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**LOWER DEVONIAN (LOCHKOVIAN) BRACHIOPODS
AND CONODONTS FROM THE 'DELORME'
FORMATION, CATHEDRAL MOUNTAIN,
SOUTHWESTERN DISTRICT OF MACKENZIE**

A.W. Norris
T.T. Uyeno



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PREFACE

This report describes an early Early Devonian brachiopod fauna and the stratigraphy of the source beds, a richly fossiliferous limestone unit referred to as the 'Delorme' Formation that outcrops on Cathedral Mountain, near Virginia Falls on the South Nahanni River, southwestern District of Mackenzie. A part of the report discusses and illustrates the associated conodonts, providing supplementary information on conodont zones represented and an independent dating of the brachiopods. The brachiopod assemblage is representative of a widely distributed *Gypidula pelagica* Zone, having Old World affinities and being known elsewhere in North America from the northern Yukon Territory, Canadian Arctic Islands, and central Nevada. The rich brachiopod fauna was first encountered in 1957 by members of the Geological Survey of Canada's Operation Mackenzie who were engaged in reconnaissance mapping and stratigraphic studies. The present study is based on more detailed collections and observations made in 1976.

Ottawa, January 1979

D.J. McLaren
Director General
Geological Survey of Canada

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**LOWER DEVONIAN (LOCHKOVIAN) BRACHIOPODS AND CONODONTS
FROM THE 'DELORME' FORMATION, CATHEDRAL MOUNTAIN,
SOUTHWESTERN DISTRICT OF MACKENZIE**

Abstract

An assemblage of 13 nonsilicified calcareous brachiopods of early Lochkovian age, characterized by *Atrypa nieczlawiensis* Kozłowski and *Gypidula pelagica lux* Johnson, Boucot, and Murphy, are described and illustrated from the upper part of the lower unit and from the upper unit of the 'Delorme' Formation measured on Cathedral Mountain. This brachiopod assemblage is representative of the *Gypidula pelagica* Zone of Johnson (1977), which is widely distributed in Nevada and in northwestern and Arctic Canada. Associated conodonts are assigned to the *woschmidti* (= *hesperius*) Zone and possibly also to the *eolatericrescens-postwoschmidti* (= *eurekaensis*) Zone of the lower Lochkovian.

A barren interval of about 343 m separates these fossiliferous beds of the 'Delorme' Formation from the graptolite *?Neodiversograptus nilssoni* (Barrande) of the lower Ludlow (Silurian) present in the underlying Road River Formation.

The basal overlying beds of the Sombre Formation are unfossiliferous and not dated.

Résumé

On a décrit et illustré un assemblage de 13 brachiopodes calcaires non silicifiés datant du Lochkovien inférieur, qui est caractérisé par la présence d'*Atrypa nieczlawiensis* Kozłowski et *Gypidula pelagica lux* Johnson, Boucot, et Murphy, et provient d'une part de la tranche supérieure de l'unité inférieure, d'autre part de l'unité supérieure de la formation de 'Delorme' mesurée sur le mont Cathedral. L'assemblage en question est représentatif de la zone à *Gypidula pelagica* de Johnson (1977), qui est au loin distribué au Nevada, et dans le nord-ouest et l'Arctique canadiens. Les conodontes associés sont placés dans la zone à *woschmidti* (= *hesperius*), et peut-être aussi dans la zone à *eolatericrescens-postwoschmidti* (= *eurekaensis*), du Lochkovien inférieur.

Un intervalle stérile d'environ 343 m sépare ces lits fossilifères de la formation de 'Delorme' de la zone graptolithique à *?Neodiversograptus nilssoni* (Barrande) du Ludlow inférieur (Silurien), présente dans la formation sous-jacente de Road River.

Les lits inférieur sus-jacents de la formation de Sombre ne sont pas fossilifères et ne sont pas datés.

INTRODUCTION

A. W. Norris

The primary objective of this paper is to describe systematically and to illustrate the calcareous brachiopod fauna and to illustrate some of the associated conodonts present in the 'Delorme' Formation on Cathedral Mountain.¹ Seven sections straddling the Silurian-Lower Devonian boundary were measured in the Virginia Falls map area during the summer of 1976. Of these, the section on Cathedral Mountain was found to be the most fossiliferous in terms of abundance and sequence of faunas, and thus a potentially useful section for comparison with other areas. The abundant fossils in the 'Delorme' Formation on Cathedral Mountain, although known since 1957 and referred to in part by several workers, had not been described previously except for two or three of the brachiopods.

The measured section is located on the south-southwest flank of Cathedral Mountain on the northwest side of Clearwater Creek, Virginia Falls (NTS 95F) map area, southwestern District of Mackenzie (see Textfig. 1). In the measured section the contact between the top of the 'Delorme' Formation and the base of the Sombre Formation is at station 11NB (latitude 61°42'52"N, longitude 125°39'30"W), and this point is 12.5 km on a bearing of 020T from Virginia Falls, which is a highly conspicuous landmark on the South Nahanni River.

The fossiliferous limestone beds of the 'Delorme' Formation outcropping on Cathedral Mountain were examined originally by me in 1957 as a member of the Geological Survey of Canada's air-supported Operation Mackenzie. Subsequently, three species of brachiopods from this section were illustrated by McLaren et al. (1962, p. 18, Pl. 8, figs. 1-9). The Early Devonian fossils from Cathedral Mountain have been referred to by a number of other workers, including Lenz and Jackson (1964), Lenz (1966, 1968), Johnson et al. (1973), and Perry (1974).

The source beds of these fossils are described in the stratigraphical part of this report. However, because of problems in nomenclature, it should be mentioned that the fossiliferous limestone beds have been included in the

uppermost part of the Road River Formation (see Gabrielse et al., 1973) or the uppermost part of an equivalent rock unit designated OSD by Douglas and Norris (1976). The fossiliferous limestone beds have been referred to also as the Delorme Formation by Lenz and Jackson in 1964 and by Lenz in 1968 as a distinctive rock unit overlying the shale of the Road River Formation. Neither of the formational terms, Road River and Delorme, as applied to the fossiliferous limestone beds in the Cathedral Mountain area, is completely satisfactory.

Brachiopods collected by Lenz from the Delorme Formation on Cathedral Mountain and identified by G.A. Cooper (see Lenz and Jackson, 1964, p. 896, 897) included the following: *Gypidula pelagica* Barrande, *Atrypa* aff. *A. reticularis nieczlawiensis* Kozłowski, *Mesodouvillina* aff. *M. subinterstitialis* Kozłowski, *Cyrtina praecedens* Kozłowski, *Schellwienella praeumbraculum* Kozłowski, *Howellella angustiplicatus* Kozłowski, *Camarotoechia* cf. *C. squamifera* McLaren, *Chonetes* aff. *C. mediocecalis* Kozłowski, *C.* cf. *C. soror* Barrande, *Amphistrophia* and *Isorthis*. Cooper (see Lenz and Jackson, 1964) correlated this brachiopod fauna with the Borszczow Stage of Podolia, which in turn had been correlated by Boucot and Pankiwskyj (1962) with the Gedinnian Stage of western Europe. From the same Cathedral Mountain section, graptolites of the *nilssoni* Zone of Ludlow age were reported by Lenz and Jackson (1964, p. 896) from an horizon in the Road River Formation about 152.4 m below the collection of Delorme brachiopods.

In discussing the *Gypidula* cf. *G. pelagica* unit of the Royal Creek area, Lenz (1966, p. 608) pointed out that *Gypidula pelagica* is an important Gedinnian index fossil in the Old World and mentioned also its association with brachiopods of Podolian affinities in the South Nahanni River region.

In a more detailed paper on the Upper Silurian and Lower Devonian biostratigraphy of the Royal Creek area, Lenz (1968, p. 591) again mentioned the occurrence of *Gypidula pelagica* in the Delorme Formation of the South Nahanni River area and its association with *Atrypa reticularis nieczlawiensis* Kozłowski, *Iridistrophia praeumbracula* (Kozłowski), and other typical Borszczow (early Gedinnian) species.

¹In regard to the naming of this formation, see paragraph 4 of this section and the first three paragraphs of the section entitled "'Delorme' Formation," p. 4.

Johnson et al. (1973), in the descriptions of *Gypidula pelagica lux*, *Atrypa nieczlawiensis*, and *Ancillotoechia gutta*, compared these to forms from Cathedral Mountain illustrated by McLaren et al. (1962).

Perry (1974) described two brachiopods (*Atrypa nieczlawiensis* and *Gypidula pelagica lux*) from Cathedral Mountain collected by A.C. Lenz.

Three of fourteen sections measured by Morrow (1976) as part of a lower Paleozoic stratigraphic study in 1975 covered parts of the Delorme Formation in an area (map areas 95F and 95G) immediately east of the Cathedral Mountain section.

Chatterton and Perry (1977) described new species and subspecies of the trilobites *Proetus* and *Warburgella*, and they also described two new species of the conodont *Icriodus*

from Lochkovian strata of the Road River and Delorme Formations at three localities. Two of the section localities (locality 3: latitude 62°15'N, longitude 125°00'W; locality 2: latitude 62°28'50"N, longitude 124°47'00"W) are situated about 80 and 110 km, respectively, north-northeast of Cathedral Mountain. The third (locality 1: latitude 65°38'00"N, longitude 136°43'30"W) is on Hart River in the Yukon Territory.

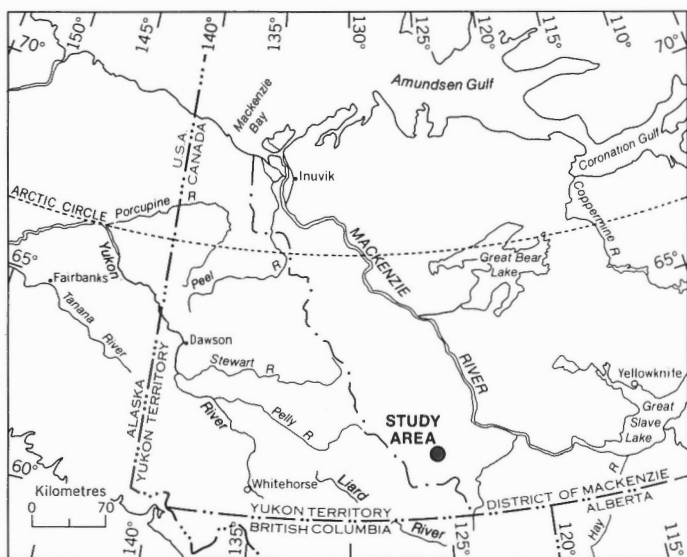
Upper Silurian to Lower Devonian facies of the Prairie Creek Embayment are described by Morrow (1978), who includes a diagrammatic representation of a section measured on Cathedral Mountain about 2.3 km east of the section measured in this study. In this section, rocks referred to as Facies 4 include rocks I designated as the Road River Formation and the lower unit of the 'Delorme' Formation. Morrow's overlying Facies 3 (1978) is equivalent to rocks here designated as the upper unit of the 'Delorme' Formation.

This study is based on material collected during the summer of 1976. Fossils previously collected from the 'Delorme' Formation of Cathedral Mountain in 1957 are stored at the Geological Survey of Canada building in Ottawa and were unavailable at the time this study was in progress.

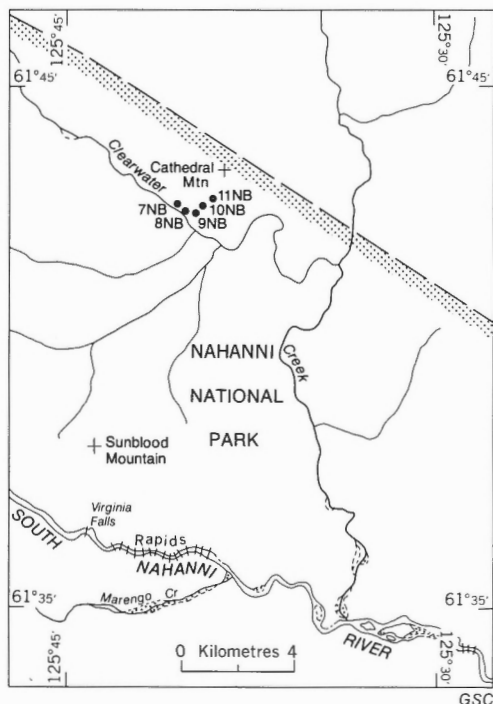
I was ably assisted in the field by S. Perry. D.W. Morrow and D.G. Cook of the Geological Survey of Canada provided efficient logistic and other support out of a base camp located about 26 km up Prairie Creek, north of the South Nahanni River and near the centre of the Virginia Falls map area. Both Morrow and Cook provided information on the distribution, sedimentation, and facies changes of Devonian rocks in the area.

