figured specimens: USNM 145756–145760.

Occurrence: Antelope Valley Limestone: USGS colln. D727 CO and D728 CO, 25 and 35 ft above base of Ranger Mountains Member. Southwest of Aysees Peak, Nevada Test Site (Ross, 1964b, p. C20, C21; pl. 1, loc. 50).

Discussion.—This species differs from *Nileus hesperaffinis*, with which it is approximately correlative, in the more even rounding of the frontal outline, wider (sag.) anterior doublure, narrower shoulders on hypostome, and longer pygidium with better defined border. It differs from *N. affinis* Billings (Whittington, 1963, p. 53–55, pl. 9, figs. 7, 9–12; pl. 10, figs. 1–7, 10, 13), in having the eyes closer to the posterior cephalic margin and in better definition of the pygidial border. The shape of the anterior doublure is more like that of *N. affinis* than like that of *N. hesperaffinis*, n. sp., but is nonetheless narrower (sag.) than in *N. affinis*. Neither of the Chinese species mentioned above in the discussion of *N. hesperaffinis* possesses a pygidium with a similar border.

Genus ILLAENOPSIS Salter, 1866

Illaenopsis? sp.

Plate 4, figure 33

A cranidium is the only specimen of this species discovered, and it is a small one with a glabella 2.4 mm long.

Glabella expanding forward, widest between anterolateral corners. Narrowest about halfway between midlength and occipital furrow; sides of this part pinched in slightly so that crest of glabella is more narrowly rounded behind midlength. Width at front equals almost nine-tenths midlength. Narrowest width equals one-half length. Length (sag.) of occipital ring only 0.07 length of glabella. Width (trans.) of occipital ring equals 0.6 length of glabella. Occipital furrow distinct but not deep. Anterior of glabella terminates at border furrow, no preglabellar field between it and narrow rounded border. Axial furrows deep, curving; from posterior border converging forward slightly then diverging to terminate in anterior border furrow.

Fixed cheeks subtriangular; width (trans.) of each at posterior border a little less than one-third cranidial width. Surface smooth and convex. Posterior border furrow shallow and narrow. Posterior border very narrow. Exact character of palpebral lobes and rims not known. In general each facial suture seems to run fairly directly anteroproximally from posterior border, crossing the narrow (exsag.) anterior border furrow and border so that anterior width of cranidium is only slightly wider than anterior width of glabella.

Figured specimen: USNM 145761.

Occurrence: Eureka Quartzite: USGS colln. D680 CO, sandy limestone, 60–90 ft above base. Ranger Mountains, Nevada Test Site (Ross, 1964b, p. C18; pl. 1, loc. 50).

Discussion.—This single specimen may not belong to the genus *Illaenopsis*, but at present I am at a loss to suggest a more likely assignment. A. R. Palmer (written commun., Dec. 10, 1964) has called my attention to its remarkable similarity, despite the lack of basal glabellar lobes, to a Middle Cambrian specimen described and illustrated as *Bonnaspis stephenensis* by Rasetti (1951, pl. 28, fig. 6). If stratigraphic position is considered, relationship to that species seems unlikely.

In his study of trilobites from the Table Head Formation, Whittington (1965, pl. 15, fig. 14) illustrated an immature specimen of *Endymionia schucherti* showing that in early stages the lateral lobes of the glabella are undeveloped. Without such lateral glabellar lobes, adults of that species would bear a superficial resemblance to this little specimen of *Illaenopsis?;* however specimens of *E. schucherti* of equally small size already possess such lobes.

The relationships of this specimen probably will not be known until more mature representatives of the same species can be collected.

Genus **RAYMONDASPIS** Pribyl, 1948

Bronteopsis of B. N. Cooper [not Nicholson and Etheridge]. Cooper, B. N., 1953, Geol. Soc. America Mem. 55, p. 24–25, pl. 9, figs. 1–16.

Whittington and Kindle, 1963, Geol. Soc. America Bull., v. 74, p. 756.

Raymondaspis Pribyl. Skjeseth, 1955, Norsk Geol. Tidsskr., v. 35, p. 20, 21.

Raymondaspis vespertinus, n. sp.

Plate 4, figures 26–30

Glabella strongly convex in anterior profile, evenly convex in lateral profile, parallel sided in posterior third, expanding anteriorly so that its great width is located one-fifth its midlength from front. Occipital ring consuming a little less than one-fifth glabellar sagittal length. Occipital furrow deep. Sides of glabella notched by one pair of glabellar furrows (*1p*) between eye centers and one-third length from rear. Width of occipital ring slightly more than one-half length. Width between eyes slightly less than half the length. Width at front seven-eighths the length. Tiny node on occipital ring. Deep axial furrows converge very little across posterior border as far forward as glabellar furrows *1p*, then diverge markedly to join border furrow opposite widest point in glabella. Axial furrows then converge sharply as very shallow preglabellar furrow.

Complete course of facial sutures behind eyes not known. Sutures delimit subcircular palpebral lobes running sharply posterolaterally and anterolaterally from lobes. When opposite a point one-fourth glabellar length from its front, facial sutures turn abruptly inward in even confluent curves to delimit an exceedingly short (sag., exsag.) preglabellar field. Fixed cheeks narrow; exclusive of palpebral lobes, fixed cheeks form two bands whose width equals one-fifth glabellar length. Cheeks roughly parallel sides of glabella and slope steeply into axial furrows. Exsagittal diameter of palpebral lobes almost one-fourth glabellar length.

Pygidium with obtusely pointed, yet rounded outline. Length almost six-tenths width. Axis about one-half as long as pygidium; anterior width of axis two-tenths that of pygidium. Axis composed of five faintly developed rings and a rounded terminal piece. Very faint suggestion of median ridge runs from tip of axis to posterior border. Pleural platforms evenly convex, devoid of segmentation, except for furrow behind articulating facet. Border furrow shallow, broad, ill defined. Border narrow, concave.

Holotype: USNM 145762.

Paratype: USNM 145763.

Occurrence: Antelope Valley Limestone: USGS colln. D1398 CO, 379 ft above base. North of Pyramid Peak, Ryan quad., California.

Discussion: This species possesses a border furrow intersecting the axial furrow as in *Raymondaspis limbatus* (Angelin) (Skjeseth, 1955, pl. 4, fig. 2) and *Bronteopsis holtedahli* Skjeseth (1955, pl. 5, fig. 4), not as in *R. nitens* (Wiman) Skjeseth, 1955, pl. 4, fig. 1), *R. gregaria* (Raymond) (Cooper, 1953, pl. 9, fig. 1), or *R. brumleyi* (Cooper) (1953, pl. 9, fig. 9). *R. vespertinus* possesses a wider frontal lobe of the glabella than does *R. gregaria*, although the proportions of the posterior half relative to the glabellar length are about the same. The eyes in *R. vespertinus* are in about the same position fore and aft but are farther apart than in *R. gregaria*. *R. gregaria* possesses a longer pygidial axis. There are similar cranidial and pygidial differences with *R. brumleyi*. In *R. limbatus* (Angelin) the glabella is narrower and the pygidium shorter and more evenly rounded. *R. nitens* (Wiman) possesses a wider frontal glabellar lobe, and its eyes are farther to the rear. Its pygidium is more smoothly convex, more evenly rounded, and a little longer than that of *R. vespertinus*. The pygidium of *R. vespertinus* is longer and less transverse than those of *R. brevicauda* Tjernvik or *R. infundibularis* Tjernvik (1956, p. 262–263, pl. 10, figs. 18, 19). *R. brevicauda* seems to be the only species with as short a pygidial axis.

R. vespertinus differs from *R. reticulatus* Whittington (1965, p. 402–406, pl. 56, figs. 1–10; pl. 57) in the anterior course of the facial suture, in the resulting anterior width of the cranidium, in the width (exsag.) of the border close to the anterior corners of the glabella, and in the lack of a median pit in the preglabellar furrow. The pygidia of the two species are much alike in form, except that in *R. vespertinus* the posterior outline is obtusely pointed.

Raymondaspis angelini (Billings) (Whittington, 1965, pl. 56, figs. 11–13) possesses a much wider (exsag.) border and a greater cranidial width at the border furrow.

Genus ILLAENUS Dalman, 1827

Illaenus auriculatus, n. sp.

Plate 5, figures 1–32, 36, 40

Cephalon strongly convex in lateral profile; more than half its length in nearly vertical underturned anterior part. Genal angles produced into rounded winglike lappets, overhanging marginal doublure.

Glabella defined posteriorly only by axial furrows whose shape changes with growth. In small stages, axial furrows nearly straight and parallel (pl. 5, figs. 11, 13.) In larger stages, furrows convex outward and short (pl. 5, figs. 6, 8). In adult stages, axial furrows take on open sigmoid course (pl. 5, fig. 1), fading out ahead of the eyes. Width of fixed cheeks at palpebral lobes on line through eye centers equals more than half glabellar width. Palpebral lobes nearly semicircular and close to posterior margin. Behind eyes, facial sutures run posterolaterally the short distance to margin. Facial sutures in front of eyes run almost straight forward, close to margin turning inward almost 90° to coalesce across front of cephalon through rostral suture. Rostral connective sutures slant obliquely inward across ventral side of margin, approach each other most closely on the posterodorsal side of doublure before diverging upward to produce rostral flange (Whittington, 1963, p. 68, text fig. 4).

Free cheeks having lateral surfaces that slope at about 65°. Posterolateral lappets obtusely pointed to rounded in outline. Posterior margin of cheek outside facial suture curves backward and then forward to genal "angle" which is on a line with eye centers. Doublure beneath free cheeks is subtubular, running back in tight curve toward the cephalic posterior margin near the crossing of the facial suture. Where lappet overhangs margin its ventral surface separated from margin and doublure by furrow. If, during enrollment, margin of pygidium rested against cephalic margin, anterior corners of the pygidium and tips of all pleura could rest in this vincular furrow, the outer surfaces being protected by the lappets. This construction is described by Whittington (1963, p. 69–70) for *I. tumidifrons* Billings.

Thorax not known.

Pygidium transversely subsemielliptical, its length about four-tenths its width. Anterior "corners" faceted. Axis triangular, low; its length about six-tenths length of pygidium, its anterior width about one-third greatest pygidial width. Doublure of median width, produced into a two-pronged tongue at middle. A slight median crease present. A large boss present on anterolateral part of doublure beneath each facet.

Hypostome with elliptical middle body. Anterior lobe subcircular, bounded posteriorly by shallow curved furrow. Posterior lobe a swollen crescent, its sagittal length about one-third that of anterior lobe. Maculae exceedingly faint, best indicated on inner side of test. Border furrow and border very narrow. Anterior wings wide across their bases. Because both available specimens are broken, length of wings and anterior juncture with cephalic doublure are not ascertainable.

The stages of development cannot be accurately described from the material at hand. The change in course of cephalic axial furrows has been noted above. Small specimens show that the free cheeks bore stout genal spines in immature stages which decreased in relative length and sharpness to form the lappets. The proportions of the rostral plate are remarkably constant during growth.

Holotype: USNM 145764.
Paratypes: USNM 145765–145782.
Occurrence: Antelope Valley Limestone: USGS colln. D1398 CO, 379 ft above base. North of Pyramid Peak, Ryan quad., California.

Discussion.—This species is closely related to the four species described by Whittington (1963, p. 66–76, pls. 15–20, text fig. 4) from Lower Head, Newfoundland. It differs from all of them in degree, just as they differ from one another. Depending on the individual, convexity of the cephalon in lateral profile seems to resemble that of *Illaenus spiculatus*, as do the genal spines of immature specimens. The shape of rostral plate also closely resembles *I. spiculatus*. Divergence of cephalic axial furrows distinguishes *I. spiculatus* from *I. auriculatus*. The doublure of the pygidium more closely resembles that of *I. consobrinus*, but the pygidial axis is stronger and longer than in that species. The dorsal aspect of the cephalon differs from that of *I. consobrinus* by having a greater width of fixed cheeks. A complete cephalon of *I. auriculatus* probably would closely resemble one of *I. bucculentus*, though it probably would be less crescentic in dorsal outline.

Although not identical with any of the species from Lower Head, Newfoundland, *I. auriculatus* is similar to all four. It also shows a marked resemblance to *I. consimilis* Billings from the middle Table Head Formation (Whittington, 1965, p. 393–397). The pygidium of *I. auriculatus* is slightly wider and has a somewhat better defined axis; the doublure covers a greater proportion of the ventral surface. The palpebral lobes and eyes are closer to the rear of the cephalon in *I. consimilis;* a slender rim is present on the anterior margin of the free cheeks and it continues onto the lappets (see Whittington, 1965, pl. 51, fig. 12) whereas no such rim exists in *I. auriculatus.*

Illaenus? sp.

Plate 5, figures 35, 37–39

Several pygidia of small size are associated with *Illaenus auriculatus* in the type collection from the Death Valley area. In dorsal aspect they are not unlike pygidia assigned to *Illaenus*. In ventral aspect, however, the doublure lacks the distinctive median forked tongue of *I. auriculatus* and the species related to it. The doublure is of the type exemplified by *I. fallax* Holm (Jaanusson, 1954, p. 574–575, text fig. 10C).

Some of the cranidia and free cheeks here placed in *I. auriculatus* may belong with these pygidia in a different subgenus. There is no positive indication for such associations, and several of the specimens are illustrated here as a matter of record.

Figured specimens: USNM 145783–145785.

Occurrence: Antelope Valley Limestone: USGS colln. D1398 CO, 379 ft above base. North of Pyramid Peak, Ryan quad., California.

Illaenus cf. I. utahensis Hintze

Plate 5, figures 33, 34

A single pygidium is available from collection D824 CO, which bears a form very similar to that of *I. utahensis*. The facets cut abruptly across the anterolateral corners of the pygidium in the same manner as in *I. utahensis*. The ventral side and doublure cannot be studied without destroying the only specimen; therefore its identity must remain in question.

Figured specimen: USNM 145786.

Occurrence: Antelope Valley Limestone: USGS colln. D824 CO, 35 ft below massive quartzite of Eureka Quartzite. Meiklejohn Peak, Nev., north side (Ross, 1964b, p. C24, C29, C30; pl. 1, loc. 32).

Discussion.—The stratigraphic position is considerably higher than one might expect to find this species unless the *Pseudoolenoides* zone of Utah is correlative with the Marmor or Porterfield Stages of southern Nevada.

Genus BATHYURUS Billings, 1859

Several specimens that are assignable to this genus have been collected from the uppermost unit of the Pogonip Group in Nevada. It is possible that *Acidiphorus? pseudobathyurus*, n. sp., should also be placed in *Bathyurus*. It differs from species of *Bathyurus* primarily in the possession of three rather than four pairs of pygidial pleura.

Bathyurus is known nowhere else below the Black River (Whittington, 1953, p. 653), a fact that supports my belief that much of what has been designated Whiterock in Nevada is in truth Marmor or younger in age and that part of the Whiterock is actually synonymous with younger stages.

Bathyurus nevadensis, n. sp.

Plate 6, figures 1–5

Cephalon subsemicircular in outline, of moderate convexity, with sharply pointed genal angles.

Glabella widest in front of palpebral lobes and at posterior margin of occipital ring; narrowest between posterior halves of palpebral lobes. Anterior outline sharply to evenly rounded. Occipital ring consuming one-fifth glabellar length (sag.). Occipital furrow offset from border furrow at axial furrow. An extremely faint pinching of sides of glabella opposite front ends of palpebral lobes may represent glabellar furrows. In lateral profile, posterior two-thirds of glabella almost flat; anterior one-third curves down with increasing convexity to preglabellar field.

Fixed cheeks very narrow except at palpebral lobes. Lobes large, subcircular. Length (exsag.) of lobes two-fifths glabellar length. On line through eye centers, width of each fixed cheek exceeds half the width of glabella. Faint axial furrows separate fixed cheeks from glabella except in front, where a sharp break in slope delimits narrow preglabellar field from glabella.

Facial suture in front of eyes runs forward and slightly outward to a point even with widest part of glabella, then turns inward to meet the opposite suture. Behind eye, the facial suture runs almost laterally, turning gently to cross the posterior margin. It intersects margin at a distance from axial furrow equal to almost six-tenths the width (trans.) of the occipital ring. It crosses margin at estimated three-fifths of distance from axial furrow to genal angle.

Free checks evenly convex with large eyes. Except at sharp genal angle, a narrow concave border is present.

Pygidium subsemicircular to subtriangular, its length equal to two-thirds its width. Axis prominent, tapering only slightly; composed of three rings in anterior one-third with only faint suggestions of segmentation at front of prominent posterior two-thirds. Termination of axis convex, bluntly rounded. Four strongly developed pleura of equal width (exsag.), separated by well-defined pleural furrows. Furrows fade out in proximal edge of smooth concave border.

Holotype: USNM 145787.
Paratypes: USNM 145788–145791.
Occurrence: Lehman Formation of Hintze (1952): USGS colln. D802 CO, about 100 ft below base of Eureka quartzite. Southern Egan Range, sec. 8, R. 63 E., T. 12 N., Lund 2° quad. Nevada. Collected by P. E. Playford, 1961.

Discussion.—In possession of four pygidial pleura, a prominent pygidial axis with rings limited to the front part and with prominent axial termination, and a concave pygidial border, this species resembles all others of *Bathyurus* except *B? acutus* Raymond (Whittington, 1953, p. 653). It differs from most species in that the pleural furrows do not cross the border; in this regard it resembles *B. superbus* Raymond.

In outline of glabella and in size and position of palpebral lobes, it resembles *B. extans* from which it differs in lacking tubercles on the surface and in being less convex in lateral profile. From all known species it differs in the lack of long genal spines, its genal angles being prodced into stout spikes.

Genus BATHYURELLUS Billings, 1865

Bathyurellus Billings. Whittington, 1953, Jour. Paleontology, v. 27, p. 660–662.

As a result of recent collections in Newfoundland, Whittington (1963, p. 55–57, pl. 11, figs. 8–10, 14) has supplemented his earlier redescription of *B. nitidus* Billings with description and illustration of developmental stages. The diminutive species *Licnocephala ovata* Ross (Ross, 1953, p. 644, pl. 64, figs. 1–3) very probably is an immature *Bathyurellus* (or very closely related to *Bathyurellus*); if it is, the range of the genus begins stratigraphically lower than heretofore realized.

Bathyurellus? sp. 1

Plate 6, figure 9

The following description is based on a single broken pygidium.

Pygidial outline transversely subelliptical, length 0.5–0.6 its width. Axis half as long as pygidium; its anterior width about one-third that of pygidium. Composed of four rings and a terminal piece; tapers slightly. Pleural platform small, composed of two triangular areas on either side of axis. Greatest width of pleural platform one-third total width of pygidium. Pleural grooves faint, possibly three pairs. Border very wide, smooth, almost flat. Its width (sag.), half the length of pygidum. A faint suggestion of two pairs of interpleural grooves on anterolateral part of border.

Figured specimen: USNM 145792.
Occurrence: Garden City Formation; USGS colln, D190d CO, 105 ft below Swan Peak Formation. Beaver Creek, Logan quad., Utah (Ross, 1964b, p. C70, C71, text fig. 7).

Discussion.—This pygidium matches paratypes assigned to *Bathyurellus pogonipensis* Hintze (1952, pl. X, figs. 12, 17, not fig. 11) in size, composition, and shape of axis, poor definition of pleural furrows, and great width of the flattened border. The holotype pygidium of *B. pogonipensis* (Hintze, 1952, pl. X, fig. 11a, b) seems to have better developed interpleural grooves on the border and is semicircular rather than subelliptical; it probably belongs to *Uromystrum* Whittington. The outline of the pygidium of *B. nitidus* is very slightly more quadrate than this specimen. *B. abruptus* Billings possesses a pygidium that is longer than wide. In *B. expansus* Billings the interpleural grooves are better developed. Except for its semielliptical outline this pygidium seems to resemble fairly closely that of *B.? affinis* Poulsen, a species referred to *Uromystrum* by Whittington (1953, p. 660).

The pygidium on which Holliday (1942, p. 473, pl. 74, fig. 7) based *Niobe? feitleri* may be that of a *Bathyurellus* as suggested by Hintze (1952, p. 140). The axis of Holliday's specimen, however, is longer and the border area narrower than in "*B.*" *pogonipensis* or in the specimen described here.

Bathyurellus sp. 2

Plate 6, figure 6

The following description is based on a single cranidium. Glabella low, almost parallel sided except for pointed anterior end; occipital furrow shallow. Width of glabella about half its length; palpebral lobes about half as long (exsag.) as glabella. Preglabellar field very short (sag.) in front of glabella. Separated distally by a break in slope from wide (sag.) flat border. Width of border on sagittal line a little less than three-tenths length of glabella.

Figured specimen: USNM 145793.
Occurrence: Antelope Valley Limestone: USGS colln. D727 CO, 25 ft above base of Ranger Mountains Member. Southwest of Aysees Peak, Nevada Test Site (Ross, 1964b, p. C20–C21, pl. 1, loc. 50).

Discussion.—In general configuration this cranidium is very similar to that of *Bathyurellus nitidus* Billings (Whittington, 1963, pl. 10, figs. 8, 11, 12, 14–17), which possesses a wider glabella and wider border. In *B. expansus* Billings (1865, fig. 306a) the border is much narrower and the preglabellar field longer (sag.). In "*B.*" *pogonipensis* Hintze (1952, p. 138–140, pl. 10, fig. 14) and in *B. teicherti* Poulsen (1937, pl. 7, fig. 2) the border is narrower and the glabella wider.

Although the specimen probably represents a new species, additional specimens including pygidia are needed as bases for its description.

Genus GONIOTELINA Whittington and Ross, 1953

Goniotelina hesperia, n. sp.

Plate 6, figures 10–15

Cephalon seemingly almost transversely elliptical with long genal spines extending backward a distance exceeding twice the sagittal length of the cephalon. Surface not pustulose.

Cranidium characterized by large palpebral lobes exceeding semicircles in outline and located so that their posterior edges are opposite or behind the occipital furrow. Glabella widest between anterior ends of eyes and at occipital ring, narrowing between posterior halves of palpebral lobes. Free cheeks equipped with exceptionally long genal spines, although their length may be manifestation of immaturity.

