MIDDLE DEVONIAN BRACHIOPODS FROM THE ROBERTS MOUNTAINS, CENTRAL NEVADA

by J. G. JOHNSON

ABSTRACT. Middle Devonian stratigraphy in the Roberts Mountains is briefly reviewed and Middle Devonian limestone strata below the Devils Gate Limestone are assigned to a brachiopod-rich formation, the Denay Limestone (new name). Walcott's *Skenidium devonicum* is made type species of a new dalmanellid genus *Vallomyonia* and his *Cryptonella*? *circula* is assigned to *Leptathyris*. The brachiopods of the *Leptathyris circula* zone (new name) and the *Pentamerella* subzone in the lower part of the Denay Limestone are described and illustrated and their palaeontologic evidence suggests an Eifelian assignment. Fifteen species are described, fourteen from the *Leptathyris circula* zone in the Roberts Mountains. Three new species and one new subspecies are *Pentamerella wintereri*, *Hadrorhynchia eurekaensis*, *Echinocoelia denayensis*, and *Warrenella kirki praekirki*. Cyrtinacea is proposed as a superfamily.

IN 1940 C. W. Merriam published the results of his stratigraphic and palaeontologic studies of the Devonian in central Nevada (text-fig. 1). The stratigraphic column known to comprise Devonian rocks was divided into two formations, the Nevada Formation below and the Devils Gate Limestone above, and both were zoned largely on the basis of brachiopods and corals. The Nevada Formation has since been the subject of additional stratigraphic studies (Merriam and Anderson 1942; Nolan, Merriam, and Williams 1956) and the term is commonly applied to beds in Eureka County between the Lone Mountain Dolomite and the Devils Gate Limestone.

Merriam's zonal scheme (1940, p. 9) was incomplete in that he recognized the presence of an unzoned gap between the '*Spirifer*' *pinyonensis* zone and the higher *Warrenella* (= *Martinia*) *kirki* zone. Inasmuch as Merriam at that time considered the *pinyonensis* zone to be Middle Devonian, the gap appeared to be an insignificant one within the Middle Devonian.

With Merriam's work as a background, the writer in 1957 and 1958 mapped and collected fossils at significant Devonian sections in the northern Simpson Park Range. Study of the brachiopods in these collections as well as in many obtained in the Roberts Mountains by Professors E. L. Winterer and M. A. Murphy and, in addition, collections from the Sulphur Spring Range made by Carlisle, Murphy, Nelson, and Winterer (1957) led to the recognition of the new faunal zone, based on brachiopods, which filled the gap between the previously defined *pinyonensis* and *kirki* zones (Johnson 1962*a*). The fossiliferous beds were designated *Athyris circula* zone and *Pentamerella* subzone. The occurrence of these two brachiopod assemblages directly on beds with the *pinyonensis* zone fauna allowed a comparison for the first time and resulted in the recognition of an almost complete faunal discontinuity between the *pinyonensis* zone below and the *circula* zone above. These studies also led Johnson (1962*a*, p. 166) to conclude that the *pinyonensis* zone is Lower Devonian (Emsian) rather than Middle Devonian as previously thought (Merriam 1940, p. 53). The Lower Devonian assignment has since been corroborated by a restudy of the *pinyonensis* zone ammonoids (House 1962, p. 253), one of which is known to come from low in the zone. The brachiopod evidence, only touched upon earlier (Johnson 1962*a*, p. 166), has been thoroughly documented and discussed in

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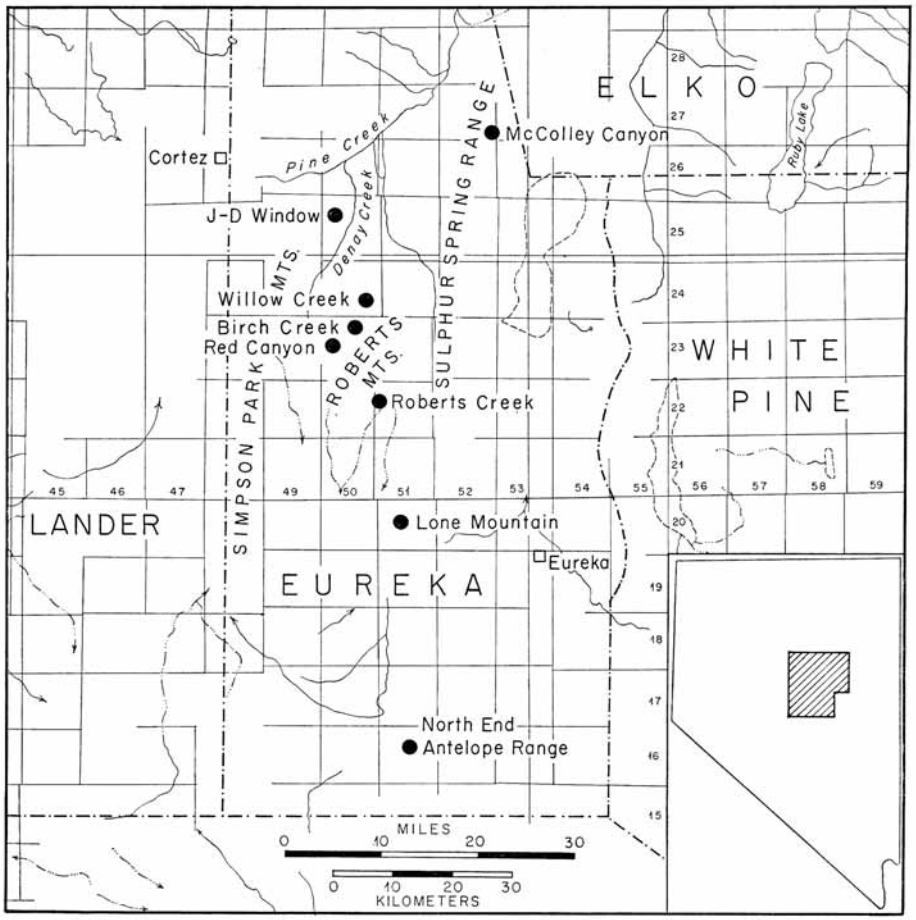
a more extensive monograph (Johnson in preparation). Studies of conodonts also indicate an Emsian assignment for the *pinyonensis* zone (Walliser *in* Johnson in preparation).



TEXT-FIG. 1. Eureka County and environs, central Nevada. Shaded portion of the inset map of Nevada delineates the area shown.

The faunal discontinuity recognized in the northern Simpson Park Range and in the northern Roberts Mountains through collections made by the writer at these localities proved to coincide with the lithologic break between argillaceous limestone of the *pinyonensis* zone and overlying ledge-forming outcrops of siliceous, platy, and flaggy grey limestone with the *Leptathyris circula* zone fauna. In a second paper (Johnson 1962*b*) the writer attempted to trace the lithologic break eastward from the fossiliferous

sections. In the limestone sections the break had already proved to be a significant one for geologic mapping and beds below it were named the McColley Canyon Member of the Nevada Limestone by Carlisle and others (1957, p. 2181). Johnson (1962*b*, p. 543) recommended that in view of coincident faunal and lithologic breaks at the top of the McColley Canyon that the surface of the discontinuity probably indicated unconformity and recommended that the McColley Canyon be elevated to formational rank.

DENAY LIMESTONE

Application of the name McColley Canyon Formation to the Lower Devonian rocks between the Lone Mountain Dolomite below and the *Leptathyris circula* zone beds at the base of the Middle Devonian section above, left unnamed Middle Devonian limestones present in the northern Simpson Park Range and in the Roberts Mountains. Neither the Sulphur Spring Range terminology of Union Mountain Sandstone and Telegraph Canyon Dolomite (Carlisle *et al.* 1957), nor Simonson Dolomite, extensively applied to Middle Devonian rocks east of Eureka County, is applicable to these sections. Neither is Nolan, Merriam, and Williams's member division of the upper Nevada, into Sentinel Mountain Dolomite, Woodpecker Limestone, and Bay State Dolomite applicable in this area on either a member or formation basis. To eliminate this deficiency the writer proposes the name Denay (Daý-nee) Limestone as a formation composing Middle Devonian limestone strata in the northern Simpson Park Range and in the Roberts Mountains (principally northern Roberts Mountains) that together with the underlying McColley Canyon Formation constitute the Nevada Group in this area. The name comes from Denay Valley which separates the north-eastern tip of the Simpson Park Range from the north flank of the Roberts Mountains. According to Winterer (oral communication 1961) the Denay Limestone interfingers with Simonson-like dolomites in the southern Roberts Mountains. The type section of the new formation, approximately 1,000 ft. thick, is on the east flank of Willow Creek Canyon on the north side of Roberts Mountains upsection from the point where the Lone Mountain–McColley Canyon Formation contact crosses Willow Creek (elev. 6,570 ft.) due east to an elevation of approximately 7,320 ft., west of the ridge that is capped by Devils Gate Limestone east of Willow Creek. The contact between the top of the McColley Canyon Formation and the base of the Denay Limestone is met at approximately 6,840 ft. in this section. An excellent supplementary section is exposed in the J–D window of the northern Simpson Park Range between Red Hill (sec. 17, T. 25 N., R. 50 E.) where the Denay is in contact with the overlying Devils Gate Limestone, and a point about a mile to the south-west where a small section of the upper McColley Canyon Formation is present at its base. This is the same as the section of 'unnamed limestone' depicted in the column for J–D Window in an earlier paper (Johnson 1962*b*, fig. 3).

AGE AND CORRELATION

Before outlining the evidence from the brachiopods it will be useful to discuss the occurrence of a goniatite-bearing collection from the Denay Limestone in the southern Roberts Mountains that bears on the problem of the age of the *Leptathyris circula* zone. According to Winterer (oral communication 1959), who has mapped the Palaeozoic rocks

in the Roberts Mountains, the stratigraphic unit here named Denay Limestone consists of a lower well-bedded limestone member and an overlying thick-bedded limestone member in its lower half as well as one or two higher members with which we are not concerned here. So far as the writer has been able to observe personally in the field and deduce from examination of collections made by others, the *Leptathyris circula* zone includes beds that lie within the lower well-bedded unit. In 1959, Winterer made a collection (loc. 4745) in the southern Roberts Mountains about 200 ft. above the lower well-bedded unit that is rich in brachiopods, pelecypods, several types of gastropods, and in addition several specimens of the goniatite *Cabrieroceras* aff. *crispiforme* (Kayser); the latter identification being made for the writer by Dr. M. R. House (written communication 1963 and House 1965). According to House, *C. crispiforme* itself is the guide fossil to the basal Givetian zone to which it gives its name and the occurrence of specimens in the Roberts Mountains designated *C.* aff. *crispiforme* suggests that the containing beds be regarded as basal Givetian. Thus, according to the goniatite evidence, the *Leptathyris circula* zone lies, apparently in its entirety, below beds of earliest Givetian age and either is Eifelian or is itself very early Givetian in age.

Twenty-three species of brachiopods are recognized in the *L. circula* zone including its basal *Pentamerella* subzone and of these fourteen are described and illustrated in this paper:

Vallomyonia devonica, '*Schuchertella*' *sp.*, *Pentamerella wintereri*, *Gypidula* cf. *recurrens*, *Hadrorhynchia eurekaensis*, *Leiorhynchus sp.*, *Spinatrypa sp. B*, *Vagrania? sp.*, *Dubaria?* cf. *thetis*, *Leptathyris circula*, *Warrenella kirki praekirki*, *Warrenella* cf. *columbina columbina*, *Echinocoelia denayensis*, *Cyrtina sp.*

Species of *Teichertina*, *Schizophoria*, *Mesopholidostrophia?*, *Productella*, *Spinatrypa*, *Anatrypa*, *Nucleospira*, *Meristina?*, and *Quadrithyris* are represented by inadequate material. The occurrence of *Vallomyonia devonica* at present has no value for correlation since the genus is unknown outside of Nevada. '*Schuchertella*' is fairly common in Lower and Middle Devonian rocks and is of no help in precise correlation. *Pentamerella wintereri* is most like species of Eifelian age in the Ural Mountains (Khodalevich 1951) and differs quite strongly from the myriad of species of the Hamilton-Traverse rocks of the eastern United States. *Gypidula* cf. *recurrens* is perhaps identical with Meyer's species which occurs in the Blue Fiord Formation of Ellesmere Island. According to McLaren (*in* Fortier *et al.* 1963, p. 61) the Blue Fiord Formation is of Eifelian age. *Hadrorhynchia* is typical of *Stringocephalus*-bearing beds in north-west Canada, but the species from the Denay Limestone is a new one. The same may be said for *Leiorhynchus* since the species apparently has not yet been reported beyond central Nevada. *Spinatrypa sp. B* is probably a new species and is quite unlike typical *Spinatrypa* species that are fairly well known in the Givetian of western Canada. Both *Vagrania* and *Dubaria* cf. *thetis* are questionably assigned and so should be given little weight in correlation. If the latter identifications could be placed on firmer ground they would probably indicate an Eifelian age for the containing beds in Nevada since they are most common in Lower Devonian and Eifelian in the Old World. *Leptathyris*, represented by *L. circula*, is a recently defined athyridid most common in the Eifelian, but present in the Lower Devonian and inasmuch as its definition is so recent its stratigraphic range is probably insufficiently known on which to base a firm correlation. *Warrenella kirki praekirki* is of little help in distinguishing Eifelian from Givetian. Similar forms are typically Middle

Devonian. *Warrenella* cf. *columbina columbina* compares very favourably with that subspecies as illustrated by Havlíček (1959, pl. 28, fig. 3) from the Acanthopyge Limestone (upper Eifelian) of central Czechoslovakia. *Echinocoelia denayensis* differs considerably from the Tully species *E. ambocoelioides* Cooper and Williams, but is fairly close to *E. incurva* Cooper and Williams, from the Mottville Member at the top of the Marcellus (or base of the Skaneateles) in New York State. According to the goniatite evidence discussed by House (1962, p. 254) at least part of the Marcellus is Givetian and *E. incurva* would be of earliest Givetian age. *E. denayensis* is also close to *E? rogeri* (= *Ambocoelia rogeri* Drot 1955, p. 565, pl. 27, fig. 3*a–d*) which is reported to be of late Eifelian (Couvinian) age. *Cyrtina* is common throughout the Devonian and so is of no help in precise correlation.