D.E. Jackson of The Open University, at Milton Keynes, England, kindly identified the graptolites from the Road River Formation.

Corals from the 'Delorme' Formation have been set aside for later study by A.E.H. Pedder of the Geological Survey of Canada.



STUDY AREA



Textfigure 1. Map showing location of measured section on Cathedral Mountain and station localities.

STRATIGRAPHY

A. W. Norris

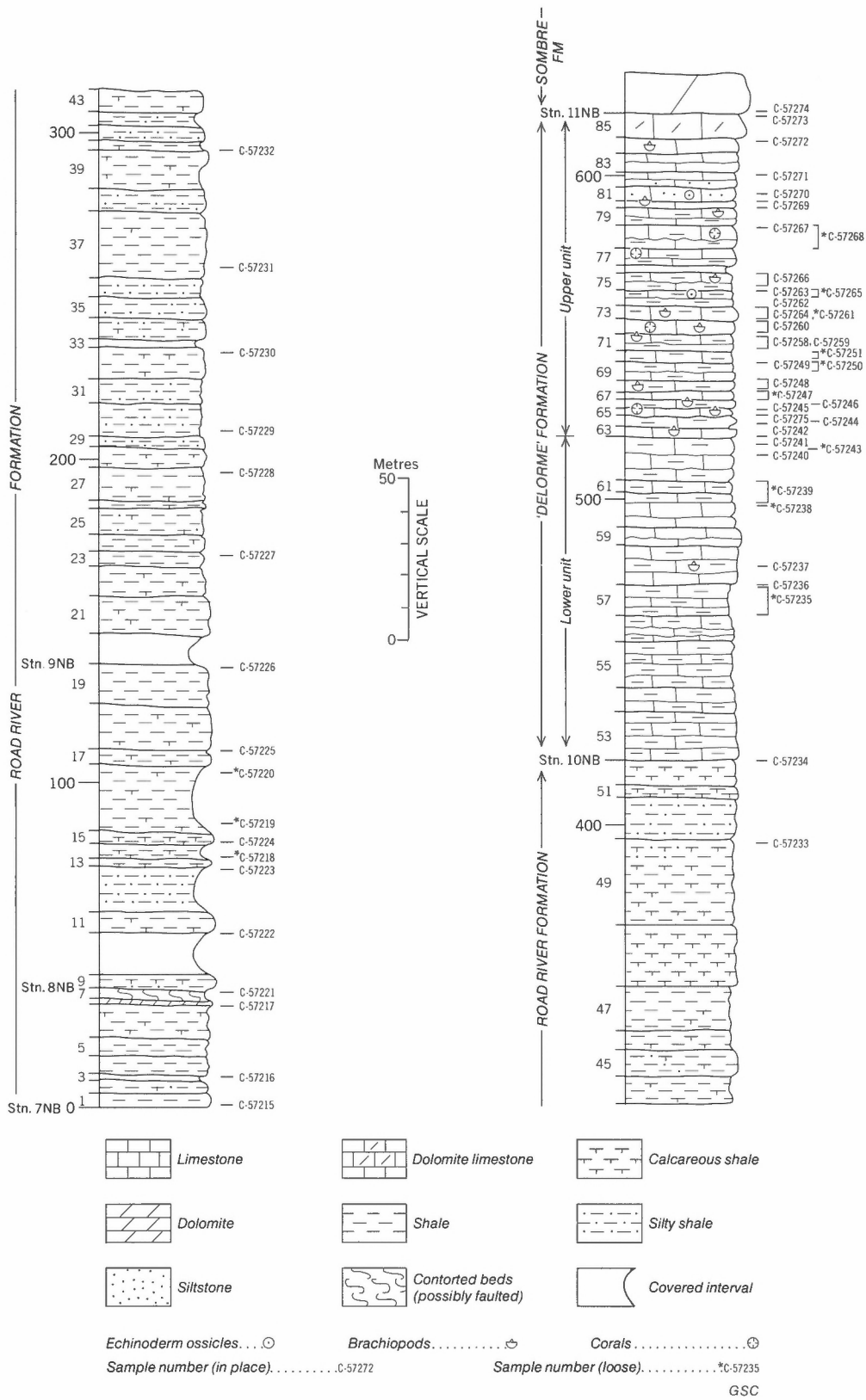
Geological Setting

In relation to the main broad tectonic elements of the northern Cordillera, the Cathedral Mountain section is located in the west-central part of the Root Basin, as delineated by Gabrielse (1967, p. 272, Fig. 1). Within this basin, the Cathedral Mountain section is on the southwest flank and near the south end of the sinuous northwest-trending Clearwater Syncline (Douglas and Norris, 1976). Throughout the length of the section, the beds strike northwest and dip 20 degrees to the northeast.

The Cathedral Mountain section (Textfig. 2) appears to be free of major structural dislocations except for a thin zone of deformed Road River beds observed along the northeast bank of Clearwater Creek near station 7NB, about 35 m above the base of the section. The zone of deformation is about 3.8 m thick and is parallel to underlying and overlying beds.

In the Cathedral Mountain area, the boundary between the Root Basin and Selwyn Basin to the southwest marks approximately a facies boundary between carbonates to the northeast and shales to the southwest. The Cathedral Mountain section is located just within the carbonate (northeast) side of the transition from carbonate to shale, where carbonate beds assigned to the 'Delorme' Formation are exceedingly thin compared to the more typical and much thicker Delorme sections northeast and north of Cathedral Mountain.

Three rock units comprising, in ascending sequence, part of the Road River Formation, all of the 'Delorme' Formation, and part of the Sombre Formation were measured on Cathedral Mountain.



Textfigure 2. Diagrammatic representation of the Cathedral Mountain section

Road River Formation

The lowest rock unit exposed at the measured section is part of the Road River Formation. This formation was defined by Jackson and Lenz (1962) for a sequence of argillaceous graptolitic strata on southern Richardson Mountains of southern Yukon Territory. In the study area, the Road River beds were measured between stations 7NB (latitude 61°42'50"N, longitude 125°41'40"W) and 10NB (latitude 61°42'50"N, longitude 125°39'55"W), along the northeast side of Clearwater Creek and up the lower part of the slope of Cathedral Mountain. The shale sequence proper and the uppermost limestone beds, here designated as Road River (restricted) and 'Delorme' formations, respectively, were included in map unit 5 of Douglas and Norris (1960, Map 22-1960), covering the Virginia Falls map area. On the revised geological map of this area (Douglas and Norris, 1976), these beds were included in a map unit designated OSD. This referred to a graptolitic shale and thinly bedded limestone unit ranging in age from Ordovician to Silurian and Devonian. On the contiguous geological map of Flat River to the west (Gabielse et al., 1973, Map 1313A), the same shale and limestone were referred to the Road River Formation.

In the measured section, beds of the Road River Formation consist of dark grey to black, fairly hard, evenly thin-bedded and fissile, platy, slightly calcareous shale, weathering tan brown and brownish grey. The beds are up to 5 cm thick, some are colour laminated pale orange and dark grey on a weathered surface, and some contain fine silt. The more calcareous beds are generally slightly thicker and more resistant than the norm.

Fossils are exceedingly sparse and consist of a few graptolites and brachiopods in the lower part of the sequence.

The contact between the Road River Formation and overlying 'Delorme' Formation is sharp; it is marked by a change from shale to more thickly bedded and more resistant, cliff-forming limestone beds weathering a bright medium orange.

About 460 m of the Road River Formation were measured between stations 7NB and 10NB, and judging from the width of the belt and bedding attitudes across the belt, this measurement would represent about one-half of the total thickness of the formation in the area.

'Delorme' Formation

Black limestone beds, here designated the 'Delorme' Formation, were included in the upper part of a graptolitic sequence specified as map unit 5 by Douglas and Norris (1960, Map 22-1960). Later (1976) they indicated the sequence as OSD in the Virginia Falls map area. In some recent publications, the graptolitic shales are referred to the Road River Formation (e.g., Gabielse et al., 1973, Map 1313A) covering the adjacent Flat River map area to the west. A comparison of the published maps clearly indicates that the Road River Formation mapped by Gabielse et al. (1973) is equivalent to all of the Douglas and Norris (1976) map unit OSD.

In using the term 'Delorme' for the fossiliferous limestone beds, I am following the usage suggested by Lenz and Jackson in 1964 and by Lenz in 1968 in their discussions of the fossils from Cathedral Mountain. The term Delorme Formation for these limestone beds is preferable to Road River Formation, even though the rocks here designated as 'Delorme' are distinctly different from the Delorme Formation of the type area. D.W. Morrow and D.G. Cook are aware of this nomenclature problem, and they intend to formally name this distinctive unit as a new formation (pers. comm., 25 August, 1977).

The name Delorme Formation was introduced by Douglas and Norris (1961, p. 10) for a sequence of buff- and light-brown-weathering, thinly bedded limestones, dolomites, and shales that overlie the Whittaker Formation and

underlie the Camsell Formation. The type section is near the headwaters of Pastel Creek on Delorme Range in Root River (NTS 95K) map area. The Delorme Formation of the type area is significantly thicker and lithologically distinct from the 'Delorme' Formation on Cathedral Mountain.

In the study area, beds of the 'Delorme' Formation were measured between stations 10NB and 11NB (Textfigs. 1 and 2) on the southwest flank of Cathedral Mountain. On the air photographs (A17441-77, 78), these beds show up as a dark grey band in contrast to lighter grey hues for the underlying shale and overlying dolomite.

Beds assigned to the 'Delorme' Formation may be subdivided into two rock units in the measured section: a lower unit of orange-weathering limestone and argillaceous limestone and an upper unit of richly fossiliferous argillaceous limestone and limestone weathering pinkish red and dark grey.

The lower unit consists of black, aphanitic limestone and argillaceous limestone in even and slightly irregular thin beds up to 15 cm thick. Argillaceous limestone partings occur between the thicker, more resistant, limestone beds. Many of the beds are coated with bright to pale orange-weathering patina. Markings suggestive of worm burrowings were noted in one bed near the middle of the unit. Megafossils consisting mainly of brachiopods occur in a few scattered beds in, roughly, the upper half of the unit. The lower unit is about 100.2 m thick.

The upper unit of the 'Delorme' Formation consists of black, aphanitic to very fine grained, irregularly and evenly thin-bedded limestone beds up to 0.5 m thick, some of which are separated by argillaceous limestone partings. Some of the limestone beds weather a dark grey and others are coated with irregular patches of a conspicuous patina that weathers to pinkish red and orange. The upper 7.5 m of the upper unit consist of a black, very fine grained, thick-bedded to massive, faintly laminated, resistant dolomitic limestone that is highly fractured. It is also coated with a patchy orange- and red-weathering patina.

Calcareous megafossils are abundant in most of the beds, and fossil groups represented include numerous brachiopods, some cup and colonial corals, a few pelecypods and gastropods, some echinoderm ossicles, and a few trilobite fragments and ostracodes.

Thickness of the upper unit is about 99.7 m. The contact with overlying dolomite beds of the Sombre Formation is sharp and irregular, but there appears to be no truncation of beds at the top of the 'Delorme' Formation.

Sombre Formation

Dolomite beds overlying the 'Delorme' Formation on Cathedral Mountains were included in map unit 16 by Douglas and Norris (1960, Map 22-1960) and later designated as the Sombre Formation (Douglas and Norris, 1976). In the present study, only the lower part of the Sombre Formation was examined in 1976. Where examined, it consists of light greenish-grey, finely granular, massive, resistant, cliff-forming dolomite weathering light grey. Parting planes are widely spaced, about 3.5 m apart. These lower beds appear to be completely barren of megafossils. Fossils, if formerly present, have been completely obliterated by dolomitization.

SEQUENCE, AGE, AND CORRELATION OF MEGAFUNAS

A.W. Norris

Within the Road River Formation, the lowest fossils collected include the brachiopod *Gracianella* sp. cf. *G. umbra* (Barrande), from 83.5 to 83.6 m up, and the graptolite *Neodiversograptus nilssoni* (Barrande), from 94.1 to 94.2 and 112 to 112.1 m up from the base of the section. These fossils are poorly preserved and were collected loose, but they were probably close to their source beds. *Gracianella* sp. cf. *G. umbra* is a moderately to weakly costate form. In

Europe, *G. umbra* occurs in the Kopanina (=Ludlow) beds of Bohemia, and it has been described also from the Megaera (=Pridoli) beds of the Carnic Alps (Johnson and Boucot, 1967, pp. 870, 871). The ?*N. nilssoni*, identified by D.E. Jackson, certainly indicates a Ludlow or younger and probably the *nilssoni* Zone of the lower Ludlow. Jackson (pers. comm., 16 December 1976) indicated that the fragments were comparable to *N. nilssoni* on features of weak ventral curvature and thecal spacing. Jackson further indicated that he has seen similar material from the *nilssoni* Zone in central Nevada.