Pygidium equipped with long terminal spine rooted in axis. Axis tapering; only the anterior two rings are distinct. A third ring is faintly developed. On the pleural platform only two furrows are present.

Holotype: USNM 145794.
Paratypes: USNM 145795–145798.
Occurrence: Antelope Valley Limestone: USGS colln. D1398 CO, 379 ft above base. North of Pyramid Peak, Ryan quad., California.

Discussion.—This species compares most closely with *Goniotelina williamsi* (Ross) (Ross 1951, pl. 14, figs. 16–22, 25), particularly in the posterior position of the large palpebral lobes and the rooting of the long pygidial spine in the axis. The number of axial rings in the pygidium is fewer than in any previously described species; only in *G. brighti* (Hintze) (1952, pl. 26, figs. 1–5) are there as few furrows on the pleural platforms.

Shortness and manner of rooting of the pygidial spine differentiate *G. brevus* (Hintze), *G. wahwahensis* (Hintze), *G. boggildi* (Poulsen), and *G. crassicornis* (Poulsen). (See Hintze, 1952, pl. 26, figs. 7–13, Poulsen, 1927, pl. 20, figs. 19–25.) Although this spine is as long in *G. brighti*, it is rooted in the border not in the axial terminus.

The great length of genal spines may be related to the small size of all available specimens of *G. hesperia* which probably cannot be told from mature *G. williamsi* or *G. brighti* on this basis.

The glabella of *G. hesperia* possesses a longer (sag.) occipital ring than any other previously described species and seems to differ in outline. The glabellae of other species have subrectangular outlines or are widest between, rather than in front of, the palpebral lobe.

The species is considered to be one of the important links between zone "J" faunas of Utah and the faunas of the lower *Orthidiella* zone of Nevada and California.

Goniotelina cf. G. subrectus (Bradley)

Plate 6, figures 24, 25

Goniotelina subrectus (Bradley). Whittington, 1953, p. 665–666, pl. 69, figs. 1, 2, 7, 8.

Glabella forming longest part of cranidium, overhanging anterior border slightly. Glabellar outline subrectangular with nasute front. Convexity low to moderate in lateral and anterior profile. Length of occipital ring one-sixth that of entire glabella. Width of glabella about 0.85 its length. Front ends of palpebral lobes opposite glabellar midpoint; lobes more than semicircles with length (exsag.) about one-third that of glabella.

Figured specimen: USNM 145799.
Occurrence: Antelope Valley Limestone: USGS colln. D725 CO, 170 ft above base of Paiute Ridge Member. Southwest of Aysees Peak, Nevada Test Site (Ross, 1964b, p. C21; pl. 1, loc. 50).

Discussion.—The above description is based on a single specimen, which closely resembles specimens of *Goniotelina subrectus* (Bradley). The main difference is in the seeming lack of pustules on the surface of the Nevada specimen.

Stratigraphically this species occurs very low in the Antelope Valley Limestone and is associated with an assemblage of the *Pseudocybele* zone. Bradley's species came from the Cassin Formation of Whittington (1953, p. 665) of Vermont. Both species are of Canadian age.

Goniotelina? aff. G. williamsi (Ross)

Plate 6, figures 7, 8

From the uppermost silty beds of the Antelope Valley Formation a few poorly preserved, partly crushed specimens have been obtained which are referable questionably to *Goniotelina.* Tentatively they are compared with *G. williamsi* (Ross) (1951, p. 69–71, pl. 14, figs. 16–22, 25). They occur in beds that are younger than those from which that species was originally described.

Surface finely granular. Glabella lacking lateral furrows; widest at front and at occipital ring, narrowest in front of occipital furrow. Its width about six-tenths the sagittal length. Palpebral lobes one-third as long (exsag.) as glabella, located well to rear. Fixed cheeks in front of eyes very narrow. Anterior cranidial outline obtusely angular to broadly rounded. Preglabellar field very narrow (sag. and exsag.).

Pygidium bearing a long, slender terminal spine based in the axis. Seemingly four axial rings and long terminal piece; a median node on each ring. Three pairs of pleura.

Figured specimens: USNM 145800, 145801.

Occurrence: Antelope Valley Limestone: USGS colln. D990 CO, 35 ft below top. Spotted Range, Nev. (Ross, 1964b, p. C49, fig. 3).

Discussion.—This species clearly is not the same as *Goniotelina williamsi* (Ross) from which it differs in the more elongate forwardly expanding glabella and smaller posteriorly located palpebral lobes. The general aspect of the cranidium is, in fact, closer to *Raymondites.* The pygidium bears the correct number of pleura for *Goniotelina.* The number of axial rings is similar to that of *G. brighti* (Hintze, 1952, pl. 26, fig. 1, 2, 6) although there is one less pair of pleura in that species. *G. williamsi* possesses the same number of pleura but fewer axial rings.

This species probably should not be assigned to *Goniotelina,* but additional specimens are needed to determine its correct taxonomic position.

Genus ACIDIPHORUS Raymond, 1925

Acidiphorus Raymond [part]. Whittington, 1965, Harvard Univ., Mus. Comp. Zoology Bull., v. 132, no. 4, p. 383.

Acidiphorus? pseudobathyurus, n. sp.

Plate 6, figures 16–23

Surface of glabella coarsely pustulose. Glabella almost parallel sided, width a little more than half the length. Strongly convex in anterior profile, moderately to strongly convex in lateral profile. Glabellar furrows not impressed, their positions indicated by two pairs of narrow smooth areas on sides of glabella close to axial furrows; *1p* near midlength of glabella and opposite front quarter of palpebral lobes; *2p* between one-fourth and one-fifth glabellar length from front and ahead of palpebral lobes. Length of occipital ring about two-tenths that of entire glabella.

Axial furrows distinct. Front of glabella narrowly rounded, slightly nasute. Preglabellar furrow and border furrow tangent at midline.

Palpebral lobes large, more than semicircles. Their length (exsag.) a little less than half that of glabella. Front of each lobe so located that four-tenths (to about five-tenths in immature specimens) of the glabella lies in front of them.

Facial sutures in front of palpebral lobes run forward with gentle curve convex outward. Anterior part of each fixed cheek a narrow band with nearly uniform width (trans.) about one-eighth that of glabella. Facial sutures subparallel to sides of glabella until they cross transverse anterior margin. Fixed cheeks lack pustules on surface.

Pygidium subtriangular. Axis tapering slightly to bluntly rounded terminus; composed of three fairly distinct rings, a fourth less distinct and best seen in decorticated specimens, and a terminal part. Two pairs of pleural furrows separate convex platform into three faintly inflated ribs in large specimens (pl. 6, fig. 22); in small specimens pleural ribs strongly inflated (pl. 6, figs. 18, 23). Border furrow indistinct, mainly a break in slope against which pleural ribs terminate. Pleural furrows continue vaguely a very short distance past this border furrow in large specimens only. Border slightly convex. Anterior width of axis one-fourth anterior width of pygidium; length of axis from three-fourths to eight-tenths that of pygidium.

Holotype: USNM 145802.

Paratypes: USNM 145803–145807.

Occurrence: Garden City Formation; USGS colln. D190d CO, 105 ft below Swan Peak Formation. Beaver Creek, Logan quad., Utah (Ross, 1964b, p. C70–71; text fig. 7).

Discussion.—In cranidial characteristics this species is clearly related to *Acidiphorus spinifer* Raymond (Whittington, 1965, pl. 44, figs. 3, 5, 9, 10); however, it differs markedly in outline and convexity of the glabella and in shape, size, and position of the palpebral lobes from *Goniotelus perspicator* (Billings).

All but one of the associated pygidia have smooth surfaces and lack any semblance of terminal spine; a single small pustulose pygidium (pl. 6, fig. 23) is damaged at the posterior end and may have born a spine based in the border. Whichever of the types of pygidia is correctly assignable to the species, it will differ from the pygidia of *A. spinifer* and of the several species that have been assigned to *Goniotelus.* On the pleural platforms there are three distinct and one faint pleural furrows. In *Acidiphorus* and *Goniotelus* there is one less furrow, in *Goniotelina* and *Eleutherocentrus* the same number, and in *Bathyurus* one more. In general form, the pygidia of *A.? pseudobathyurus* are similar to those of *Goniotelina* and *Bathyurus*, although the border furrow is a little better defined than in the latter.

The correct taxonomic position of this species must remain uncertain for the time being. It differs from *Goniotelus* in features of both cranidium and pygidium, from *Acidiphorus* in features of the pygidium, from *Goniotelina* in characteristics of the cranidium, and from *Bathyurus* in both respects. *A.? pseudobathyurus* seems to be intermediate between *Goniotelina* and *Bathyurus.* The convexity of the glabella is more like that of *Bathyurus* than of *Goniotelina.* Stratigraphic position within the *Anomalorthis* zone indicates that the species is younger than most species of *Goniotelina*, the same age as *Eleutherocentrus*, and older than most species of *Bathyurus.*

Genus STRIGIGENALIS Whittington and Ross, 1953

Strigigenalis sp.

Plate 6, figures 26, 27

This species is represented by a single broken cranidium, which lacks the occipital ring. No description is possible, but it does seem that the length (sag.) of the preglabellar field is greater than in *S. cassinensis* Whittington and that convexity of the glabella is greater than in *S. abdita* Ross.

Figured specimen: USNM 145808.

Occurrence: Antelope Valley Limestone; USGS colln. D1398 CO, 379 ft above base. North of Pyramid Peak, Ryan quad., California.

Genus ISCHYROTOMA Raymond, 1925

Dimeropygiella Ross, 1951, Peabody Mus. Nat. History Bull. 6, p. 123–125.

Hintze, 1952, Utah Geol. and Mineralog. Survey Bull. 48, p. 153–156.

Ross, 1953, Jour. Paleontology, v. 27, no. 5, p. 637–638.

Ischyrotoma Raymond. Whittington, 1963, Harvard Coll. Mus. Comp. Zoology Bull., v. 129, no. 1, p. 45–48.

Ischyrotoma sp.

Plate 7, figures 1–7

All the specimens obtained seem to be immature. Therefore, comparisons with other species as to relative proportions are of limited value. The possession of genal spines, for instance (pl. 7, figs. 4, 5) is probably an immature characteristic; all other known species lose the genal spines in mature specimens. Lack of mature specimens and smallness of the number make formal description of this species inadvisable. Certain differences from previously described species, however, may be noted.

The cranidium lacks a preglabellar field as it does in *I. caudanodosa* (Ross) and *I. twenhofeli* Raymond. In both *I. ovata* (Hintze) and *I. blanda* (Hintze) a preglabellar field is present. Fixed cheeks are wider and less strongly elevated than in any of these other species, and the palpebral lobes are lower and shorter (exsag.). Although the lateral profile of the glabella is as convex as in other species, that of the entire crandidium is less convex.

The pygidium differs from the pygidia of *I. caudanodosa*, *I. ovata*, and *I. blanda* in possessing a single terminal node rather than a pair of nodes on the end of the axis; in this respect it seems to resemble the pygidium of *I. twenhofeli*. *Ischyrotoma* sp. has five axial rings as do *I. caudanodosa* and *I. twenhofeli*. Both *I. blanda* and *I. ovata* possess three axial rings.

The borders of the free cheeks are more coarsely pustulose than in any other species, but this may be caused by immaturity. The borders of *I. caudanodosa* are the most coarsely pustulose of any of the known species.

Figured specimens: USNM 145809–145811.

Occurrence: Antelope Valley Linestone: USGS colln. D1398 Co, D1399 CO, 379 ft above base; in float derived from interval 410–435 ft above base. North of Pyramid Peak, Ryan quad., California.

Discussion.—This species, like *Goniotelina hesperia* previously discussed, provides a link between the faunas of zone J of Ross (1951) (*Pseudocybele nasuta* zone) and the *Orthidiella* zone in which it was found.

Genus AMPYX Dalman, 1827

Ampyx compactus, n. sp.

Plate 7, figures 8–16

Length of cranidium, exclusive of glabellar spine, a little less than half the width. Glabella widest at seven-tenths of its length from the back; its greatest width equals seven-tenths its length. Narrowest in occipital furrow where width is one-half its length. Posterior crest of glabella carinate ahead of occipital furrow. Occipital ring and posterior border continuous, without sharp break at axial furrows. Ring and border moderately elevated, sloping gently into shallow occipital and border furrow. Axial and preglabellar furrow very shallow. Anterior part of glabella (2/10–3/10) overhangs cephalic margin. Anterior spine round, curving upward gently. Because of coarseness of silicification, muscle scars are not clearly discernible on any specimens; on some, a shallow depression present on each side of glabella in front of occipital ring and above axial furrow.

Fixed cheeks gently convex sloping forward, bent down at posterodistal corners. Posterior border furrow shallow, lacking pits found in some species close to facial suture. Each suture cuts posterior border at a distance from axial furrow equal to 1½ times the posterior width of glabella.

Free cheeks and thorax not known.

Pygidium one-third as long as wide. Articulating half ring alone marks axis. Axis tapering, of low convexity, axial furrows not impressed. Axis defined by breaks in slope. Pleural platforms flat sloping into steepened border without clear demarcation between the two. Posterior margin upswept at midline, bow shaped in posterior view.

Holotype: USNM 145812.

Paratypes: USNM 145813–145815.

Occurrence: Antelope Valley Limestone: USGS colln. D1398 CO, 379 ft above base. North of Pyramid Peak, Ryan quad., California.

227-858 O—66——3

Discussion.—This species lacks well-defined muscle scars or glabellar furrows that characterize such species as *Ampyx nasutus* Dalman (Whittington, 1950, pl. 74, fig. 3), *A. virginiensis* Cooper (Whittington, 1959, pl. 29, figs. 1–4), *A. camurus* Raymond (Cooper, B. N., 1953, pl. 5, figs. 1, 7), and *A. americanus* Safford and Vogdes (Cooper, B. N., 1953, pl. 5, fig. 8). The glabella is shorter and more thickset than in other species. The pygidium lacks the pronounced rim that separates the flattened pleural platforms from steeply sloping or vertical border in many species; in this regard, *A. compactus* resembles *A. camurus* Raymond (Cooper, B. N., 1953, pl. 5, fig. 2), *A. nasutus* Dalman (Whittington, 1950, pl. 74, figs. 7, 9), some specimens assigned to *A. virginiensis* (Whittington, 1959, pl. 30, figs. 16, 20, not specimens on pl. 31), and *A. laeviusculus* Billings (1865, p. 295, fig. 285). Poor definition of the pygidial axis in *A. compactus* (pl. 7, figs. 13, 16) distinguishes it from *A. virginiensis*, *A. laeviusculus*, and *A. nasutus* but not from *A. camurus*.

Although the pygidium is similar to that of *A. laeviusculus* Billings (Whittington, 1965, p. 318, pl. 12, figs. 1–4, 6, 9, 12), its width is three times its length as opposed to 2½ times in the Table Head species. The length of the glabella relative to the width of the cranidium is less in *A. compactus*.

Ampyx sp.

Plate 7, figures 20, 21

Cephalic parts represented only by minute immature specimens.

Pygidium one-third as long as wide. Length of axis and flat pleural platforms about three-fifths total sagittal length of pygidium. Axis composed of four rings and articulating half ring; axis blunt, tapers slightly; axial furrows shallow. Two pairs of pleural furrows on platforms. A fine ridge separates pleural platforms from sloping border. Margin of border bow shaped.

Figured specimen: USNM 145816.

Occurrence: Antelope Valley Limestone: USGS colln. D727 CO, 25 ft above base of Ranger Mountains Member. Southwest of Aysees Peak, Nevada Test Site (Ross, 1964b, p. C20–C21; pl. 1, loc. 50).

Discussion.—This pygidium is described as a matter of record; without better knowledge of the cephalon no species can be based on it.

Although it must be approximately correlative, this pygidium is quite different from that of *Ampyx compactus*, described above.

Genus LONCHODOMAS Angelin, 1854

Lonchodomas retrolatus, n. sp.

Plate 7, figures 22–28

Only cranidia and pygidia of this species have been recognized in the present collections. All specimens are small as compared, for instance, with *A. virginiensis* Cooper (Whittington, 1959, pl. 29, fig. 2).

Glabella widest at about four-tenths of the length in front of posterior margin of occipital ring; width about three-fourths the glabellar length exclusive of anterior spine. Narrowest in occipital furrow where width is half the glabellar length. Axial ring confluent with posterior border, not interrupted by axial furrows. Anterior face of ring and border sloping very steeply into border furrow. A slight pit present in some specimens in posterior border furrow close to facial suture. Axial furrows lightly impressed, confluent beneath protruding front of glabella. Anterior third of glabella overhangs an extremely short frontal area (pl. 7, figs. 22, 23). Anterior of glabella sharply pointed, almost circular in cross section. Anterior spine grooved along dorsal side.

Glabellar muscle attachments not clearly differentiated. Posterior scars alined crudely from junction of posterior border and axial furrows forward in subparallel creases almost to widest part of glabella (pl. 7, figs. 22, 23, 26). Another short elongate scar immediately in front of greatest width and above anterior pit (pl. 7, fig. 24). Anterior pit a deep narrow slot.

Cheek gently convex. Because of lack of free cheeks, determination of nature of border or genal spines is impossible. If glabella is oriented horizontally, cheeks slope forward at about 37°. Greatest width of each fixed cheek, at posterolateral angle, 1.5 times as wide as greatest width of glabella. Facial sutures run forward from posterior margin with slight sinuosity to meet in a continuous curve beneath front of glabella.

Pygidium broadly triangular, with flattened pleural lobes and nearly vertical border. Length equal to ⅓–$\frac{4}{10}$ the width. Axis tapering to reach border. At anterior end, width of axis about three-tenths that of pygidium. Definition of axial rings varies with specimens but three can be distinguished on most; these are exceedingly short, being only 0.2 mm in length (sag.). Anterior pair of pleural furrows is deep, and curves with concave side forward. Other furrows faint, as many as four pairs discernible on some specimens. Border furrow shallow, bounding a very narrow relatively high border. Border tends to be three times as high as wide.

Holotype: USNM 145817.

Paratypes: USNM 145818–145822.

Occurrence: Eureka Quartzite: USGS colln. D680 CO, sandy limestone, 60–90 ft above base. Ranger Mountains, Nevada Test Site (Ross, 1964b, p. C18; pl. 1, loc. 50).

Discussion.—This species differs from *Lonchodomas carinatus* Cooper (Cooper, B. N., 1953, p. 17–18, pl. 7, figs. 12–17, 19–23; Whittington, 1959, p. 473–481, pl. 32, 33; text fig. 8) in lacking the carinate sagittal crest on the glabella and in possessing a more markedly triangular pygidium. The glabellar outline is wider and shorter than in *L. politus* Cooper (Cooper, B. N., 1953, p. 18, pl. 6, figs. 1, 2, 5–10) and the pygidium is obtusely pointed rather than rounded at the posterior midline. In pointed outline the pygidium of *L. retrolatus* resembles that of *L. karakanensis* Weber but has a better defined axis (Chugaeva, 1959, p. 31–32, pl. 1, fig. 18); in features of the cranidium the two species are very similar (Chugaeva, 1958, pl. 2, figs. 1, 2). *L. tecturmasi* Weber (Chugaeva, 1958, p. 32–33, pl. 2, figs. 3–5) possesses a glabella more like that of *L. carinatus* than like *L. retrolatus*, n. sp. *L. tumidium* Tripp (1962, p. 15–16, pl. 2, figs. 20a–c) is a little more elongate, both in glabellar and cranidial outline, than this Nevada species.

The outline of the glabella distinguishes *L. retrolatus* from both *L. normalis* (Billings) (Whittington, 1965, p. 314, pl. 10) and from *L. clavulus* Whittington (1965, p. 316, pl. 11), in both of which the maximum glabellar width is closer to the front. These two Table Head species possess pygidia that are longer relative to width than *L. retrolatus*.

Genus CERAURUS Green, 1832

Ceraurus Green. Cooper, B. N., 1953, Geol. Soc. America Mem. 55, p. 27.

Ceraurus? sp.

Plate 7, figure 32

A single pygidium of this genus has been obtained from the vicinity of the northern Pahranagat Range. It is poorly preserved in silty limestone.

Anterior pleura produced into long spines curving to become parallel to axial line. Although weathered, the spines appear circular in cross section. Second axial ring small; each lateral pleuron curves slightly at proximal end but otherwise is oriented parallel to axial line. Rounded tip of each pleuron protrudes from margin. Third segment lacks axial furrows, so axial ring is not separated from its pleura and wraps around three sides of the rounded boss comprising the terminal piece.

Figured specimen: USNM 145823.

Occurrence: Pogonip Group, upper part of Lehman Formation of Hintze (1952) (Unit B of upper limestone formation of Reso, 1963, pl. 2): USGS colln. D1065 CO. Pahranagat Range, Nev. (Ross, 1964b, p. C82). Antelope Valley Limestone: USGS colln. D830 CO, 470 ft below base of massive Eureka Quartzite. Meiklejohn Peak, Nev., north side (Ross, 1964b, p. C29–C30).

Discussion.—Whittington (1965, p. 408–411, pl. 60) assigned a species, *Ceraurus polydorus* (Billings), from the middle Table Head Formation to the genus *Ceraurinella;* the pygidium is incomplete but appears to be differently constructed in the posterior three segments. The present specimen seems to be more closely comparable to *C. trapezoidalis* Esker (1964, p. 201–204, pl. 2, figs. 1–4), recently described from the Pooleville Member of the Bromide Formation of Oklahoma. The species is probably also represented by a poorly preserved pygidium in the upper part of the Antelope Valley Limestone on the north of Meiklejohn Peak; this occurrrence was not reported by me previously (Ross, 1964b).

Genus CYDONOCEPHALUS Whittington, 1963

Cydonocephalus scrobiculus Whittington

Plate 7, figures 17–19

A single specimen referable to this species is present in the collections from the Ryan quadrangle, California. No representatives of the genus has been found so far in more easterly areas of Nevada. The present specimen is unfortunately encrusted with silicified silt particles that obscure glabellar furrows *2p* and *3p* and the proximal ends of *1p* as well as the ornamentation.