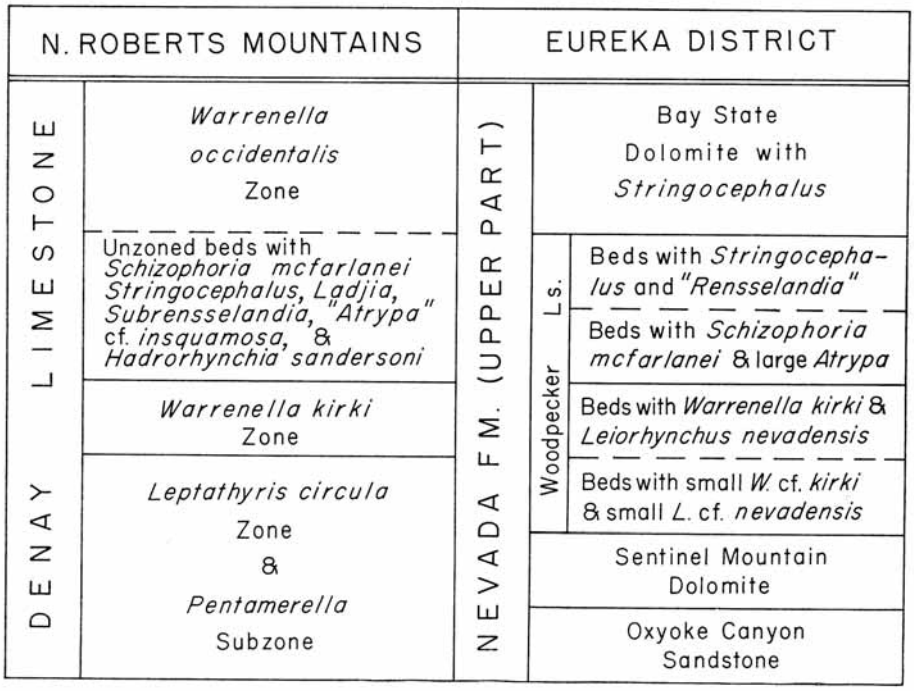
In summary, the brachiopods appear to have their closest relations to brachiopod species from beds elsewhere assigned to the Eifelian, possibly high Eifelian, and some lesser affinity with Givetian species. The goniatite occurrence also suggests that beds bearing the *L. circula* fauna are older than early Givetian.

There seems to be little reason to pursue the possibility that beds within the *L. circula* zone could be Lower Devonian inasmuch as the underlying '*Spirifer*' *pinyonensis* zone fauna is completely different and is very high Lower Devonian, Emsian, and possibly upper Emsian (Johnson in preparation). It is suggested, therefore, that the combined evidence is sufficient to indicate a tentative Eifelian assignment for the *L. circula* zone.

The stratigraphic occurrence of the *L. circula* zone south of the area studied by the writer in the Simpson Park Range and Roberts Mountains can be deduced from data published by C. W. Merriam. Merriam (written communication 1958) indicated that forms identical to those listed as *L. circula* in this paper occur in the 'lower Nevada Formation' at the north end of the Antelope Range. Merriam (1940, p. 23; 1963, p. 45, table 2) includes some 718 ft. of strata in his 'lower Nevada' unit at Lone Mountain. However, he notes that the lower 530 ft. is much more fossiliferous than the remaining part of the 'lower Nevada'. Probably, beds between 530 and 718 ft. above the base of the Nevada at Lone Mountain belong to the *L. circula* zone and taken in conjunction with Merriam's recognition of *L. circula* in his 'lower Nevada' in the Antelope Range, indicates that the views of the writer and of Merriam are in essential harmony regarding what part of the fossiliferous western sections is equivalent to the Oxyoke Canyon Sandstone to the east. Johnson (1962*b*, fig. 3) has already concluded that the Union Mountain Sandstone (= Oxyoke Canyon Sandstone) is at least partially equivalent to the *L. circula* zone, an identical position as that which would be indicated by the presence of the *L. circula* zone at the top of Merriam's 'lower Nevada' (1963, p. 45, table 2).

Outside of central Nevada the only brachiopod faunas that appear to bear any resemblance to that of the *L. circula* zone are reported from north-western Canada and from the Canadian Arctic Archipelago. Few of the significant forms of the *L. circula* zone have been reported in these areas although '*Athyris*' *circula* was reported from the upper Hume Formation of the MacKenzie Basin by Warren and Stelck (1962, p. 278). The species *Gypidula* cf. *recurrens* may prove to be significant for correlation in the Eifelian in western North America and in the Arctic since it is reported from the Blue Fiord Formation of Ellesmere Island. According to Dr. A. W. Norris of the Geological Survey of Canada (written communication, December 1964), the specimens referred

to here as *Gypidula* cf. *recurrens* compare most closely with a form present in the upper Blue Fiord Formation (GSC loc. 26525). Crickmay's report (1962, p. 3) of *G.* cf. *pseudogaleata* from the Bear Rock Formation (called by him Lower Devonian) may be an occurrence of a similar form. Crickmay reported the species to be present with *Fimbrispirifer*, a form present in the Blue Fiord, but not present in Lower Devonian faunas of



TEXT-FIG. 2. Suggested local correlation between the brachiopod-rich Denay Limestone on the north side of the Roberts Mountains and the sequence of mainly dolomite members of the Middle Devonian part of the Nevada Formation in the Eureka district (Nolan *et al.* 1956). '*Rensselandia*' in the Eureka district was examined on loan from Dr. C. W. Merriam after this paper went to press. Merriam's specimens are large and well preserved and upon preparation prove to belong to *Subrensselandia*.

central Nevada studied by Johnson (in preparation). More adequate comparisons of correlative faunas must await description and illustration of more of the oldest Middle Devonian species in Canada.

The stratigraphic position of the *L. circula* zone and *Pentamerella* subzone is depicted in text-fig. 2 which shows the relations of the assemblage zones and undefined faunal units of the Denay Limestone on the north side of the Roberts Mountains in comparison with the faunal sequence of the upper part of the Nevada Formation of the Eureka District as reported by Nolan, Merriam, and Williams (1956, p. 47).

SYSTEMATIC PALAEONTOLOGY

Phylum BRACHIOPODA
Suborder ORTHOIDEA
Superfamily ENTELETACEA Waagen 1884

[*nom. transl.* Alikhova 1960 (*ex* Enteletinae Waagen 1884)]

Family SCHIZOPHORIIDAE Schuchert and LeVene 1929
Genus VALLOMYONIA gen. nov.

Type species. Skenidium devonicum Walcott 1884, p. 116, pl. 13, fig. 4, 4*a*.

Discussion. The new genus is represented only by minute or small shells with a shallow dorsal sulcus. Internally very small pedicle valves bear minute dental lamellae, but larger specimens with the width of about a centimetre completely lack them. In the brachial valve the structures are for the most part delicate. The cardinalia consist of thin, widely divergent brachiophores to which are attached long rod-like brachiophore processes. The brachiophores of very small specimens are supported by short, thin, brachiophore supporting plates that are continuous anteriorly with ridges bounding the muscle field laterally and short, thin, fulcral plates serve as the bases of the sockets. Larger specimens, with a maximum width of about a centimetre, have more strongly differentiated muscle bounding ridges that have become separate from the brachiophore bases and lie outside of them—giving a greater relative width to the posterior adductor muscle scars. Larger specimens also show the anterior adductor scars enclosed anteriorly and the whole of the antero-lateral margin of the muscle field is slightly elevated by the well-developed muscle bounding ridges. Both minute and small specimens bear a high, triangular median septum that extends from near the base of the cardinal process to the anterior margin of the shell.

The genus *Prokopia* Havlíček 1953 was considered by the writer as a possible receptacle for Walcott's species and specimens of *Prokopia bouskai* from the Eifelian Trebotov limestones kindly sent by Dr. Vladimír Havlíček have a relatively strongly convex pedicle valve and appear to lack dental lamellae, however, the hinge teeth are relatively ponderous and are supported postero-laterally by shell material deposited in the umbonal cavities, thus short dental lamellae, if present, could have been made obsolescent. The ventral muscle field of *Prokopia* is broadly transverse and approximately semicircular in outline, separated from the interior of the valve along its anterior edge by a small step or elevated platform similar to that developed in small specimens of *Levenea*. The median septum of *Prokopia* is very high and triangular and apparently reaches nearly to the anterior edge of the valve. Its adductor muscle field is bounded antero-laterally by relatively strongly impressed margins that define a pair of triangular muscle impressions much the shape as are present in *Hypsomyonia*, however, the anterior edges of the muscle bounding ridges are not elevated above the floor of the valve as in the latter genus. On the specimen of *Prokopia* at hand it is not possible to detect fulcral plates. The sockets apparently are defined by shell material connecting the bases of the brachiophores laterally with the floor of the valve.

Vallomyonia resembles *Monelasmina* Cooper 1955 (see also Pedder 1959) in some respects, but Cooper's genus bears strong dental lamellae in the ventral valve and a

relatively long pair of diductor muscle impressions. The cardinalia of *Monelasmina*, in addition, are of the *Schizophoria* type, that is, with well-developed brachiophore supporting plates in contrast to the relatively minute ones seen only on very small specimens of *Vallomyonia*. *Vallomyonia* seems closest to Cooper's genus *Hypsomyonia* (1955) from the Frasnian Independence Shale of Iowa and so far as their differences can be evaluated the two genera can be distinguished by only slight elevation of the muscle bounding ridges in the brachial valve of *Vallomyonia* in contrast to *Hypsomyonia* in which the whole adductor muscle field is elevated above the floor of the valve. *Vallomyonia* is the most logical ancestor to *Hypsomyonia* that has come to the writer's attention.

Vallomyonia devonica (Walcott 1884)

Plate 23, figs. 1–17

Material. The holotype, USNM no. 13827, was borrowed from the U.S. National Museum. It is a silicified specimen attached to a small slab of limestone and is from the same locality of Walcott's at Lone Mountain (553) as are the types of *Leptathyris circula*. There are several other specimens of *L. circula* on the type slab.

Figured specimens. USNM nos. 145478–83, 145538, 145538A, 145538B.

Exterior. The shells are minute to small, transversely suboval to subquadrate in outline, and unequally biconvex in lateral profile. The pedicle valve is relatively low and not strongly convex and is faintly carinate. The brachial valve is nearly flat or gently convex and markedly sulcate. The interarea of the pedicle valve is steeply apsacline to nearly catacline, low, triangular, and nearly flat. The delthyrium is triangular and open, enclosing an angle of about 40°. Among the larger specimens, approaching a centimetre in maximum width, there is commonly a small concave plate inside the apex of the delthyrium. The ventral beak is short. The interarea of the brachial valve is long, flat, and anacline.

The ornament consists of numerous subangular costellae of several sizes which increase in number anteriorly by bifurcation and by implantation. The shell substance is relatively thin and delicate, and is endopunctate.

Interior of pedicle valve. The hinge teeth are small, stubby, and triangular with their long edges parallel to the interarea of the valve. They are supported basally by very short, thin, widely divergent dental lamellae which define a transverse, apically situated, ventral muscle field. Larger specimens have the dental lamellae almost completely obsolescent. The muscle field is transverse and smooth, unfaceted, and undivided medially by a myophragm. Its anterior edge is at the same level as the interior of the valve or is slightly elevated in larger specimens. The interior is crenulated in the anterior half of the shell or peripherally by the impress of the costellae.

Interior of brachial valve. The cardinal process is bilobate, short, and triangular with its myophore face approximately parallel to the plane of the interarea. It is supported basally by the posterior end of the median septum and postero-laterally by a pair of ancillary struts (Williams and Wright 1963, p. 9). The latter structures, however, join laterally to the brachiophores and not to brachiophore supports. The brachiophores are slender and suboval in cross-section and are extended as long slender brachial processes toward the

ventral valve and with a slight anterior inclination. The sockets are defined between the interarea and the brachiophores in very small shells by minute fulcral plates that are elevated well above the floor of the valve. Brachiophore supporting plates on very small specimens diverge moderately antero-laterally and recurve to become subparallel to the midline and continue as ridges bounding the lateral edges of the unpartitioned adductor muscle field. On larger specimens brachiophore supporting plates are obsolescent and the muscle-bounding ridges become more widely set apart and distinct from the brachiophore bases. Also the posterior adductors become relatively wider and the whole adductor muscle field becomes elevated along its margin. A high triangular median septum is present from the base of the cardinal process almost to the anterior edge of the valve. The interior is moderately to strongly crenulated by the impress of the costellae.