A thick interval (about 342.7 m) barren of fossils separates the *nilssoni* Zone graptolites in the Road River Formation from the next highest megafossils, which appear about half way up in the lower unit of the 'Delorme' Formation. Although the shales of the Road River Formation in this barren interval are variably calcareous, they would not break down, with the exception of one sample, in the attempt to obtain conodonts from them.

The megafossils obtained from the upper half of the lower unit and from the upper unit of the 'Delorme' Formation are listed on the accompanying chart (Textfig. 3), which shows also the relative abundance and distribution of the fossils. An examination of the chart suggests that the megafossils belong to a single faunal assemblage in which *Atrypa nieczlawiensis* Kozłowski and *Gypidula pelagica lux* Johnson, Boucot, and Murphy are by far the most abundant forms. Only the more abundant and better-preserved brachiopods are described and illustrated in the present report, and these are as follows:

	'Delorme' Formation	
	Lower unit	Upper unit
1. <i>Lingula</i> sp.	X	X
2. <i>Resserella</i> sp. cf. <i>R. elegantuloides</i> (Kozłowski)		X
3. <i>Schizophoria paraprime</i> Johnson, Boucot, and Murphy	X	X
4. <i>Mesodouvillina?</i> sp.	X	X
5. <i>Iridistrophia</i> sp. cf. <i>I. umbella</i> (Barrande)	X	
6. <i>Gypidula pelagica lux</i> Johnson, Boucot, and Murphy	X	X
7. <i>Gypidula</i> sp., costate form		X
8. <i>Ancillotoechia</i> sp. cf. <i>A. gutta</i> Johnson, Boucot, and Murphy		X
9. <i>Spirigerina marginaliformis</i> Alekseeva		X
10. <i>Atrypa nieczlawiensis</i> Kozłowski	X	X
11. <i>Metaplasia lenzi</i> Johnson, Boucot, and Murphy	X	X
12. <i>Howellella</i> sp.	X	
13. <i>Cyrtina</i> sp.	X	

Other important elements that are not described nor illustrated in this study include well-preserved *Stylopleura* sp. (a rugose coral to be studied by A.E.H. Pedder) that occurs in scattered beds in the upper unit of the 'Delorme' and very poorly preserved trilobite fragments suggestive of *Warburgella* sp., also present in the upper unit.

Forms that appear to be confined to the upper part of the lower unit comprise:

- Iridistrophia* sp. cf. *I. umbella* (Barrande)
- Howellella* sp.
- Cyrtina* sp.

Forms occurring in both the lower and upper units of the 'Delorme' Formation are:

- Lingula* sp.
- Schizophoria paraprime* Johnson, Boucot, and Murphy
- Mesodouvillina?* sp.

- Gypidula pelagica lux* Johnson, Boucot, and Murphy
- Atrypa nieczlawiensis* Kozłowski
- Metaplasia lenzi* Johnson, Boucot, and Murphy

Forms occurring only in the upper unit comprise:

- Resserella* sp. cf. *R. elegantuloides* (Kozłowski)
- Gypidula* sp., costate form
- Ancillotoechia* sp. cf. *A. gutta* Johnson, Boucot, and Murphy
- Spirigerina marginaliformis* Alekseeva

A large part of the 'Delorme' brachiopod fauna is closely similar or identical to forms in lower Gedinnian beds of Nevada. Forms present in both areas include the following (see Johnson et al., 1973, p. 8, Table 1):

- Resserella elegantuloids* (Kozłowski)
- Schizophoria paraprime* Johnson, Boucot, and Murphy
- Iridistrophia* sp. cf. *I. umbella* (Barrande)
- Gypidula pelagica lux* Johnson, Boucot, and Murphy
- Ancillotoechia gutta* Johnson, Boucot, and Murphy
- Spirigerina marginaliformis* Alekseeva
- Atrypa nieczlawiensis* Kozłowski
- Metaplasia lenzi* Johnson, Boucot, and Murphy
- Howellella* sp.
- Cyrtina* sp.

The distinct differentiation into lower "FL" and upper "FU" faunas made by Johnson et al. in the Roberts Mountains Formation of the Birch Creek section II-III of Nevada is not apparent in the 'Delorme' Formation of Cathedral Mountain. More recently, Johnson (1977, pp. 19, 20) has referred to the lower and upper F brachiopod faunas of Nevada as intervals 1 and 2, respectively. The interval 1 fauna is also referred to as the *Salopina submurifer* fauna, which belongs to a community of small species. The succeeding interval 2 in Nevada is represented by at least two brachiopod communities, a community of large species referred to as the *Gypidula pelagica lux* fauna and a community referred to as the *Notoparmella* fauna.

Brachiopods in the 'Delorme' Formation that occur also in the lower Gedinnian Borszczow beds of Podolia (Kozłowski, 1929; Nikiforova, 1954) include the following forms:

- Resserella* sp. cf. *R. elegantuloides* (Kozłowski)
- Gypidula pelagica lux* Johnson, Boucot, and Murphy
- Iridistrophia* sp. cf. *I. umbella* (Barrande)
- Atrypa nieczlawiensis* Kozłowski

Brachiopods from the 'Delorme' Formation on Cathedral Mountain showing similarities to forms in lower Lochkovian strata of Bohemia, Czechoslovakia (Havlíček, 1959, 1961, 1967; Chlupáč, 1972, 1976) include:

- Mesodouvillina?* sp.
- Iridistrophia* sp. cf. *I. umbella* (Barrande)
- Gypidula pelagica lux* Johnson, Boucot, and Murphy
- Atrypa nieczlawiensis* Kozłowski
- Howellella* sp.

Of the brachiopods present in the 'Delorme' Formation at Cathedral Mountain, some are widely distributed in the Delorme Formation and equivalent rocks in the area north and northwest of Cathedral Mountain studied by Perry (1974). These forms, throughout the southwestern District of Mackenzie, appear to have a restricted range in lower Lochkovian rocks and include:

- Schizophoria paraprime* Johnson, Boucot, and Murphy
- Gypidula pelagica lux* Johnson, Boucot, and Murphy
- Ancillotoechia* sp. cf. *A. gutta* Johnson, Boucot, and Murphy
- Atrypa nieczlawiensis* Kozłowski
- Spirigerina marginaliformis* Alekseeva

GSC LOCALITY NUMBER	FIELD SAMPLE NUMBER (* Fossils collected loose)	INTERVAL FROM BASE OR ROCK UNIT (in metres)	ROCK UNIT	ROAD RIVER FORMATION (420.3 m, incomplete)		'DELOERME' FORMATION (199.9 m)		SOMBRE FM
				Lower unit (100.2 m)	Upper Unit (99.7 m)	Lower unit (100.2 m)	Upper Unit (99.7 m)	
			COELENTERATA					
			cf. <i>Coenites rectilineatus</i> (Simpson)					
			<i>Favosites</i> sp.					
			<i>Stylopleura</i> sp.					
			BRYOZOA					
			undet. bryozoans					
			BRACHIOPODA					
			LINGULIDAE					
			<i>Lingula</i> sp.					
			DALMANELLIDAE					
			<i>Resserella</i> sp. cf. <i>R. elegantuloides</i> (Kozłowski)					
			SCHIZOPHORIIDAE					
			<i>Schizophoria paraprima</i> Johnson, Boucot and Murphy					
			LEPTAENIDAE					
			<i>Leptaena</i> sp.					
			STROPHEODONTIDAE					
			<i>Brachyprion?</i> sp.					
			<i>Cymostrophia</i> sp.					
			<i>Mesodouvillina</i> sp.					
			CHILIDIOPSISIDAE					
			<i>Indistropia</i> sp. cf. <i>I. umbella</i> (Barrande)					
			GYPIDULIDAE					
			<i>Gypidula pelagica lux</i> Johnson, Boucot and Murphy					
			<i>Gypidula</i> sp. - costate form					
			TRIGONIRHYNCIIDAE					
			<i>Ancillotoechia</i> sp. cf. <i>A. gutta</i> Johnson, Boucot and Murphy					
			ATRYPIDAE					
			<i>Gracianella</i> sp. cf. <i>G. umbra</i> (Barrande)					
			<i>Spirigera marginaliformis</i> Alekseeva					
			<i>Atrypa nieczlawniensis</i> Kozłowski					
			<i>Atrypa</i> sp.					
C-57274	10NB11	0.2-0.3						
C-57273	10NBh1	99.6-99.7						
C-57272	10NBg1	91.9-92.0						
C-57271	10NBf1	81.6-81.7						
C-57270	10NBd1	74.7-74.8						
C-57269	10NBd1	70.5-72.5						
C-57268	10NBc1	58.0-65.5						
C-57267	10NBb1	60.5-60.6						
C-57266	10NBa1	45.2-51.2						
C-57265	*10NBz	41.0-45.2						
C-57262	10NBx	45.0-45.1						
C-57263	10NBw	45.1-45.2						
C-57264	10NBv	36.2-41.0						
C-57261	*10NBu	36.2-41.0						
C-57260	10NBt	31.7-36.2						
C-57259	10NBs	31.6-31.7						
C-57258	10NBs	27.0-31.7						
C-57251	*10NBq	23.2-27.0						
C-57250	10NBq	17.8-23.2						
C-57249	10NBp	23.1-23.2						
C-57248	10NBn	13.3-17.8						
C-57247	*10NBm	11.4-13.3						
C-57246	10NBm	8.7-8.8						
C-57245	10NB1	7.9-8.0						
C-57275	10NB1	6.8-6.9						
C-57244	10NBk	4.7-4.8						
C-57242	10NBj	4.4-4.5						
C-57243	*10NBj	0-0.1						
C-57241	10NBh	0-0.1						
C-57240	10NBf	98.2-98.3						
C-57239	*10NBd	79.7-86.7						
C-57238	*10NBd	79.6-79.7						
C-57237	10NBc	60.2-60.3						
C-57236	10NBb	54.2-54.3						
C-57235	*10NBa	44.6-54.2						
C-57234	9NB9	0-0.1						
C-57233	9NB8	369.5-394.6						
C-57232	9NB7	294.8-294.9						
C-57231	9NB6	258.9-260.0						
C-57230	9NB5	239.9-234.0						
C-57229	9NB4	218.7-218.8						
C-57228	9NB3	197.6-197.7						
C-57227	9NB2	172.6-173.1						
C-57226	9NB1	137.3-137.4						
C-57225	8NB5	117.1-117.2						
C-57220	8NBc	112.0-112.1						
C-57219	*8NBb	94.1-94.2						
C-57224	8NB4	86.9-87.0						
C-57218	*8NBa	83.5-83.6						
C-57223	8NB3	79.4-79.5						
C-57222	8NB2	56.9-57.0						
C-57221	8NB1	38.9-39.0						
C-57217	7NB3	35.0-35.1						
C-57216	7NB2	11.1-11.2						
C-57215	7NB1	0-0.1						

In conclusion, the Silurian-Devonian boundary is within a barren interval and remains undetermined. This boundary appears to be very poorly defined throughout a large area of the southwestern District of Mackenzie. The presence of *Gypidula pelagica lux* in the 'Delorme' Formation on Cathedral Mountain suggests a correlation with beds above the Pridolian-Lochkovian contact but still within the lower Lochkovian, based on its occurrence in central Nevada. *Atrypa nieczlawiensis* and *Ancillotoechia gutta* are known also from the upper part of the Nevadan lower Lochkovian. The presence of *Gypidula pelagica lux* in the 'Delorme' Formation on Cathedral Mountain suggests also that the containing beds are broadly equivalent to the *Gypidula* cf. *G. pelagica* unit of Lenz (1966, 1968) in the Road River Formation at Royal Creek, Yukon Territory. The brachiopod assemblage of the 'Delorme' Formation on Cathedral Mountain is clearly a part of the *Gypidula pelagica* Zone, recently formally erected by Johnson (1977, p. 20) and known to be widely distributed in Nevada, District of Mackenzie, Yukon Territory, and the Canadian Arctic islands. In Nevada, this assemblage zone comprises the brachiopod faunas of Johnson's (1977, p. 20) intervals 1 and 2.