The California specimen resembles those from Newfoundland in the faintness of glabellar furrows *2p* and *3p*, in the extremely faint longitudinal furrows connecting the proximal ends of furrows *1p* with the occipital furrow, and in shape of the glabella. It differs in possession of a stub of a genal spine on the proximal side of the facial suture on the posterior border. This feature may be immature, as it is in *C. torulus* Whittington.

Figured specimen: USNM 145824.

Occurrence: Antelope Valley Limestone: USGS colln. D1398 CO, 379 ft above base. North of Pyramid Peak, Ryan quad., California.

Discussion.—This species is one of several that show a close correspondence to a trilobite assemblage described by Whittington (1963) from Western Newfoundland.

Cheirurid?, indet.

Plate 9, figures 40–44

Two very unusual and fragmentary pygidia have been discovered in USGS collection D1398 CO. I originally believed that these might belong to an odontopleurid, but H. B. Whittington (written commun., Dec. 17, 1964) has pointed out their similarity to pygidia of cheirurids like *Sphaerocorypha*.

These pygidia carry two fantastic pairs of spines. Front pair arises in anterolateral corner of border, rising laterally (pl. 9, figs. 40, 43) or anterolaterally (pl. 9, figs. 41, 42). Second pair rooted adjacent to first but rises posterolaterally. Border thickly rounded. Axis low, composed of two rings and terminal piece but not bounded by distinct axial furrows.

The specimens are illustrated as a matter of record. More complete specimens may be found in the future and may give a clue to their identity.

Figured specimens: USNM 145825, 145826.

Occurrence: Antelope Valley Limestone: USGS colln. D1398 CO, 379 ft above base. North of Pyramid Peak, Ryan quad., California.

Genus HELIOMEROIDES Evitt, 1951

A single immature cranidium proves the existence of heliomerid trilobites in the Western United States. This specimen comes from the *Orthidiella* zone of the Ryan quadrangle on the eastern boundary of Death Valley, Calif. Out of the thousands of silicified trilobites of all sizes that have been prepared and examined from the Basin Ranges in the past decade, it is remarkable that no other heliomerids have been recognized.

Heliomeroides sp.

Plate 7, figures 29, 30

The single cranidium discovered is only 1.0 mm long and is clearly immature. Comparison with others discussed by Evitt (1951, p. 588–603) and by Whittington (1963, p. 88–89) is not practical. The specimen is important in establishing the western geographic range of *Heliomeroides*.

Figured specimen: USNM 145827.

Occurrence: Antelope Valley Limestone: USGS colln. D1397 CO, 367 ft above base. North of Pyramid Peak, Ryan quad., California.

Discussion.—The species of *Heliomeroides* discussed by Evitt were derived from the Lower Lincolnshire beds of Virginia, the Kimmswick of Illinois, the Chazy of New York, the lower Athens of Virginia, and the Middle Ordovician of Newfoundland. Whittington's species were derived from Lower Head, Newfoundland, in beds that probably correlate with the middle Table Head. According to the stadial scheme of Cooper (1956, pl. 1), the ages of these occurrences are Marmor to Trenton, except for those of Newfoundland and the western Basin Ranges, which are Whiterock.

Genus PSEUDOMERA Holliday, 1942

Pseudomera Holliday. Whittington, 1961, Jour. Paleontology, v. 35, No. 5, p. 917–918.

Pseudomera sp.

Plate 7, figure 31

A single cranidium, very poorly preserved, is assignable to *Pseudomera* and is critical in dating the high beds of the Pogonip in the Bare Mountain quadrangle, Nevada.

Glabella wider at anterior lobe than at occipital ring. Occipital furrow curved convex side forward. Three lateral glabellar lobes present, separated by subparallel glabellar furrows. Furrows *1p* run posteroproximally from axial furrow, curving backward at inner end but failing to reach occipital furrow. Lateral lobe *1p* is much shorter (exsag.) at its inner end than lobe *2p*. Outer length (exsag.) of all three lateral lobes about the same. Preglabellar furrow deeper laterally than medianly.

Eyes positioned opposite outside ends of glabellar furrows *2p*. Behind eyes, facial suture inferred to have run laterad at about 90° to axis before crossing posterior border furrow, there turning to rear to margin. In front of eyes, facial suture, seems to parallel axis to border furrow, then extend inward diagonally across border.

Figured specimen: USNM 145828.

Occurrence: Antelope Valley Limestone: USGS colln. D832 CO, 360 ft. below Eureka Quartzite, 385 ft. above *Palliseria* zone. Meiklejohn Peak, Nev., north side (Ross, 1964b, p. C29, C30; pl. 1, loc. 32).

Discussion.—The present single specimen is too poorly preserved to show whether there is a median pit in the preglabellar furrow. The relative depth of inner and outer ends of glabellar furrows *3p* cannot be determined. Despite these inadequacies, I am confident that this specimen is probably either a *Pseudomera* similar to *Pseudomera billingsi* Whittington or the same as a species referred to *P.* cf. *P. barrandei* (Billings) by Whittington (1961, p. 918).

The specimen is associated with *Calyptaulax* and *Sowerbyella?* above other assemblages of undoubted Marmor or Porterfield age. *Pseudomera* is generally considered indicative of the *Anomalorthis* zone of the Whiterock Stage.

Genus ECTENONOTUS Raymond, 1920

Ectenonotus whittingtoni, n. sp.

Plate 7, figures 33, 34; plate 8, figures 1–22

Ectenonotus cf. *westoni* (Billings). Whittington, 1961, Jour. Palentology, v. 35, No. 5, p. 916; pl. 99, figs. 5, 10–15.

Glabella (including occipital ring) approximately three-fourth as wide as long. Occipital ring composes two-tenths sagittal length but less of exsagittal length. Occipital furrow curved and deep, conforming to posterior of each lateral glabellar lobe (*1p*). Lateral lobes subequal. Approximate angles formed by the midline and projection of lateral furrows: *1p*, 75°; *2p*, 73°; *3p*, 50°; these angles seem to vary between sides of same specimen and between internal and external surfaces of carapace. As a result, these values express averages based on far too few specimens to make an adequate statistical sample. Distal end of lateral furrow *3p* is a pit close to anterior border furrow, proximal end an elongate pit close to midline with intervening furrow obsolete. Furrows *1p* and *2p* deep and continuous to axial furrow.

Axial furrows deep, terminating anteriorly at intersection with anterior border furrow; intersection opposite middle of distal ends of anterior glabellar lobes. Broadly V-shaped anterior end of glabella bounded by anterior border furrow, which turns abruptly laterally and downward at its intersection with axial furrows on each side.

Fixed cheeks narrow anteriorly, wide (trans.) and very steep posteriorly and laterally. Length (exsag.) of part behind eyes varies with age. Eye centers are opposite lateral glabellar lobes *3p* in cranidia with a midlength of 1.0 mm, opposite glabellar furrows *2p* in cranidia 3–4 mm long, and opposite glabellar lobes *2p* in cranidia 20 mm long. Palpebral rims bounded proximally by distinct palpebral furrow that divides front of fixed cheek approximately in half, but fades out as it approaches anterior marginal furrow. Surface of fixed cheeks coarsely pitted; in immature specimens also finely pustulose. Genal angles rounded in adult stages. Cranidia 1.6 mm long bear tiny relict genal spines (pl. 8, figs. 12, 13), and those only 1.0 mm long have relatively large genal spines (pl. 8, figs. 16, 17).

Hypostome typically pliomerid with semiovoid middle body lacking maculae. Border furrow distinct and continuous around posterior of middle body. Border widest sagittally, narrowest anterolaterally; its outline semioval. Anterior wings have strong condyles. Surface of large specimens have particularly strong pustules along middle.

Thorax unknown, except that specimen illustrated by Whittington (1961, pl. 99, fig. 15) probably belongs to this species.

Pygidium has axis composed of 12 segments and a minute terminal piece. Axis depressed convex. Pygidia 10 mm long have eight pairs of pleura with suggestion of a ninth at posterior end. A smaller pygidium 2.6 mm long has nine axial segments and eight pairs of pleura (pl. 8, fig. 19), whereas one 1.3 mm in length seems to have eight or nine axial segments and seven or eight pairs of pleura. Only after posterior pinched median ridge of pygidium is developed do axial rings seem to outnumber pleura appreciably. Clearly, the ridge is composed of small undifferentiated pleura.

Holotype: USNM 145829.

Paratypes: USNM 145830–145840, 146508.

Occurrence: Antelope Valley Limestone: USGS colln. D727 CO, 25 ft above base of Ranger Mountains Member. Southwest of Aysees Peak, Nevada Test Site (Ross, 1964b, p. C20–C21; pl. 1, loc. 50). USGS colln. D1398 CO, 379 ft above base. North of Pyramid Peak, Ryan quad., California.

Discussion.—This species differs from *Ectenonotus westoni* (Billings) in its narrower glabella, faintly and incompletely developed anterior (*3p*) glabellar furrows, and pygidium with fewer axial segments. The anterior (*3p*) glabellar furrows of *E. westoni* may be a little more acutely angled relative to the midline. *E.* cf. *E. westoni* described by Whittington (1961, p. 916) probably belongs to this species. Both species seem to be diagnostic of the lower part of the *Orthidiella* zone of the Whiterock Stage of Cooper (1956).

In the localities at the Nevada Test Site this species has not been found silicified, but specimens from the Ryan quadrangle, California, have been replaced. Unfortunately much of the silty matrix adheres to the silicified specimens, many of which are too delicate to permit the removal of the matrix.

Genus MIRACYBELE Whittington, 1965

Miracybele Whittington, 1965, Harvard Univ., Mus. Comp. Zoology Bull., v. 132, no. 4, p. 422–424.

On the basis of *Encrinurus mira* Billings from the middle Table Head Formation, Whittington erected the genus *Miracybele* and on the basis of his thorough redescription of the type species (Whittington, 1965, p. 424–427) recognition of other representatives of the genus in the Nevada Ordovician is possible.

Whittington (1965, p. 427; and Whittington in Kay, 1962, table 2, unit 2) recognized the genus in the *Orthidiella* zone. My own 1965 collections at Ikes Canyon, Toquima Range, indicate that the same species as *Miracybele*? sp. 1 (pl. 8, fig. 23–25) is probably the one present in the lowest Antelope Valley Limestone.

As indicated in the species description below, *Miracybele*? sp. 1 differs from *M. Mira* (Billings) (Whittington, 1965, pl. 65) in the construction of the pygidial pleura although having the same pygidial axis. Another cybelid, here designated *Miracybele*? sp. 2 (pl. 8, figs. 26, 27), occurs high in the Antelope Valley Limestone in the Spotted Range where I misidentified five very poor specimens as *Ceraurinella*? sp. (Ross, 1964b, p. C50, USGS colln. D990 CO). *Miracybele*? sp. 2 possesses the same kind of pygidial construction with sagitally discontinuous axial rings as *Cybele valcourensis* Raymond, a Chazy species. Future collections will probably show that it does not belong to *Miracybele*.

Miracybele? sp. 1

Plate 8, figures 23–25

This species is represented by one incomplete cranidium and three poorly preserved pygidia.

Cranidium, incomplete, decorticated. Width at posterior border twice the length. Front of cranidium nasute in outline, but free cheeks not known.

Glabella clavate in outline, narrow posteriorly, widening forward, anterior rounded, cleft by shallow median furrow above broad median pit in preglabellar furrow. Length of glabella eight-tenths length of cranidium. Its greatest width, opposite glabella furrow *3p*, equals three-fourths its length. Width at occipital ring a little more than six-tenths its length and at glabellar lobe *1p* a little less than six-tenths its length. Length (sag.) of occipital ring one-seventh that of entire glabella. Lateral glabellar furrow *1p* is transverse, reaching axial furrow, is 0.85 of glabellar length from front. Furrow *2p* a transverse pit isolated from axial furrow, is 0.55 of glabellar length from front. Furrow *3p* a shallow transverse crease, isolated from axial furrow, 0.35 of glabellar length from front. A faint pair of creases, possibly antennal attachments, diagonally oriented anteroproximally-posterodistally, about one-fourth length from front of glabella. Shallow median furrow creases front of glabella sagittaly, running backward about one-fifth its length. Axial furrows shallow, terminating in deep fossulae opposite diagonal "antennal" creases. Preglabellar furrow very shallow except in median pit elongated transversely. Anterior cranidial border widest (sag.) at midline, narrowing posterolaterally at anterolateral part of glabella, interrupted by a furrow running anterolaterally from fossula. Fixed cheek very wide. Eyes opposite glabellar furrows *2p*. Distance from midline to eye lobes approximately equals greatest width of glabella.

Pygidium elongate, its width about seven-tenths its length. Long, tapering axis composed of more than 14 rings. Width of axis at front equals about four-tenths its length. Four pairs of slender flowing pleura anastomosed to form pleural platforms.

Figured specimens: USNM 145841–145843.

Occurrence: Antelope Valley Limestone: USGS colln. D727 CO, 25 ft above base of Ranger Mountains Member. Southwest of Aysees Peak, Nevada Test Site (Ross, 1964b, p. C20–21; pl. 1, loc. 50).

Discussion.—In the orientation, position of glabellar furrows and general outline of the glabella, position of eyes, and nasute outline of the cranidial anterior, this species resembles *Paracybeloides girvanensis* (Reed) (Dean, 1962, pl. 11, figs. 12, 15; Reed, 1906, pl. 17, figs. 1, 2). It differs in possession of a border in front of the glabella, a median pit in the border furrow, and a sagittal median furrow cleaving the front of the glabella, discrete rather than fused lateral glabellar lobes—features which ally it more closely with *Miracybele mira* (Billings), a correlative Newfoundland species.

The similarities to *Miracybele mira* (Billings) (pl. 8, figs. 26, 27) are numerous, but differences are almost equal in number. Both species possess three pairs of glabellar furrows, a pair of "antennal" furrows similarly oriented, a median cleft in the anterior lobe of the glabella, and an anterior border with median transverse pit in the border furrow. In both, the fossulae in the axial furrows are located beside the anterior lobe in front of glabellar furrows *3p*. In both, an eye ridge originates behind the fossula to run posterolaterally across the fixed cheek to the raised eye. In both, there are about 14 axial rings in the pygidium and 4 pairs of pleura.

The glabellar furrows of *M. mira* (Whittington, 1965, pl. 64, figs. 3, 6, 11) are strongly developed and run to the axial furrows; in *Miracybele?* sp. 1 only furrows *1p* reach the axial furrow, *2p* and *3p* being isolated within the glabella. The "antennal" furrows of *M. mira* run diagonally back to the distal ends of glabellar furrows *3p*, whereas in the Nevada species they are also isolated. The anterior lobe of the glabella forms the widest part of the glabella in *M. mira* but is narrower than lateral lobes *3p* in this species. The anterior border in *M. mira* is narrow (sag.) in front of the midline of the glabella and wider near the anterolateral part of the glabella; in the present species the opposite is true, and a very different cranidial outline is thus produced.

Pygidial pleura of both *M. mira* and *Paracybeloides girvanensis* are composed of two parts. Each pleuron is divided by a pleural furrow into a robust posterior and a slender anterior part. In the Nevada species, *Miracybele?* sp. 1, the pleural furrows are not developed, there being four pairs of simple pleura.

This species shares with *Paracybeloides girvanensis* the presumably advanced characteristic of partly obsolete glabellar furrows, but it has marked differences from that species. It shares almost all major structural features with *M. mira*, from which it differs in development of those features. It may represent a different genus from either, but the single cranidium and three poorly preserved pygidia are not adequate for erection of a species, let alone a genus.

Its stratigraphic importance stems from its occurrence in the *Orthidiella* zone on the Nevada Test Site and in the lower 70 feet of the Antelope Valley Limestone at Ikes Canyon, Toquima Range (USGS colln. D1603 CO). This species should not be confused with *Miracybele?* sp. 2 which occurs at the top of the Antelope Valley Limestone in the Spotted Range (USGS colln. D990 CO).

Miracybele? sp. 2

Plate 8, figures 26, 27

Five poor calcitic specimens plus a few silicified specimens of this species were collected. Two of the latter are illustrated.

Larger calcitic specimens show that sixth thoracic segment from front bears enormously elongate pleurae; in *M. mira* (Whittington, 1965, pl. 66, fig. 4) this elongate segment seems to be seventh from front. These specimens also show that genal spines overlap sixth thoracic segment where pleurae are flexed backward.

Two silicified pygidia (pl. 8, figs. 26, 27) show four pairs of curving pleurae, of which fourth encloses tip of axis. On axis anterior ring is complete, but remaining rings, of which there are about 13, are discontinuous across sagittal part of axis. Paired nodes probably present on axis in more mature and better preserved specimens, but only suggested on those illustrated. There are also paired nodes on pleurae; better specimens are required to determine whether they have regular arrangement.

Figured specimens: USNM 146508, 155560.

Occurrence: Antelope Valley Limestone: USGS colln. D990 CO, 35 feet below top. Along crest of ridge in southwest end of Spotted Range, Nevada (Ross, 1964b, p. C49–C50, text fig. 3).

Discussion.—This species is similar to *Cybele valcourensis* Raymond from Valcour, N.Y. It is probably also present in the uppermost Antelope Valley beds in the Pahranagat Range, Nevada (USGS colln. D1381 CO). The beds in which *Miracybele?* sp. 2 occurs in the Spotted Range can be correlated with considerable confidence at Meiklejohn Peak to the west (Ross, 1964b, p. C30) with strata that contain Marmor or younger fossils. The species should not be confused with *Miracybele?* sp. 1, which is found in a lower faunal zone.

Genus PROTOCALYMENE, n. gen.

Genus *Protocalymene* is represented by a single species from the *Orthidiella* zone of Nevada and California. *Protocalymene mcallisteri*, described in the next section, is the type species of this new genus, which bears some resemblance to *Neseuretus* Hicks (Whittard, 1960, p. 138–141).

Typically the glabella of *Neseuretus* possesses three pairs of lateral furrows, the anterior pair faint and isolated from the axial furrow (Whittard, 1960, p. 139). None of the present specimens possesses a comparable pair of furrows and the lack does not seem to be attributable to mode of preservation. Convexity of the cranidium in lateral profile is greater in the North American species than in any of those from Britain (Whittard, 1960, pls. 19, 20).

The pygidia of previously described species of *Neseuretus* possess a minimum of five axial rings plus a terminal piece, one more axial ring than in the present species. The posterior end of the axis in most species tapers to a point, whereas it is blunt in this one.

P. mcallisteri is a Late Arenig or Early Llanvirn (Early Whiterock) calymenid. In immature stages it is obviously a proparian with long genal spines. In adult stages it becomes gonatoparian.

Whittington (1965, p. 419–420, pl. 50, figs. 10, 12–15) very tentatively assigned two cranidia from the middle Table Head Formation of Newfoundland to the genus *Calymenidius* Rasetti; these specimens probably belong to *Protocalymene*. Their exact position within the Table Head is not indicated; however, I have collected a few specimens from the *Orthidiella* zone at Ikes Canyon, Toquima Range, Nev., which may be conspecific with those from Newfoundland.

Protocalymene mcallisteri, n. sp.

Plate 9, figures 1–28

Cephalon strongly convex without genal spines in adult stages. Surface sparsely granulated, except on border that is closely covered with pustules. In anterior view, border sharply arched.

Glabella tapering anteriorly to broadly rounded front. Narrowly convex with deep axial furrows. Glabellar furrows *1p* sharply incised posteromedianly but very short. Their intersection with axial furrows opposite middle of palpebral lobes. Basal glabellar lobes (*1p*) only slightly inflated; their greatest length (exsag.) equal to one-fourth the sagittal length of glabella. Glabellar furrow *2p* merely a slight crease close to axial furrows, approximately opposite front of palpebral lobes. A shallow fossula in each axial furrow at its confluence with shallow preglabellar furrow. Width of glabella between palpebral lobes about three-fourths the glabellar length. Occipital ring longer sagittally than at axial furrows; sagittal length almost three-tenths that of glabella. A single large pustule centered on occipital ring.

Preglabellar field gently convex, width (sag.) equalling one-tenth length of glabella, bounded anteriorly by very shallow border furrow. Upper surface of border flattened. Width (sag.) of border twice that of preglabellar field. Width of fixed cheeks about half that of midwidth of glabella. Palpebral lobes small, with thickened rim; lobes slant inward steeply. Posterior part of fixed cheeks (equals posterolateral limbs) very narrow (exsag.) and long (trans.).

Facial suture originates on under side of border laterad of midline, running anterolaterally and upward across anterior face of border. At anterodorsal edge of border, suture turns posterolaterally across border, then runs almost straight back to palpebral lobes. Back of lobes, it turns sharply outward. All mature specimens are broken in posterolateral part of the fixed cheeks. Immature specimens bear very large genal spines, but no genal spines are present in mature specimens.

Thorax not known.

Pygidium strongly convex. Approximate ratio of length to height to width equals 2:3:5. Axis composed of four rings, a broad terminal piece, and an articulating half ring. Anterior ring more strongly developed than other three. Anterior width of axis one-half that of pygidium; its length almost equals that of pygidium. Interpleural furrows well developed, defining four pleura with faint pleural furrows on the anterior two pairs. Border furrow weak, interpleural furrows extending almost to margin. Rounded border best developed at rear. Paired pustules on each axial ring.

Holotype: USNM 145848.

Paratypes: USNM 145849–145859.

Occurrence: Antelope Valley Limestone: USGS colln. D728 CO, 25 ft above base of Ranger Mountains Member. Southwest of Aysees Peak, Nevada Test Site (Ross, 1964b, p. C20; pl. 1, loc. 50). USGS colln. D1398 CO, 379 ft above base. North of Pyramid Peak, Ryan quad., California.

Discussion.—This species possesses a more convex cranidium than any species of *Neseuretus* and has a pygidium with fewer segments. During its development, the number of segments in the pygidium increases; a specimen (pl. 9, figs. 27, 28 (292)) about 1.0 mm long possesses only two segments and is almost as long as wide. On the other hand, a pygidium that is 1.5 mm long has acquired what seems to be the full complement of five axial rings. If the largest specimen available is meraspid (small size suggests that such may be true), it is possible that more segments were present in the holaspid stage and that no holaspids are included in the collections. Such a situation would remove one of the differences between *P. mcallisteri* and species of *Neseuretus*.