Occurrence. *Vallomyonia devonica* is a relatively common species in the *Leptathyris circula* zone in the exposures of the Denay Limestone at the north-eastern tip of the Simpson Park Range, on the north side of the Roberts Mountains at Willow Creek, and on the west side of the Roberts Mountains south of Hanson Creek and east of Red Canyon. It is also present in the *Pentamerella* subzone at Birch Creek.

Suborder PENTAMEROIDEA
Superfamily PENTAMERACEA M'Coy 1844

[*nom. transl.* Schuchert 1896 (*ex* Pentameridae M'Coy 1844)]

Family PENTAMERIDAE M'Coy 1844
Subfamily GYPIDULINAE Schuchert and LeVene 1929
Genus GYPIDULA Hall 1867

Type species. *Pentamerus comis* Owen 1852, p. 583, pl. 3A, fig. 4.

EXPLANATION OF PLATE 23

Figs. 1–17. *Vallomyonia devonica* (Walcott). 1–3, *Pentamerella* subzone, locality 4744, northern Roberts Mountains. 4–17, lower *Leptathyris circula* zone, locality 4739. 1, Interior of pedicle valve ×6, USNM 145538. 2, Interior of brachial valve ×4, USNM 145538B. 3, Interior of brachial valve ×4, USNM 145538A. 4, Interior of pedicle valve ×5, USNM 145479. Note very short dental lamellae. 5, Oblique view of interior of fragment of brachial valve ×4, USNM 145480. Note high triangular median septum. 6–10, Ventral, dorsal, anterior, posterior, and side views ×5, USNM 145482. 11–15, Ventral, dorsal, anterior, posterior, and side views ×4, USNM 145483. 16, Interior of brachial valve ×8, USNM 145478. Note high triangular median septum. 17, Interior of brachial valve ×8, USNM 145481. Note long slender brachial processes.

Figs. 18–22. '*Schuchertella*' *sp.* 18–20, Exterior, interior, and posterior views of pedicle valve ×2, USNM 145485, *Pentamerella* subzone, loc. 4744. 21, 22, Interior and exterior views of brachial valve ×3, USNM 145484, upper *Leptathyris circula* zone, loc. 4737.

Figs. 23–35. *Pentamerella wintereri* Johnson sp. nov. *Pentamerella* subzone, lower *Leptathyris circula* zone, northern Roberts Mountains. 23, Exterior of pedicle valve ×3, USNM 145496, loc. 4741. 24, Exterior of pedicle valve ×3, USNM 145497, loc. 4741. 25, Interior of pedicle valve ×4, USNM 145494, loc. 4740. 26, Exterior of pedicle valve ×3, USNM 145495, loc. 4741. 27, Exterior of brachial valve ×2, paratype, USNM 145488, loc. 4744. 28, Exterior of brachial valve ×2, paratype, USNM 145487, loc. 4744. 29, Exterior of pedicle valve ×2, holotype, USNM 145486, loc. 4744. 30, Interior of brachial valve ×4, USNM 145491, loc. 4740. 31, Interior of brachial valve ×4, USNM 145492, loc. 4740. 32, Exterior of brachial valve ×3, USNM 145493, loc. 4741. 33, Exterior of brachial valve ×2, paratype, USNM 145490, loc. 4744. 34, 35, Interior and exterior of pedicle valve ×3, paratype, USNM 145489, loc. 4744.

Gypidula cf. *recurrens* (Meyer 1913)

Plate 24, figs. 1–7

1913 *Pentamerus pseudogaletus* Hall, mut. nov. *recurrens* Meyer p. 34, pl. 7, figs. 5A–C.

Material figured. USNM nos. 145498–500.

Exterior. The shells are elongate subpyriform in outline and strongly unequally biconvex in lateral profile. The pedicle valve bears a relatively broad and very strongly curved umbo and the valve, along its midline, commonly curves through an arc of 180° or slightly more. The brachial valve is subquadrate in outline and is only moderately convex and cap-like. There is a low, poorly defined, elongate, narrow fold on the pedicle valve. The brachial valve bears a shallow, broad, subrectangular sulcus at its anterior and commonly projects as a short to relatively long tongue on the largest specimens. There commonly are two or three low rounded plications, strongest at the fold and sulcus near the anterior commissure, but extending along approximately the anterior two-thirds of the length of the pedicle valve. The largest specimens bear a pair of shallow furrows bordering the sulcus on the brachial valve and affecting only the posterior fourth or fifth of the length of the brachial valve. Larger specimens bear a relatively strongly developed, moderately incurved, interarea on the pedicle valve. The pedicle valve does not flare broadly toward the anterior, but maintains almost subparallel lateral extremities.

Interior of pedicle valve. There is an elongate, V-shaped, rhomboidal spondylium originating beneath the delthyrium and projecting slightly more than half its length anterior to the hinge line. It is supported along its entire length by a thin median septum, but the septum retreats slightly basally, not attaining as great a distance anterior as the distal end of the spondylium.

Interior of brachial valve. The brachial valve bears a short, flat, orthocline interarea medially that equals slightly less than half the maximum width of the valve. It consists of two long, low, flat, triangular areas with their bases at the posterior edge of the valve and the two medial basal angles meeting at the beak. The sockets are defined by the inner edges of the interarea and the postero-lateral edges of the inner plates. The inner plates are triangular in outline, diverge antero-laterally, and converge slightly basely toward the midline. The outer plates curve outward and then recurve medially in a cylindroidal fashion, then join the interior of the valve along two discrete, slightly divergent tracks.

Occurrence. The writer has collected specimens from the west flank of the Willow Creek on the north side of the Roberts Mountains and has examined several other collections made by Winterer and his students from other places in the Roberts Mountains including the southern Roberts Mountains.

Genus PENTAMERELLA Hall 1867

Type species. Atrypa arata Conrad 1841, p. 55.

Pentamerella wintereri sp. nov.

Plate 23, figs. 23–35

Material. The specimen, USNM no. 145486, in fig. 29 of Plate 23 is the holotype. It is a free pedicle valve, no articulated specimens being available among several hundred studied. The holotype measures 10·8 mm. in width, 7·6 mm. in length, and 4·7 mm. in thickness. The specimens in figs. 27, 28 and 33–35 of Plate 23 are paratypes. These include USNM nos. 145587–97.

Diagnosis. Small, strongly biconvex *Pentamerella*, with strong, rounded plications.

Exterior. The shells are transversely suboval in outline and unequally biconvex in lateral profile. Pedicle valves are about twice as strongly convex as brachial valves and are very strongly incurved at the beak which, however, is short and stubby. No interarea is developed on any of the specimens examined, the palintrope curves smoothly to join the sides of the valves. The delthyrium is open and triangular. Many of the well-preserved pedicle valves bear an apical plate filling a quarter or a third of the delthyrium and covering, but not filling, the posterior end of the spondylium. The pedicle valve bears a shallow sulcus extended anteriorly as an elongate projecting tongue and the brachial valve bears a relatively well-defined median fold that accommodates the projecting anterior tongue of the pedicle valve.

The exterior bears a few strong rounded plications on each valve. Commonly there are three plications on the fold of the brachial valve and two plications in the sulcus of the pedicle valve. However, on some specimens, the pedicle valve bears a single median plication within the sulcus. On some larger specimens that bear a single medium plication in the early growth stage, a second plication may be intercalated toward the anterior. There commonly are two or three plications on each flank of the brachial valve and from two to four plications on each flank of the pedicle valve.

Interior of pedicle valve. There is an elongate spondylium of rhomboidal outline situated beneath the delthyrium and projecting anteriorly beyond the hinge line. It is supported apically by a median septum, but the length of the septum appears to be subject to some variability in its length along the base of the valve (compare figs. 25 and 34 of Pl. 23). The surface is crenulated by the impress of the plications.

Interior of brachial valve. The sockets are rudimentary, being formed by the edge of the shell on the postero-lateral edge above the inner plates. The inner plates diverge antero-laterally and converge toward the midline. The outer plates are elongate and subparallel, in some shells meeting along a line medially and in others joining the surface of the valve along a pair of discrete subparallel tracks. A number of variations may be seen between structures which are easy to classify as one type or the other. The interior is crenulated by the impress of the plications.

Occurrence. The new species is extremely abundant at some horizons within a few feet to 50 or 60 ft. above the base of the Denay Limestone on the north side of the Roberts Mountains. The writer has

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EXPLANATION OF PLATE 24

Figs. 1–7. *Gypidula* cf. *recurrens* (Meyer). Lower *Leptathyris circula* zone, loc. 4739, northern Roberts Mountains. 1–5, Dorsal, anterior, posterior, side, and ventral views ×1, USNM 145498. 6, Interior of brachial valve ×2, USNM 145499. 7, Interior of pedicle valve ×2, USNM 145500.

Figs. 8–23. *Leiorhynchus* sp. Lower *Leptathyris circula* zone and *Pentamerella* subzone, northern Roberts Mountains. 8, Side view of interior of both valves ×3, USNM 145503, loc. 4739, lower *Leptathyris circula* zone. Note long crus, high triangular median septum, and short dental lamella. 9–13, Side, dorsal, ventral, anterior, and posterior views ×2, USNM 145501, loc. 4740, *Pentamerella* subzone. 14–18, Dorsal, ventral, side, posterior, and anterior views ×3, USNM 145502, loc. 4739, lower *Leptathyris circula* zone. 19–23, Dorsal, ventral, posterior, anterior, and side views ×2, USNM 145504, *Leptathyris circula* zone, loc. 4743, west slope of Roberts Mountains.

Figs. 24–28. *Dubaria*? cf. *thetis* (Barrande). Lower *Leptathyris circula* zone, loc. 4739, northern Roberts Mountains. 24–28, Ventral, dorsal, side, anterior, and posterior views ×2, USNM 145520.

collected slabs with abundant disarticulated specimens in both Willow Creek and Birch Creek Canyons and in the small canyon immediately east of the mouth of Willow Creek along the front of the range. Other collections have been made by E. L. Winterer in the southern Roberts Mountains in the vicinity of Roberts Creek. Cooper (1942, p. 1773) mentions the presence of small *Pentamerella* at Lone Mountain indicating that the species may be present there also. Another species of small *Pentamerella* is present in a silicified collection containing *Stringocephalus* and *Subrensselandia* in Red Canyon on the west flank of the Roberts Mountains. However, the *Stringocephalus* zone specimens bear more and finer plications. The species has not been recognized in the Denay Limestone exposures in the northern Simpson Park Range.

Comparison. The new species most closely resembles *P. suspecta* Khodalevich (1951, pl. 7, fig. 7*a–d*) and *P. sosvaensis* Khodalevich (1951, pl. 7, fig. 11*a–d*) from the Eifelian of the Ural Mountains. *P. sosvaensis* may be distinguished by being more elongate and plicate only on the anterior half of the shell. *P. suspecta* is very similar to the new species in size, relative convexity, and in the size and number of the plications. However, the illustrated specimen is somewhat more strongly rhomboidal in outline than *P. wintereri*. *P. arata* Conrad, *P. pavilionensis* Hall, and *P. dubia* Hall (Hall and Clarke 1895, pl. 71) are all much larger than the new species and thus cannot be closely compared. All appear, however, to have relatively smooth umbonal regions on both valves so that specimens the size of those typical of the Nevada fauna would be much less strongly plicate. *P. obsolescens* Hall (1867, pl. 58, figs. 24, 25) is a small species, but almost completely lacks plications. *P. thusnelda* Nettelroth (1889, p. 51, pl. 31, figs. 26–28) is a much larger and elongate species than is *wintereri*. Branson (1923) named two new species from the Middle Devonian of Missouri. *P. wintereri* contrasts strongly with one of these, *P. missouriensis*, in having a much shorter ventral beak and less prominent ventral umbo. *P. wintereri* differs from Branson's second species, *P. fultonensis*, in having plications (Branson 1923, pl. 16, figs. 21–23; pl. 24, figs. 1–4). The new species differs from *P. liorhyncha* Cooper and Cloud (1938, p. 447, pl. 54, figs. 12–16, 31–34) which is decidedly more elongate and pyriform in outline.

P. athyroides (Winchell) as illustrated by Imbrie (1959, pl. 51, figs. 6–10) is a larger species with plications not developed on the umbones. The same may be said of *P. petoskeyensis* (Imlay) and *P. papilla* Imbrie (Imbrie 1959, pl. 51, figs. 25–30, 18–24). *P. aulax* Imbrie (1959, pl. 51, figs. 11–17) has much finer plications than does *P. wintereri*. Other named species of Imbrie, *P. pericosta*, *P. lingua*, *P. aftonensis*, *P. tumida*, and *P. alpenensis* all differ from *P. wintereri* in being relatively large forms that lack plications on the umbones. *P. proteus* Imbrie (1959, pl. 53, figs. 1–8), a small species with a few plications that originate close to the posterior, differs in having a transverse subrhomboidal outline and a much smaller apical angle than do specimens of *P. wintereri*. The species *Spirifer davidsoni* Schnur (1853, pl. 35, fig. 7; pl. 44, fig. 3), a *Pentamerella* according to Havlíček (1952, p. 2, pl. 1, figs. 7, 9), is very similar to *P. wintereri* but has a considerably more prominent beak in the pedicle valve. *P. sclavus* Norris from the Middle Devonian Horn Plateau Formation of the Mackenzie District of north-west Canada (McLaren and Norris 1964, p. 37, pl. 13, figs. 9–13) is larger and has a narrower and more elongate ventral beak than does *P. wintereri*. The Canadian species *Pentamerus borealis* Meek was assigned to *Pentamerella* by Schuchert (1897, p. 302), but it appears that exception should be taken to the assignment since '*P.*' *borealis* bears a ventral fold and dorsal sulcus (Meek 1868, pl. 13, fig. 11*a, b, d*). In any event '*P.*' *borealis* bears little similarity to *Pentamerella wintereri*.