DISCUSSION OF CONODONT FAUNAS

T.T. Uyeno

Twenty-eight samples from the Cathedral Mountain section were processed and examined (Textfig. 3). Sixteen were from the Road River Formation; of these, only one (GSC loc. C-57221) yielded conodonts. Eleven were from the 'Delorme' Formation, and one was from the Sombre Formation.

The samples from the Road River Formation, although consisting of variably calcareous shale, did not break down or etch when treated with formic acid. The single sample that yielded conodonts is from 38.9 to 39.0 m up from the base of the section in the Road River Formation, and it contains a new species of *Ozarkodina* that superficially resembles *Ozarkodina remscheidensis* (Ziegler) (see Pl. 5, fig. 5). It is dated as Siluro-Devonian, but as it occurs about 55 m below *Neodiversograptus nilssoni*, it is Ludlow or older in age.

Two samples, GSC localities C-57236 and C-57240, from 54.2 to 54.3 and 98.2 to 98.3 m, respectively, above the base of the lower unit of the 'Delorme' Formation, contain *Ozarkodina* sp. cf. *O. remscheidensis* (Ziegler). On the basis of the known range of *O. remscheidensis* elsewhere, these samples are possibly late Pridolian to Early Devonian. However, the two samples (Textfig. 3) are bracketed by brachiopods that strongly suggest an early Lochkovian age.

The succeeding two samples, GSC localities C-57242 and C-57275, from 4.4 to 4.5 and 6.8 to 6.9 m above the base of the upper unit of 'Delorme' Formation, contain *Caudicriodus* sp. cf. *C. woschmidti* (Ziegler), *Ozarkodina* n. sp. G of Uyeno (1977) (see Pl. 5, figs. 6, 7), and *Pedavis* n. sp. (Pl. 5, figs. 8, 9). These forms probably represent part of the *C. woschmidti* Zone of Walliser (1964), of late Pridolian to early Lochkovian age.

Ozarkodina n. sp. G occurs in member D of the Read Bay Formation, 23.1 m above the base of the member at its type section on eastern Cornwallis Island (GSC loc. C-49976). Although the new species cannot be dated precisely at that locality, it occurs between the intervals that contain conodonts of the uppermost *eosteinhornensis* Zone (late Pridolian) below and of the *woschmidti* and *eurekaensis* zones above (early Lochkovian) (Uyeno, 1977, p. 214, Fig. 41.2).

The next two samples, GSC localities C-57249 and C-57259, from 23.1 to 23.2 and 31.6 to 31.7 m, respectively, above the base of the upper unit of the 'Delorme' Formation, contain *Caudicriodus woschmidti* (Ziegler) (see Pl. 5, figs. 10-17), *Belodella* sp., *Delotaxis* sp., and *Ozarkodina remscheidensis remscheidensis* (Ziegler). This assemblage is assigned to the *C. woschmidti* Zone.

Conodonts in the succeeding four samples, GSC localities C-57261, C-57263, C-57271, and C-57273, from 36.2 to 41.0, 45.1 to 45.2, 81.6 to 81.7, and 99.6 to 99.7 m, respectively, above the base of the upper unit of the 'Delorme' Formation, comprise *Ozarkodina* sp. cf. *O. remscheidensis* (Ziegler), *O. remscheidensis remscheidensis* (Ziegler), *Panderodus* sp., and indeterminate fragments. These occur in an interval above an assemblage assigned to the *C. woschmidti* Zone and are dated as early Lochkovian, based on the known upper range of *O. remscheidensis remscheidensis* elsewhere (Ziegler, 1971; Klapper, 1969, p. 25, Table 1). This assemblage could belong to either the *woschmidti* Zone (= *hesperius* Zone of Klapper, 1977) or the *eolatericrescens-postwoschmidti* Zone of Ziegler (1975) (= *O. eurekaensis* Zone of Klapper and Murphy, 1975). The interval containing this assemblage overlaps a large part of the upper range of *Gypidula pelagica lux* in the Cathedral Mountain section. The *Gypidula pelagica* beds of Nevada (Klapper and Murphy, 1975, p. 23) and the *Gypidula* cf. *G. pelagica* unit of the Royal Creek in the Yukon Territory (Klapper et al., 1971, Fig. 1, p. 289) are associated with conodonts assigned to the *O. eurekaensis* Zone. In the absence of diagnostic elements of either Klapper's conodont Fauna 3 (in Klapper et al., 1971) (= *Ozarkodina* n. sp. D Zone of Klapper, 1977) or the equivalent brachiopod fauna G and the presence of brachiopods of fauna F, this conodont assemblage is probably part of the *O. eurekaensis* Zone.

The sample, GSC locality C-57274 from 0.2 to 0.3 m above the base of the Sombre Formation, yielded only *Panderodus* sp., a form that ranges from Middle Ordovician to Middle Devonian.

This evidence on conodont distribution in the Cathedral Mountain section suggests that at least two conodont zones, the *woschmidti* Zone (= *hesperius* Zone) and the *eolatericrescens-postwoschmidti* Zone (= *eurekaensis* Zone) of the lower Lochkovian, occur within the range of distribution of the brachiopod faunal assemblage characterized by *Atrypa nieczlawiensis* and *Gypidula pelagica lux*. This differs from the sequences in Nevada and in Royal Creek, Yukon Territory, where *Gypidula pelagica* is associated with conodonts assigned to the *eurekaensis* Zone of the lower Lochkovian. However, the faunas of Johnson's recently named (1977, p. 20) *Gypidula pelagica* Zone, comprising brachiopods of intervals 1 (*Salopina submurifer* fauna) and 2 (*Gypidula pelagica lux* fauna), coexist with the conodont faunas of the *hesperius* and *eurekaensis* zones, respectively. As thus defined, the range of the *Gypidula pelagica* Zone of Nevada, relative to the conodont zones, appears to correspond closely to that found on Cathedral Mountain.

Unfortunately, a lack of conodont recovery from samples of the Road River Formation and the lower part of the 'Delorme' Formation precludes placement of the Silurian-Devonian boundary in the section.

SYSTEMATIC PALEONTOLOGY

A.W. Norris

Phylum Brachiopoda Dumeril, 1806
Class Inarticulata Huxley, 1869
Order Lingulida Waagen, 1885
Superfamily Lingulacea Menke, 1828
Family Lingulidae Menke, 1828

Genus *Lingula* Bruguière, 1797, Pl. 250

Type species: *Lingula anatina* Lamarck, 1801, p. 141; ICZN pend.

Lingula sp.
Plate 1, figure 1

Material. Represented by three crushed valves.

Dimensions.

GSC No.	53086
	(mm)
Length (L)	+ 16.20
Width (W)	12.45
Ratio (L/W)	1.30

Description. Valve of moderate size, linguiform in outline, elongate oval, 1.3 times longer than wide, lateral margins very gently convex, about subparallel, posterolateral and anterolateral margins broadly rounded, anterior margin gently rounded in later growth stages but slightly indented in younger growth stages. Beak presumably pointed.

Shell material black, shiny, and very thin.

Ornament of fine concentric growth lines. Very fine closely spaced markings along the length of the valve more or less parallel to midline and most conspicuous in the middle third of the valve. Marking suggestive of a pedicle groove, 1.9 mm wide and + 6.8 mm long along the midline at posterior end of valve.

Discussion. *Lingula* is a very long-ranging form with many species, especially in the Silurian and Devonian, and is regarded as having little stratigraphic value. The present form is somewhat similar in shape outline and in concentric and radial markings to *Lingula rectilatera* Hall (1859, p. 156, Pl. 9, figs. 6, 8) from the New Scotland Formation of the Helderberg Group of eastern New York State. *Lingula rectilatera* has been recorded also by Clarke (1908, p. 214, Pl. 47, figs. 3, 5, 6) from the Grand Grève Formation, Percé Rock, eastern Canada.

Occurrence. Figured specimen is from GSC locality C-57265. Other specimens occur in GSC localities C-57235 and C-57266. All specimens are from the upper rock unit of the 'Delorme' Formation.

Figured specimen. GSC 53086

Class Articulata
 Superfamily Enteleteacea Waagen, 1884
 Family Dalmanellidae Schuchert, 1913
 Subfamily Resserellinae Lazarev, 1970

Genus *Resserella* Bancroft, 1928

Type species: *Orthis canalis* J. de C. Sowerby in Murchison, 1839, p. 630, Pl. 13, fig. 12a; OD [= *Parmorthis* Schuchert and Cooper, 1931, p. 246 (type, *Orthis elegantula* Dalman, 1828)]

Resserella sp. cf. *R. elegantuloides*
 (Kozłowski)

Plate 1, figures 2 - 10

- 1929 *Dalmanella elegantuloides* Kozłowski, p. 63, Textfigs. 9a, 10, 11, Pl. 2, figs. 1 - 16
- 1954 *Parmorthis elegantuloides* (Kozłowski); Nikiforova, p. 48, Pl. 2, figs. 3 - 6
- 1971 *Resserella elegantuloides* (Kozłowski); Walmsley and Boucot, p. 514, Pl. 98, fig. 8, Pl. 99, fig. 1a - 1e
- 1973b *Resserella elegantuloides* (Kozłowski); Johnson, p. 1019, Pl. 1, figs. 16 - 20
- 1973 *Resserella elegantuloides* (Kozłowski); Johnson, Boucot, and Murphy, p. 17, Pl. 14, figs. 1 - 21
- 1974 *Resserella elegantuloides?* (Kozłowski); Perry, p. 189, Pl. 7, figs. 1 - 12

Material. Twelve calcareous specimens, all rather poorly preserved.

Dimensions.

GSC No.	53087	53088	53089
	(mm)		
Length of pv (Lp)	14.45	+10.35	10.05
Length of bv (Lb)	13.95	10.05	9.45
Width (W)	16.55	11.45	11.00
Depth of shell (D)	4.80	4.55	5.00
Ratio (Lp/W)	0.87	0.90	0.91
Ratio (Lp/D)	3.01	2.27	2.01

Description. The shells are somewhat small, transversely subquadrate to transversely elliptical in outline and unequally biconvex in lateral profile. Depth of pedicle valve is about twice that of the brachial valve. Hinge line is straight and is equal to about three-quarters of maximum width, which is near posterior third of length of shell. Cardinal angles rounded, lateral margins slightly to broadly curved, anterior margin straight to broadly rounded. Anterior commissure is broadly and weakly sulcate.

Pedicle valve gently convex, highest along midline in posterior third of valve. A low, narrow, carinate-like fold originates over beak and splays out anteriorly. Ventral palintrope is rather long and curved, but the beak is short and pointed. The ventral interarea is low, triangular, slightly curved, and apsacline; in specimen GSC 53089 it is nearly 0.6 of maximum width of shell. Delthyrium is triangular and is poorly preserved in all specimens.

Brachial valve is very gently convex, highest along midline at from one-quarter to one-third length from beak, and slightly resupinate toward anterior lateral margins. A weak sulcus originates at about one-quarter length from beak, widens anteriorly, and extends to anterior margin. The dorsal interarea is low, flat, and anacline. Beak is small and inconspicuous.

Ornament consists of rounded, radial costellae that increase in number anteriorly by bifurcation and intercalation. Twelve occur in a space of 5 mm at 5 mm from pedicle beak on specimen GSC 53087. Some of the costellae are stronger than others, producing an uneven semifascicostellate aspect. Median sectors of both valves have finer subparallel costellae, especially conspicuous on the brachial valve and considered typical of resserellids. Radial ornament is crossed at irregular intervals by relatively poorly defined, or on one specimen well-defined, concentric growth lines. Fine, closely spaced punctae can be seen on abraded parts of shells.

Discussion. On external features, including subquadrate outline, ventribiconvex profile, shape of ventral fold and dorsal sulcus, and parvicostellate ornamentation, this form resembles that of *Resserella elegantuloides* (Kozłowski) from the type area. The ventral umbo and interarea of the form from Cathedral Mountain are not extended as far posterior of the hinge line as they are in the type material.

Occurrence. Illustrated specimens are from GSC localities C-57250, C-57265, and C-57248; the species occurs also in GSC localities C-57245, C-57246, C-57251, C-57258, and C-57265. All of these are within the upper unit of the 'Delorme' Formation.

In central Nevada, *Resserella elegantuloides* occurs in the F fauna of the Roberts Mountains Formation of early Lochkovian age (Johnson et al., 1973) and in the slightly younger strata of the lower part of the Windmill Limestone of mid-Lochkovian age (Johnson, 1973b).

In the southwestern District of Mackenzie, *R. elegantuloides* is reported by Perry (1974) from beds 225.5 m below the top of the Delorme Formation at his S-2 section (latitude 63°19'24"N, longitude 128°36'00"W). At this locality it occurs in the lower range of *Spirigerina supramarginalis* and is dated as probable middle to late Lochkovian in age.