The species designated "aff. *Calymenidius* sp. ind." by Whittington (1965, p. 419–420; pl. 59, figs. 10, 12–15) is congeneric with *P. mcallisteri*, but it differs from the Nevada species in greater width of fixed cheeks, less pronounced anterior taper of the glabellar outline, and somewhat stronger convexity of the glabella in anterior profile. No pygidium is known for the Table Head species.

Genus CALYPTAULAX Cooper, 1930

Calyptaulax Cooper. Whittington, 1965, Harvard Univ. Mus. Comp. Zoology Bull., v. 132, No. 4, p. 430–431).

That *Calliops* Delo is a synonym of *Calyptaulax* Cooper is the conclusion of Whittington (1965, p. 430–431), with which I agree. Separation of the two genera has seemed artificial because all the supposed distinguishing features of *Calliops* are included within the range of features characteristic of *Calyptaulax*.

The genus is represented in the upper beds of the Antelope Valley Limestone by two, and possibly more, species. Most specimens are extremely difficult to prepare adequately for photography. They occur in compact silty limestone, and only when they have weathered into relief on bedding surfaces does there seem to be any hope of preparing them at all.

Calyptaulax aff. C. angusta (B. N. Cooper)

Plate 8, figures 34, 35

Calliops angusta Cooper, B.N., 1953, Geol. Soc. America Mem. 55, p. 35–36; pl. 14, figs. 1, 2.

Only one cranidium well-enough preserved to give some idea of convexity of glabella and depth of glabellar furrows. Others show only general outlines. Genal spines short but sharp as in *C. troosti* (Cooper, B.N., 1953, pl. 14, fig. 7).

Frontal lobe of glabella occupies one-half the sagittal length of glabella; its width twice its sagittal length. Lateral lobes *3p* and *2p* separated from median lobe by very faint furrows. Lateral glabellar furrows *3p* would intersect at approximately 125° if projected to the midline, and furrows *2p* at approximately 145°. These angles are well within limits illustrated by Cooper (1953, pl. 14, figs. 1, 3, 4, 6).

Pygidium subtriangular in outline, its length (sag.) equal to about two-thirds its width. Axis slender, tapering, its width at anterior ring about one-fourth that of pygidium, its length about three-fourths that of pygidium. Axis composed of six fairly distinct anterior rings plus about three very faint rings and a terminal piece. Axial furrows distinct along sides of axis but not around terminus. Pleural platforms gently convex; six pleura, of which only front four are distinct. Pleural furrows straight, terminating at inner edge of border. Interpleural furrows very faint proximally, somewhat better defined where they cross the concave border. Border not delimited by a furrow.

Figured specimens: USNM 145844, 145845.

Occurrence: Antelope Valley Limestone, USGS colln. D829 CO, D832 CO. 360 and 530–550 ft below top. Meiklejohn Peak, north side (Ross, 1964b, p. C24, C29–C31; pl. 1, loc. 32). USGS colln. D990 CO. 35 ft below top. Spotted Range, Nev. (Ross, 1964b, p. C49–C50).

Discussion.—Although the critical features for distinguishing between species are absent on most of the cranidia, the outlines suggest a form something like *Calyptaulax angusta* Cooper. Proportions of the frontal glabellar lobe compared to overall length of the glabella and orientation of glabellar furrows *3p* and *2p* are variable according to Cooper's (1953, pl. 14, figs. 1, 3, 4, 6) illustrations; hence the present specimens fall well within its range. One of his paratypes (Cooper, 1953, pl. 14, fig. 1) shows faint separation of lobes *3p* and *2p* from the median lobe as in the cranidium described here.

The possession of short genal spines differentiates this western form from most species of *Calyptaulax*. *C. troosti* also possesses genal spines, but its glabellar furrows *1p*, according to Cooper (1953, p. 40), meet across the crest of the glabella.

The outline of the pygidium and its segmentation agree rather closely with Cooper's (1953, p. 36) description of the pygidium of *C. angusta*. Although his illustrations indicate a great convexity for the Appalachian specimens, these specimens from Nevada seem to have been flattened to some extent.

Calyptaulax cornwalli, n. sp.

Plate 8, figures 28–33

Cephalon strongly convex, coarsely pustulose. Border narrow, smooth, distinct along front of cephalon only. Frontal glabellar lobe three times as wide as long. Glabellar furrows *3p* directed anterolaterally, very slightly curved, and would intersect at an angle of 150°–155° if projected to sagittal line. Glabellar lobes *3p* inequilaterally pentagonal; width 2.5 times the greatest length (exsag.). Width of glabella at lobes *3p* nine-tenths width of frontal lobe. Glabellar furrows *2p* directly posterolaterally and would intersect at angle of 140° if projected to sagittal line. Glabellar lobes *2p* about one-third as long (exsag.) as lateral lobes *3p* and half as wide. Width of glabella at lobes *2p* six-tenths that of frontal lobe. No furrow separates. Glabellar lobes *2p or 3p* from central part of glabella. Glabellar furrows *1p* oriented posterolaterally and would intersect at angle of 120°–125° if projected to sagittal line. Glabellar lobes *1p* furnished with large round bosses completely circled by furrows. Total width at these lobes including bosses almost same as at glabellar lobes *2p*. Occipital ring strong, raised, longer (sag.) than glabellar lobe *1p*.

Although partly subjective, sagittal lengths of lobes of the glabella and the occipital ring relative to total length of glabella including occipital ring are:

	Percent
Frontal lobe	45
Glabellar lobes *3p*	9
Glabellar lobes *2p*	10
Glabellar lobes *1p*	16
Occipital ring	20
	100

Genal angles are right-angled and rounded. Eight horizontal rows of facets in the compound eyes.

Pygidium subtriangular without border or border furrow. A specimen 7.7 mm long possesses six complete axial rings, two less well defined and a terminal axial part unmarked by rings. At least six pleurae indicated by furrows; each pleura bears a pleural furrow that starts a short distance distally from axial furrow but runs almost to margin. These pleural furrows contrast with interpleural furrows that start in axial furrow and fade well short of margin. Very small evenly spaced pustules are alined across axial rings and along front and back halves of pleurae. Axial furrows strong along sides of axis but shallow around posterior termination.

Holotype: USNM 145846.
Paratype: USNM 145847.
Occurrence: Upper part of Pogonip Group: USGS colln. D813 CO, in thrust plate, southeast of Joshua Hollow, Nev., altitude 4,240 ft. Nevada coordinates, central zone: E. 506,850 ft; N. 781,750 ft, Bare Mountain quad., Nevada.

Discussion.—This species is differentiated from almost all others by the transverse direction of the anterior lateral glabbellar furrows *3p*. It resembles *Calyptaulax strasburgensis* fairly closely in this respect as well as in convexity. Although the original description of *C. strasburgensis* (Delo, 1940, p. 99–100) calls for only four pairs of pygidial pleurae, illustrations by Cooper (1953, pl. 17, figs. 5, 6, 14) show that six can be differentiated. The Nevada species lacks the preglabellar median pit and has a shorter frontal glabellar lobe and much shorter *2p* and *1p* glabellar lobes.

Only *C. callicephala* (Hall) (Cooper, B. N., 1953, pl. 16, fig. 12) has more transversely placed glabellar furrows *3p*. Relative sagittal lengths of glabellar lobes compare very closely, but the frontal lobe is not as wide as in the Nevada species. According to Delo's description, the pygidia of the two are very similar.

This species seems to resemble most closely *C. strasburgensis* Ulrich and Delo and *C. callicephalla* Hall. One might conclude that its age is therefore probably Porterfield or younger, but such a conclusion would be speculative. This is clearly not the same species (*C.* aff. *C. angusta*, described above) as occurs in collns. D829 CO and D832 CO on the north and west sides of Meiklejohn Peak.

Genus APATOLICHAS Whittington, 1963

Apatolichas? sp.

Plate 9, figure 35

A single broken incomplete pygidium seems to represent the genus *Apatolichas* and is illustrated as a matter of record. Because much of the pleural part as well as the posterior tip of the axis is broken, positive assignment to the genus is not possible.

Figured specimen: USNM 145860.

Occurrence: Antelope Valley Limestone: USGS colln. D1398 CO, 379 ft. above base. North of Pyramid Peak, Ryan quad., California.

Genus DIACANTHASPIS Whittington, 1941

Diacanthaspis sp.

Plate 9, figures 29–34

This species is represented in the present collection by two cranidia and three pygidia. All are exceedingly small and all are imperfect.

Surface ornamented with pustules of two sizes, which prevent a clear view of dorsal surface and its components. Posterolateral parts of fixed cheeks broken on all cranidia.

Glabella poorly defined laterally, composed of a high elongate central lobe with lateral lobes *1p* and *2p*. Glabella widest at lateral lobes *1p*, opposite glabella midpoint. Length (exsag.) of lateral lobe *2p* about one-half that of *1p*. Glabellar furrows run distally anterolaterally. Occipital ring bears a large median tubercle and a pair of long spines based to rear and on either side of tubercle. Spines project posterolaterally and upward. Length (sag.) of occipital ring about one-third that of glabella.

Underside of carapace shows that a shallow longitudinal furrow connects inner ends of glabella furrows. Front of glabella transgresses border furrow and lies in dorsal side of border.

Eye ridges rooted in faint axial furrows immediately behind anterior border and ahead of distal end of glabellar lobe *2p*.

Pygidium transversely semielliptical, width about 2½ times length. Dominated by pair of large posterolateral spines which are rooted in anterior axial ring and lie in and cross pleural platforms and interrupt border. Axial furrows barely indent this pair of spines. Axis composed of two segments, one axial ring and poorly defined terminal piece, ending in border furrow. Border furrow weak, border convex. Two pairs of spines based on border between the large dominating spines and one pair in front of them.

Figured specimens: USNM 145861–145864.

Occurrence: Antelope Valley Limestone: USGS colln. D727 CO, 25 ft above base of Ranger Mountains Member. Southwest of Aysees Peak, Nevada Test Site (Ross, 1964, p. C20–21, pl. 1, loc. 50). USGS colln. D1398 CO, 379 ft above base. North of Pyramid Peak, Ryan quad., California.

Discussion.—This species because of the incompleteness of diagnostic material cannot be compared fully with others. The glabella is narrower than that of *Diacanthaspis cooperi* Whittington. The pygidium differs in the development of the large pair of spines, the counterparts of which on *D. cooperi* are smaller, are directed upward, and are not involved in the border. There are more border spines in *D. cooperi.*

A similar, possibly the same, species is present in the lower part of the Antelope Valley Limestone at the Nevada Test Site (USGS colln. D727 CO) where a single cranidium (pl. 9, fig. 29) was found in essentially correlative strata. This cranidium has smaller paired spines on the occipital ring. The underside of the carapace shows that the fundamental structures are quite similar. A pygidium from the test site (pl. 9, fig. 31) differs from that described above in the greater convexity of the axis, lesser strength of the large paired spines, and possession of one more pair of border spines in front of the major spines. All the spines are directed posteriorly instead of being splayed out.

This occurrence extends the range of *Diacanthaspis* downward to the *Orthidiella* zone.

Odontopleurid, indet.

Plate 9, figures 36–39

Several free cheeks have been obtained in USGS collection D1398 CO for which no other parts have been recognized. These cheeks bear a prominent subspherical eye and a prominent row of stubby spines along the ventral side of the border.

These specimens are illustrated so they can be compared elsewhere with more complete specimens that may give a clue to their identity. They may belong to *Diacanthaspis* sp., previously described, with which they are associated, and they may represent individuals larger than those for which cranidia have so far been found.

Figured specimens: USNM 145865, 145866.

Occurrence: Antelope Valley Limestone: USGS colln. D1398 CO, 379 ft above base. North of Pyramid Peak, Ryan quad., California.

Genus CLELANDIA Cossman, 1902

Although *Clelandia* is a Lower rather than a Middle Ordovician genus, two very different species from the same collection are described here. Both come from the Goodwin Limestone of the lower part of the Pogonip Group of the Ryan quadrangle, California. They are important elements in an assemblage proving the Early Ordovician age of beds which in nearby areas have been assigned to the Late Cambrian and placed in the Nopah Formation.

This genus has been known previously from *C. parabola* (Cleland) and *C. utahensis* Ross. The former, according to the original description by Cleland, lacked an occipital spine. Raymond (1937, in explanation of pl. 1, fig. 25) claimed that a large occipital spine had been overlooked in the original description. Cleland's (1900, p. 255–256 (15–16), pl. 16, figs. 1–3) illustrations show that the occipital ring of the type specimen is damaged; although Cleland made no mention of any occipital spine in other specimens, Raymond's comment may have been correct.

Two new species are described below; one lacks an occipital spine, and the other possesses a double spine of peculiar construction. The two occur together, and the occurrence suggests that in the beds of Tribes Hill Limestone of New York two species may also be present—*C. parabola* lacking a spine, and an unnamed species possessing a stout spine.

Clelandia bispina, n. sp.

Plate 10, figures 1–16

Cephalon subsemicircular in outline with very long genal spines and large occipital spine directed posterodorsally. Anterior margin drawn upward in such a way as to give snouted appearance to cephalon in lateral view.

Cranidium subtrapezoidal, widest at posterior margin. Glabella nearly semiconical; occipital ring bearing massive occipital spine of unique construction. Anterior side of spine deeply grooved; groove actually a continuation of occipital furrow. Lying in groove is second spine arising from preoccipital part of glabella. Occipital ring occupies about one-fourth of glabellar length. Occipital furrow obscure on lower flanks of glabella, vaguely connected with posterior border furrow. Axial furrows lightly impressed across posterior border, but deep and converging forward from border furrow. At front of glabella, axial furrows are not confluent but turn abruptly to front and run parallel for short distance before fading out in preglabellar field.

Fixed cheeks gently convex and almost horizontal. Palpebral rims and furrows and lobes lacking. Preglabellar field sloping gently downward. Facial sutures cutting posterior margin so that cranidium is widest at posterior border; cranidial length approximately 0.85 this posterior width. Sutures curve sharply inward to border furrow then run fairly straight with converging courses until opposite glabellar midpoint; then they follow short but very open curve to produce mere suggestion of palpebral lobes, converging again until opposite a point about one-sixteenth glabellar length from its front. Sutures then run forward subparallel and turn fairly abruptly to meet in a sharp curve at the midline.

Free cheeks form a continuous yoke, lack border or border furrow, but possess strong genal spines as long as cranidium. Only border furrow is extension of posterior furrow that crosses posterior facial suture from cranidium, turns abruptly posteriorly parallel to suture, and fades out at margin. Eyes seemingly lacking. Lateral surfaces convex and steep.

Thorax and pygidium not known.

Holotype: USNM 146126.
Paratype: USNM 146127–146132.
Occurrence: Goodwin Limestone: USGS colln. D1394 CO, approximately 180 ft above base as designated by McAllister. North of Pyramid Peak, Ryan quad., California.

Discussion.—Within the genus Clelandia this species is unique not only in the possession of its peculiar double occipital-preoccipital spine but also in the unusual extension of the glabella into the preglabellar area. Both the features are recognizable on cranidia only 0.6 mm long. The courses of facial sutures are fairly straight instead of having the pronounced outward curve found in *C. utahensis* and *C. aspina*, n. sp.

The association of this unusual and ornate species with relatively plain *C. aspina*, n. sp., raises the possibility of sexual dimorphism or of very different adaptation to distinct ecologic niches.

Clelandia aspina, n. sp.

Plate 10, figures 17–22

Cranidium two-thirds to three-fourths as long as wide. Glabella low, semiconical. Occipital ring flat, devoid of spine, consuming about one-third glabellar length. Occipital furrow shallow, continuous with posterior border furrow. Axial furrows distinct in crossing posterior border, converging to meet in sharply rounded angle in front of glabella. Fixed cheeks convex, sloping fairly steeply.

Facial sutures cross posterior border anterolaterally so that greatest width of cranidium is in front of posterior border furrow. Sutures then converge in curving course until opposite a point on glabella about one-fifth its length from front. They then run forward subparallel for a very short distance before converging to join in a blunt curve.

Free cheeks, thorax, and pygidium not known.

Holotype: USNM 145867.
Paratype: USNM 145868.
Occurrence: Goodwin Limestone: USGS colln. D1394 CO, approximately 180 ft above base as designated by McAllister. North of Pyramid Peak, Ryan quad., California.

Discussion.—This species most closely resembles *Clelandia utahensis* Ross (1951, p. 117, pl. 29, figs. 1–4, 6–9), from which it is distinguished by the lack of occipital spine and the somewhat steeper slope of the fixed checks. Relative to its length, the cranidium is wider than in any other species.

STRATIGRAPHIC SECTIONS

SECTION A, NORTH OF PYRAMID PEAK, CALIF.

Thanks to the efforts of J. F. McAllister a good section of Ordovician rocks was located about 2 miles north of Pyramid Peak. McAllister and I are of the opinion, as a result of separate and joint fieldwork in the surrounding region, that an 81-foot silty limestone unit about 290 feet above the base of the Goodwin Limestone is the same as unit 3 of McAllister (1952) in the Quartz Spring area and the same as the lowest unit of the Pogonip (?) as provisionally interpreted by Hazzard (1937) in the Nopah Range. In this section, Early Ordovician trilobites are present 170 feet lower and are probably present 328 feet lower.

Following a conference in the field on April 3, 1963, the base of the Pogonip was considered by McAllister to be 13 feet lower than by me, as indicated in the following measured section.

It is probable that 43 feet of strata classified in the top of the Antelope Valley Limestone in this section are equivalent to the lower Copenhagen Formation or to the Barrel Spring Formation. Fossils collected nearby in 1965 by McAllister (written commun., 1965) 20 feet below the top include *Valcourea* sp. and *Orthambonites*? *dinorthoides* Cooper (USGS colln. D1616 CO).

North of Pyramid Peak, Calif.

[Section measured in Pogonip Group along crest of spur 1.95 miles north of Pyramid Peak. The base of the Pogonip is at an approximate altitude of 4,800 ft. California coordinates, zone 4: E. 2,701,500 ft, N. 404,350 ft, Ryan quad.]

	Feet
Eureka Quartzite (thicknesses from McAllister):	
Quartzite, white, vitreous	180±200
Quartzite, partly dolomitic, brown	285±200
	400
Pogonip Group:	
Antelope Valley Limestone:	
Dolomite, light-gray, weathers pale-grayish orange. Very silty and in part finely sandy. Sandy streaks weather dark-yellowish orange	4
Dolomite, light-gray, weathers light gray	2
Dolomite, light-gray, weathers very pale orange. Very silty; in part very finely sandy, weathers dark-yellowish orange	37
Limestone, coarsely crystalline, very silty, with sponges like those in Toquima Range. Abundant *Eofletcheria* and cephalopods. USGS colln. 4263 CO	2
Limestone, dark-gray, resistant	20
Limestone, in ½- to 3-in. layers of light gray separated by pink-weathering silty limestone. Indeterminate ostracodes from 6 ft above base of unit	28
Limestone, sandy, irregularly laminated, very high percentage of well-rounded quartz sand grains	8

	Feet
Pogonip Group—Continued	
Antelope Valley Limestone—Continued	
Limestone, silty, in thin beds and laminae, weathers pink, pale-yellowish orange, and lavender	23
Limestone, pale-red, very silty, weathers dark-yellowish orange	4
Limestone, light-gray, coarse-grained, weathers light gray	9
Limestone, dark-gray, cherty	7
Limestone, dark-gray, massive	8
Limestone, very silty, thin-bedded and laminated. Both pale red and gray on fresh break. Weathers dark-yellowish orange. Prominent marker where not covered by float	19
Limestone, like underlying unit but with increasingly higher silt content toward top	70
Limestone, dark- to medium-gray, resistant, irregular laminae and thin layers welded into massive beds. Lower 55 ft slightly cherty. "*Girvanella*" throughout but fewer in top 90 ft. Small ***Palliseria*** 200 ft above base; large ***Palliseria*** and ***Maclurites*** 285–525 ft above base of unit	530
Limestone, laminated irregularly in ½- to 1-in. layers, separated by silty partings weathering in dark-yellowish orange and brown relief. Unit form cliff. Brachiopods in USGS colln. D1400 CO from 4 ft above base of unit	26
Limestone in discontinuous irregular 1- to 2-in. laminae and layers interspersed with pink-weathering silty limestone. Scattered chert nodules parallel bedding; cliff forming	22
Limestone, dark-gray, in 2- to 6-in. layers separated by pale-red finely laminated limestone that weathers pink. Forms nonresistant slope, partly covered by float. Trilobites in USGS colln. D1398 CO from 11 ft above base and other fossils from upper part taken from float derived from within top 25 ft: USGS colln. D1399 CO	68
Limestone, in 1-in. laminae with wavy-silty partings, weathers pink. Very weak unit. Fossils from top 1 ft in USGS colln. D1397 CO	30
Limestone, medium- to dark-gray, massive	116
Limestone, medium-gray, very silty and siliceous, weathers brown. "Crepe"	17
Siltstone, green, and partly nodular gray crystalline limestone. Silicified siltstone near top of interval results in "crepe" structures on weathered surfaces. Trilobite from top 2 ft; USGS colln. D1396 CO	43
Limestone, light-gray; abundant silty partings that are partly silicified. Partings stand in weathered relief, are dark-yellowish orange to dark brown, and compose about 50 percent of rock. Some partings composed of very fine sand showing laminar cross-bedding. A few beds of coarse-grained limestone contain trilobites (***Ptyocephalus***) and brachiopods. USGS colln. D1395 CO	49
Limestone, light-gray, contains abundant crinkly silty partings which weather pale- to dark-yellowish orange	37
Limestone, medium-gray, coarse-grained, resistant; in beds 6 in.–2 ft thick	56

	Feet
Pogonip Group—Continued	
Antelope Valley Limestone—Continued	
Limestone, fine-grained, fossiliferous; in 3- to 18-in. beds; interbedded with silty nodular limestone in 3-ft beds	20
Thickness of Antelope Valley Limestone	1,255
Ninemile Formation:	
Siltstone and shale, green, interbeds of nodular limestone. Form a weak saddle in ridge. *Archaeorthis*, *Hesperonomea*, and *Ptyocephalus*	113
Goodwin Limestone:	
Limestone, silty, partly nodular; thinly bedded and laminated, partly intraformational conglomerate. Unit weathers a distinctive pale to grayish brown (5YR 4/2) mottled with pale-red splotches	51
Limestone, coarsely crystalline, thinner bedded than unit below, silty partings increase upward and weather pink. Slightly less resistant than underlying unit	18
Limestone, dark- to medium-gray, in 1- to 3-ft beds	83
Limestone, dark- to medium-gray, massive; bedding poorly defined	68
Limestone, medium-gray, resistant, abundantly cherty	14
Limestone, silty, and limy siltstone, which weather yellowish orange. Weak, forming a reentrant	15
Limestone, medium-gray, intraformational conglomerate, thin layered, forming 1–3 ft beds. Large light-colored chert stringers abundant	64
Limestone, silty, grading upward to cleaner limestone	3
Limestone, silty, limy siltstone and intraformational conglomerate interlayered in beds 2 in.–2 ft thick. High silt content weathers dark-yellowish orange. Forms weak saddle in all ridges. (This unit probably the same as McAllister's (1952) unit 3 in the Quartz Spring area. It is probably the provisionally lowest unit of the Pogonip(?) of Hazzard (1937, p. 276, 321) in the Nopah Range)	81
Limestone, thick-bedded, resistant	9
Limestone, thin and irregularly laminated; welded into a resistant unit	4
Limestone, massive	14
Limestone, medium-gray, in beds 1–4 ft thick, forming cliff; very cherty in lower part	65
Limestone, dark-gray, in 2- to 6-in. beds, interlayered with red silty limestone, weathering pink	11
Limestone, medium-gray in 6-in.–2-ft beds. Abundant chert nodules parallel bedding 13–43 ft above base of interval. Upper 10 ft weak, forming reentrant	66
Limestone, with silty partings between thin layers. Beds 1–3 ft thick. Silicified trilobites 6 ft below top of interval. USGS colln. D1394 CO	84
Limestone in ½- to 1-in. laminae, with silty partings; weak	7
Limestone, thin-bedded to irregularly laminated with some silty partings. Limestone weathers medium gray. Large chert stringers and silty partings weather dark-yellowish orange. Limestone forms resistant ledge	21
Limestone, thin-bedded with clastic dolomite rhombs in matrix around pebbles of intraformational conglomerate	1

	Feet
Pogonip Group—Continued	
Goodwin Limestone—Continued	
Dolomite, very light gray, coarsely crystalline, cherty; weathers pale-grayish orange	2
Limestone, very thin bedded to finely laminated, medium-gray, with silty partings weathering pale red to yellowish orange. A few chert stringers 7–15 ft above base of interval and coarse bioclastic limestone lenses in upper 15 ft. Trilobites 14 ft above base of interval. USGS colln. D1393 CO	58
Base of Pogonip Group in my opinion, but not according to McAllister.	
Dolomite, thin-bedded, very light gray, abundant laminae with very fine angular sand and silt weathering brown	13
Thickness of Goodwin Limestone	752
Base of Pogonip Group according to McAllister.	
Upper Cambrian:	
Nopah Formation: Dolomite, thin-bedded, light-gray, weathering light gray	18
Not measured below this depth.	