Suborder STROPHOMENOIDEA
Superfamily ORTHOTETACEA Waagen 1884
[*nom. transl.* Williams 1953 (*ex* Orthotetinae Waagen 1884)]
Family SCHUCHERTELLIDAE Williams 1953
[*nom. transl.* Stehli 1954 (*ex* Schuchertellinae Williams 1953)]
Subfamily SCHUCHERTELLINAE Williams 1953
Genus SCHUCHERTELLA Girty 1904

Type species. Streptorhynchus lens White 1862, p. 28.

'*Schuchertella*' sp.

Plate 23, figs. 18–22

Material figured. USNM nos. 145484–5.

Discussion. Assignment to *Schuchertella* is not firm since pseudopunctae were not observed.

Exterior. The species is small, averaging about a centimetre in width and is transversely subsemicircular to shield-shaped in outline. The valves are unequally biconvex in lateral profile with the pedicle valve more strongly convex than the brachial valve and commonly somewhat elevated with a moderately twisted beak. The ventral interarea is apsacline, flat, and triangular. Its height varies and the delthyrium is covered by a gently convex pseudodeltidium. The ornament consists of fine, rounded, slightly parvicostellae costellae that increase in number anteriorly, principally by intercalation. The costellae are crossed by a few irregularly spaced growth lines. A shallow sulcus may be developed on the brachial valve. The maximum width of the valves is attained near midlength.

Interior of pedicle valve. The hinge teeth are relatively large and triangular in horizontal section. They leave stout tracks on the inner edges of the delthyrium, but there are no supporting dental lamellae. The interior of the valve is not crenulated by the impress of the costellae.

Interior of brachial valve. The socket ridges are widely divergent antero-laterally and are unsupported on their divergent inner edges. Two short prongs of shell material are attached to the posteromedial edges of the socket ridges and project posteriorly. It was not determined whether a chilidium was present or not. The interior is not crenulated by the impress of the costellae.

Occurrence. This small species of '*Schuchertella*' is present in one collection from high in the *Leptathyris circula* zone in the southern Roberts Mountains and from the *Pentamerella* subzone on Birch Creek in the northern Roberts Mountains.

Suborder RHYNCHONELLOIDEA
Superfamily RHYNCHONELLACEA Gray 1848
[*nom. transl.* Schuchert 1896 (*ex* Rhynchonellidae Gray 1848)]
Family TRIGONIPHYNCHIIDAE Schmidt 1965
Genus HADRORHYNCHIA McLaren 1961

Type species. Pugnoides sandersoni Warren 1944, p. 115, pl. 2, figs. 5, 6.

Hadrorhynchia eurekaensis sp. nov.

Plate 25, figs. 1–23

Material. The specimen in figs. 6–10 of Plate 25, USNM no. 145511, is designated the holotype. It measures 10·8 mm. in width, 9·8 mm. in length, and 8·0 mm. in thickness. The other illustrated specimens are paratypes. They include USNM nos. 145505–10.

Diagnosis. Multicostate *Hadrorhynchia*, costae relatively strong on the umbonal regions. Shape lenticular to subcuboidal, not reflexed.

Exterior. Most of the available specimens of this species are small or medium sized and bear a pyriform to subpentagonal outline. Commonly, smaller specimens are somewhat elongate and pyriform while the large ones develop slight irregularities in the shape resulting in the subpentagonal outline. The valves are strongly biconvex in lateral profile with the brachial valve about a quarter to a third more strongly convex than the pedicle valve. Smaller specimens are more commonly somewhat lenticular, but a lesser number of even very small specimens attain the subcuboidal outline more common to medium-sized specimens. The beak of the pedicle valve is moderately incurved and projects somewhat strongly anterior to the umbo of the brachial valve. There is a triangular delthyrium and low, apsacline, incurved interarea. The beak angle is commonly between 90° and 100° and is relatively constant for a distance equal to about a third of the length of small shells and a fourth or fifth of the length of larger shells and then decreases anteriorly to the place of maximum width which is anterior to midlength. On most specimens the pedicle valve has a relatively flattened outline along the lateral flanks as viewed from the side, then curves abruptly in a nearly geniculate fashion at the anterior commissure. The sulcus, however, attains a more uniform curvature from the beak to the anterior commissure. The pedicle valve bears a shallow median sulcus that originates in the posterior portion of the valve and becomes relatively well marked anteriorly where it is accentuated by the development of a tongue-like projection that is accommodated by a subrectangular fold in the anterior portion of the brachial valve. The ornament consists of numerous subangular costae which have smoothly rounded crests. The costae expand in size anteriorly and do not bifurcate. Commonly, the median costae on the brachial valve become relatively broad anteriorly and appear notably broader than the adjoining lateral costae at the same distance from the beak which continue strongly curving adjacent to the projecting tongue of the sulcus. Most commonly there are three costae in the ventral sulcus and four costae on the dorsal fold, but specimens with lesser and greater numbers are also encountered.

Interior of pedicle valve. The hinge teeth are small and delicate. They are supported basally by thin dental lamellae of triangular outline which are situated relatively close to the postero-lateral walls of the valve. The interior is crenulated by the impress of the costellae.

Interior of brachial valve. The sockets are long and narrow and are cylindroidal in shape, being defined postero-laterally by the inner edge of the shell and basely and ventrally by the curved hinge plates. A pair of triangular horizontal plates connects the inner edges of the outer hinge plates with the crura which arise medially on either side of a narrow V-shaped septalium that is supported by a long high median septum. The crura

are T-shaped in cross-section and curve strongly ventrally, recurving with their convex edges facing antero-laterally. The interior is fairly strongly crenulated over much of the length of the valve by the costellae.

Occurrence. This species is the most common rhynchonellid in the *Leptathyris circula* zone on the north and south sides of the Roberts Mountains. The species is also present in the *Warrenella kirki* zone overlying the *L. circula* zone in the J–D window of the northern Simpson Park Range. It appears that *Rhynchonella transversa* of Meyer (1913, pl. 7, fig. 7*a–e*; not Hall) from the Blue Fiord Formation of Ellesmere Island could belong to *H. eurekaensis*. Unfortunately the Arctic species is unknown internally.

Comparison. *H. sandersoni* (Warren) has much more poorly developed costae on the posterior portion of the valve. In addition, the anterior sulcus appears to be deeper on *sandersoni* and the shells are commonly relatively more transverse. Furthermore, maximum width of *H. eurekaensis* appears on almost all the shells to be developed at a somewhat greater distance anterior to the beak (McLaren 1962, pl. 7). *H. eurekaensis* appears to be distinguishable from *H. intermissa* and *H. vallorum* Crickmay (1963, pl. 7) on the same grounds that it may be distinguished from *sandersoni*.

Family LEIORHYNCHIDAE Stainbrook 1945

[*nom. transl.* Crickmay 1952 (*ex* Leiorhynchinae Stainbrook 1945)]

Genus LEIORHYNCHUS Hall 1860

Type species. *Orthis quadricostata* Vanuxem 1842, p. 168, fig. 2.

Leiorhynchus sp.

Plate 24, figs. 8–23, text-fig. 3

Material figured. USNM nos. 145502–4, 145521.

Exterior. The shells are variable in outline and convexity, commonly subpyriform to somewhat pentagonal in outline. Most specimens are strongly biconvex with the brachial valve more convex than the pedicle valve. A few specimens are relatively lenticular. The beak angle is about 90° or a little more and the postero-lateral margins are relatively

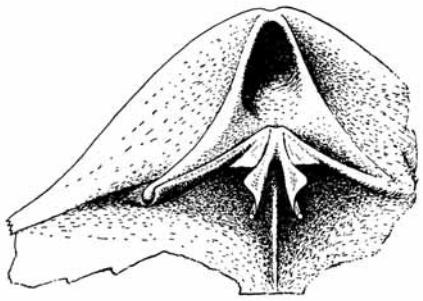
EXPLANATION OF PLATE 25

Figs. 1–23. *Hadrorhynchia eurekaensis* Johnson sp. nov. Lower *Leptathyris circula* zone, loc. 4739, northern Roberts Mountains. 1–5, Ventral, dorsal, side, posterior, and anterior views ×2, paratype, USNM 145509. 6–10, Ventral, dorsal, side, posterior, and anterior views ×2, holotype, USNM 145511. 11–15, Ventral, dorsal, side, posterior, and anterior views ×3, paratype, USNM 145510. 16, 17, Interior of fragment of pedicle valve and posterior of brachial valve ×4, paratype, USNM 145505. The two valves belong to the same individual. In fig. 16 note shape of the dental lamella. 18, 19, Dorsal and ventral views ×3, paratype, USNM 145506. 20, 21, Dorsal and ventral views ×3, paratype, USNM 145508. 22, 23, Ventral and dorsal views of small specimen ×3, paratype, USNM 145507.

Figs. 24–28. *Spinatrypa* aff. *lata* (Warren 1944). Near base of Telegraph Canyon Member of Nevada Formation, loc. 3536, Union Mountain, Sulphur Spring Range. Horizon probably should be assigned to *Warrenella kirki* zone. 24–28, Anterior, posterior, side, ventral, and dorsal views ×2, USNM 145514.

Figs. 29–35. *Spinatrypa sp. B*. 29, 30, Dorsal and ventral views ×3, USNM 145512, loc. 4738, *Pentamerella* subzone, southern Roberts Mountains. 31–35, Ventral, dorsal, side, posterior, and anterior views ×2, USNM 145513, loc. 4741, *Pentamerella* subzone, northern Roberts Mountains.

straight in the posterior third of the shell. Maximum width is commonly anterior to mid-length. The beak of the pedicle valve is strongly incurved and bears a small apical foramen. The pedicle valve bears a broad flat-bottomed sulcus in its anterior half and the brachial valve bears a corresponding subrectangular fold. In most specimens, the fold is divided medially by a shallow narrow furrow and anteriorly may bear two to four low rounded plications. Most larger specimens bear a few very short plications adjoining the fold and sulcus, but affect only a small portion of the length of the shell.



TEXT-FIG. 3. Interior of posterior portion of articulated shell of *Leiorhynchus* sp., USNM 145521. Sketch of articulating apparatus on the right side is generalized because of poor preservation. Note circular cross-section of the crura and the prominent flanges that extend ventrally from them.

Interior of pedicle valve. The hinge teeth are small and delicate and are attached along the inner edge of the postero-lateral shell margin. They are supported by a pair of short thin dental lamellae that converge medially to join, forming a sessile spondylium. No median septum is present. The dental lamellae converge at an angle of about 75–80°.

Interior of brachial valve. The dental sockets are exceedingly narrow and diverge antero-laterally, nearly parallel to the valve margin. The crura originate at the beak and diverge at a very small angle as they project antero-ventrally. They are circular in cross-section with fluted lateral flanges that are roughly parallel to the plane of commissure along their posterior portions, but which become depressed below the level of the crura and extend anteriorly along planes nearly parallel to the median plane (text-fig. 3). Anteriorly the bases of the crura and their lateral flanges are connected to the inner edges of the hinge plates by a pair of thin, narrow, triangular plates. Medially the dorsal edges of the crura are attached to a high median septum. No septalium is present. The median septum is long and blade-like, reaching about half way or slightly less to the anterior of the shell.

Occurrence. Leiorhynchus sp. is a relatively uncommon species in the *Leptathyris circula* zone on the north side of the Roberts Mountains. A number of specimens have also been collected from the Denay Limestone in the northern Simpson Park Range.

Suborder ATRYPOIDEA
Superfamily ATRYPACEA Gill 1871

[*nom. transl.* Schuchert and LeVene 1929 (*ex* Atrypidae Gill 1871)]

Family ATRYPIDAE Gill 1871
Subfamily ATRYPINAE Gill 1871
Genus SPINATRYPA Stainbrook 1951

Type species. Atrypa hystrix var. *occidentalis* Hall 1858 (*errore pro A. aspera* var. *occidentalis* Hall 1858, p. 515).

Spinatrypa aff. *lata* (Warren 1944)

Plate 25, fig. 24–28

1944 *Atrypa borealis* var. *lata* Warren, p. 122, pl. 3, figs. 7–9.
1962 *Spinatrypa lata* McLaren and Norris, pl. 8, figs. 25–27.

Material figured. USNM no. 145514.

Exterior. The shells are transversely suboval to subpentagonal in outline and subequally biconvex in lateral profile. The valves are more or less lenticular and none are strongly convex. A few of the smaller specimens are elongate with the maximum width near midlength or posterior to it, however, the relatively larger specimens are all transverse and have their maximum width posterior to midlength at a distance approximately one-third of the distance from the ventral beak. The ventral beak is small, pointed, and nearly straight and is pierced apically by a small circular foramen. The foramen joins anteriorly and dorsally with a broad, low, triangular delthyrium enclosing an angle greater than 90°, which is completely covered by deltidial plates that lie adjacent to the umbo of the brachial valve that has its beak incurved beneath them. On most specimens the brachial valves are of relatively even convexity across the midline, but pedicle valves are mildly carinate, except anteriorly where a faint ventral sulcus appears or is suggested by dorsal deflection of the anterior commissure.