In the type area of Podolia, *R. elegantuloides* was reported by Kozłowski (1929, p. 67) to occur in strata of the Borszczow Stage (Gedinian), especially in the middle part.

Figured specimens. GSC 53087, 53088, and 53089

Superfamily Enteleteacea Waagen, 1884
Family Schizophoriidae Schuchert and LeVene, 1929
Subfamily Schizophoriinae Schuchert
and LeVene, 1929

Genus *Schizophoria* King, 1850

Type species: *Conchylolithus (Anomites) resupinatus*
Martin, 1809, Pl. 49, figs. 13 and 14

Schizophoria paraprima Johnson, Boucot, and
Murphy, 1973
Plate 1, figures 11 - 25

- 1973 *Schizophoria paraprima* Johnson et al., p. 24, Pl. 10,
figs. 19 - 34, Pl. 11, figs. 1 - 11
1974 *Schizophoria paraprima* Johnson et al.; Perry, p. 195,
Pl. 7, figs. 22 - 32

Diagnosis. Small biconvex, transverse *Schizophoria* lacking fold and sulcus; ventral diductor scars separated by a broad, flat ridge, or myophragm (Johnson et al., 1973, p. 24).

Material. Twenty-three specimens from scattered beds.

Dimensions.

GSC No.	53090 53091 53092 53093			
	(mm)			
Length of pv (Lp)	10.95	16.00	14.35	12.45
Length of bv (Lb)	10.45	14.30	13.75	11.80
Width (W)	13.35	17.35	18.20	13.10
Depth of shell (D)	6.15	7.45	8.50	12.25
Ratio (Lp/W)	0.82	0.92	0.78	0.95
Ratio (Lp/D)	1.78	2.14	1.68	1.01

Description. The shells are small, transversely oval in outline, and unequally biconvex in lateral profile, the pedicle valve being generally deeper than the brachial valve. Maximum width is near midlength. Hinge line is short and straight and joins broadly curved cardinal angles. Lateral commissures are sharply rounded and slightly deflected ventrally in the anterior direction. Anterior commissure is broadly and smoothly rounded and nearly rectimarginate in young specimens, but it is gently arched toward the brachial valve in older specimens, without forming a distinct fold and sulcus.

Pedicle valve is gently arched along the midline, the greatest height occurring about one-third to one-half total length from beak. Beak is short and stubby and barely projects beyond the adjoining interarea. Interarea of pedicle valve is apsacline, slightly curved, and has variable height that is invariably higher than that of the opposite valve. Delthyrium is triangular, appears to be open, and has an angle of less than 60 degrees.

Dorsal valve is gently convex along midline and highest about one-quarter length from beak. Beak is small, short, and stubby, and it barely projects beyond the interarea. Dorsal interarea is anacline to orthocline and flat.

Shell material is thin and finely punctate. Ornament of shell consists of numerous very fine radial costellae that increase in number anteriorly, mainly by bifurcation.

Interiors of valves not investigated. The abraded brachial valve of one specimen (GSC 53091) shows the bases of a

pair of platelike brachiophore-supporting processes that diverge anteriorly and are convex outward. On the same abraded specimen, the impression of the base of a ridgelike myophragm is also evident.

Discussion. On characteristic external features such as small size, thin shell, lack of a fold and sulcus, and transversely oval shape, the specimens from the 'Delorme' Formation on Cathedral Mountain are comparable to *S. paraprima* from Nevada.

Occurrence. Figured specimens are from GSC localities C-57250, C-57264, C-57258, and C-57265, respectively. This form in the Cathedral Mountain section is from GSC localities C-57235 and C-57237 in the upper part of the lower rock unit and from GSC localities C-57245, C-57250, C-57258, C-57260, C-57264, C-57265, C-57266, C-57267, C-57269, and C-57270 in the upper rock unit of the 'Delorme' Formation.

Schizophoria paraprima occurs typically in lower Gedinian strata of the lower part of the Roberts Mountains Formation of central Nevada (Johnson et al., 1973).

In the southwestern District of Mackenzie, Perry (1974, pp. 196, 583) reported *S. paraprima* from his S-2 section (latitude 63°19'24"N, longitude 128°36'00"W) in the interval 336.8 to 344.4 m below the top of the Delorme Formation.

Figured specimens. GSC 53090, 53091, 53092, and 53093

Family Stropheodontidae Caster, 1939
Subfamily Douvillinae Caster, 1939

Genus *Mesodouvillina* Williams, 1950

Type species: *Stropheodonta (Brachyprion) subinterstitialis*
var. *seretensis* Kozłowski, 1929, p. 96, Pl. 4,
figs. 1 - 7, Textfigs. 28, 29
Mesodouvillina? sp.
Plate 1, figures 26, 27

Material. Exterior of brachial valve and 2 incomplete brachial valves, all embedded in matrix.

Dimensions.

GSC No.	53094
	(mm)
Length (L)	8.25
Width (W)	+13.10
Ratio (L/W)	0.63

Description. Brachial valve outline is subsemicircular, moderately concave, with posterolateral corners slightly extended. Maximum width developed at hinge line. Dorsal interarea is low, subrectangular, and hypercline. Shell ornament is parvicostellate; 5 to 7 weaker secondary costellae are developed between the primaries along the anterior margin. Very fine, closely spaced, concentric growth lines can be seen on some parts of the shell. A weak 'seersucker' ornament (Caster, 1939) of discontinuous concentric rugae is most conspicuous on the posterior two-thirds of the valve. Shell appears to be pseudopunctate.

Discussion. On the basis of shell shape, parvicostellate ornamentation, and rugate development, this shell resembles some of the forms designated as *Mesodouvillina* sp. 2 by Perry (1974), from the lower and middle Lochkovian beds of the Delorme Formation in the southwestern District of Mackenzie.

Occurrence. Specimens from GSC locality C-57239 in the upper part of the lower unit of the 'Delorme' Formation.

Figured specimen. GSC 53094

Superfamily Davidsoniacea King, 1850
Family Chilidiopsididae Boucot, 1959

Diagnosis. Impunctate davidsoniaceans

Genus *Iridistrophia* Havlíček, 1965

Type species: *Orthis umbella* Barrande, 1848
Iridistrophia sp. cf. *I. umbella* (Barrande)
Plate 1, figures 28-32

- 1848 *Orthis umbella* Barrande, p. 206, Pl. 19, fig. 1
1879 *Orthis umbella* Barrande, Pl. 58, fig. 1
1929 *Schellwienella praeumbracula* Kozłowski, p. 105, Textfig. 32, Pl. 5, figs. 3-6
1954 *Schellwienella praeumbracula* Kozłowski; Niki-forova, p. 84, Pl. 8, fig. 5
1965 *Iridistrophia umbella* (Barrande); Havlíček, p. 292, Pl. 1, figs. 4-6, 9, 11
1967 *Iridistrophia umbella* (Barrande); Havlíček, p. 194, Pl. 41, figs. 7-16, Pl. 42, figs. 3, 5, 8
1973 *Iridistrophia* cf. *umbella* (Barrande); Johnson et al., p. 38, Pl. 21, figs. 1-828

Material. About seven specimens showing the exteriors of pedicle and brachial valves. Most of the shells are incomplete and all are firmly embedded in matrix.

Dimensions.

GSC No.	53095	53096	53097
		(mm)	
Length (L)	13.35	5.65	18.4
Width (W)	16.45	7.30	2 x 14.1 = 28.2
Ratio (L/W)	0.81	0.77	0.65

Description. Shells are of medium to large size. The valves are subsemicircular in outline and resupinate in lateral profile. The hinge line is straight and is equal to maximum width in younger specimens and slightly less than maximum width in older specimens. Cardinal angles close to a right angle in younger specimens and are rounded in older specimens. Maximum width varies from hinge line to about midlength of shells. Anterior margin very slightly and broadly uniplicate.

Pedicle valve convex over umbonal region and gently concave in anterior half of valve. Interarea is flat and low, not completely evident on any of the shells.

Brachial valve is gently and evenly convex. A weakly developed sulcus occurs along the midline over the umbonal region.

The ornament consists of subangular to rounded, radial costellae that increase in number anteriorly by intercalation and bifurcation. Eleven to thirteen costellae occur in a space of 5 mm at 5 mm from the beak. The radial disposition of the costellae change from straight to slightly curved beyond the midregions of the valves. On the posterolateral parts of the flanks the costellae become more and more curved, concave toward the hinge line. Some specimens show a slight and irregular development of parvicostellae. Closely spaced concentric growth lines occur in the interspaces separating the costellae. Some specimens show small nodelike enlargements where the concentric growth lines intersect the costellae.

Discussion. Although the material is fragmentary and limited, the specimens from Cathedral Mountain appear, judging by external features, to be relatively close to the Bohemian and Podolian forms. The form from the Cathedral Mountain area was recorded previously as *Schellwienella praeumbraculum* Kozłowski by Lenz and Jackson (1964, p. 896) and as *Iridistrophia praeumbracula* (Kozłowski) by Lenz (1968, p. 591).

Occurrence. Figured specimens from GSC locality C-57235; also present in GSC locality C-57237. Both are in the upper part of the lower unit of the 'Delorme' Formation.

Figured specimens. GSC 53095, 53096 and 53097

Suborder Pentameridina Schuchert and Cooper, 1931
Superfamily Pentameracea McCoy, 1844
Family Gypidulidae Schuchert and LeVene, 1929
Subfamily Gypidulinae Schuchert and LeVene, 1929

Genus *Gypidula* Hall, 1867

Type species: *Gypidula typicalis* Amsden, 1953, p. 140

Gypidula pelagica lux Johnson, Boucot, and Murphy
Plate 1, figures 33-47; Plate 2, figures 1-18; Textfigures 4, 5

- 1962 *Gypidula* sp.; McLaren, Norris, and McGregor, p. 18, Pl. 8, figs. 1-3
1970 *Gypidula pelagica* (Barrande); Johnson, p. 97, Pl. 15, figs. 12-15
1970 *Gypidula pelagica* (Barrande); McLaren, Norris, and Cumming, p. 620, figs. 1, 2
1973 *Gypidula pelagica lux* Johnson, Boucot, and Murphy, p. 31, Pl. 18, figs. 1-18, Pl. 19, figs. 1-12
1974 *Gypidula pelagica lux* Johnson, Boucot, and Murphy; Perry, p. 228, Pl. 11, figs. 46-51, Textfigs. 44, 45

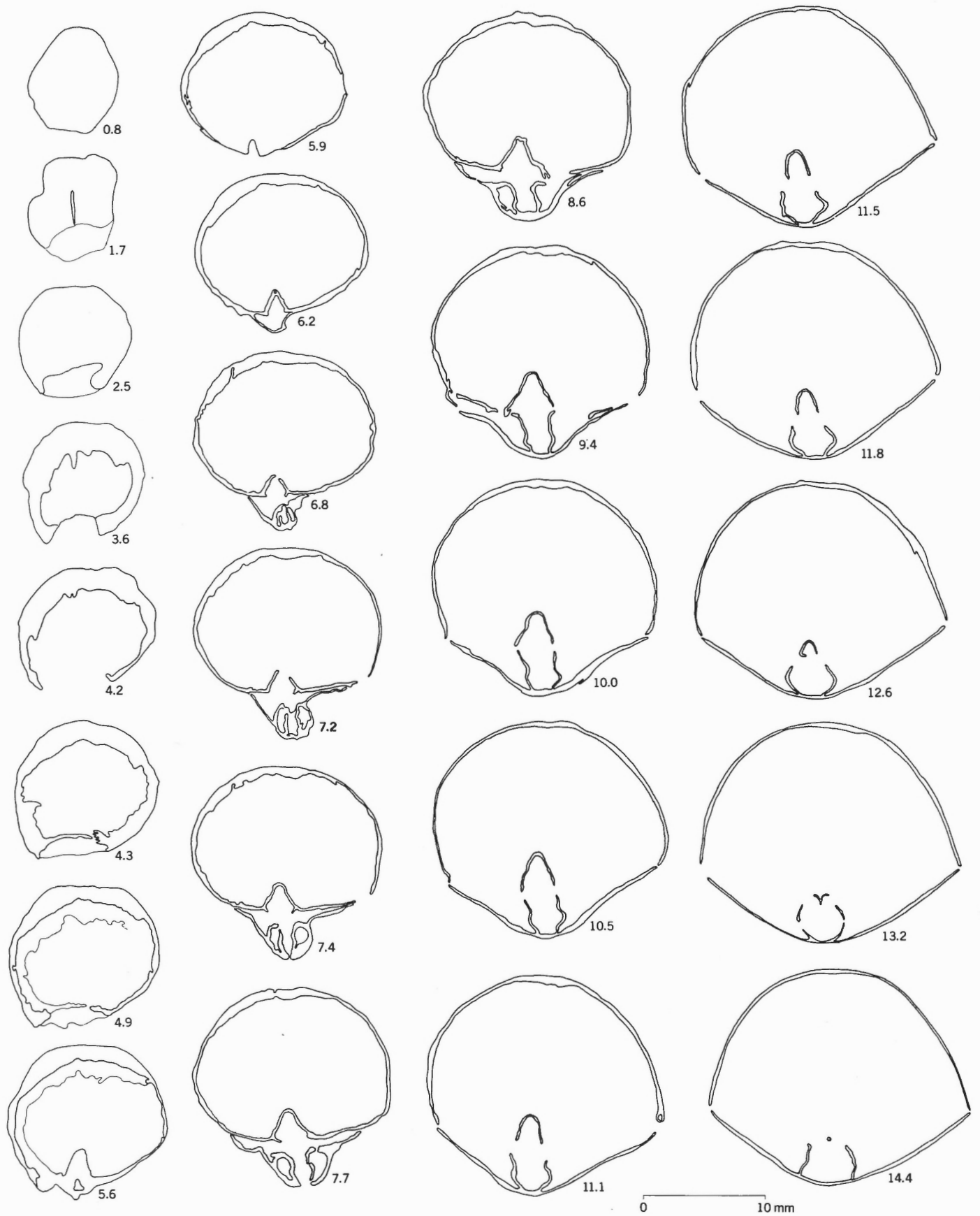
Diagnosis. "A subspecies of *Gypidula pelagica* almost completely lacking in plications and with the curvature of the brachial valve strongly developed posteriorly, but much less so anteriorly" (Johnson et al., 1973, p. 31).