FOSSILS LISTED BY USGS NUMBERED COLLECTIONS

4263 CO. Antelope Valley Limestone, 43 ft below top. Identified by W. A. Oliver, Jr.

Eofletcheria sp.
Orthoconic cephalopod
Similar *Eofletcherias* have come from the upper 40 ft of the Pogonip in the White Pine Range and the Antelope Valley Limestone at the Nevada Test Site.

D1400 CO. Antelope Valley Limestone, 488 ft above base of formation (22 ft below bottom of middle, thick-bedded member).

Orthidiella sp.
Orthambonites sp.
Carolinites sp.
Nileus sp.
Goniotelina sp.
Ampyx sp.

D1399 CO. Antelope Valley Limestone, from float derived from 410–435 ft above base of formation.

Orthidiella extensa Ulrich and Cooper.
Orthambonites marshalli Wilson. This species occurs at top of *Orthidiella* zone in Quartz Spring area and at bottom of *Anomalorthis* zone in Pahranagat Range.
Ingria sp.
Carolinites angustagena, n. sp.
Illaenus sp.
Goniotelina sp.
Ischyrotoma sp.
Ampyx sp.
Ectenonotus sp.
Small ostracodes

D1398 CO. Antelope Valley Limestone, 379 ft above base of formation. This collection, in particular, is closely comparable to an assemblage from Lower Head, Newfoundland (Whittington, 1963).

Orthidiella sp.
Orthambonites eucharis Ulrich and Cooper
Trinodus cf. *T. clusus* (Whittington)
Carolinites angustagena, n. sp.
Nileus hesperaffinis, n. sp.

Raymondaspis vespertinus, n. sp.
Illaenus auriculatus, n. sp.
Illaenus sp.
Goniotelina hesperia, n. sp.
Strigigenalis sp.
Ischyrotoma sp.
Ampyx compactus, n. sp.
Cydonocephalus scrobiculus Whittington
Ectenonotus whittingtoni, n. sp.
Protocalymene mcallisteri, n. gen., n. sp.
Apatolichas sp.
Diacanthaspis sp.

D1397 CO. Antelope Valley Limestone, 367 ft above base of formation. This collection includes the first known specimens of *Heliomeroides* from western North America.
Orthidiella sp.
Carolinites angustagena, n. sp.
Nileus sp.
Goniotelina sp.
Ischyrotoma sp.
Ampyx sp.
Cydonocephalus sp.
Heliomeroides sp.
Ectenonotus cf. *E. westoni* (Billings)

Colln. D1397, D1398, and D1399, above, are from the *Orthidiella* zone of the Whiterock Stage. Some elements are holdovers from the older *Pseudocybele* zone, that is, *Ischyrotoma* (*Dimeropygiella* of Ross) and *Goniotelina* (*G. hesperia* is similar to *G. williamsi* of the Garden City Formation).

D1396 CO. Antelope Valley Limestone, 203 ft above base.
Ptyocephalus sp.
Very small conodonts

D1395 CO. Antelope Valley Limestone, 139 ft above base.
Ptyocephalus cf. *P. declevita* Ross
Paranileus sp.
Carolinites genacinaca Ross
Ischyrotoma caudanodosa (Ross)

Colln. D1395 CO and D1396 CO belong to the Late Canadian zone of *Pseudocybele* (zone J of Ross, 1951). They indicate that the lower 200+ ft of the Antelope Valley Limestone, as well as the Ninemile Formation, is of late Early Ordovician age, a fact which is also true in the type area of the formation and on the Nevada Test Site.

D1394 CO. Goodwin Limestone, 11 ft above base. This collection includes a very unusual new species of *Clelandia*.
Clelandia bispina, n. sp.
Clelandia aspina, n. sp.
Symphysurina sp.
Bellefontia sp.
Xenostegium sp.
Remopleuridiella sp.
Hystricurus sp.

D1393 CO. Goodwin Limestone, 27 ft above base.
Symphysurina? sp.

Colln. D1393 CO and D1394 CO are of early Early Ordovician age.

SECTION B, SPECTER RANGE, NEVADA

In 1964, a partial section of Pogonip rocks on the west side of the Specter Range was measured by Harley Barnes, and collections of fossils were made by R. J. Ross, Jr., and L. A. Wilson. Barnes made available his field notes, which are given in the following section. The columnar section is shown on plate 11.

Although the top of the Pogonip and higher units are not included because of faulting, the part of the section presented here is very similar in lithic character and in spacing of fossil zones to the section north of Pyramid Peak. (See fig. 1, pl. 11, and section *A*.)

Specter Range, Nev.

By Harley Barnes

[Section measured in Pogonip Group (incomplete) from west to east across north-trending ridge in sec. 4, T. 16 S., R. 52 E., Specter Range quad. About 9 miles southwest of Mercury, Nev., and 1½–1¾ miles north of U.S. Highway 95. Section taped by K. A. Sargent, E. N. Hinrichs, and J. H. Stewart. Information in brackets is discussion or interpretation (by Barnes). The word "silty" as used in these notes may refer to silt, clay, or simply iron-stained clayey dolomitic limestone]

	Thickness in feet Unit	Cumulative
Antelope Valley Limestone:		
Aysees Member (part):		
14. Ledgy thin-bedded limestone interbedded with silty material. Limestone, medium-light-gray, aphanitic. Silty material: limestone, grayish-orange weathering, iron-stained; perhaps contains siliceous interstitial material; very thin bedded	25+	25+
[This unit may be lithologically equivalent to base of Johnson and Hibbard's unit I (1957, p. 347). This unit is so much faulted that without more careful mapping of the area I cannot be sure that this is truly Johnson and Hibbard's unit I, or that the underlying unit H equivalent is complete in this measured section. I measured a complete section of unit I plus the top 100 ft of unit H near triangulation station Eagle about 4 miles northwest of here.]		
13. Cliff-forming nonsilty limestone. Unit grades into unit 12 below. Medium-light- to medium-dark-gray very fine to coarse grained limestone; bedding indistinct and very thin to irregular; massive splitting. Relatively little grayish-orange weathered color; uncommon irregular dolomite laminae that weather light olive gray; abundant small (½–¾ in.) pits of light-olive- to light-brownish-gray color resulting from solution of fossils on weathered surfaces (brachiopods, gastropods, straight-coned cephalopods, *Girvanella*, *Receptaculites*, *Maclurites*). First *Palliseria* noted about 127 ft above base of unit where *Receptaculites* are abundant. *Palliseria* very abundant. Upper part of unit is blocky as well as massive splitting and contains abundant fossil fragments	311	

Antelope Valley Limestone—Continued
Aysees Member (part)—Continued
13—Continued

	Thickness in feet Unit	Cumulative
[Much brecciation along route of this section above basal 100 ft of unit 13, but no major displacement was seen from base of cliff. Ridge crest occurs 127 ft above base of unit. Top of unit is well down the dip slope on east side of ridge and probably is faulted. I am not at all sure that color changes at top of unit mark the base of Johnson and Hibbard's unit I (1957, p. 347); rather, color changes may be result of alteration associated with faulting. I believe unit 13 is probably the equivalent of most of Johnson and Hibbard's unit H, but may not include top of that unit.]		
Total Aysees Member measured		336+

Ranger Mountains Member:

	Unit	Cumulative
12. Mottled silty limestone forms rounded and irregular cliffs; series of ledges and benches in lower part, cliff in upper part. Medium gray mottled with grayish-orange to moderate-yellowish-brown silty partings; very fine to medium grained, some coarse grained fossil fragments that locally form "bioclastic" beds; bedding thin to irregularly laminated; slabby to massive splitting. Silty partings, probably largely iron-stained limestone with clay-sized interstitial material; occur in irregular very thin beds and laminae which form mottling that is commonly coarser than the "chickenwire" weathering pattern lower in section. Unit becomes progressively less silty in upper 46 ft. Abundant fossils and fossil fragments (straight-coned cephalopods and 1/2- to 1-in brachiopods), mostly unsilicified, in very thin beds in lower 60 ft	106	106
USGS colln. D1441 CO about 45 ft above base of unit.		

Paiute Ridge Member:

	Unit	Cumulative
11. Massive-splitting cliff-forming limestone. Limestone, medium-light- to medium-dark-gray with minor streaks and mottling of grayish orange; very fine to medium grained; thin to thick to irregularly bedded; distinctly to indistinctly bedded; massive to blocky splitting	101	101
[May be lithologic equivalent of unit F of Johnson and Hibbard (1957, p. 347).]		
USGS colln. D1438 CO about 15 ft above base of unit.		

Antelope Valley Limestone—Continued
Paiute Ridge Member—Continued

	Thickness in feet Unit	Cumulative
10. Ledge-forming limestone shows abundant "chickenwire" weathering. Minor "siltstone," actually medium-dark- to brownish-gray limestone with conspicuous grayish-orange weathered surfaces; very fine grained; very thin bedded; flaggy splitting; less resistant to erosion; forms bench at top of unit	50	151
[Lithology similar to that of unit 9, making a total thickness of about 283 ft; units 9 and 10 combined may be lithologic equivalent of unit E of Johnson and Hibbard (1957, p. 347). Offset in measured section. Upper part of section is offset about 2,000 ft northward along western base of ridge near top of talus (offset stations marked with red paint; lath with strips of red cloth at base of upper part of section).]		
USGS colln. D1440 CO; about 2 ft below top of unit. Probably zone J of Ross, 1951.		
9. Ledges of gray limestone, with interbeds of nodular limestone embedded in siltstone and silty limestone; grades upward to uninterrupted limestone ledges. Limestone, weathers to medium gray with grayish-orange to moderate-yellowish-brown mottling; medium to coarse grained; thin bedded to very thin bedded and irregularly laminated; slabby to massive splitting; abundant silicified fossil fragments, scattered chert. Some of limestone is nodular and very fine grained; much of it shows moderate-brown to dusky-brown "case-hardened" and "chickenwire" patterns on weathered surfaces, probably reflecting siliceous cement stained with iron oxide. Interbeds of siltstone, silty limestone, and nodular limestone similar to those lithologies in Ninemile Formation occur in lower 95 ft of unit; above that part, unit is almost all limestone. "Chickenwire" weathering is conspicuous in upper part and is continuous about 110–145 ft above base; overlying this weathered section is an 8-ft band of "case-hardened" limestone. Intraformational conglomerate abundant in parts of unit. About 207 ft above base of unit is bottom of a 13-ft ledge of very coarse grained limestone that contains abundant fossil fragments and is thin bedded but massive splitting; about 233 ft above base is a 1-ft gray limestone bed with abundant silicified		

	Thickness in feet Unit	Cumulative
Antelope Valley Limestone—Continued		
Paiute Ridge Member—Continued		
9—Continued *Girvanella* forming a break in a "chickenwire"-weathered ledge. The 13-ft ledge and the 1-ft bed appear to be lenticular and an individual bed cannot be traced laterally with assurance for more than a few hundred feet	233	
USGS colln. D1439 CO about 31–55 ft below top of unit. Probably zone J of Ross, 1951. *Hesperonomea* 20 ft above base of unit. No collection.		
USGS colln. D1437 CO 5 ft above base of unit.		
Total thickness of Paiute Ridge Member		384
Total measured thickness of Antelope Valley Limestone		826+
Ninemile Formation:		
[Limestone nodules and lenticular thin beds imbedded in shale and siltstone; form conspicuous talus-covered slope. Proportion of limestone to shale and limy siltstone increases upward and lenticular thin beds of limestone become more persistent upward. Contact with overlying Antelope Valley Formation is gradational but is placed at base of lowest persistent ledge, which is here about 2 ft thick.]		
8. Largely covered with talus but probably Ninemile Formation	56	56
7. Limestone nodules embedded in shale and siltstone. Limestone medium gray to olive gray, weathers light medium gray; aphanitic to very fine grained; occurs as nodules and lenses in limy siltstone and shale, which weather pale red, pale yellowish orange, and light to moderate brown	88	
Abundant fossil fragments locally in limestone.		
USGS colln. D1435 CO, 49 ft above base of unit 7.		
Total thickness of Ninemile Formation		144
Goodwin Limestone:		
6. Ledge-forming, well-bedded; weathers medium gray to medium light gray, commonly mottled and streaked with pale red, pale yellowish orange, and moderate brown; similar to limestone described in unit 4 in that it contains common intraformational conglomerate, chert in nodules, lenses, and beds, laminae of iron-stained clayey and silty limestone and dolomitic limestone, and beds of coarse limestone "sand" in which fossil fragments are common. Top 15 ft contains much limestone with brownish gray-weathering fragments, commonly silty; this lithology like that in top 10 ft of unit 4. Iron-stained clayey and silty dolomitic limestone more common in upper part of unit. Broad brownish-weathering bands that can be traced along outcrop are composed of abundant irregular laminae forming moderate-brown embossed weathered surfaces, probably because of siliceous cement; a 40-ft band occurs from 138 to 178 ft above base of unit. Chert in beds, nodules, and lenses especially abundant in basal 20 ft	332	332
Siphuncles of straight-coned cephalopods on bedding planes about 46 ft above base. Chitinous fragments of linguloid brachiopods common on plates of silty limestone about 15 ft above base.		
USGS collns. D1434 CO, 1433 CO, 1432 CO, and 1431 CO from 120 ft, 115 ft, 105 ft, and 10 ft, respectively, above base.		
5. Talus-covered slope with several limestone ledges Chiefly limy siltstone; limestone with siliceous cement that forms moderate-brown embossed weathered surface, and olive-gray to medium-gray to pale-red iron-stained clayey dolomitic limestone; weathers pale-yellowish orange, light brown, pale red to moderate and dusky brown; irregularly laminated. Ledge-forming limestone; weathers light-medium gray with mottling and has pale-yellowish-orange, moderate brown, and pale red siliceous-cemented laminae; ledges more closely spaced upward, becoming dominant lithology in upper 5–10 ft; contains intraformational conglomerate with discoidal limestone pebbles and cobbles as much as 4 in. in diameter	63	395
4. Ledge- and cliff-forming; upper third of unit forms cliff below unit 5. Limestone, chiefly light medium to light-gray; fresh and weathered colors similar; fine to medium grained; thin bedded to laminated; some thick beds in upper cliff. Some laminated beds are very fine grained to aphanitic; some appear to have siliceous cement. Chert is abundant in part of unit; occurs in 1- to 3-in. beds and lenses (like chert in lower units). Some intraformational conglomerate — discoidal limestone pebbles as much as 4 in. long. In upper 10 ft, brownish gray is a distinctive additional color on weathered surface of thick-bedded limestone that		

Goodwin Limestone—Continued	Thickness in feet Unit	Cumulative
4—Continued		
is generally a medium to medium light gray mottled with pale-yellowish orange and pale red from irregular laminae and fragments of iron-stained clayey dolomitic limestone; brownish-gray color is probably due to brownish interstitial stain of iron oxide	177	572
USGS colln. D1430 CO, 42 ft below top of unit.		
3. Limestone with abundant chert, minor laminated dolomite, and laminated siltstone; forms brown ledgy slope. Limestone light gray; weathers medium-light gray; fine to medium grained; chiefly thin bedded, some very thin bedded and laminated. Abundant irregular thin beds of chert, like chert in unit 2 below; common irregular laminae of "siliceous carbonate" (probably limestone with siliceous cement producing moderate-brown embossed "case-hardening" on weathered surface). From 13 to 28 ft below top are two 2- to 3-ft units of laminated limy moderate red dolomite, weathering to pale red and pale-yellowish orange; contains interbedded irregular lenses and very thin beds of chert. At base is 2–3 ft of moderate-yellowish-brown-weathering laminated limy siltstone (graded bedding; some medium sand grains) and silty limestone	53	625
[In lower part of unit are a number of minor high-angle faults crossing line of section subparallel to strike of beds. Maximum stratigraphic displacement of any fault about 30 ft, net displacement of all faults about 5 ft (west side up).]		
USGS colln. D1429 CO, 1 ft below top of unit 3.		
2. Dolomite, grading upward into limestone. Dolomite (lower 134 ft) medium gray; weathers medium-light gray; finely to coarsely crystalline; bedding ranges from distinct thin beds that are slabby splitting to indistinct thin to thick beds that are blocky splitting; thin beds commonly include lenses and very thin beds of light-gray chert that weathers light gray to dusky brown and pale-yellowish-orange or pale-red irregularly shaped laminae that probably are iron-stained clayey dolomitic limestone. Limestone (upper 49 ft) chiefly medium- to medium-light gray; weathers medium-light gray commonly with pale-red tint; fine to medium grained; bedding distinct, regular to irregular, thin bedded to laminated; slabby splitting; forms ledgy slope. Pale-red and pale- to medium-yellowish-orange irregularly shaped laminae, probably composed of iron-stained clayey dolomitic limestone. Minor very fine grained limestone that weathers pale red in upper part	183	808
USGS colln. D1428 CO, 32–34 ft below top of unit 2.		
[Conformable gradational contact (basal part of Goodwin is dolomitized). Contact placed just below lowest chert; basal part of Goodwin is thin bedded and more distinctly bedded than upper part of Smoky Member of Nopah Formation; Goodwin weathers lighter gray, commonly pale red and buff cast.]		
Total thickness of Goodwin Limestone		808
Total measured thickness of Pogonip Group		1,778+
Nopah Formation:		
Smoky Member:		
1. Dolomite, chiefly medium- to medium-dark gray mottled; minor amount medium-light-gray; fresh and weathered colors similar; bedding indistinct, thin to thick; blocky to slabby splitting; forms ledgy slope	90+	

FOSSILS LISTED BY USGS NUMBERED COLLECTIONS

D1441 CO. Antelope Valley Limestone, 45 ft above base of Barnes' unit 12.
Orthidium cf. *O. bellulum* Ulrich and Cooper
Orthidiella sp.
Orthambonites sp.
This collection is significant in showing that *Orthidium*, a guide fossil to the *Rhysostrophia* zone (Cooper, 1956, p. 127), actually occurs in the *Orthidiella* zone. This is confirmed by USGS colln. D1514 CO from Ikes Canyon, Toquima Range.

D1438 CO. Antelope Valley Limestone, 15 ft above base of Barnes' unit 11.
Archaeorthis sp.
Hesperonomea sp.
Ptyocephalus sp.
Presbynileus sp.
Goniotelina sp.

D1440 CO. Antelope Valley Limestone, about 2 ft below top of Barnes' unit 10.
Archaeorthis? sp.
Ptyocephalus sp.
Presbynileus sp.

D1439 CO. Antelope Valley Limestone, 31–55 ft below top of Barnes' unit 9.
Archaeorthis sp.
Ptyocephalus sp.

D1437 CO. Antelope Valley Limestone, 5 ft above base of Barnes' unit 9.
Ptyocephalus cf. *P. vigilans* Whittington
Shumardia exopthalmus Ross, n. sp.
Ischyrotoma sp. (equals *Dimeropygiella* of former usage)

D1435 CO. Ninemile Formation, 49 ft above base of Barnes' unit 7.
Ampyx sp.
Ptyocephalus sp.
Shumardia sp.
Psalikilus? sp.