The ornament consists of numerous, well-developed, rounded costae that increase in number most commonly by bifurcation on the pedicle valve and by intercalation on the brachial valve. They are crossed by numerous well-developed concentric growth lamellae that occur at regular intervals from the posterior to the anterior margin of the valves. The number and size of the radial costellae is variable, but in general the costae are relatively fine for the genus.

Occurrence. This species comes from just above the Union Mountain Sandstone in the northern part of the Sulphur Spring Range in beds that were incorrectly assigned to the *Heliolites* horizon by Carlisle and others (1957, loc. 3536). Present in the same collection are numerous small ambocoeliids and some small athyroids close to *Leptathyris circula*. Species of this type from the Sulphur Spring Range are regarded as a possible link between finely costellate *Spinatrypa* of the *L. circula* zone in the Roberts Mountains as well as in the northern Simpson Park Range and with *Spinatrypa* cf. *andersonensis* which is common in the typical *Warrenella kirki* zone.

Spinatrypa sp. B

Plate 25, figs. 29–35

Diagnosis. Transverse lenticular *Spinatrypa* with fine costellae and growth lamellae.

Material figured. USNM nos. 145512, 145513.

Discussion. This species has a size, outline, and convexity similar to *Spinatrypa* cf. *lata* described above, however, it may be distinguished by its finer ornament. The radial costellae are exceptionally fine for the genus and appear commonly to be somewhat irregular and subject to numerous bifurcations and intercalations posteriorly. Costellae remain essentially fine and narrow anteriorly. In some cases their width is less than some

of the main costellae posteriorly. They are crossed by numerous, very fine, imbricating, concentric growth lamellae.

This appears to be a new species insofar as the writer has been able to find no closely comparable form in the literature. However, the specimens available are relatively few in number and are not exceptionally well preserved. Thus, pending a more extensive collection of more adequately preserved specimens, this form will be referred to as *Spinatrypa sp. B.* This is *Spinatrypa sp. B* of Johnson (1962*a*, p. 166).

Occurrence. Spinatrypa sp. B is a common atrypoid of the *Leptathyris circula* zone and *Pentamerella* subzone in the northern Roberts Mountains and in the *L. circula* zone in the northern Simpson Park Range.

Subfamily CARINATININAE Rzhonsnitskaya 1960
Genus VAGRANIA Alekseeva 1959

Type species. Atrypa kolymensis Nalivkin 1936, p. 17, pl. 2, fig. 8.

Vagrania? sp.

Plate 26, figs. 1–12

Material figured. USNM nos. 145515–19.

Discussion. Vagrania is a strongly costate or plicate atrypoid that lacks concentric growth lamellae. Instead, as shown by Alekseeva (1960, pl. 10, fig. 3), the genus bears a fine ornament consisting of numerous, very fine pustules scattered over the surface in a quincunx pattern. Internally, large specimens carry diagnostic and unusual structures (Boucot, Johnson, and Staton 1964, pl. 128, figs. 10–12).

The specimens described below from central Nevada are very small and do not develop the structures which are known to be present in larger specimens of the genus, however, as yet we have no knowledge of the development of these same structures in small specimens of the Russian types. The exterior of the specimens, in addition, is a bit too roughly preserved to ascertain the original presence or absence of the peculiar fine ornament of the genus. In the absence of these features questionable assignment is made on the basis of the coarse ribbing and lack of concentric ornament on the specimens from the Roberts Mountains.

Exterior. The shells are elongate suboval to somewhat pyriform or subtrigonal in outline and subequally biconvex in lateral profile. The beak of the pedicle valve is short and pointed and projects posteriorly, straight or nearly straight. The hinge line is short and strongly curved and the pedicle valve bears a relatively flat palintrope consisting of two triangular flat surfaces on either side of the circular or suboval foramen present anterodorsally to the beak of the pedicle valve. The anterior commissure is rectimarginate.

The ornament consists of well-defined, rounded, radial costae that increase in number anteriorly by bifurcation and by implantation; the latter most commonly on the brachial valve and the former on the pedicle valve (see figs. 5 and 6 of Pl. 26).

Interior of pedicle valve. The hinge teeth are thin and plate-like and are approximately perpendicular to the median line. They are attached directly to the inner edges of the valve and are not supported by dental lamellae. The interior is moderately strongly crenulated by the impress of the costae.

Interior of brachial valve. The sockets are relatively narrow and broadly divergent antero-laterally. They bear a pair of crural lobes on their inner edges. The inner edges of the crural lobes border the notothyrial cavity and diverge antero-laterally.

Occurrence. This small species of *Vagrania? sp.* is relatively common in the *Pentamerella* subzone on the north side of the Roberts Mountains at Willow Creek and in the small canyon immediately east of Willow Creek along the north face of the Roberts Mountains. The species is also present with *Pentamerella* in the southern Roberts Mountains east of Roberts Creek.

Family LISSATRYPIDAE Twenhofel 1914

[*nom. transl.* Boucot, Johnson, and Staton 1964 (*ex* Lissatrypinae Twenhofel 1914)]

Subfamily SEPTATRYPINAE Kozlowski 1929

Genus DUBARIA Termier 1936

Type species. D. lantenoisi Termier 1936, p. 1266, pl. 17, 17 *bis*.

Dubaria? cf. *thetis* (Barrande 1847)

Plate 24, figs. 24–28

1847 *Terebratula thetis* Barrande, p. 349, pl. 14, fig. 5.
1879 *Atrypa thetis* Barrande, p. 54, pl. 86, case IV, figs. 1–11.
1951 *Septatrypa*(?) *thetis* Khodalevich, p. 84, pl. 21, figs. 6*a–d*.
1962 *Rhynchatrypa thetis* Siehl, p. 200, pl. 28, figs. 1, 2; pl. 37, fig. 11; pl. 38, figs. 1, 2.

Material figured. USNM no. 145520.

Exterior. The shell is subtrigonal in outline and lenticular in lateral profile with the pedicle valve nearly flat or reflexed and the brachial valve moderately convex. In the pedicle valve, approximately the first centimetre of shell is low convex, but antero-laterally the flanks flatten out on larger shells and the median portion becomes deflected into a deep flat-bottomed sulcus. The brachial valve is evenly rounded from the umbo to the antero-lateral flanks, but the median section is only faintly curved, nearly flat, due to the elevation anteriorly of a well-developed, rounded to nearly flat fold. The hinge line is short and moderately curved.

EXPLANATION OF PLATE 26

Figs. 1–12. *Vagrania? sp. Pentamerella* subzone; figs. 1–4, 8–12 northern Roberts Mountains; figs. 5–7 southern Roberts Mountains. 1, 2, Interior and exterior of pedicle valve ×3, USNM 145516, loc. 4740. 3, Dorsal view ×3, USNM 145518, loc. 4740. 4, Ventral view ×3, USNM 145519, loc. 4740. 5–7, Dorsal, ventral, and posterior views ×3, USNM 145517, loc. 4738. 8–12, Anterior, posterior, side, dorsal, and ventral views ×2, USNM 145515, loc. 4741.

Figs. 13–22. *Leptathyris circula* (Walcott 1884). Lower *Leptathyris circula* zone, loc. 4739, northern Roberts Mountains. 13–17, Dorsal, ventral, anterior, posterior, and side views ×2, USNM 145522. 18–22, Posterior, anterior, dorsal, ventral, and side views ×2, USNM 145523.

Figs. 23–30. *Echinocoelia denayensis* Johnson sp. nov. 23, Interior of brachial valve ×3, USNM 145524, loc. 4743, *Leptathyris circula* zone, west slope of Roberts Mountains. 24, Interior of brachial valve ×3, paratype, USNM 145525, loc. 4739, lower *Leptathyris circula* zone, northern Roberts Mountains. 25, Exterior of brachial valve ×3, paratype, USNM 145526, loc. 4739, lower *Leptathyris circula* zone, northern Roberts Mountains. 26–30, Ventral, anterior, posterior, side, and dorsal views ×3, holotype, USNM 145527, loc. 4739, lower *Leptathyris circula* zone, northern Roberts Mountains.

The ornament consists of a few poorly defined concentric growth lines developed in the anterior two-thirds of the valves. No radial ornament is present.

Discussion. Unfortunately, only two specimens of this form are available and neither show the internal structures, however, the external form and lack of radial ornament are so distinctive it appears that these shells merit a provisional assignment to *Dubaria* and particularly to the broad lenticular form *Dubaria thetis*. So far as the writer knows, this form is restricted to the Emsian and Eifelian in central Europe and in the Ural Mountains, however, the genus is most common in latest Silurian and early Devonian rocks in Bohemia, the Carnic Alps, and in European and Central Asian Russia.

Occurrence. Dubaria? cf. *thetis* is present in a single collection in the northern Roberts Mountains on the west flank of Willow Creek in the lower *Leptathyris circula* zone.

Suborder ATHYRIDOIDEA
Superfamily ATHYRIDACEA M'Coy 1844
[*nom. transl.* Williams 1956 (*ex* Athyridae M'Coy 1844)]
Family ATHYRIDIDAE M'Coy 1844
Subfamily ATHYRIDINAE M'Coy 1844
[*nom. transl.* Waagen 1883 (*ex* Athyridae M'Coy, 1844)]
Genus LEPTATHYRIS Siehl 1962

Type species. L. gryphis Siehl 1962, p. 212, pl. 36, fig. 1, pl. 39, figs. 2, 3.

Leptathyris circula (Walcott 1884)

Plate 26, figs. 13–22; text-fig. 4

1884 *Cryptonella*? *circula* Walcott n. sp., p. 163, pl. 15, figs. 2, *a*, *b*.
1940 ?*Cryptonella circula* Merriam, pl. 11, fig. 8.
1962 *Athyris circula* Johnson 1962*a*, p. 166.

Material. The holotype, USNM no. 13861, was borrowed from the U.S. National Museum and was accompanied by twenty-four paratypes. They are small silicified shells with the valves tightly welded together. However, one of the paratypes has the ventral beak broken away revealing the cardinalia in the brachial valve. They exactly duplicate the structure described above from specimens collected by the writer from the Roberts Mountains. The structure of this paratype is shown in text-fig. 4. The label with the types indicates that they are from the 'Lower Devonian' at Lone Mountain.

Figured specimens. USNM nos. 145522, 145523.

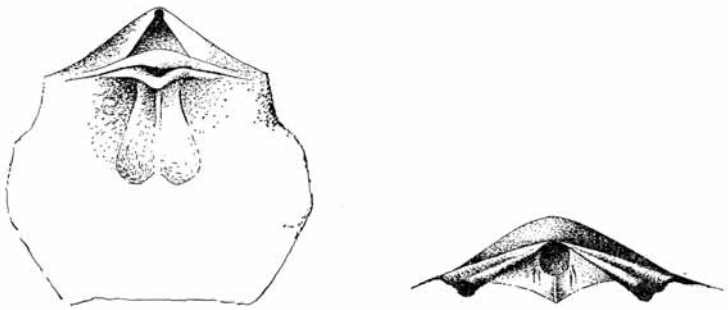
Discussion. Siehl (1962, p. 212) proposed *Leptathyris* for small non-lamellose athyridids with a thin, depressed, medially-crested, cardinal plate. These are diagnostic features of '*Athyris*' *circula*, which is therefore assigned to *Leptathyris*.

Exterior. The species is small and subcircular to elongate suboval or short pyriform in outline. In lateral profile the valves are unequally biconvex with the pedicle valve slightly more convex than the brachial valve. The ventral beak is sub-erect. The palintrope is only faintly rounded, nearly flat, but beak ridges are absent. The hinge line is short and curved. There is a triangular delthyrium commonly enclosing about 70°. It is unmodified by deltidial plates and in all the specimens examined there invariably is a minute ragged opening at the apex of the delthyrium. Its ubiquitous presence suggests that it is in fact

a mesothyrid or permesothyrid foramen. Both valves curve evenly anteriorly and antero-laterally with slightly more gentle curvature than at the umbos. There is no fold, but some specimens develop a flattened area on the anteromedial part of the pedicle valve or a faintly indented sulcus and the anterior commissure is gently deflected toward the brachial valve.

The ornament consists of a few widely spaced, faint, concentric growth lamellae. No radial ornament was observed.

Interior of pedicle valve. The hinge teeth are supported by a pair of thin dental lamellae that are situated close to the inner postero-lateral walls of the valve. The anterior edges of the dental lamellae converge slightly towards the midline and are continued for a short



a *b*

TEXT-FIG. 4. *Leptathyris circula*. *a*, Interior of pedicle valve from the Roberts Mountains with fragment of brachial valve retaining cardinal plate attached. *b*, Cardinalia of brachial valve of a paratype from Lone Mountain showing the shape of the cardinal plate and the apical foramen.

distance as ridges that bound the muscle impression. These ridges terminate anteriorly at about the place of constriction between the pedicle cavity and the diductor muscle scars. The diductors are faintly impressed, elongate, and slightly divergent. Medially there is a faintly elevated myophragm dividing the diductors into two more or less separate tracks that blend anteriorly with the interior of the valve (text-fig. 4).