Material. GSC 53098: a young, narrow, elongate individual. GSC 53099: a young, relatively broad, individual. GSC 53100: a young adult individual. GSC 53101: a rather broad, adult individual. GSC 53102: a very broad, adult individual. GSC 53103: an elongate, adult individual. GSC 53104: a very narrow, elongate, adult individual. GSC 53134: a relatively broad, young adult individual, serially sectioned. And GSC 53135: a somewhat broad young individual, serially sectioned. All are from GSC locality C-57241.

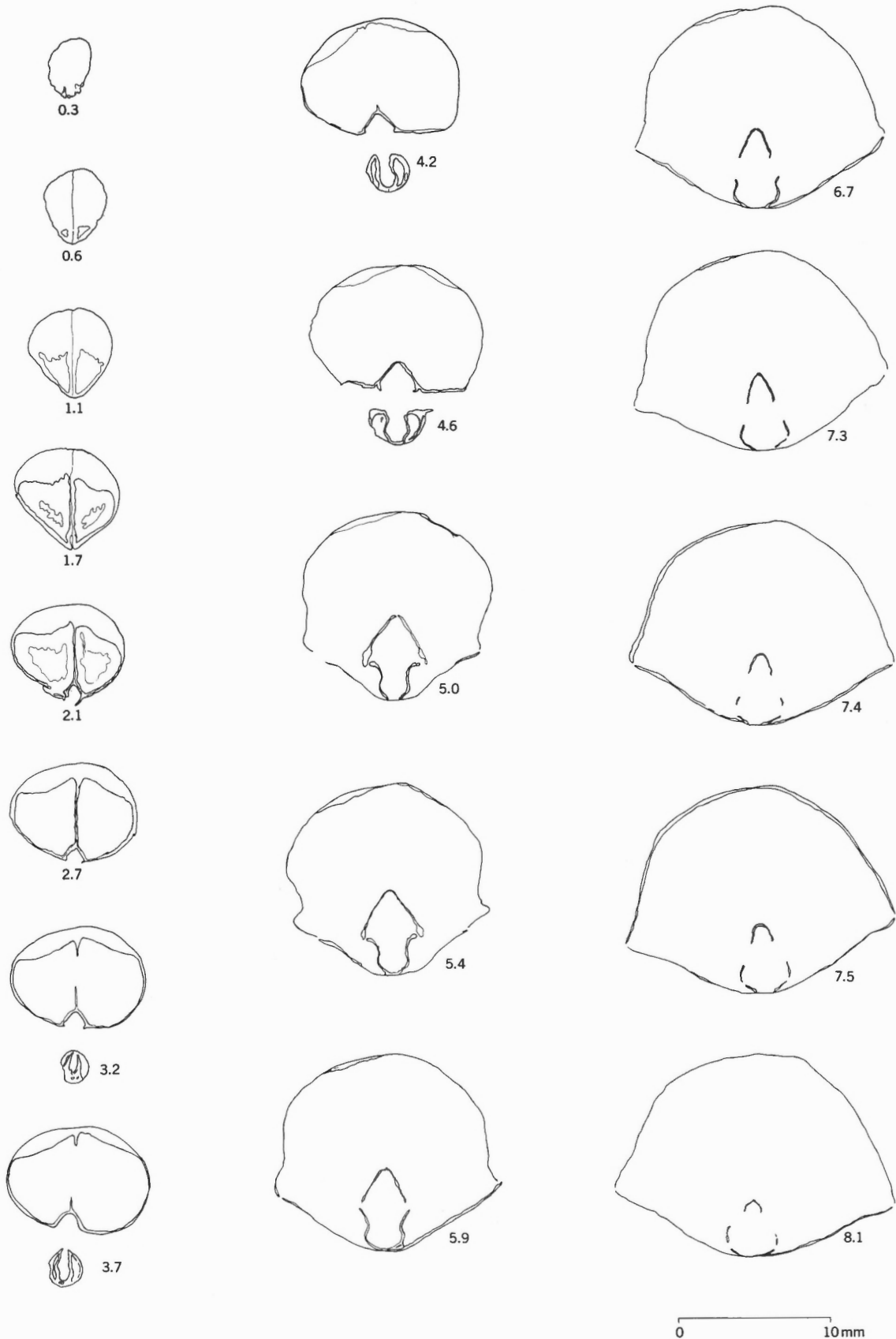
Eighty-two specimens from scattered beds in the upper part of the lower unit and from the upper unit of the 'Delorme' Formation. This is the second most abundant form in the Cathedral Mountain section.

Dimensions.

GSC No.	53098	53099	53100	53101	53102	53103	53104	53134	53135
					(mm)				
Length of pv (Lp)	15.45	13.65	20.40	27.30	27.60	29.45	28.15	22.20	18.50
Length of bv (Lb)	13.30	13.15	17.45	23.85	24.05	24.95	24.60	-	17.25
Width (W)	13.25	14.20	19.85	24.95	27.55	25.95	22.55	20.90	19.80
Depth of shell (D)	11.60	10.30	15.30	18.45	19.25	21.35	19.35	18.85	13.50
Ratio (Lp/W)	1.17	0.96	1.02	1.09	1.00	1.13	1.25	1.06	0.93
Ratio (Lp/D)	1.33	1.33	1.33	1.48	1.43	1.38	1.45	1.18	1.37



Textfigure 4. *Gypidula pelagica lux* Johnson, Boucot, and Murphy. Camera lucida drawings of serial transverse sections; distances are in millimetres forward from the crest of the pedicle umbo. GSC 53134. GSC locality C-57241.



Textfigure 5. *Gypidula pelagica lux* Johnson, Boucot, and Murphy. Camera lucida drawings of serial transverse sections; distances are in millimetres forward from the crest of the pedicle umbo. GSC 53135. GSC locality C-57241.

Description. Shell outline is elongate oval to pyriform, longer than wide, with greatest width anterior of midlength; lateral commissures nearly straight in young stages, gently convex dorsally in adult stages; anterior commissure is weakly sulcate in young stages, broadly and strongly sulcate in adult stages; hinge line is relatively long, slightly round and sloping slightly anteriorly; umbonal extremities broadly rounded.

Pedicle valve is strongly convex, highest posterior to midlength, in young stages accounting for about one-half thickness of shell; in adult stages pedicle valve makes up two-thirds or more thickness of shell; beak tapering to a rounded end, strongly curved, lying near to, but not touching, the dorsal umbo. Interarea large, ill defined laterally by rounded beak ridges; delthyrium is triangular and open. Fold is broadly rectangular, confined to anterior third or more of adult shell, which becomes more pronounced anteriorly.

Brachial valve is weakly to moderately convex, the greatest convexity occurring over or immediately anterior of umbo. Beak is relatively small, pointed, moderately to strongly inturned. Sulcus is broad, shallow, flat-bottomed, appears near midlength and gradually becomes more pronounced anteriorly to form a tongue-like extension.

The exterior of shell is smooth except for two, three, or four very faint broad plications developed on the fold and sulcus of a few adult specimens. Four faint plications can be seen on both the fold and sulcus of specimen GSC 53103.

Interior of pedicle valve seen only in serial sections (Textfigs. 4, 5). Hinge teeth are very small and project from the junctions of the shell wall and spondylium. The delthyrium opens anteriorly and ventrally into a spondylium of elongate outline and V-shaped cross-section that is supported by a bladellike median septum in the posterior part of the valve. Thick secondary shell material is present in umbonal cavity.

In interior of brachial valve the dental sockets are ill defined between the lateral edges of inner plates and shell wall. Inner plates seen in cross-section curve ventrolaterally in posterior part of shell and then toward the plane of symmetry anteriorly. They are joined to the outer plates, which in turn are joined to the floor of the valve along slightly diverging paths anteriorly.

Comparison. Johnson et al. (1973) considered that the form designated as *Gypidula* sp. by McLaren et al. (1962) from Cathedral Mountain was consubspecific with the *G. pelagica lux* from Nevada. The similarity of the forms from the two areas undoubtedly is very close. Some shells from the 'Delorme' Formation develop two, three, or four very faint broad undulations in the fold and sulcus, a feature noted also in a few adult shells from Nevada. Internally, the median septum supporting the spondylium in the pedicle valve of the form from Cathedral Mountain does not extend as far anteriorly as does that of the Nevada form (Textfigs. 4, 5; Johnson et al., 1973, Pl. 19, figs. 11, 12). The unusually short brachial cardinalia illustrated by Johnson et al. (1973, Pl. 18, fig. 16) seems to be atypical for the subspecies.

Discussion. The species *Gypidula pelagica* (Barrande) is characterized by a nearly smooth exterior and by a prominent trapezoidal tongue-like extension of the dorsal sulcus. Some of the specimens illustrated by Barrande (1879) show a tendency to have the ventral fold divided by an indistinct median furrow, which becomes more prominent anteriorly and gently indents the sulcal tongue at the midline of the anterior commissure.

Occurrence. In the measured section *Gypidula pelagica lux* has been collected from GSC localities C-57237, C-57238, and C-57239 from the lower unit and from GSC localities C-57241, C-57244, C-57245, C-57246, C-57249, C-57250, C-57251, C-57258, C-57259, C-57264, and C-57268 from the upper unit of the 'Delorme' Formation.

The calcareous specimens of *G. pelagica lux* collected by A.C. Lenz in 1970 and described and illustrated by Perry (1974) are recorded from 91.4 m below the top of the Delorme Formation at Cathedral Mountain (latitude 61° 43'N, longitude 125° 38'W). This locality appears to be at or very near the section that I measured.

In the type area, *Gypidula pelagica lux* occurs as part of the upper "F" fauna of Gedinnian age, in the upper part of the Roberts Mountains Formation in the Birch Creek area of central Nevada (Johnson et al., 1973, pp. 10, 32).

In Bohemia, *Gypidula pelagica* was recorded by Barrande (1879) from the E2 Stage at St. Ivan. More recent workers, for example, Chlupáč (1976, p. 176), have indicated that this species occurs in beds assigned to the Lochkovian Stage.

In Podolia, Kozłowski (1929) indicated that *Sieberella* cf. *S. galeata* (a form placed in synonymy with *G. pelagica* by some workers) occurs in the Tajna beds at Celejów, which appear to correlate approximately with the Isfara beds of Russia (Nikiforova, 1937).

In the central Asiatic part of Russia, Nikiforova (1937) recorded *Gypidula pelagica* from the Isfara and *Marginalis* beds, which were correlated with an upper part of the Budnany Limestone (E2) of Bohemia.

Figured specimens. GSC 53098 to 53104, and 53134 and 53135, all from GSC locality C-57241

Gypidula sp. (costate form)
Plate 2, figures 19 - 22

Material. Represented by two calcareous specimens.

Dimensions.