D1434 CO. Goodwin Limestone, 120 ft above base of Barnes' unit 6.
Finkelnburgia? cf. *F. scenidioides* Ulrich and Cooper
Syntrophiid brachiopod, indet.
Hystricurus sp.
Leiostegium sp.

D1433 CO. Goodwin Limestone, 115 ft above base of Barnes' unit 6.
Cephalopods

D1432 CO. Goodwin Limestone, 105 ft above base of Barnes' unit 6.
Parahystricurus sp.

D1431 CO. Goodwin Limestone, 10 ft above base of Barnes' unit 6.
Nanorthis? sp.

D1430 CO. Goodwin Limestone, 42 ft below top of Barnes' unit 4.
Finkelnburgia? sp. (no interiors of valves, identification very questionable)

D1429 CO. Goodwin Limestone, 1 ft below top of Barnes' unit 3.
Bellefontia sp.

D1428 CO. Goodwin Limestone, 32–34 ft below top of Barnes' unit 2.
Symphysurina, n. sp.?

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[Italic page numbers indicate descriptions and major references]

PLATES 1–10

PLATE 1

FIGURES 1, 2. *Orthambonites michaelis* (Clark) (p. D3).
USGS colln. D629 CO, Swan Peak Formation, Logan quad., Utah.
1. Pedicle interior, a rubber cast, × 2, USNM 145662.
2. Brachial interior, a rubber cast, × 2, USNM 145663.

3–7. *Desmorthis planus*, n. sp. (p. D5).
USGS colln. D 829 CO.
3. Holotype, brachial interior, stereophotograph, × 3, USNM 145691.
4, 6. Paratype, pedicle valve, ventral and anterior views, × 3, USNM 145692.
5. Paratype, brachial exterior, × 6, USNM 145693.
7. Paratype, pedicle interior, stereophotograph, × 3, USNM 145694.

8. *Orthambonites swanensis* Ulrich and Cooper (p. D3).
USGS colln. D629 CO, Swan Peak Formation, Logan quad., Utah, brachial interior, × 2, USNM 145664. Illustrated for comparison with *O. michaelis* (Clark), (pl. 1, fig. 2).

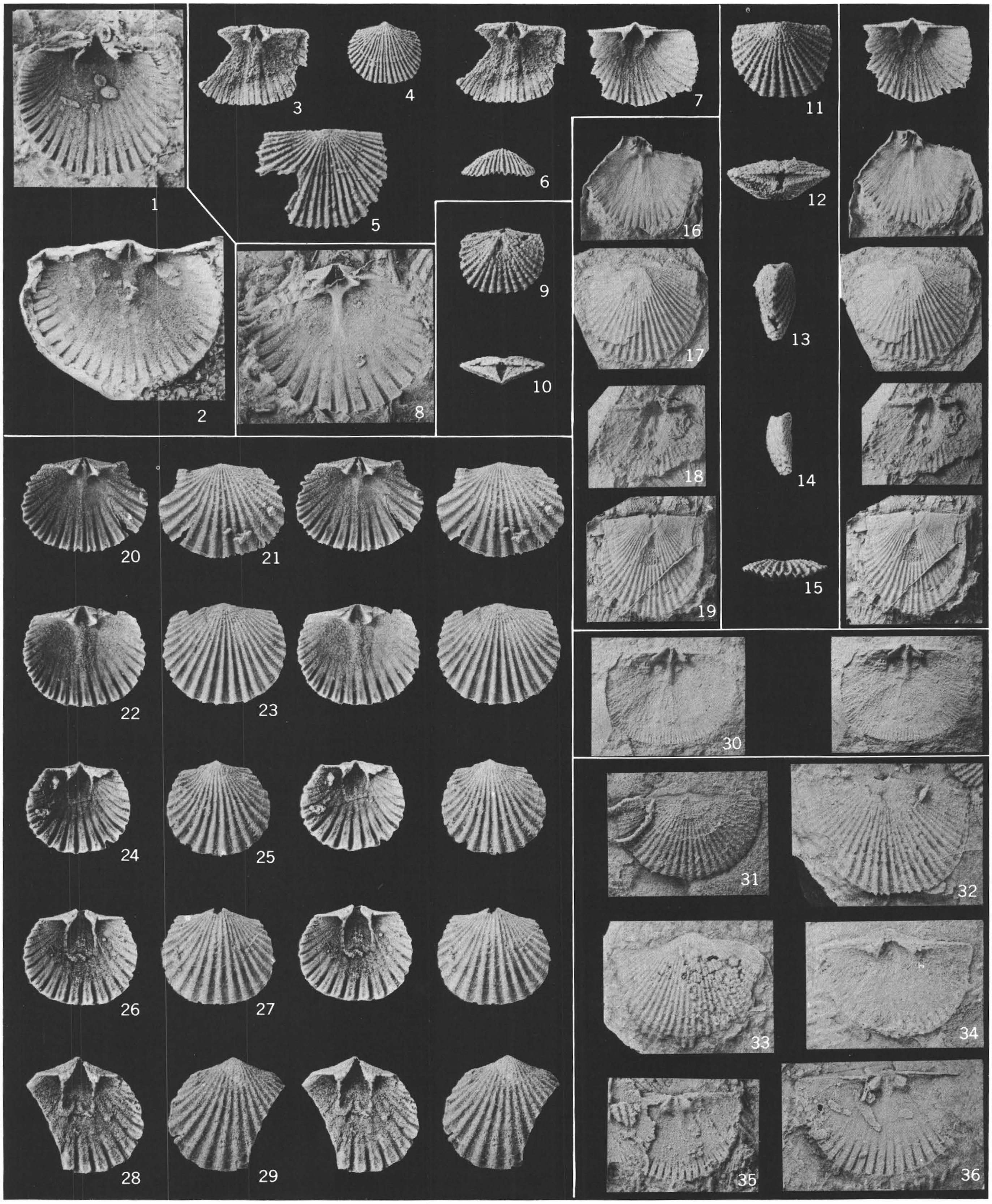
9–15. *Ptychopleurella kleinhamplei*, n. sp. (p. D4).
USGS colln. D819 CO.
9, 10, 14, 15. Paratype, brachial exterior, posterior, lateral, and anterior views, × 3, USNM 145687.
11–13. Holotype, pedicle exterior, posterior and lateral views, × 3, USNM 145686.

16–19. *Hesperorthis* cf. *H. dubia* Cooper (p. D4).
Stereophotographs × 1. All figures are rubber casts. Barrel Spring Formation, northern Inyo Mountains, Independence quad., California. Collected by Wilfrid Davis of San Jose State College.
16. Brachial interior, USGS colln. D1476 CO, USNM 145682.
17. Pedicle exterior, USGS colln. D1479 CO, USNM 145683.
18. Pedicle interior, USGS colln. D1475 CO, USNM 145684.
19. Brachial exterior, USGS colln. D1477 CO, USNM 145685.

20–29. *Orthambonites perplexus*, n. sp. (p. D3).
Stereophotographs, × 2, USGS colln. D835 CO.
20, 21. Holotype, brachial valve, USNM 145668.
22, 23. Paratype, brachial valve, USNM 145666.
24, 25. Paratype, pedicle valve, USNM 145674.
26, 27. Paratype, pedicle valve, USNM 145672.
28, 29. Paratype, pedicle valve, USNM 145675.

30. *Plaesiomys*? sp. (p. D4).
Stereophotograph, × 1, brachial interior, Barrel Spring Formation, USGS colln. D1477 CO, USNM 145681.

31–36. *Orthambonites decipiens* (Phleger) (p. D2).
All figures × 2. Rubber casts of topotype material. Barrel Spring Formation.
31. Pedicle exterior, USNM 145656.
32. Brachial exterior; a very flat slightly sulcate valve, possibly immature *Hesperorthis*, USNM 145657.
33. Pedicle exterior, alate form with above average number of costae, USNM 145658.
34. Pedicle interior, USNM 145659.
35. Brachial interior, USNM 145660.
36. Brachial interior, USNM 145661.



BRACHIOPODS: *ORTHAMBONITES, DESMORTHIS, PTYCHOPLEURELLA HESPERORTHIS,* AND *PLAESIOMYS* ?

PLATE 2

FIGURES 1–7. *Skenidioides oklahomensis* Cooper (p. D5).
USGS colln. D829 CO.
1, 2, 4, 5. Pedicle valve, exterior, interior (stereophotograph), anterior, and posterior × 6, views, USNM 145695.
3. Pedicle interior (stereophotograph, × 6) USNM 145696.
6, 7. Brachial valve, interior (stereophotograph) and exterior views, × 6, USNM 145697.

8–14. *Atelelasma primotica*, n. sp. (p. D6).
USGS colln. D831 CO.
8, 9. Holotype, brachial valve, exterior and interior (stereophotograph) views, × 3, USNM 145698.
10, 11, 13. Paratype, pedicle valve, lateral, interior (stereophotograph), and interarea (stereophotograph) views, × 3, USNM 145699.
12, 14. Paratype, pedicle valve, lateral and exterior (stereophotograph) views, × 3, USNM 145700.

15, 16. *Stenocamara*? sp. (p. D6).
USGS colln. D713 CO, fragmentary specimens.
15. Pedicle interior, × 5, USNM 145702.
16. Brachial interior, × 5, USNM 145703.

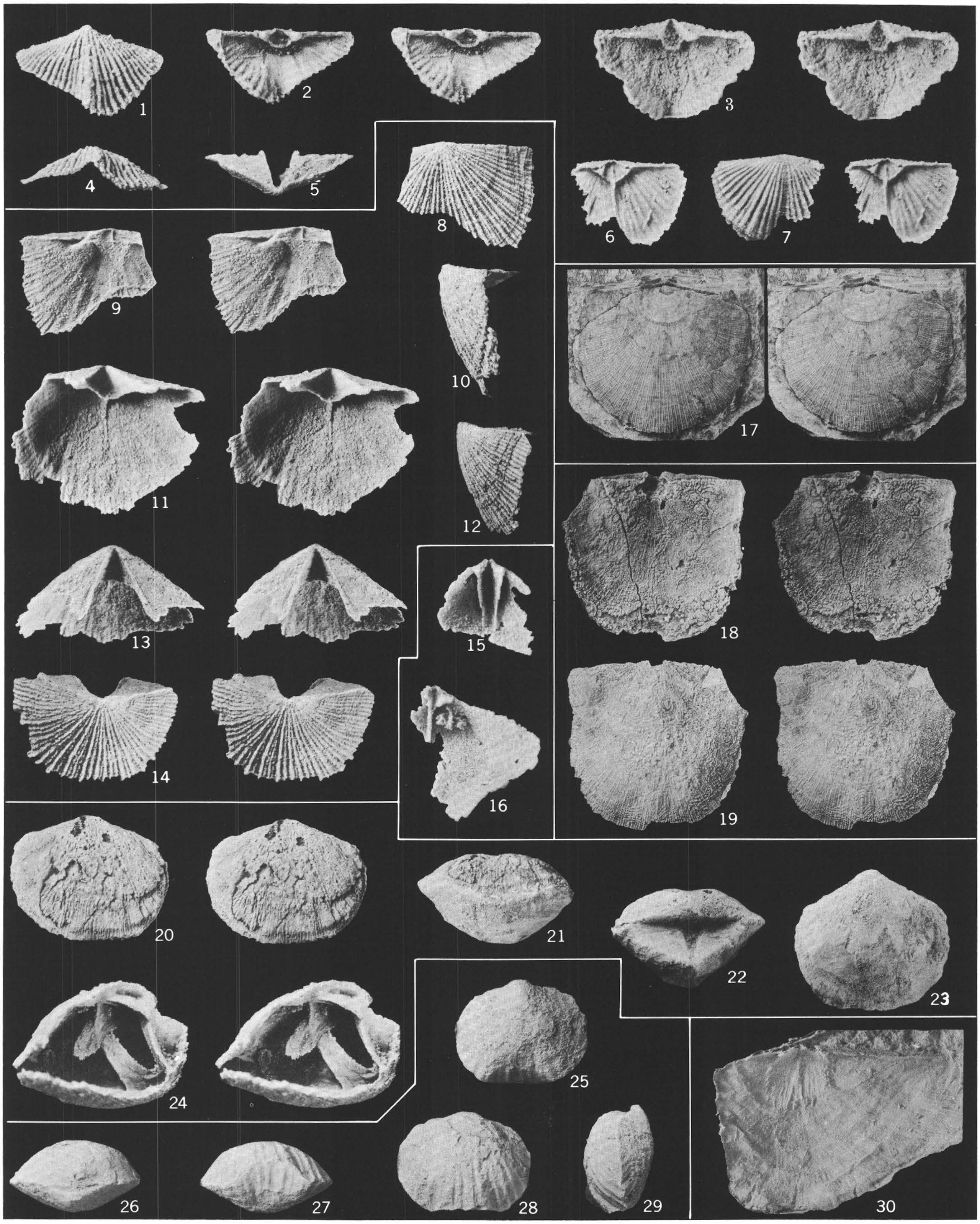
17. *Macrocoelia*? sp. 1 (p. D7).
Stereophotograph, × 1, USGS colln. D713 CO, pedicle valve, exterior, USNM 145714.

18, 19. *Macrocoelia*? sp. 2 (p. D7).
Stereophotographs, × 1, USGS colln. D731 CO, USNM 145715, brachial and pedicle views.

20–24. *Laticrura* cf. *L. heteropleura* Cooper (p. D7).
USGS colln. D824 CO.
20–23. Complete shell, × 3, brachial exterior (stereophotograph), anterior, posterior, and pedicle exterior, USNM 145716.
24. Broken specimen of articulated valves showing right brachial structure and hinge tooth, stereophotograph, × 4, USNM 145717.

25–29. *Oxoplecia monitorensis* Cooper (p. D6).
USGS colln. D824 CO, complete individual, pedicle, posterior, anterior, brachial, and lateral views, × 2, USNM 145701.

30. Undetermined strophomenid (not described).
USGS colln. D1476 CO, × 1, Barrel Spring Formation, Al Rose Canyon, Independence quad., California.



BRACHIOPODS: *SKENIDIOIDES*, *ATELELASMA*, *STENOCAMARA*?
MACROCOELIA?, *LATICRURA*, AND *OXOPLECIA*

PLATE 3

FIGURES 1–10. *Leptellina occidentalis* Ulrich and Cooper (p. D6).

Stereophotographs, × 3.

1, 2. Complete individual, damaged, showing marked geniculation, brachial and pedicle valves, exteriors, USGS colln. D819 CO, USNM 145704.

3. Brachial valve exterior, USGS colln. D829 CO, USNM 145705.

4, 6. Pedicle valve, damaged, exterior and interior, USGS colln. D819 CO, USNM 145706.

5. Brachial valve, interior, USGS colln. D829 CO, USNM 145707.

7. Pedicle valve, damaged, interior, USGS colln. D829 CO, USNM 145708.

8. Pedicle valve, interior, USGS colln. D831 CO, USNM 145709.

9, 10. Brachial valve, damaged, interior and exterior, USGS colln. D831 CO, USNM 145710.

11–15. *Sowerbyella* cf. *S. perplexa* Cooper (p. D7).

Stereophotographs, × 3, USGS colln. D820 CO.

11. Brachial valve, exterior, USNM 145711.

12. Brachial valve, interior, USNM 146507.

13, 15. Pedicle valve, two different interior views, USNM 145712.

14. Pedicle valve, exterior, USNM 145713.

16. *Valcourea* sp. 2 (p. D5).

Brachial valve, exterior, × 2, USGS colln. D680 CO, limestone in Eureka Quartzite, USNM 145690.

17, 18. *Valcourea* sp. 1 (p. D5).

USGS colln. D819 CO.

17. Brachial interior, × 5, damaged, USNM 145688.

18. Pedicle interior, × 5, damaged, USNM 145689.

19, 20. *Trinodus* sp. 1 (p. D9).

USGS colln. D728 CO, stereophotographs.

19. Cranidium, × 10, USNM 145720.

20. Pygidium, × 5, USNM 145721.

21–25. *Trinodus* cf. *T. clusus* (Whittington) (p. D9).

USGS colln. D1398 CO.

21, 23, 24. Cranidium, dorsal anterior and left lateral views, × 7, USNM 145718.

22, 25. Pygidium, dorsal and right lateral views, × 8, USNM 145719.

26–28. *Carolinites indentus*, n. sp. (p. D11).

26. Paratype, free cheek (stereophotograph), × 5, USGS colln. D728 CO, USNM 145731.

27, 28. Holotype, cranidium, dorsal (stereophotograph) and lateral views, × 10, USGS colln. D727 CO, USNM 145730.

29–39. *Carolinites angustagena*, n. sp. (p. D10).

All specimens from USGS colln. D1398 CO, except figs. 35–37 from USGS colln. D1399 CO. All figures stereophotographs except fig. 39.

29, 30. Holotype, cranidium, lateral and dorsal views, × 7, USNM 145732.

31, 32. Paratype, cranidium, lateral and dorsal views, × 8, USNM 145733.

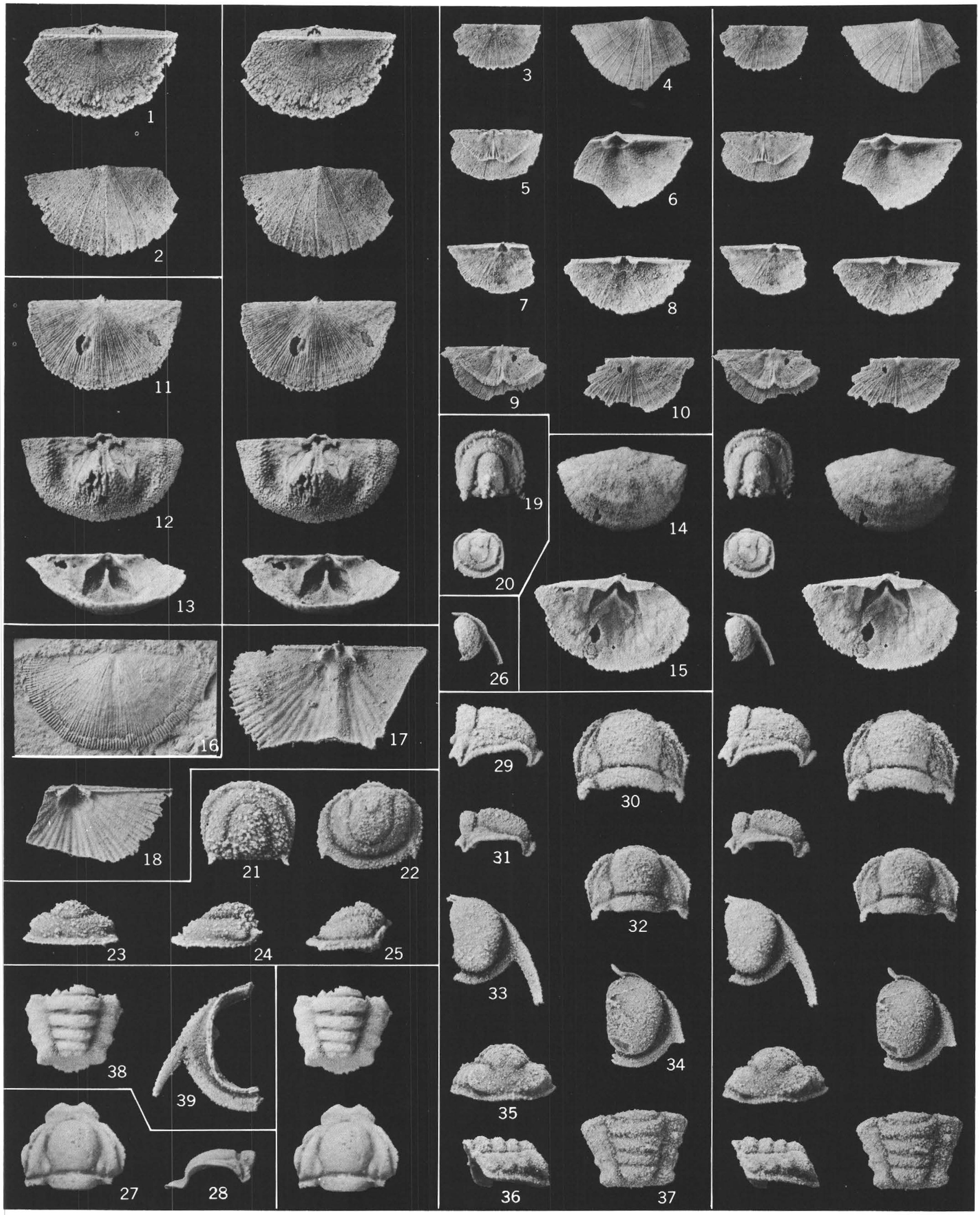
33. Paratype, free cheek, dorsal view, × 7, USNM 145734.

34. Paratype, free cheek, dorsal view of a more mature specimen with genal spine reduced to a stump, × 4, USNM 145735.

35–37. Paratype, pygidium, posterior, lateral, and dorsal views, × 4, USNM 145736.

38. Paratype, pygidium, dorsal view, × 7, USNM 145737.

39. Paratype, free cheek with eye broken away, × 7, USNM 145738.



BRACHIOPODS: *LEPTELLINA*, *SOWERBYELLA*, AND *VALCOUREA*
TRILOBITES: *TRINODUS* AND *CAROLINITES*

PLATE 4

FIGURES 1–5. *Isotelus* sp. (not described).

USGS colln. D814 CO. Upper beds of Antelope Valley Limestone, southeast of Joshua Hollow on southwest side of small knoll. Altitude 4,440 ft. Nevada coordinates, central zone: E. 506,700 ft., N. 780,400 ft., Bare Mountain quad., Nevada.

1, 2. Cranidium, dorsal and right lateral views, × 3, USNM 145739.

3, 4. Pygidium, posterior and dorsal views, × 2, USNM 145740.

5. Pygidium, immature, dorsal view, × 5, USNM 145741.

6–9. *Isotelus spurius* Phleger (p. D12).

USGS colln. D680 CO. All figures stereophotographs.

6. Free cheek, dorsal view, × 5, USNM 145742.

7. Cranidium, dorsal view, × 5, USNM 145743.

8. Pygidium, dorsal view, × 2, USNM 145744.

9. Hypostome, ventral view, × 5, USNM 145745.

10, 11. *Megistaspis*? sp. (p. D13).