EXPLANATION OF PLATE 27

Figs. 1–5. *Cyrtina sp.* Lower *Leptathyris circula* zone, loc. 4739, northern Roberts Mountains. 1–5, Anterior, posterior, side, ventral, and dorsal views ×2, USNM 145528.

Figs. 6–9. *Warrenella* cf. *columbina columbina* (Havlíček 1959). Lower *Leptathyris circula* zone, loc. 4739, northern Roberts Mountains. 6–9, Anterior, side, dorsal, and ventral views ×3, USNM 145529.

Figs. 10–25. *Warrenella kirki praekirki* Johnson subsp. nov. Figs. 10–24, lower *Leptathyris circula* zone, loc. 4739, northern Roberts Mountains; fig. 25, zone unknown, loc. 4742, northern Roberts Mountains. 10–14, Anterior, posterior, side, dorsal, and ventral views ×1·5, holotype, USNM 145530. 15–19, Posterior, anterior, side, dorsal, and ventral views ×2, paratype, USNM 145531. 20, Interior of brachial valve ×4, paratype, USNM 145532. 21, Interior of posterior portions of articulated fragments of both valves ×5, paratype, USNM 145533. 22, Interior of fragment of pedicle valve ×3, paratype, USNM 145534. 23, Interior of brachial valve ×4, paratype, USNM 145535. 24, Exterior of fragment ×5, paratype, USNM 145536. 25, Interior of fragment of pedicle valve ×2, USNM 145537.

Interior of brachial valve. The sockets diverge antero-laterally and are unsupported by crural plates. Their inner edges are joined by an apically perforate cardinal plate which is slightly depressed dorsally across its width, but which is crested along the median line with its crest ventrally directed. In plan view the anterior edge of the cardinal plate is two sided, converging anteromedially. Neither median septum nor myophragm are present. The spiralia have their apices directed laterally and appear to consist commonly of six or eight turns.

Occurrence. Leptathyris circula is very common in the lower two or three hundred feet of the Denay Limestone at a number of places in the Roberts Mountains and in the northern Simpson Park Range. As reported previously (Johnson 1962*a*, p. 167) Merriam states that forms assignable to this species are present at the north end of the Antelope Range.

Suborder SPIRIFEROIDEA

Superfamily DELTHYRIACEA Phillips 1841

[*nom. transl.* Ivanova 1960 (*ex* Delthyridae Phillips 1841)]

Family RETICULARIIDAE Waagen 1883

[*nom. transl.* Ivanova 1960 (*ex* Reticulariinae Waagen 1883)]

Genus WARRENELLA Crickmay 1953

Type species. W. eclectea Crickmay 1953, p. 596, figs. 1–5, 16–19.

Warrenella kirki praekirki subsp. nov.

Plate 27, figs. 10–25

Material. The holotype is USNM no. 145530, illustrated in figs. 10–14 of Plate 27 and measures 19·2 mm. in width, 18·2 mm. in length, and 11·4 mm. in thickness. It was collected at locality 4739 on the west slope of Willow Creek Canyon in the northern Roberts Mountains. The remainder of the specimens illustrated on Plate 27 are paratypes excepting fig. 25 which originates from another locality. These include USNM nos. 145531–7.

Diagnosis. Includes relatively transverse, less strongly convex specimens of *W. kirki* in populations lacking elongate individuals.

Exterior. The shells are transversely suboval in outline and unequally biconvex in lateral profile with the pedicle valve about twice as strongly convex as the brachial valve. The hinge line is equal to about two-thirds the maximum width of the valves which is attained near midlength. The cardinal angles are rounded and obtuse. The pedicle valve bears a low apsacline triangular interarea with a relatively strongly incurved beak. The interarea is divided medially by a triangular open delthyrium enclosing an angle of about 70°. The interarea of the brachial valve is long, narrow, and anacline. The pedicle valve commonly bears an indistinct medial sulcus which may extend from the umbo or may develop anterior to it. The sulcus of all the specimens examined is relatively shallow and rounded, not angular. A fold is not developed on the brachial valve.

There are no radial plications. The concentric ornament consists of numerous very fine, concentric growth lines and a few more strongly accentuated ones, more commonly on the anterior of larger shells. The fine ornament consists of concentric rows of fine radial striae along the anterior edge of the growth lamellae, but not continuing back to the anterior edge of the previous growth lamellae.

Interior of pedicle valve. The hinge teeth are strong knob-like projections, directed dorsally and converging slightly postero-medially. They are supported basely by stout dental lamellae that initially converge slightly toward the midline and diverge slightly from it along their anterior edges. The dental lamellae are very closely set together at the umbo and constrict that space in most specimens making the pedicle cavity obsolescent. The ventral muscle scar is deeply impressed, triangular, and elongate with slightly divergent sides laterally and a semicircular outline anteriorly where it blends with the interior of the shell. The adductor muscle scars compose a pair of elongate raised ridge-like tracks medially which are separated by a subangular myophragm. On some specimens the adductor tracks appear to extend slightly anterior to the anterior edge of the elongate oval anterior portion of the diductor impressions.

Interior of brachial valve. The hinge plates define relatively strong, deep, subconical, and broadly divergent sockets that are attached beneath the inner edges of the dorsal interarea. Commonly, there is a small rim of shell material extending laterally from the distal end of the socket beneath the interarea and parallel to it. Medially the hinge plates bear a pair of triangular crural plates that are attached to the inner surface of the posterior end of the valve, but which are free of the floor of the valve along most of their length. The crural plates are relatively strongly concave on their inner (medial) faces and with their dorsal sides thus attaining a position subparallel to the interior of the umbo of the valve. Medially in the notothyrial cavity, the site of diductor attachment is composed of a deeply striate, transverse, comb-like process. The adductor muscle scars comprise two pairs of very elongate subelliptical impressions with the medial pair more deeply impressed and separated from the lateral pair by thin rounded ridges. The medial pair are divided by a thin low myophragm throughout most of their length.

Comparison. The new subspecies is distinguished from *Warrenella kirki kirki* by a more transverse outline and a less well-developed median sulcus in the pedicle valve of the former. A typical population of *W. kirki kirki* includes transverse specimens, but these commonly bear a relatively strong subangular sulcus. Included with these are an almost equal number of elongate suboval specimens. *W. kirki praekirki* appears to be the initial subspecies in Nevada, subject to a trend from transverse to elongate specimens. Some collections above *W. kirki kirki* contain an abundance of markedly elongate forms and lack of any of the transverse ones typical of the early forms or which are also found in the middle stratigraphic horizons. *W. occidentalis* is a very large transverse species with a relatively deep median sulcus which may be relatively flat-bottomed in some forms. In the writer's opinion, the Canadian species *W. franklini* is very close to the transverse forms of *kirki kirki* and may prove to be a senior synonym of that species. *W. occidentalis* may have been derived from the later form at a time when the typical *kirki kirki* gave rise to two species out of its diverse population.

Crickmay (1962, p. 10) has recently assigned his species *W. timetea* to the genus *Tingella* Grabau, because of the presence of crural plates. *Timetea* is very close to *occidentalis* of Nevada and may be conspecific, however, the writer has not studied large collections of the Canadian species. Specimens of *occidentalis* from Nevada also bear relatively large crural plates as do all the specimens assigned to *kirki* and its various subspecies discussed here. However, the writer is not convinced that the information on the structural details and external ornament of *Tingella* are well enough known to bring

that name into widespread usage in western North America. All of the reticulariid genera in the Devonian that the writer has studied from Nevada and including a number of species from both the Lower and Middle Devonian, bear crural plates that are attached to the base of the valve along varying percentages of their total length. It seems appropriate that the type species of *Warrenella* be much more closely studied with regard to the structure of the cardinalia to determine whether crural plates are present and buried in secondary shell material, or present and not in contact with the base of the valve, or are completely absent.

Grabau's only figured internal mould of *Tingella* (1933, pl. 43, fig. 7), in addition to showing long slots for the crural plates, also shows thin, discrete, widely spaced, dental lamellae in the pedicle valve and a muscle field that is not impressed. *W. kirki* typically bears dental lamellae that are closely set and adjoin umbonal cavities that bear considerable secondary shell material. This suggests to the writer that *W. kirki*, despite its well-developed crural plates, is not closely related to *Tingella*.

Warrenella appears to be a senior subjective synonym of *Minatothyris* Vandercammen 1957, which is based on a species from the Frasnian of western Europe (*Spirifer eury-glossus* Schnur), a species which is in fact very close to the type of *Warrenella*. The latter genus, as viewed by the writer and discussed above, is also a senior subjective synonym of *Sinothyris* Minato 1953, which is based on the west European Givetian species *S. maureri* Holzapfel. This, on exterior considerations at least, appears to be a species relatively close to the group of *franklini*, *occidentalis*, and *timetea*. Vandercammen (1957) has already included *maureri* in *Minatothyris* and it is evident that Minato's conception of *Sinothyris* based on Grabau's illustration and description was erroneous since the type species lacks a ventral median septum.

Occurrence. W. kirki praekirki is at present known only from the *Leptathyris circula* zone in Eureka County, Nevada.

Warrenella cf. *columbina columbina* (Havlíček 1959)

Plate 27, figs. 6–9

1959 *Eomartiniopsis columbina columbina* Havlíček, p. 190, pl. 28, figs. 3–5.

Material figured. USNM no. 145529.

Exterior. The shells are transversely subquadrate in outline and strongly biconvex in lateral profile with the pedicle valve more strongly so than the brachial valve. The beak on the pedicle valve is relatively short and stubby. The hinge line is short and straight medially and there is a narrow triangular apsacline interarea, slightly incurved near the beak, and equal to a little less than half the maximum width of the valves. The interarea is cleft medially by a triangular open delthyrium enclosing an angle 55–60°. The umbo on the brachial valve is relatively prominent, strongly convex, and the beak is strongly incurved. The cardinal angles are obtuse and strongly rounded. The maximum width is posterior to the midlength and the antero-lateral margins slope forward and converge slightly toward the midline. There is a deep subangular sulcus on the pedicle valve, originating near the umbo and becoming decidedly stronger and flaring in width toward the anterior commissure. The brachial valve bears a rounded fold that is faintly marked off from the lateral portions of the valve.

The ornament consists of numerous fine concentric growth lines. The fine radial ornament, if present, was not detected due to inadequate preservation.

Interior of pedicle valve. There are a pair of short thick dental lamellae in the apex of the valve that diverge only slightly from one another and which are situated very close together at the beak. The diductor scar consists of a triangular, faintly impressed area which blends anteriorly with the interior of the valve. The umbonal cavities are free of infilling secondary shell material.

Occurrence. The species appears at two localities in the *Leptathyris circula* zone on the north side of the Roberts Mountains and in a single collection from Lone Mountain which also contains specimens of *Warrenella kirki praekirki.*

Family AMBOCOELIIDAE George 1931

[*nom. transl.* Ivanova 1960 (*ex* Ambocoeliinae George 1931)]

Genus ECHINOCOELIA Cooper and Williams 1935

Type species. E. ambocoelioides Cooper and Williams 1935, p. 844, pl. 59, figs. 9, 13, 17, 21, 23.

Echinocoelia denayensis sp. nov.

Plate 26, figs. 23–30

Material. The specimen, USNM no. 145527, illustrated in figs. 26–30 of Plate 26 is the holotype. It measures 9·0 mm. in width, 8·0 mm. in length, and 7·6 mm. in thickness. Other figured specimens include USNM nos. 145524–6.

Diagnosis. Echinocoelia with typical form, but with rudimentary, anteriorly free, crural plates.

Exterior. The shells are subtrigonal in outline and strongly unequally biconvex, pyramidal in lateral profile. The brachial valve is only gently curved, nearly flat and cap-like. The pedicle valve is deeply convex and strongly arched with a high, steeply apsacline to nearly catacline, only slightly incurved interarea which is equal to about three-quarters of the maximum width of the valves. It is cleft medially by a high, triangular, open delthyrium that encompasses an angle of about 30°. The interarea on the brachial valve is long, low, and anacline. Most specimens are transverse, but become less so with an increase in size. The outline of larger specimens, especially brachial valves, is somewhat pentagonal with the maximum width well posterior to midlength and with the sides sloping antero-medially and truncated by a short anterior commissure at right angles to the median plane. No fold or sulcus is developed on the pedicle valve but a very faint flattening or depression of the interior edge of the brachial valve causes the anterior commissure to be deflected slightly ventrally.

The valves are without plication but develop a fairly strongly lamellose ornament of concentric growth lines that are very numerous and closely set and which are more pronounced at a few irregular intervals. Preservation of the fine ornament is imperfect, but on the best preserved specimens it appears to consist of extremely fine radial striae situated in concentric rows on the growth lamellae.

Interior of pedicle valve. The hinge teeth are small, thin, elliptical processes which project dorsally from the base of the hinge line and have their long axes approximately midway

between the hinge line and the median plane. The hinge teeth leave small ridge-like tracks on the inner edges of the delthyrium. There are no dental lamellae. The apex of the delthyrium is closed by a small plate.

Interior of brachial valve. The sockets are broad, shallow, and widely divergent anterolaterally. They are attached on their medial edges to relatively large triangular crural plates which contact the interior surface of the valve posteriorly, but which are free anteriorly. Medially there is a small knob-like cardinal process in the apex of the notothyrium. Commonly there is a long, low, narrow myophragm running most of the length of the valve. The adductor muscle scars, however, are not impressed. Commonly, on the more lamellose brachial valves, the interior is strongly crenulated in the anterior half of the shell by the concentric undulations of the more prominent growth lamellae.