GSC No.	53105	53106
	(mm)	
Length of pv (Lp)	+22.25	18.60
Length of bv (Lb)	20.05	16.45
Width (W)	22.80	18.40
Depth of Shell (D)	18.55	12.40
Costae on fold of pv	3	3
Costae on sulcus of bv	2	2
Costae on flanks of pv	? - ?	? 1 - 2
Costae on flanks of bv	? - ?	? 3 - ? 2

Discussion. The available specimens resemble *Gypidula pelagica lux* in shape outline but have variably developed, broad plications on the fold and sulcus and less distinct plications on the flanks of the shell. On specimen GSC 53105, two plications originate immediately anteriorly of the umbo of the brachial valve and broaden anteriorly. The two plications are separated by a relatively narrow inter-plication furrow. On the pedicle valve of the same specimen (part of which is broken), the fold has three broad low plications. On specimen GSC 53106, three low broad plications on the fold of the pedicle valve are conspicuous only on the anterior third of the shell. On the brachial valve of the same specimen, two broad plications on the sulcus appear near the anterior margin. Both specimens show one to three broad, indistinct plications on the flanks of the pedicle valve; these are even less distinct on the brachial valve.

These specimens bear some resemblance to plicate forms of *Gypidula pelagica*, particularly the form illustrated by Barrande (1879, Pl. 23, figs. 10a-11b). However, the specimens from Cathedral Mountain are less elongate and exhibit other slight shape differences.

The available specimens also somewhat resemble those illustrated as *Gypidula* sp. F by Johnson et al. (1973, pp. 32, 33, Pl. 20, figs. 1 - 7) from the lower Lochkovian "F" fauna of Nevada.

Occurrence. From GSC locality C-57241 in the lower part of the upper unit of the 'Delorme' Formation.

Figured specimens. GSC 53105 and 53106

Superfamily Camarotoechacea Havlíček
Family Trigonirhynchiidae Schmidt, 1965

Genus *Ancillotoechia* Havlíček, 1959

Type species: *Rhynchonella ancillans* Barrande, 1879, Pl. 36

Ancillotoechia sp. cf. *A. gutta* Johnson, Boucot,
and Murphy, 1973
Plate 2, figures 23-32

1962 "*Camarotoechia*" sp.; McLaren, Norris, and McGregor,
Pl. 8, figs. 7-9

1973 *Ancillotoechia gutta* Johnson, Boucot, and Murphy,
p. 43, Pl. 22, figs. 1-19

1974 *Ancillotoechia* cf. *gutta* Johnson et al.; Perry, p. 313,
Pl. 24, figs. 56-60, Textfigs. 48, 49

Diagnosis. Shell small and of unequal length and width;
ventral flanks curved, not reflexed; four costae on dorsal
fold, dorsal median septum present.

Material. Represented by 13 calcareous specimens.

Dimensions.

GSC No.	53107	53108
	(mm)	
Length of pv (Lp)	11.35	12.95
Length of bv (Lb)	9.60	12.45
Width (W)	11.90	18.05
Depth of shell (D)	8.00	9.25
Ratio (Lp/W)	0.95	0.72
Ratio (Lp/D)	1.42	1.40
Costae on sulcus of pv	3	3
Costae on flanks of pv	8-7	7-7
Costae on fold of bv	4	4
Costae on flanks of bv	6-6	6-7

Description. The shells are subpentagonal, their width slightly greater than their length. In lateral profile the valves are subequally biconvex, the brachial valve having approximately twice the depth of the pedicle valve. Hinge line is comparatively long and slightly convex, lateral commissures directed ventrally, anterior commissure markedly uniplicate.

Pedicle valve along midline strongly convex over umbo and strongly deflected dorsally toward anterior margin. Flanks gently convex and sharply delineated from the sulcus. Apical angle of beak is about 84 degrees. Beak is suberect to erect and is closely appressed to and extends posteriorly beyond dorsal umbo. The delthyrium is triangular and open. Deltidial plates were not observed. Pedicle opening is oval and submesothryridid. Sulcus is U-shaped and originates immediately anterior to umbo and widens and deepens anteriorly; near anterior margin it is sharply deflected dorsally and posteriorly to produce a pronounced tongue.

Brachial valve is moderately convex; it has about twice the depth of the pedicle valve, highest at or anterior to midlength. Lateral flanks strongly convex. Brachial beak is closely appressed against the opposing valve. Fold originates over the umbo and gradually widens and increases in height anteriorly, where it is sharply delineated from the flanks.

Valves are ornamented by simple subangular radial costae that are separated by V-shaped subangular intercostal furrows. Costae are relatively fine over the umbones and markedly increase in strength anteriorly. Flanks have six to eight costae. Pedicle sulcus has four costae and brachial fold has three. Along anterior and anterolateral margins of shell a zigzag crenulate pattern is formed by the interlocking subangular costae. A few fine concentric growth lines were seen on part of one specimen where the shell had not been abraded.

Interiors of valves were not investigated because of limited material.

Comparison. Externally the shells from Cathedral Mountain bear a very close resemblance to *Ancillotoechia gutta* Johnson, Boucot, and Murphy (1973) from Nevada, although none of the forms illustrated from Nevada is as broad as some of the forms from Cathedral Mountain.

Ancillotoechia cf. *A. gutta*, described by Perry (1974, pp. 313-317, Pl. 24, figs. 56-60, Textfigs. 48, 49) from the Delorme Formation in southwestern District of Mackenzie, is similar to the form from Nevada except that serial sections show the development of a plate covering the anterior part of the septalium. Perry (1974, pp. 316, 317) suggested that this cover plate in the Nevada silicified material was either not preserved or was possibly broken.

The form from Cathedral Mountain bears a fairly close resemblance to the broader forms of *Ancillotoechia nucula* from the Skala of Podolia as illustrated by Kozłowski (1929, Pl. 6), but the costae on the flanks of the Cathedral Mountain form are not as numerous as those on the forms from the Skala beds.

Occurrence. In the Cathedral Mountain section, *Ancillotoechia* sp. cf. *A. gutta* occurs sparingly in GSC localities C-57250, C-57265, C-57266, C-57268, C-57269, C-57270, and C-57272, all from the upper unit of the 'Delorme' Formation.

Ancillotoechia gutta occurs typically in the lower Lochkovian "F" fauna of central Nevada (Johnson et al., 1973).

Ancillotoechia cf. *A. gutta* was reported by Perry (1974, p. 316) from the Delorme Formation in three sections: S-6 (Delorme Range; latitude 62°46'N, longitude 125°15'W), S-7 (Whittaker anticline; latitude 62°28'50"N, longitude 124°47'00"W), and S-12 (Tundra Ridge; latitude 62°15'N, longitude 125°00'W). In section S-6, it occurs at 1911.1 m, and in sections S-7 and S-12 it is represented in collections from 408.4 and 717.8 m, respectively, from the top of the formation.

Figured specimens. GSC 53107 and 53108 from GSC locality C-57268.

Superfamily Atrypacea Gill
Family Atrypidae Gill
Subfamily Atrypinae Gill

Genus *Spirigerina* D'Orbigny, 1849

Type species: *Terebratula marginalis* Dalman, 1828, p. 42; SD
Aleksseeva, 1960, p. 64

Spirigerina marginaliformis Aleksseeva, 1960
Plate 2, figures 33-39; Plate 3, figures 1-21

1939 *Atrypa marginalis* Khodalevich, p. 47 (see synonymy),
Pl. 25, figs. 1-3; not Dalman

1960 *Spirigerina marginaliformis* Aleksseeva, p. 65, Pl. 7,
fig. 1

1960 *Plectatrypa marginalis sibirica* Rzhonsnitskaya;
Sarycheva, Pl. 53, fig. 24

- 1962 *Spirigerina marginaliformis* Alekseeva; p. 161, Textfigs. 76, 77, Pl. 9, fig. 10
 1973 *Spirigerina marginaliformis* Alekseeva; Johnson, Boucot, and Murphy, p. 50, Pl. 25, figs. 1 - 7
 1973b *Spirigerina marginaliformis* Alekseeva; Johnson, p. 1023, Pl. 3, figs. 6 - 24
 1974 *Spirigerina marginaliformis* Alekseeva; Perry, p. 367, Pl. 31, figs. 48 - 52

Material. Represented by 10 calcareous specimens.

Dimensions.

GSC No.	53109	53110	53111	53112	53113	53114
	(mm)					
Length of pv (Lp)	15.45	18.60	8.90	12.65	13.05	12.95
Length of bv (Lb)	13.65	17.20	17.05	11.65	11.95	11.95
Width (W)	15.45	18.75	7.95	13.60	13.90	14.25
Depth of shell (D)	7.45	8.45	7.85	7.75	7.35	7.95
Ratio (Lp/W)	1.0	0.99	1.12	0.93	0.94	0.91
Ratio (Lp/D)	2.07	2.20	1.13	1.63	1.77	1.63

Description. The valves are suboval to subpentagonal and are generally unequally biconvex in lateral profile. Hinge line is relatively short and slightly curved; lateral commissures with pronounced ventral deflections toward the edges of the ventral sulcus; anterior commissure is moderately to strongly uniplicate.

Pedicle valve is generally gently convex, highest at about one-third length from beak. Beak is orthocline, small, short, pointed, and pierced apically by a circular submesothyridd foramen. Pedicle interarea is narrow but conspicuous. Delthyrium has two deltidial plates that delineate anterior edge of foramen. Pedicle sulcus originates at or anterior to midlength and is broad, shallow; it is commonly sharply geniculate near anterior margin and forms a tongue-like trapezoid projection.

Brachial valve is generally more evenly and strongly convex than opposing valve, highest at or anterior to midlength along the midline. Lateral flanks are gently convex. Brachial beak is closely appressed against the opposing valve. The brachial fold is low and rounded and originates at about midlength, where it is indistinct and becomes pronounced only near the anterior margin.

Most of the specimens of this species show varying degrees of exfoliation, so that the costae and other fine markings are generally obliterated. Where well preserved, the costae are subangular in cross-section, sharp, and relatively few (up to about 26); they increase in number anteriorly by bifurcation and implanation and seem to occur in ill-defined bundles. They are separated by U-shaped interspaces of equal or greater width. Concentric growth lines are mainly obliterated, but where they are present, there is a suggestion that at least some of them were extended into alate lamellae (GSC 53112; Pl. 3, figs. 8, 9).

Interiors of valves not known.

Discussion. *Spirigerina marginaliformis* Alekseeva and its synonym *Spirigerina sibirica* (Rzhonsnitskaya) are distinguished from the younger species, *Spirigerina supramarginalis* (Khalfin), by its more plentiful and finer costae. In recent Russian literature, for example, Alekseeva et al. (1970, p. 133), *S. marginaliformis* has been placed in synonymy with *S. supramarginalis*.

Some of the forms from Cathedral Mountains are somewhat similar in shape, size, and costation to *Spirigerina bicostata* (Stauffer) from the Vaughn Gulch Limestone, Inyo Range, California, as illustrated by Johnson (1973b, Pl. 5, figs. 25 - 29). *Spirigerina bicostata* appears to be characterized by a rather flat pedicle valve and a highly inflat brachial valve. The Cathedral Mountain specimens can be

distinguished from the California form by the greater convexity of the pedicle valve as well as by other, less conspicuous, shape differences.

The specimens described and illustrated by Savage (1970, p. 659, Pl. 102, figs. 42 - 49) from the limestone at the base of the Mandagery Park Formation, New South Wales, Australia, and assigned to *S. supramarginalis* (Khalfin) seem to bear closer similarity to *S. marginaliformis* than to *S. supramarginalis*. The Mandagery Park fauna has been correlated by Johnson (1975) with the lower part of the *Quadrithyris* Zone of Nevada. Conodonts associated with Mandagery Park megafauna are dated by Savage (1974, p. 6) as close to mid-Gedinnian.

A finely costate form of *Spirigerina* from the Maradana Shale of New South Wales is also assigned by Savage (1974, p. 40, Pl. 11, figs. 1 - 9) to *S. supramarginalis*. This form too might better be referred to *S. marginaliformis*. The containing beds are dated as early Gedinnian (early Lochkovian).

Occurrence. In the Cathedral Mountain section, *S. marginaliformis* occurs in GSC localities C-57243 to C-57246, and C-57250, C-57264, and C-57268, all from the upper unit of the 'Delorme' Formation.

In the Natla River area of the southwestern District of Mackenzie, *S. marginaliformis* was recorded by Perry (1974, pp. 367, 368) from 544.07 m below the top of the Delorme Formation, from his S-1 section (latitude 63°18'18"N, longitude 128°34'00"W). At this locality it occurs in beds approximately 15.24 m below *S. supramarginalis* and is dated as early to middle Lochkovian.