USGS colln. D680 CO.

10. Pygidium, stereophotograph, dorsal view, × 2, USNM 145748.

11. Free cheek, dorsal view, × 5, USNM 145749.

12–17. *Nileus* sp. (p. D14).

All figures stereophotographs except figs. 16, 17.

12, 13. Hypostome, ventral and lateral views, × 5, USGS colln. D727 CO, USNM 145756.

14. Cranidium, damaged, × 1, USGS colln. D727 CO, USNM 145757.

15. Pygidium, damaged, dorsal view, × 4, USGS colln. D728 CO, USNM 145758.

16. Free cheeks yoked as a single unit, immature, dorsal view, × 10, USGS colln. D728 CO, USNM 145759.

17. Free cheek, damaged, ventral view, × 4, USGS colln. D728 CO, USNM 145760.

18–25. *Nileus hesperaffinis*, n. sp. (p. D13).

USGS colln. D1398 CO. All figures stereophotographs except figs. 22, 24.

18, 19. Free cheek, paratype, damaged, right lateral and dorsal views, × 4, USNM 145750.

20. Hypostome, paratype, ventral view, × 7, USNM 145751.

21. Pygidium, paratype, ventral view, × 4, USNM 145752.

22, 24. Cranidium, holotype, dorsal and lateral views, × 3, USNM 145753.

23. Pygidium, paratype, dorsal view, × 4, USNM 145754.

25. Free cheeks, yoked, paratype, damaged, ventral view, × 4, USNM 145755.

26–30. *Raymondaspis vespertinus*, n. sp. (p. D15).

USGS colln. D1398 CO. Figs. × 7, all stereophotographs except fig. 29.

26, 27. Pygidium, paratype, damaged, lateral and dorsal views, USNM 145763.

28–30. Holotype, cranidium, anterior, lateral, and dorsal views, USNM 145762.

31, 32. *Isoteloides*? sp. (p. D12).

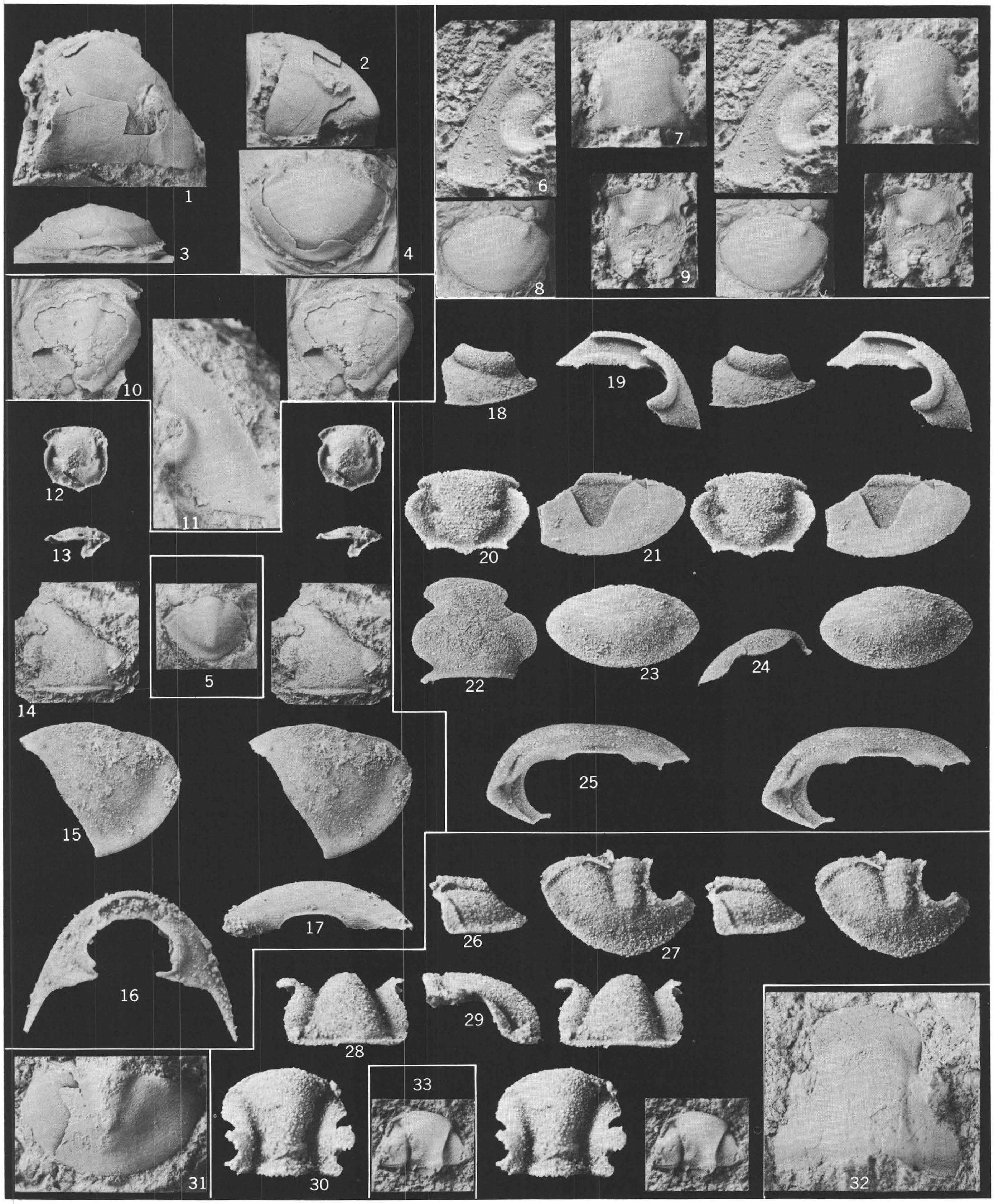
USGS colln. D725 CO.

31. Pygidium, × 2, USNM 145747.

32. Cranidium, dorsal view, × 2, USNM 145746.

33. *Illaenopsis*? sp. (p. D14).

Stereophotograph, USGS colln. D680 CO, cranidium, dorsal view, × 5, USNM 145761.



TRILOBITES: *ISOTELUS*, *MEGISTASPIS*?, *NILEUS*, *RAYMONDASPIS*
ISOTELOIDES?, AND *ILLAENOPSIS*?

PLATE 5

[All figs. stereophotographs except figs. 33–40]

FIGURES 1–32, 36, 40. *Illaenus auriculatus*, n. sp. (p. D16).

USGS colln. D1398 CO.

1–3. Holotype, cranidium, damaged, anterior, lateral, and dorsal views, × 2, USNM 145764.

4–6. Paratype, cranidium, slightly damaged, lateral, anterior, and dorsal views, × 4, USNM 145765.

7, 8, 10. Paratype, cranidium, damaged, anterior, dorsal, and lateral views, × 2, USNM 145766.

9, 11, 12. Paratype, cranidium, anterior, dorsal, and lateral views, × 7, USNM 145767.

13, 14, 16. Paratype, cranidium, dorsal, anterior, and lateral views, × 10, USNM 145768.

15. Paratype, hypostome, ventral view, × 7, USNM 145769.

17, 19, 21. Paratype, free cheek, dorsal, lateral, and anterior views, × 2, USNM 145770.

18, 20. Paratype, pygidium, dorsal and posterior views, × 2, USNM 145771.

22, 24. Paratype, free cheek, dorsal and lateral views, × 7, USNM 145772.

23, 25. Paratype, free cheek, lateral and dorsal views, × 7, USNM 145773.

26. Paratype, free cheek, dorsal view, × 10, USNM 145774.

27, 28, 30. Paratypes, three rostral plates, posterior views, ×5, ×4, ×5, USNM 145775–145777.

29. Paratype, free cheek, ventral view, × 5, USNM 145778.

31. Paratype, pygidium, ventral view, × 4, USNM 145779.

32. Paratype, pygidium, ventral view, × 2, USNM 145780.

36. Paratype, pygidium, ventral view, × 7, USNM 145781.

40. Paratype, pygidium, ventral view, × 7, USNM 145782.

33, 34. *Illaenus* cf. *I. utahensis* Hintze (p. D17).

USGS colln. D824 CO, pygidium, dorsal and posterior views, × 2, USNM 145786.

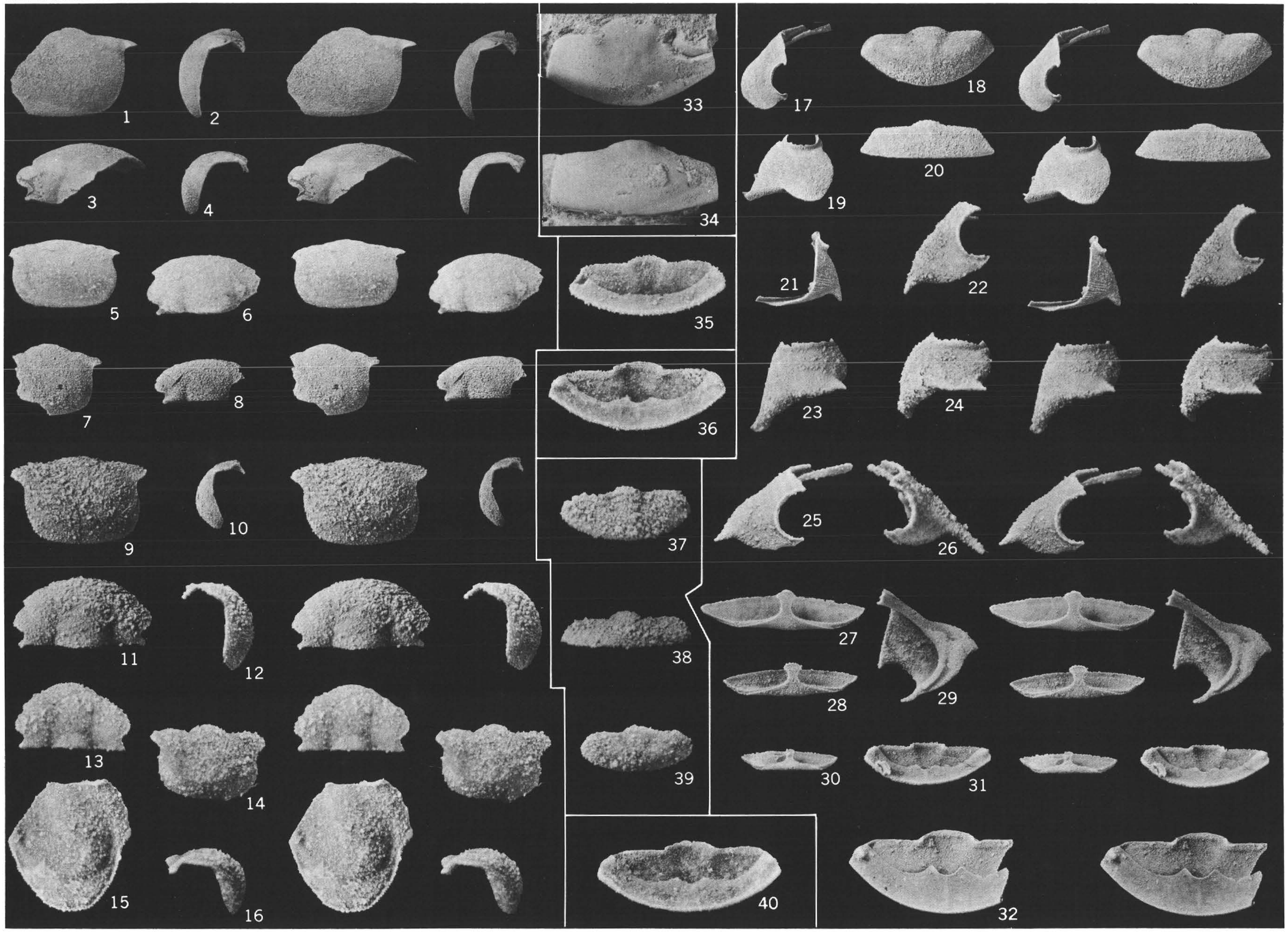
35, 37–39. *Illaenus*? sp. (p. D17).

USGS colln. D1398 CO. Pygidia, × 10, with edge of doublure lacking median notch. Possibly immature stages of *I. auriculatus* n. sp.

35. Ventral view, USNM 145783.

37, 38. Dorsal and posterior views, USNM 145784.

39. Dorsal view, USNM 145785.



TRILOBITES: *ILLAENUS*

PLATE 6

[All figs. stereophotographs except figs. 6, 7, 21, 26]

FIGURES 1–5. *Bathyurus nevadensis*, n. sp. (p. D17).
USGS colln. D802 CO.
1. Holotype, cranidium, dorsal view, × 2, USNM 145787.
2. Paratype, cranidium, dorsal view, × 2, USNM 145788.
3. Paratype, free cheek, dorsolateral view, × 2, USNM 145789.
4. Paratype, pygidium, dorsal view, × 1, USNM 145790.
5. Paratype, pygidium, dorsal view, × 1, USNM 145791.

6. *Bathyurellus* sp. 2 (p. D18).
USGS colln. D727 CO, cranidium, dorsal view, × 2, USNM 145793.

7, 8. *Goniotelina*? aff. *G. williamsi* Ross (p. D19).
USGS colln. D990 CO.
7. Pygidium, dorsal view, × 3, USNM 145800.
8. Cranidium, dorsal view, × 3, USNM 145801.

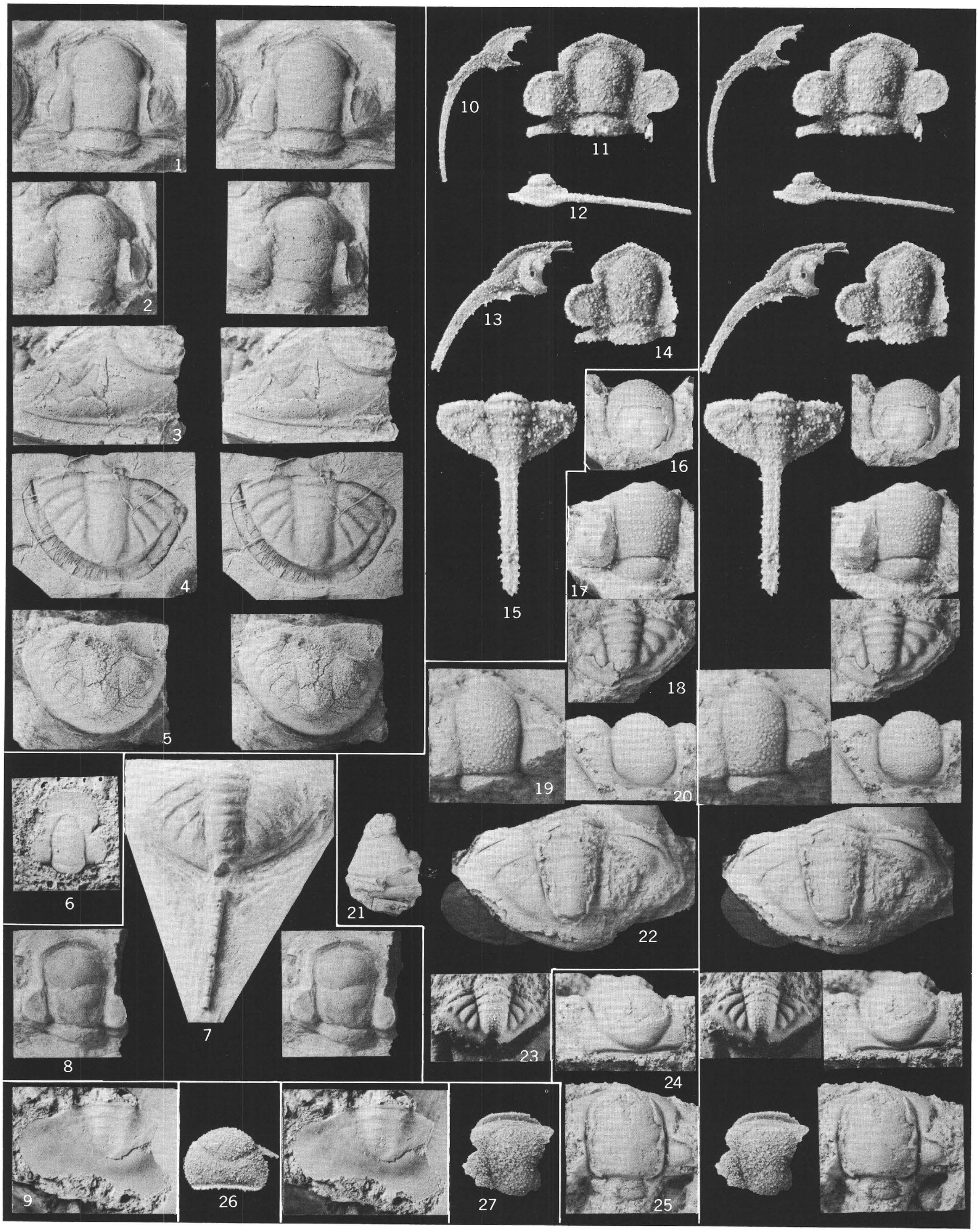
9. *Bathyurellus*? sp. 1, (p. D18).
USGS colln. D190d CO, pygidium, dorsal view, × 3, USNM 145792.

10–15. *Goniotelina hesperia*, n. sp. (p. D19).
USGS colln. D1398 CO.
10, 12. Paratype, free cheek, lacking eye surface, dorsal, lateral views, × 4, USNM 145795.
11. Holotype, cranidium, dorsal view, × 7, USNM 145794.
13. Paratype, free cheek, dorsal view, × 7, USNM 145796.
14. Paratype, cranidium, dorsal view, × 7, USNM 145797.
15. Paratype, pygidium, dorsal view, × 10, USNM 145798.

16–23. *Acidiphorus*? *pseudobathyurus*, n. sp. (p. D20).
USGS colln. D190d CO.
16, 17. Holotype, cranidium, anterior and dorsal views, × 1½, USNM 145802.
18. Paratype, pygidium, dorsal view, × 2, USNM 145803.
19, 20. Paratype, cranidium, dorsal and anterior, × 5, USNM 145804.
21. Paratype, free cheek, fragmentary, lateral view, × 1, USNM 145805.
22. Paratype, pygidium, dorsal view, × 2, USNM 145806.
23. Paratype, pygidium, dorsal view, × 5, USNM 145807.

24, 25. *Goniotelina* cf. *G. subrectus* (Bradley) (p. D19).
USGS colln. D725 CO, cranidium, anterior and dorsal views, × 3, USNM 145799.

26, 27. *Strigigenalis* sp. (p. D21).
USGS colln. D1398 CO, cranidium, anterior and dorsal views, × 5, USNM 145808.



TRILOBITES: *BATHYURUS, BATHYURELLUS, GONIOTELINA ACIDIPHORUS,* AND *STRIGIGENALIS*

PLATE 7

[All figs. stereophotographs except figs. 2, 3, 5, 7, 31, 32]

FIGURES 1-7. *Ischyrotoma* sp. (p. D21).

USGS colln. D1398 CO.

1–3. Cranidium, dorsal, lateral, and anterior views, × 8, USNM 145809.

4, 5. Free cheek, dorsal and lateral views, × 10, USNM 145810.

6, 7. Pygidium, dorsal and posterior views, × 10, USNM 145811.

8–16. *Ampyx compactus*, n. sp. (p. D21).

USGS colln. D1398 CO.

8–10. Holotype, cranidium, lateral, dorsal, and anterior views, × 6, USNM 145812.

11, 12. Paratype, cranidium, dorsal and lateral views, × 4, USNM 145813.

13, 16. Paratype, pygidium, dorsal and posterior views, × 7, USNM 145814.

14, 15. Paratype, cranidium, small dorsal and lateral views, × 10, USNM 145815.

17–19. *Cydonocephalus scrobiculus* Whittington (p. D23).

USGS colln. D1398 CO. Cranidium, dorsal, anterior, and lateral views, × 4, USNM 145824.

20, 21. *Ampyx* sp. (p. D22).

USGS colln. D727 CO, pygidium, dorsal and posterior views, × 10, USNM 145816.

22–28. *Lonchodomas retrolatus*, n. sp. (p. D22).

USGS colln. D680 CO. All figures × 5.

22, 23. Holotype, cranidium, dorsal and lateral views, USNM 145817.

24. Paratype, cranidium, anterior oblique view, USNM 145818.

25. Paratype, cranidium with spine poorly preserved, lateral and dorsal views, USNM 145819.

26. Paratype, cranidium, dorsal view, USNM 145820.

27. Paratype, pygidium, dorsal view, USNM 145821.

28. Paratype, pygidium dorsal view, USNM 145822.

29, 30. *Heliomeroides* sp. (p. D24).

USGS colln. D1398 CO, cranidium, dorsal and lateral views, × 10, USNM 145827.

31. *Pseudomera* sp. (p. D24).

USGS colln. D832, cranidium, poorly preserved, dorsal view, × 1, USNMM 145828.

32. *Ceraurus*? sp. (p. D23).