Occurrence. Echinocoelia denayensis is a common species in the *Leptathyris circula* zone on the north side of the Roberts Mountains as well as on the west slope, east of Red Canyon. This species is also present in the *L. circula* zone in the northern Simpson Park Range.

Comparison. Echinocoelia ambocoelioides Cooper and Williams (1935, p. 844, pl. 59) has a more pyriform outline than *E. denayensis* and long crural plates, lacking in the latter species. The new species is very close to *E. incurva* Cooper and Williams (1935, p. 845, pl. 59, figs. 20, 24, 25) but has a more nearly catacline palintrope and intermittantly coarse concentric growth lines. The interior of *E. incurva* is unfortunately not known. *E. denayensis* very closely resembles *Ambocoelia rogeri* Drot (1955, p. 565, pl. 27, fig. 3*a–d*). Drot (p. 566) mentions the presence of a septum (= *?*myophragm) in the brachial valve, but excludes her new species from *Echinocoelia* which it resembles in most characters. *E. denayensis* differs from *E.? rogeri* in having a relatively flatter brachial valve that bears a less well pronounced ventral deflection of its anterior commissure. The palintrope of *E.? rogeri* is less incurved at the beak and there are some minor differences in surface ornament as a comparison of the illustrated specimens will indicate, but it is not certain what value these may have.

Superfamily CYRTINACEA Fredericks 1912
[*nom. transl.* Johnson herein]

Discussion. Inclusion of the cyrtinids in the Spirifereinacea has been suggested (Ivanova 1960, p. 278), however, such an assignment should not be taken to indicate more than a morphologic grouping of the punctate Spiriferoidea. If phylogenetic implications were assumed, this procedure would require *Spiriferina* and its allies to have been derived from *Cyrtina*, a connexion regarded as improbable by the writer since *Cyrtina* possessed a more specialized morphology, exemplified by its tichorhinum and stout apically perforate deltidium, long before the appearance of the more generalized spiriferinaceids. *Cyrtina* appeared at or near the beginning of the Early Devonian and represented a major new stock contrasting markedly with the then existing Cyrtiidae (the eospiriferids) and the Delthyridae (principally *Delthyris* and *Howellella*).

Family CYRTINIDAE Fredericks 1912
[*nom. transl.* Stehli 1954 (*ex* Cyrtininae Fredericks 1912)]
Genus CYRTINA Davidson 1858

Type species. Calceole heteroclite Defrance 1824, p. 306, pl. 80, figs. 3, 3*a*.

Cyrtina sp.

Plate 27, figs. 1–5

Material figured. USNM no. 145528.

Exterior. The shells are transversely subtrigonal to sub-semicircular in outline and strongly unequally biconvex in lateral profile. The pedicle valve is strongly convex, subpyramidal, and the brachial valve is gently convex and cap-like. The pedicle valve bears a high, nearly flat, catacline, triangular interarea cleft medially by a long delthyrium enclosing an angle of about 20°. The deltidium is not preserved. There is a shallow subangular sulcus on the pedicle valve and a corresponding strong rounded fold on the brachial valve and three or four rounded plications on each flank of the valves separated by shallow U-shaped interspaces.

Occurrence. Cyrtina sp. is present, but not common in the *Leptathyris circula* zone on the north side of the Roberts Mountains.

APPENDIX OF LOCALITIES

The numbers listed below are those of the locality register of the Department of Geology, University of California, Los Angeles.

3536 North-east slope of Union Mtn., north-east of McColley Canyon, elev. 6,825, 900 ft. W., 3,350 ft. N. of SE. cor. of sec. 20, T. 27N., R. 53E., Mineral Hill quad., Sulphur Spring Range, Elko Co., Nevada. Telegraph Canyon Member of Nevada Fm. (Carlisle *et al.* 1957).

4737 Approx. 4,500 ft. due E. of Roberts Creek on small spur on south slope of hill 7964, elev. 7,420, sec. 1 (unsurveyed) T. 22N., R. 50E., Roberts Creek Mtn. quad., Roberts Mts., Eureka Co., Nevada. Denay Ls., M. Dev., 20–50 ft. above top of McColley Canyon Fm. Collector: E. L. Winterer, 1959.

4738 Approx. 3,300 ft. due E. of Roberts Creek, elev. 6,920, eastward across canyon from hill 6963, 7,400 ft. almost due N. of NE. cor. sec. 24, T. 22N., R. 50E. Roberts Creek Mtn. quad., Roberts Mts., Eureka Co., Nevada. Denay Ls., M. Dev., about 300 ft. above top of McColley Canyon Fm. Collector: E. L. Winterer, 1959.

4739 Approx. 3,200 ft. due W. of Willow Creek, elev. 7,520, at crest of ridge between Willow Creek and Birch Creek, 4,200 ft. south of SE. cor. of sec. 22, T. 24N., R. 50E., Roberts Creek Mtn. quad., northern Roberts Mts., Eureka Co., Nevada. Denay Ls., M. Dev., approx. 170 ft. above top of McColley Canyon Fm. Collectors: Student group 11, 1958 and J. G. Johnson, 1959.

4740 East of Willow Creek, elev. 6,900 ft., 2,800 ft. E., 3,700 ft. S. of SE. cor. of sec. 15, T. 24N., R. 50E., Roberts Creek Mtn. quad., northern Roberts Mts., Eureka Co., Nevada. Lower Denay Ls., M. Dev. Collector: J. G. Johnson, 1959.

4741 Elev. approx. 6,800 ft., on east flank of Willow Creek, approx. 6,500 ft. upstream from Willow Creek Ranch, 1,900 ft. S., 2,300 ft. E. of SE. cor. of sec. 22, T. 24N., R. 50E., Roberts Creek Mtn. quad., northern Roberts Mts., Eureka Co., Nevada. Denay Ls., M. Dev. Collector: J. G. Johnson, 1959.

4742 South flank of Hanson Creek, north of Red Canyon, elev. 7,320 ft., 7,900 ft. due E. of SE. cor. of sec. 1, T. 23N., R. 49E., west slope of Roberts Creek Mtn., Roberts Creek Mtn. quad., Eureka Co., Nevada. Denay Limestone, M. Dev. Collectors: Student group 14, 1958.

4743 South-west slope of hill 8919, east of Red Canyon, elev. 8,040 ft., 10,400 ft. E., approx. 1,200 ft. S. of SE. cor. of sec. 12, T. 23N., R. 49E., Roberts Creek Mtn. quad., Eureka Co., Nevada. Denay Limestone. M. Dev. Collector: unknown.

4744 Elev. 7,880 ft., head of Birch Creek, crest of ridge *c.* 5,500 ft. NNW. of Cooper Peak, and *c.* 9,100 ft. ESE. of Western Peak, T. 23N., R. 50E., northern Roberts Mts., Roberts Creek Mtn. quad., Eureka Co., Nevada. Denay Limestone, M. Dev. Collector: M. A. Murphy, 1957.

4745 Elev. 8,640 ft. east slope of saddle 500 ft. N. of hill 8788, approx. 3 miles W. and 3 miles N. of Roberts Creek Ranch, T. 22N., R. 50E., southern Roberts Mts. west of Roberts Creek, Roberts Creek Mtn. quad., Eureka Co., Nevada. Denay Limestone, M. Dev. Collector: E. L. Winterer, 1959.

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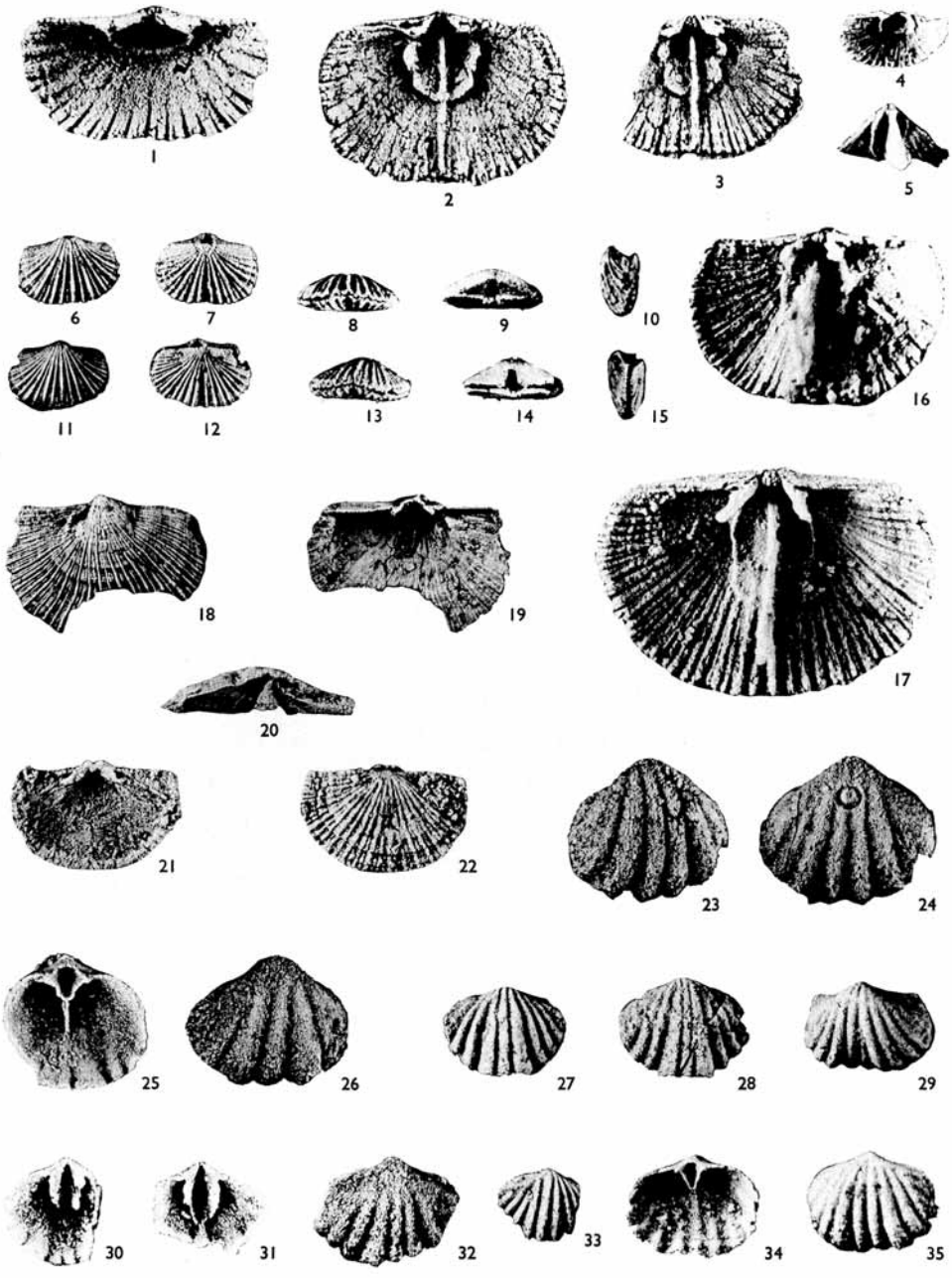

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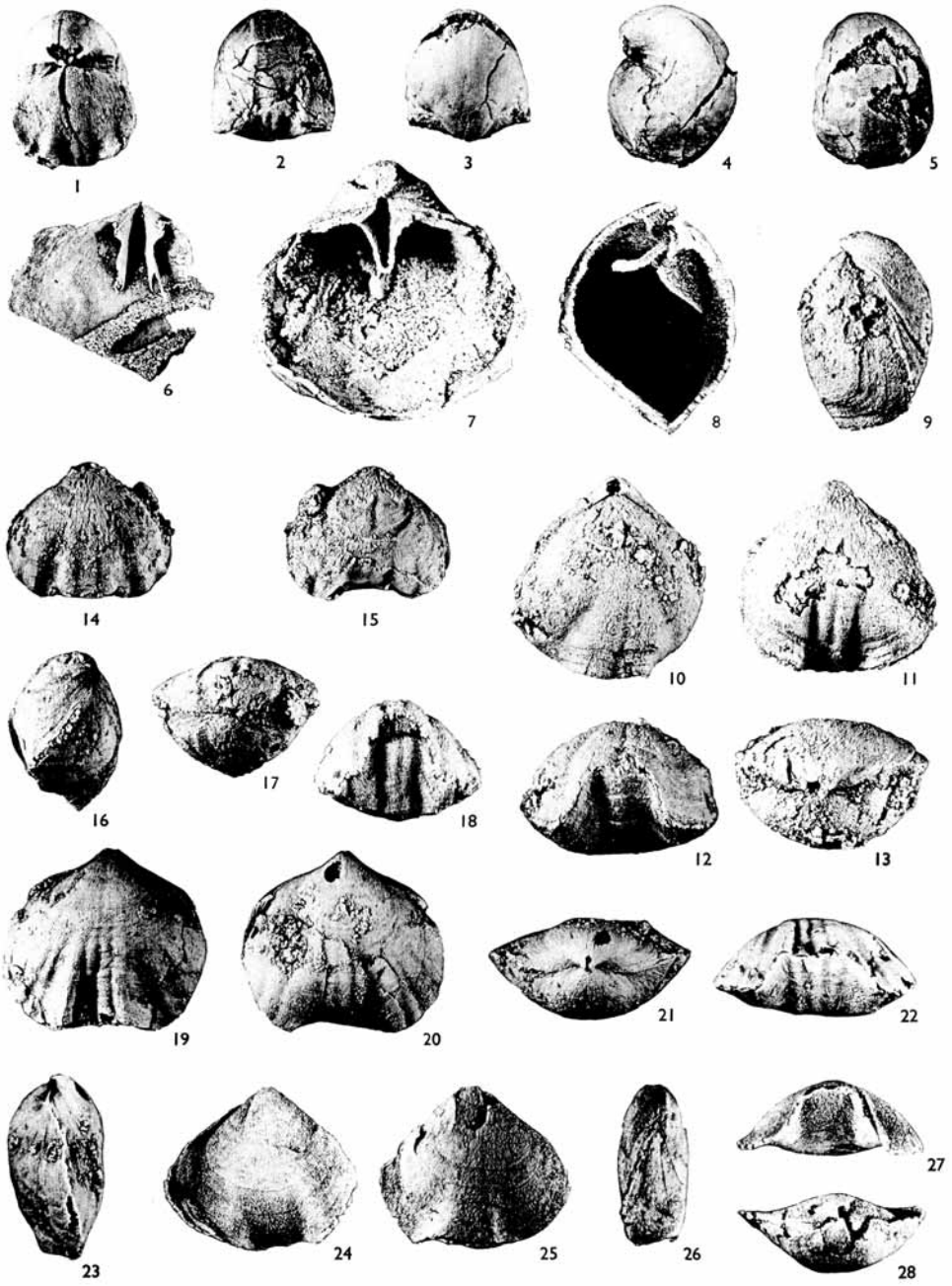