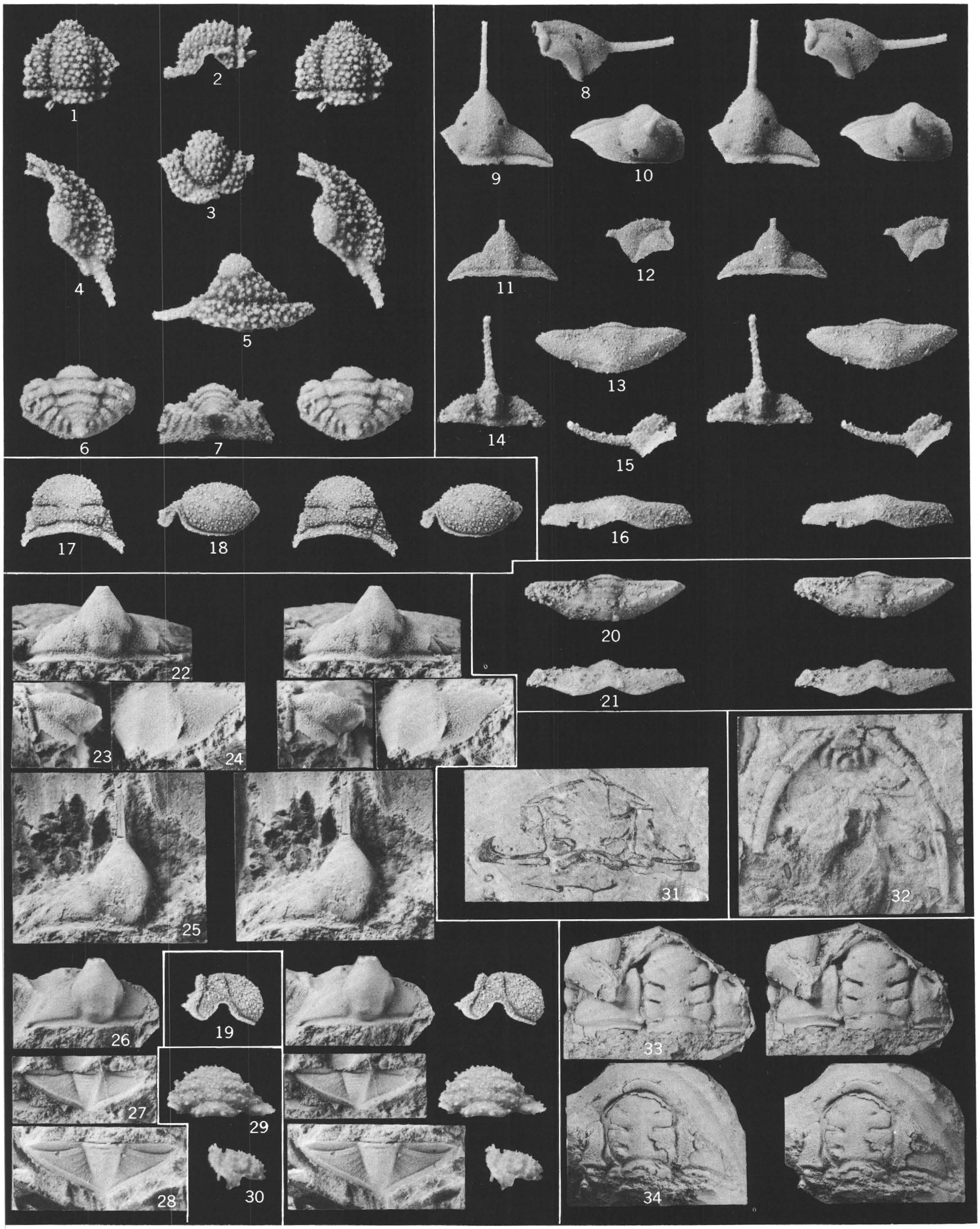
USGS colln. D1065 CO, pygidium, dorsal view, × 2, USNM 145823.

33, 34. *Ectenonotus whittingtoni* n. sp. (D24).

USGS colln. D727 CO.

33. Rubber cast taken from obverse of specimen shown in fig. 34. × 1.

34. Paratype, cranidium, × 1, USNM 145830.



TRILOBITES: *ISCHYROTOMA, AMPYX, CYDONOCEPHALUS, LONCHODOMAS, HELIOMEROIDES PSEUDOMERA, CERAURUS?*, AND *ECTENONOTUS*

PLATE 8

FIGURES 1–22. *Ectenonotus whittingtoni*, n. sp. (p. D24).

All figures stereophotographs except fig. 21. Figs 1–3, holotype, from USGS colln. D727 CO. Figs. 4–22, paratypes from USGS colln. D1398 CO.

1–3. Pygidium, dorsal, lateral, and posterior views, × 2, USNM 145829.

4, 5, 7. Cranidium, lateral, dorsal, and anterior views, × 4, USNM 145831.

6, 8, 9. Cranidium, anterior, lateral, and dorsal views, × 4, USNM 145832.

10, 11. Cranidium, lateral and dorsal views, × 7, USNM 145833.

12, 13, 15. Complete cephalon, lateral, dorsal, and anterior views, × 7, USNM 145834.

14. Hypostome, ventral view, × 4, USNM 145835.

16, 17. Cranidium. lateral and dorsal views, × 10, USNM 145836.

18. Pygidium, dorsal view, × 2, USNM 145837.

19. Pygidium, dorsal view, × 7, USNM 145838.

20. Pygidium, dorsal view, × 10, USNM 145839.

21, 22. Free cheek, lateral and dorsal views, × 2, USNM 145840.

23–25. *Miracybele*? sp. 1 (p. D25).

USGS colln. D727 CO. All figures × 5.

23. Cranidium, dorsal view, USNM 145841.

24. Pygidium, dorsal view, USNM 145842.

25. Pygidium, dorsal view, USNM 145843.

26, 27. *Miracybele*? sp. 2 (p. D26).

Both figures × 10, USGS colln. D990 CO.

26, 26a. Pygidium, dorsal and right lateral views, USNM 146508.

27. Pygidium. dorsal view, stereophotograph, USNM 155560.

28–33. *Calyptaulax cornwalli*, n. sp. (p. D29).

USGS colln. D813 CO. All figures × 3.

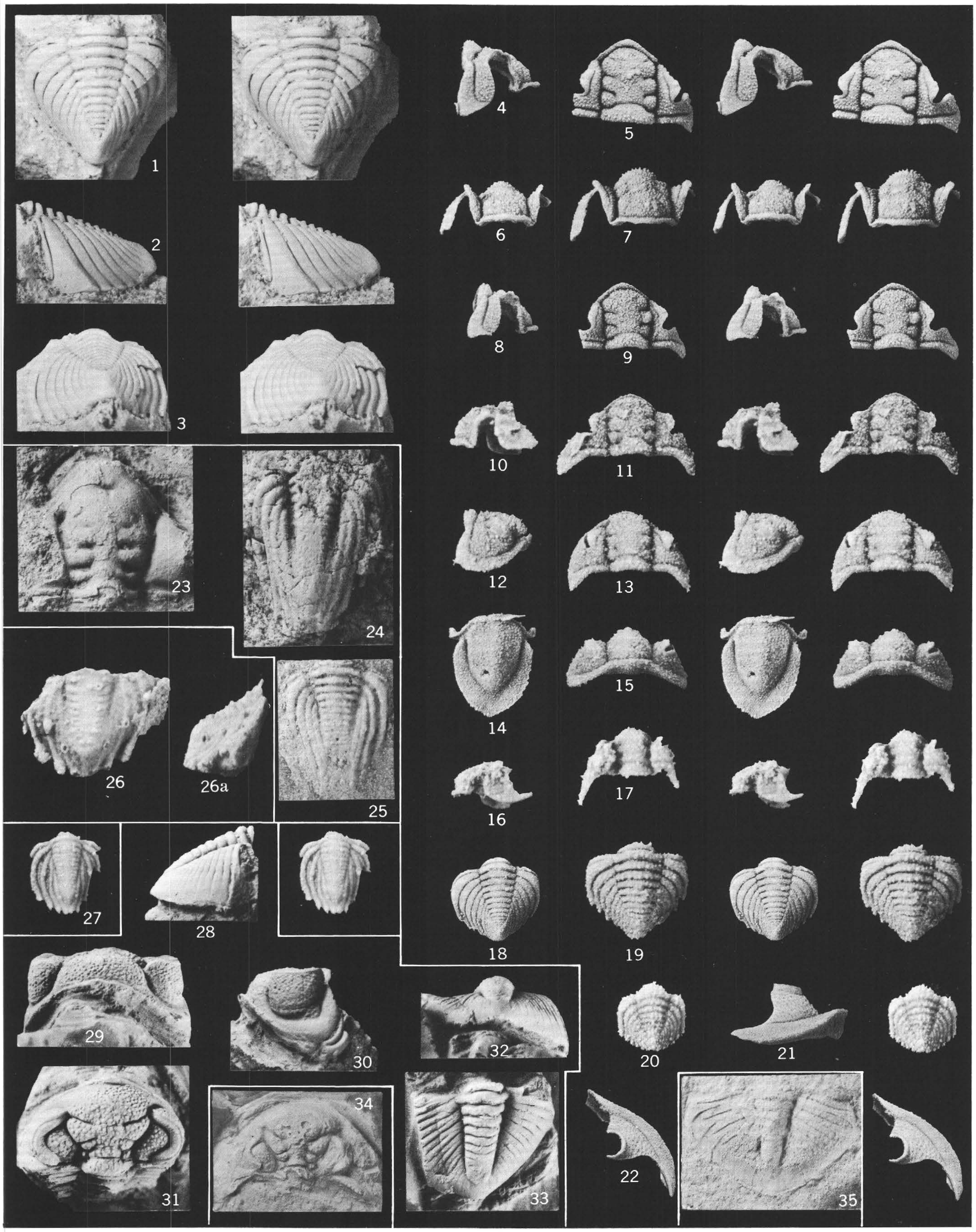
28, 32, 33. Paratype, pygidium, lateral, posterior, and dorsal views, USNM 145847.

29–31. Holotype, cephalon, anterior, lateral, and dorsal views, USNM 145846.

34, 35. *Calyptaulax* aff. *C. angusta* (B. N. Cooper) (p. D28).

34. Cranidium, dorsal view, × 2, USGS colln. D990 CO, USNM 145844.

35. Pygidium, dorsal view, × 3, USGS colln. D829 CO, USNM 145845.



TRILOBITES: *ECTENONOTUS, PARACYBEDLOIDES?, MIRACYBELE, CALYPTAULAX*

PLATE 9

FIGURES 1–28. *Protocalymene mcallisteri*, n. sp. (p. D27).

Figs. 5–7 illustrate holotype; others are paratypes.

1. Cranidium, damaged, dorsal view (stereophotograph), × 7, USGS colln. D1398 CO, USNM 145849.
2. Free cheek, dorsal view (stereophotograph), × 7, USGS colln. D1398 CO, USNM 145850.
3. Cranidium, damaged, dorsal view (stereophotograph), × 10, USGS colln. D728 CO, USNM 145859.

4, 8, 9. Pygidium, lateral, dorsal (stereophotograph), and posterior views, × 10, USGS colln. D728 CO, USNM 145851.

5–7. Cranidium, dorsal (stereophotograph), anterior, and lateral views, × 7, USGS colln. D1398 CO, USNM 145848.

10–12. Cranidium, dorsal (stereophotograph), anterior, and lateral views, × 8, USGS colln. D1398 CO, USNM 145852.

13, 14, 18. Free cheek, dorsal (stereophotograph), lateral, and anterior views, × 10, USGS colln. D728 CO, USNM 145853.

15–17. Cranidium, dorsal (stereophotograph), anterior, and lateral views, × 8, USGS colln. D1398 CO, USNM 145854.

19–21. Cranidium, dorsal (stereophotograph), anterior, and lateral views, × 8, USGS colln. D1398 CO, USNM 145855.

22–24. Cranidium, dorsal (stereophotograph), anterior, and lateral views, × 10, USGS colln. D1398 CO, USNM 145856.

25, 26. Pygidium, posterior and dorsal views (both stereophotographs), × 10, USGS colln. D728 CO, USNM 145857.

27, 28. Pygidium, dorsal (stereophotograph) and posterior views, × 10, USGS colln. D1398 CO, USNM 145858.

29–34. *Diacanthaspis* spp. (p. D30).

All figures × 10; all stereophotographs except figs. 31, 33.

29. Cranidium, dorsal view, USGS colln. D727 CO, USNM 145861.

30, 32, 33. Cranidium, ventral, dorsal, and lateral views, USGS colln. D1398 CO, USNM 145862.

31. Pygidium, dorsal view, USGS colln. D728 CO, USNM 145863.

34. Pygidium, dorsal view, USGS colln. D1398 CO, USNM 145864.

35. *Apatolichas?* sp. (p. D29).

Fragmentary pygidium, dorsal view, stereophotograph, × 4, USGS colln. D1398 CO, USNM 145860.

36–39. Odontopleurid trilobite, indet. (p. D30).

USGS colln. D1398 CO. All figures stereophotographs except fig. 36.

36, 39. Free cheek, lateral and dorsal views, × 7, USNM 145865.

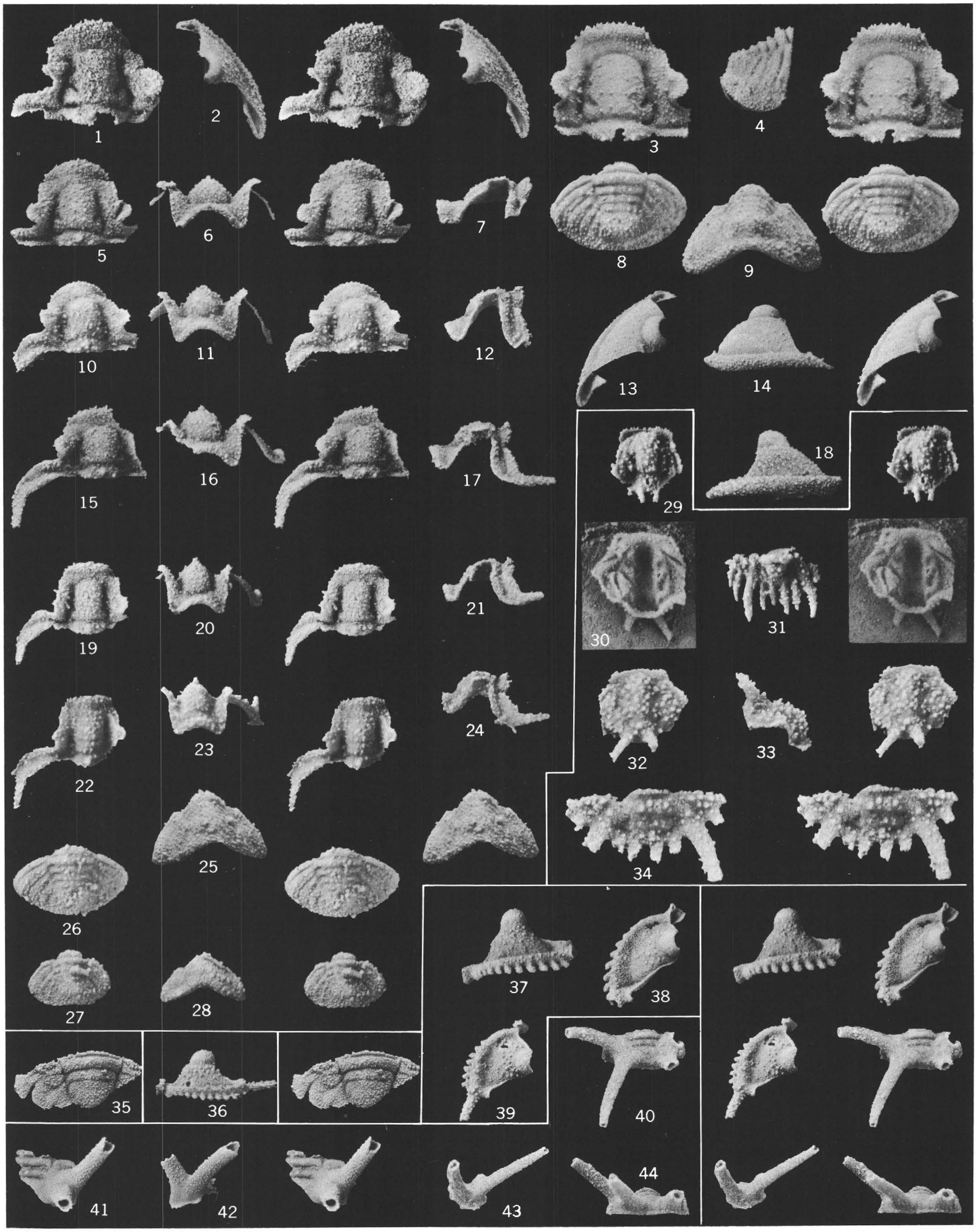
37, 38. Free cheek, lateral and dorsal views, × 7, USNM 145866.

40–44. Cheirurid? trilobite, indet. (p. D23).

USGS colln. D1398 CO. All figures stereophotographs except fig. 42.

40, 43, 44. Pygidium, dorsal, lateral, and posterior views, × 4, USNM 145825.

41, 42. Pygidium, dorsal and lateral views, × 2, USNM 145826.



TRILOBITES: *PROTOCALYMENE*, *DIACANTHASPIS*?, *APATOLICHAS* ?
ODONTOPLEURID, AND *CHEIRURID*?

PLATE 10

[All figures are stereophotographs]

FIGURES 1–16. *Clelandia bispina*, n. sp. (p. D31).
USGS colln. D1394 CO. Specimen in figs. 1–3 is holotype; others are paratypes.
1–3. Cephalon, dorsal, lateral, and anterior views, × 7, USNM 146126.
4–6. Cephalon, dorsal, lateral, and anterior views, × 7, USNM 146127.
7, 9, 10. Cranidium, dorsal, lateral, and anterior views, × 7, USNM 146128.
8. Free cheeks, yoked as single unit, dorsal view, × 7, USNM 146129.
11–13. Cranidium, dorsal, anterior, and lateral views, × 7, USNM 146130.
14. Cranidium, immature, dorsal view, × 20, USNM 146131. Note that occipital spine is double.
15, 16. Cranidium, anterior and dorsal views, × 20, USNM 146132. Note that double occipital spine has not yet developed at this small size.

17–22. *Clelandia aspina*, n. sp. (p. D3).
USGS colln. D1394 CO.
17–19. Holotype, cranidium, lateral, dorsal, and anterior views, × 7, USNM 145867.
20–22. Paratype, cranidium, anterior, dorsal, and lateral views, × 10, USNM 145868.

23–33. *Shumardia exopthalmus*, n. sp. (p. D10).
USGS colln. D724 CO. All figures × 10. Holotype shown in figs. 23, 24; others are paratypes.
23, 24. Cephalon, dorsal and anterior views, USNM 145722.
25, 26. Cephalon, dorsal and anterior views, USNM 145723.
27, 28. Cephalon, dorsal and anterior views, USNM 145724.
29. Cephalon, dorsal view, USNM 145725.
30. Cephalon, oblique ventral view, showing continuous doublure without evidence of facial sutures, USNM 145726.
31. Pygidium, dorsal view, USNM 145727.
32. Pygidium, dorsal view, USNM 145728.
33. Pygidium, dorsal view, USNM 145729.

34, 35. Genus and species undet.
Pygidium, posterior and dorsal views, × 6, USGS colln. D1399 CO. Not described. USNM 145869.

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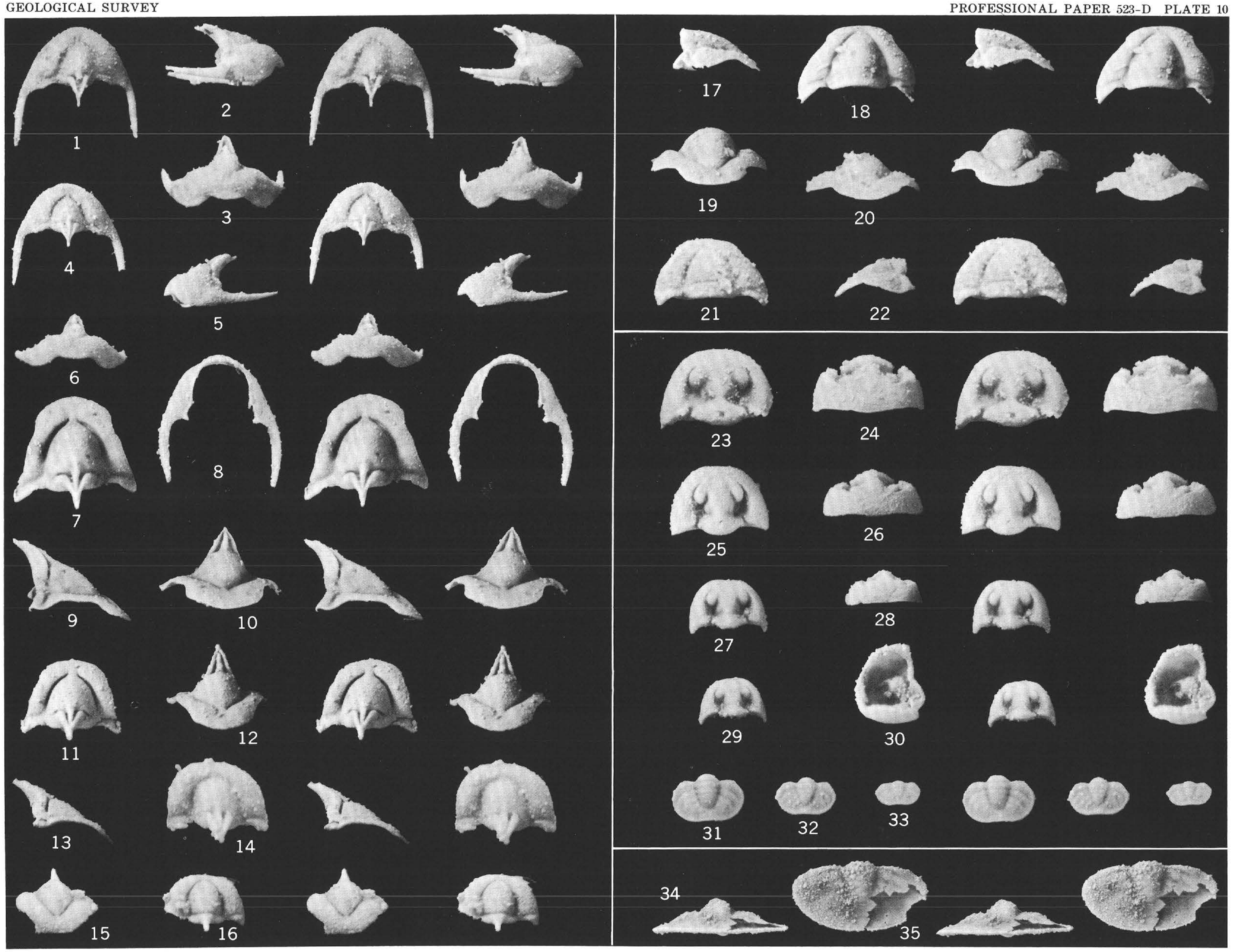

TRILOBITES: *CLELANDIA* AND *SHUMARDIA*