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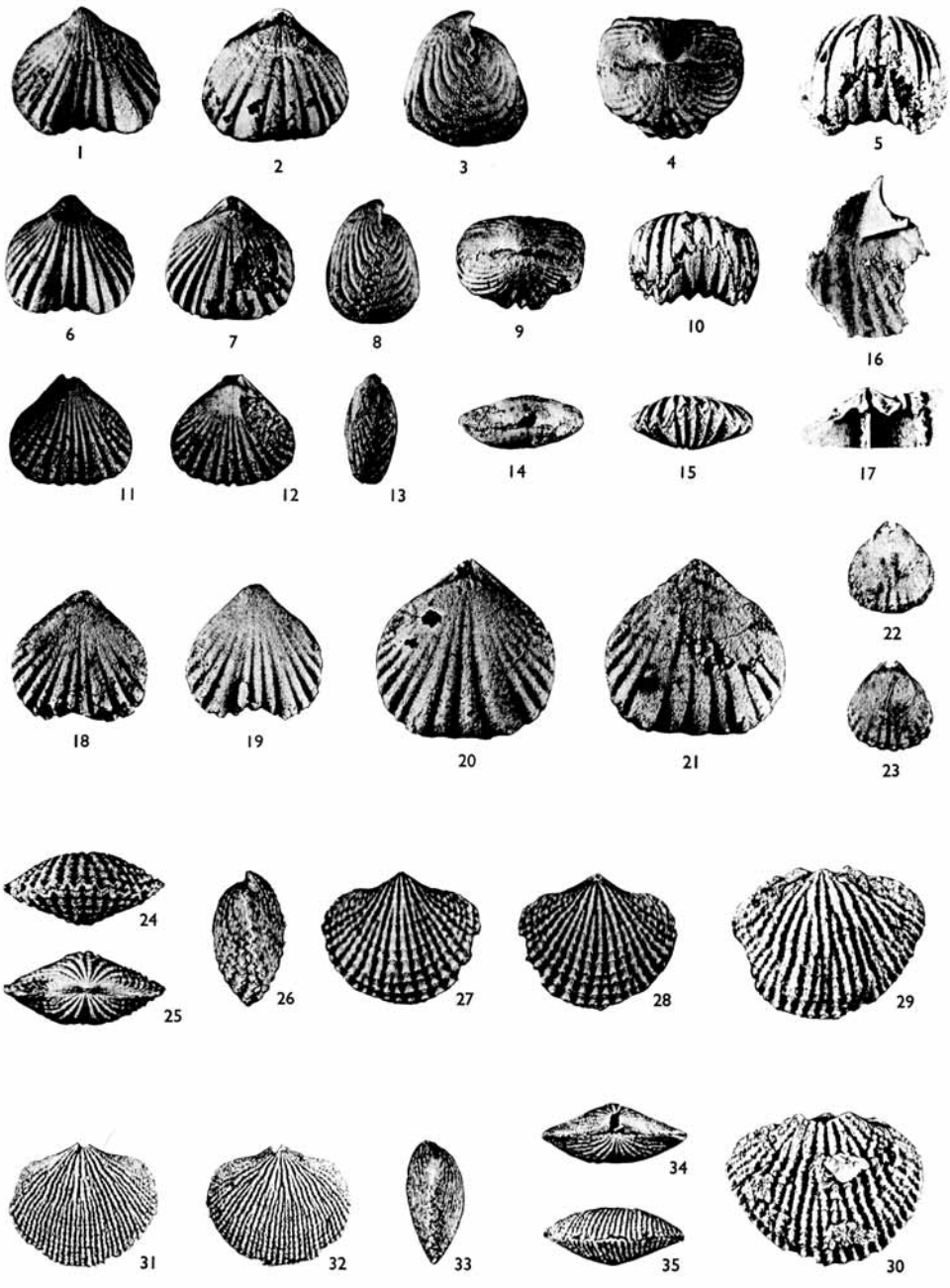

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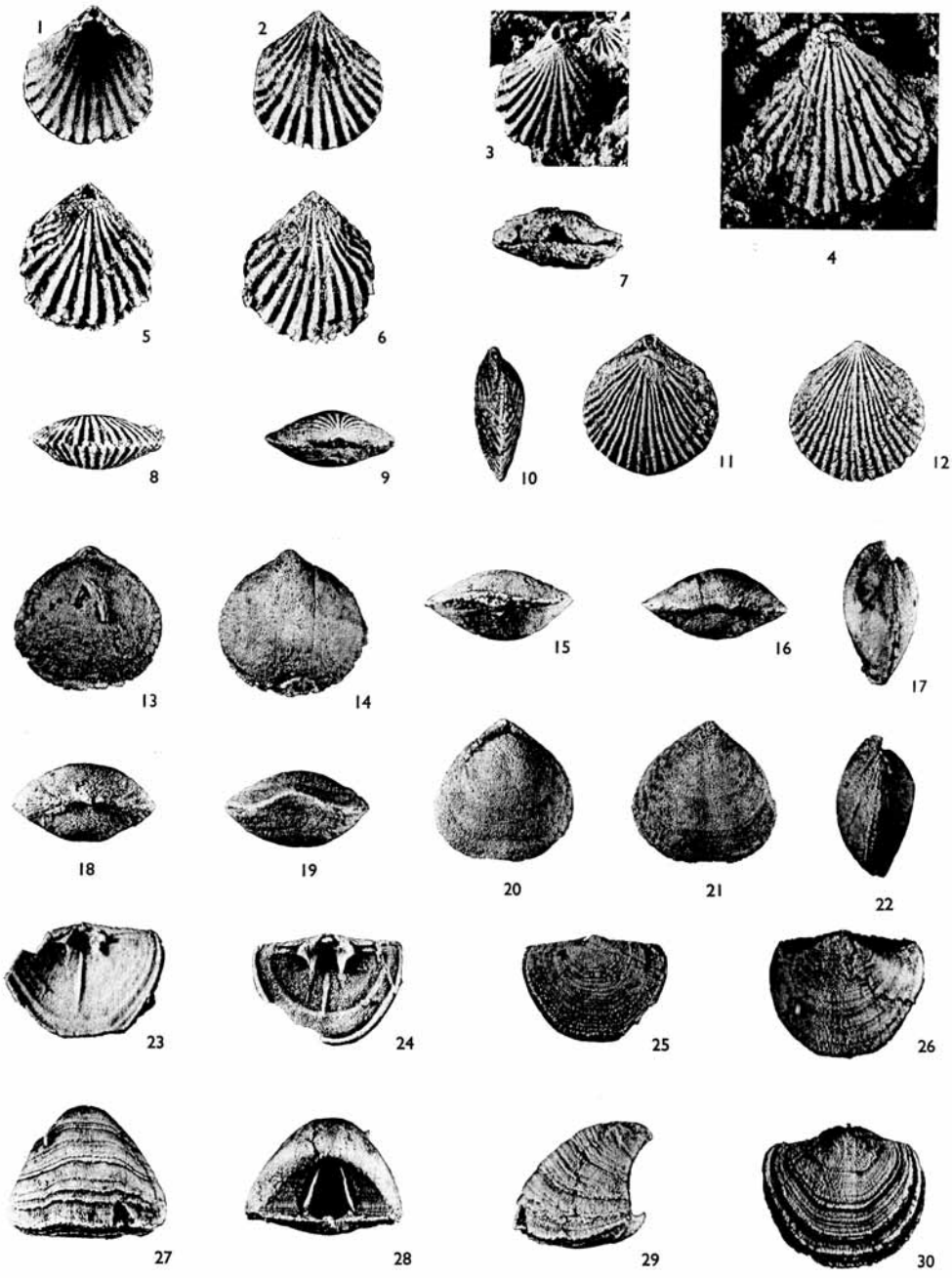

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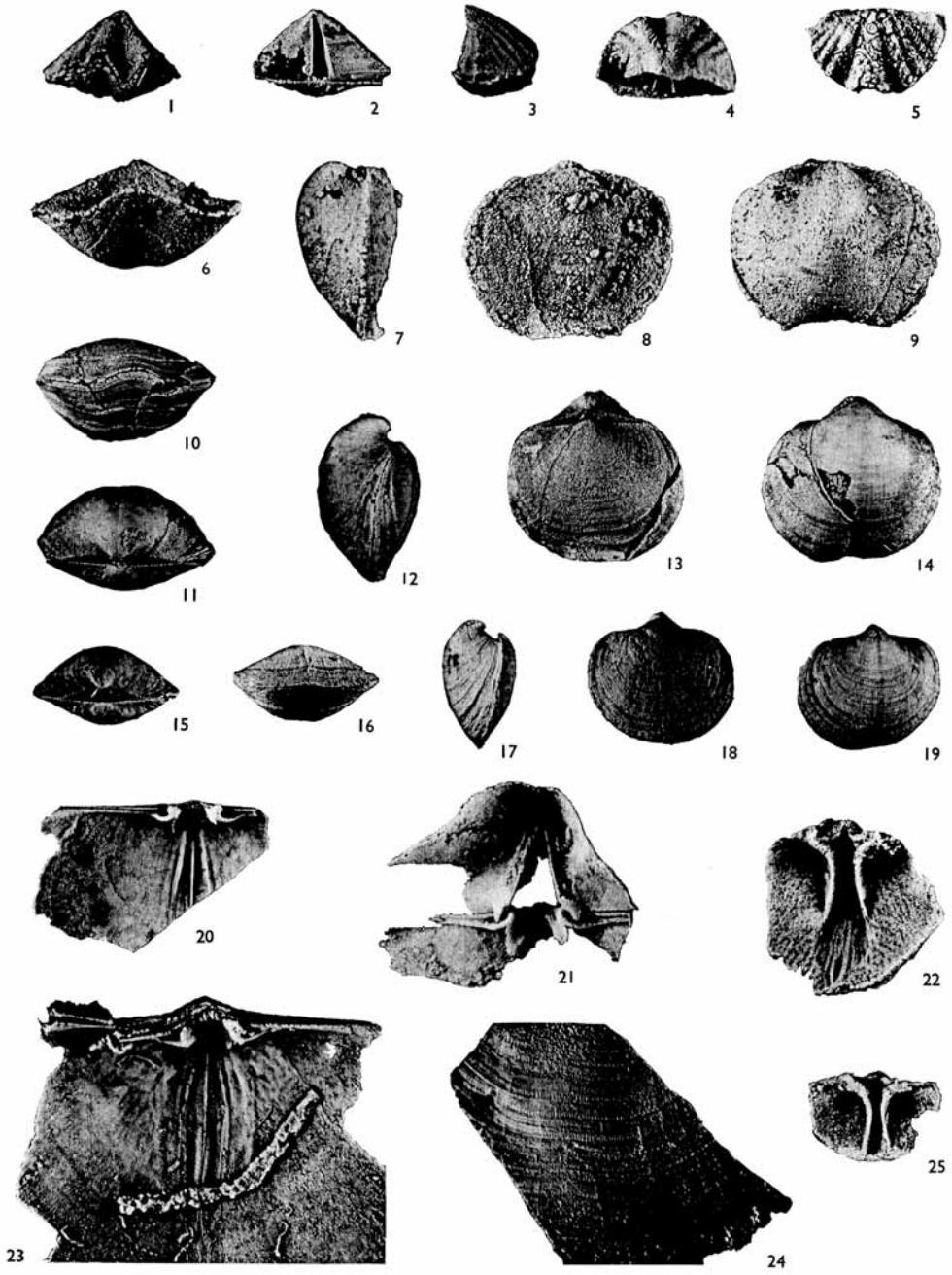

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