In the Royal Creek area of the northern Yukon Territory, *S. marginaliformis* occurs in the lower part of the lower Lochkovian *Gypidula* cf. *G. pelagica* unit of Lenz (1968), where it has been referred to as *S. sibirica* (Rzhonsnitskaya) by Lenz and Pedder (1972, p. 14).

In Nevada, *S. marginaliformis* has been recorded from the F1 fauna of the Roberts Mountains Formation in the Roberts Mountains (Johnson et al., 1973) and from the lower Windmill Limestone at Coal Canyon of central Nevada (Johnson, 1973b). These two occurrences are dated as early and middle Lochkovian, respectively.

In Russia, *Spirigerina marginaliformis* occurs typically in the Petropavlovsk Formation, outcropping on the eastern slope of the Urals and assigned to the upper Ludlow and Gedinnian stages (Alekseeva, 1960). It is also in the Kuznetsk Basin, in beds assigned to the Gedinnian Stage of the Lower Devonian (Alekseeva, 1962).

Figured specimens. GSC 53109 and 53110 are from GSC locality C-57250; GSC 53111 and 53112 from GSC locality C-57244; GSC 53113 from GSC locality C-57245; and GSC 53114 from GSC locality C-57268. All are from the upper unit of the 'Delorme' Formation.

Genus *Atrypa* Dalman, 1828

Type species: *Anomia reticularis* Linné, 1758, p. 702

Atrypa nieczlawiensis Kozłowski, 1929

Plate 3, figures 22 - 40; Plate 4, figures 1 - 30
 Textfigures 6, 7

- 1929 *Atrypa reticularis* var. *nieczlawiensis* Kozłowski, p. 170, Pl. 8, figs. 14 - 17
 1962 *Atrypa* sp. McLaren, Norris, and McGregor, Pl. 8, figs. 4 - 6
 1970 *Atrypa* cf. *A. reticularis nieczlawiensis* Kozłowski; McLaren, Norris, and Cumming, p. 620, Pl. 10, fig. 3
 1973 *Atrypa nieczlawiensis* Kozłowski; Johnson, Boucot, and Murphy, p. 47, Pl. 24, figs. 14 - 27
 1974 *Atrypa nieczlawiensis* Kozłowski; Perry, p. 347, Pl. 29, figs. 18 - 23

Material. GSC 53115: a young biconvex individual. GSC 53116: a young, rotund, elongate individual. GSC 53117: a planoconvex inflat individual. GSC 53118: a nearly equally biconvex individual. GSC 53119: a broad, thick individual. All preceding are from GSC locality C-57241. GSC 53120: a young, elongate, thick individual from GSC locality C-57250. GSC 53121: a thin, very broad individual from GSC locality C-57265. GSC 53122: a very thin, elongate individual from GSC locality C-57248. GSC 53123: a thin, elongate individual, partly embedded in matrix to show development of marginal frill, from GSC locality C-57265.

This form is represented by 334 calcareous specimens; it is by far the most abundant form in the Cathedral Mountain section.

Dimensions.

GSC No.	53115	53116	53117	53118	53119	53120	53121	53122	53123	53136	53137
						(mm)					
Length of pv (Lp)	13.0	+15.7	17.8	15.5	20.4	14.4	18.0	21.1	18.1	21.6	18.7
Length of bv (Lb)	12.1	15.3	16.6	14.9	19.3	13.6	17.3	19.9	—	19.3	18.2
Width (W)	13.0	15.9	18.5	15.9	22.5	15.1	20.4	22.6	19.2	22.5	21.5
Depth of shell (D)	6.7	9.3	12.4	10.5	13.5	8.6	9.1	7.4	9.6	14.8	9.4
Hinge line length	9.4	13.8	12.0	11.9	19.4	11.5	16.9	18.8	17.0		
Hinge angle (in degrees)	140	128	151	135	137	137	161	166	157		
Depth of sulcus at anterior margin	0	1.5	6.5	3.2	6.5	0.6	0	2.6	—		

Description. Shell attains a small to medium size, subequally biconvex in lateral profile, varying from relatively thin to highly inflat forms at maturity; outline is variable, from subcircular to almost semicircular to elongate suboval; generally wider than long (greatest width at or posterior to midlength); posterolateral extremities rounded, anterior commissure nearly rectimarginate in young stages and in mature thin forms, moderately to strongly uniplicate in mature thick forms.

Pedicle valve gently and irregularly arched from back to front along midline, the greatest curvature generally being immediately anterior to beak, gently to moderately arched transversely, commonly strongly elevated in umbonal region, flattened toward posterolateral extremities, recurved in adult thin forms. Sulcus absent or only weakly developed in young stages, relatively broad and weakly to strongly upturned in later stages. Beak small, very short and incurved, lying closely appressed against the dorsal umbo and having small circular foramen evident on some specimens; foramen is completely covered in some gerontic specimens where beak is strongly incurved over brachial umbo; beak ridges sharp; interarea narrow; deltidial plates not evident.

Brachial valve weakly to strongly arched longitudinally, generally highest and most strongly arched near midlength; pronounced narrow trough along midline over umbo, flattened and slightly recurved toward posterolateral extremities. Beak hidden.

Exterior of both valves ornamented by moderately fine rounded costellae that increase in number by dichotomy and implanation. The costellae are separated by very narrow slitlike interspaces. Five to seven costellae occur in a space of 2 mm at 5 mm from the beak across the midline. Variably spaced concentric growth lines, each of which once extended as marginal frill beyond the main part of the shell (Pl. 4, figs. 29, 30), are strongly developed on most individuals. The imbricating alate lamellae are very thin and fragile and are generally broken when the shell is extracted from the rock matrix. Most dichotomy and implanation of radial costae occurs immediately anterior of the concentric growth lines.

Interior of pedicle valve. Small deltidial plates are evident in serially sectioned specimen (Textfig. 6). A pair of inwardly directed hinge teeth are oriented subparallel to the hinge line and are supported basally by dental lamellae that

join the interior shell wall. Anteriorly, each tooth is joined by a laterally directed subsidiary tooth, which is separated from the main tooth by a relatively broad indentation and from the posterior lateral margin of the shell by a narrow, deep, slitlike indentation. Shell material enclosing umbonal cavity is fairly thick.

Interior of brachial valve. Discrete dental socket plates are broadly divergent and are directed obliquely inward to partly enclose the notothyrial cavity. A broad tooth socket is present along the ventral side of each plate. An ill-defined subsidiary socket to accommodate the subsidiary tooth of the opposite valve is present where the socket plate joins the posterolateral margin of the shell. Pronglike crura attached to the anterior ends of the socket plates are directed obliquely inward and extend into the delthyrial cavity of the pedicle valve. Jugal processes from the primary lamellae of the spiralia are almost in juxtaposition near the plane of symmetry of the shell. The two dorsally tapering spiral cones of the spiralia have 12 to 13 spiral whorls in serially sectioned specimen (GSC 53136). A broad, ill-defined myophragm is present along the midline on the floor of the notothyrial cavity; it disappears anteriorly at about 2.9 mm from the pedicle beak (Textfig. 6).

Discussion. The distinctive features of *Atrypa nieczlawiensis* are its uniformly narrow, rodlike costellae separated by narrow slitlike interspaces, which are crossed by conspicuous growth lines. The growth lines mark the site of attachment of thin, alate, fragile lamellae that formed an imbricating frill covering the shell, but these are seldom preserved (Pl. 4, figs. 29, 30). Other, less diagnostic, features are its evenly suboval and biconvex shape and its relatively small size at maturity. Johnson et al. (1973, p. 47) indicate that species of *Atrypa nieczlawiensis* type form a distinct subgroup of *Atrypa* related to the true *Atrypa reticularis*. Of the varieties of *Atrypa reticularis* described by Alexander (1949) from the British Isles, *A. nieczlawiensis* bears the closest superficial resemblance to *A. reticularis* var. *murchisoni* from the Lower Ludlow Shales, Ledbury, Herefordshire.

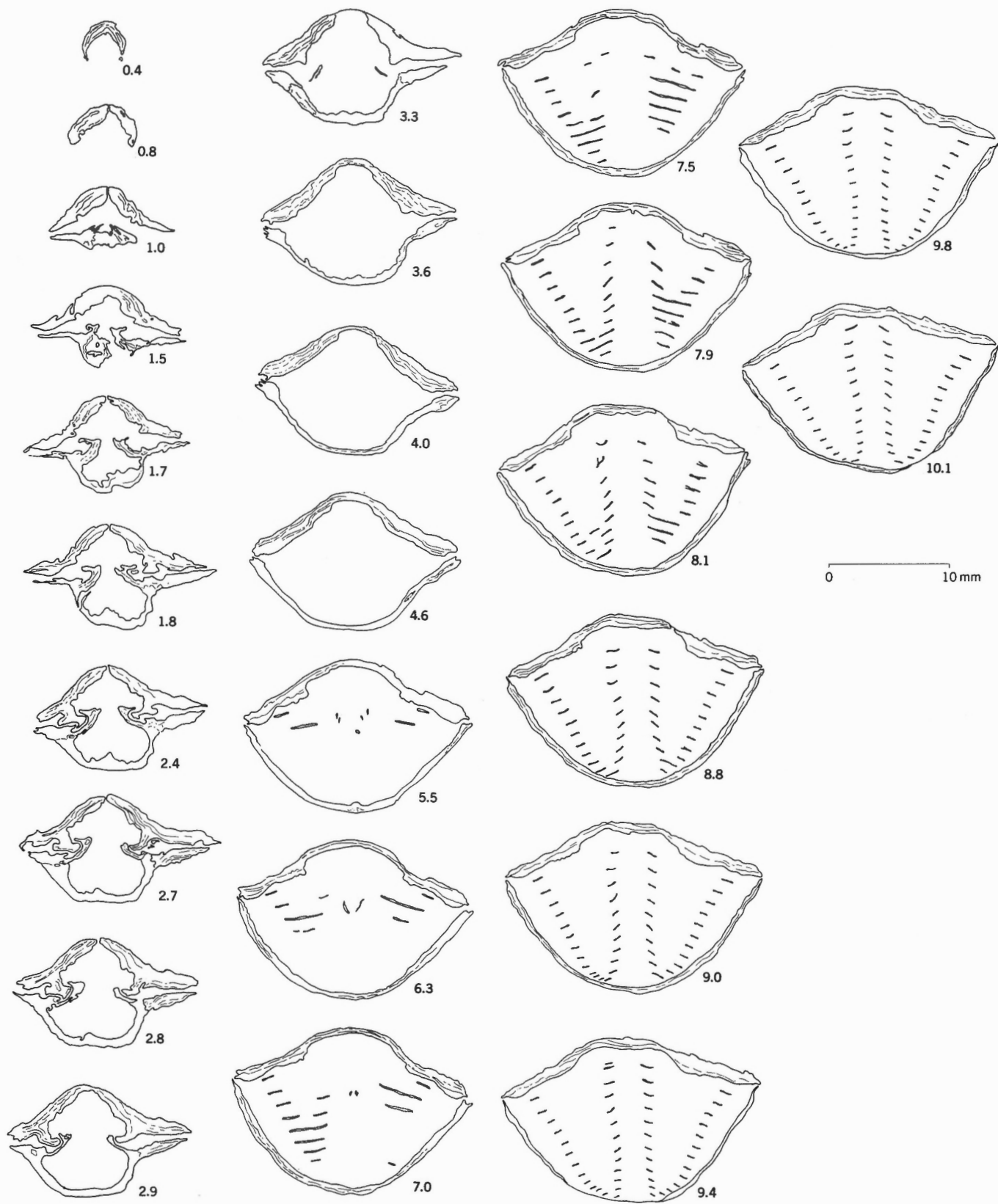
Atrypa arctostriata Foerste, as described and illustrated by Amsden (1949, p. 63, Pl. 9, figs. 10-15) from the Brownsport Formation of Silurian age of Tennessee, appears to be closely similar to *A. nieczlawiensis* from Cathedral Mountain. The similarity is especially close on comparison with thin forms from Cathedral Mountain. The Tennessee form appears to be smaller at maturity, thinner, and somewhat more lenticular than is *A. nieczlawiensis*, but otherwise it is very similar.

Occurrence. From GSC localities C-57235, C-57237, C-57238, and C-57239 in the lower unit and from GSC localities C-57241, C-57244, C-57245, C-57246, C-57247, C-57248, C-57250, C-57251, C-57258, C-57264, C-57265, C-57266, C-57268, C-57269, and C-57272 in the upper unit of the 'Delorme' Formation at Cathedral Mountain.

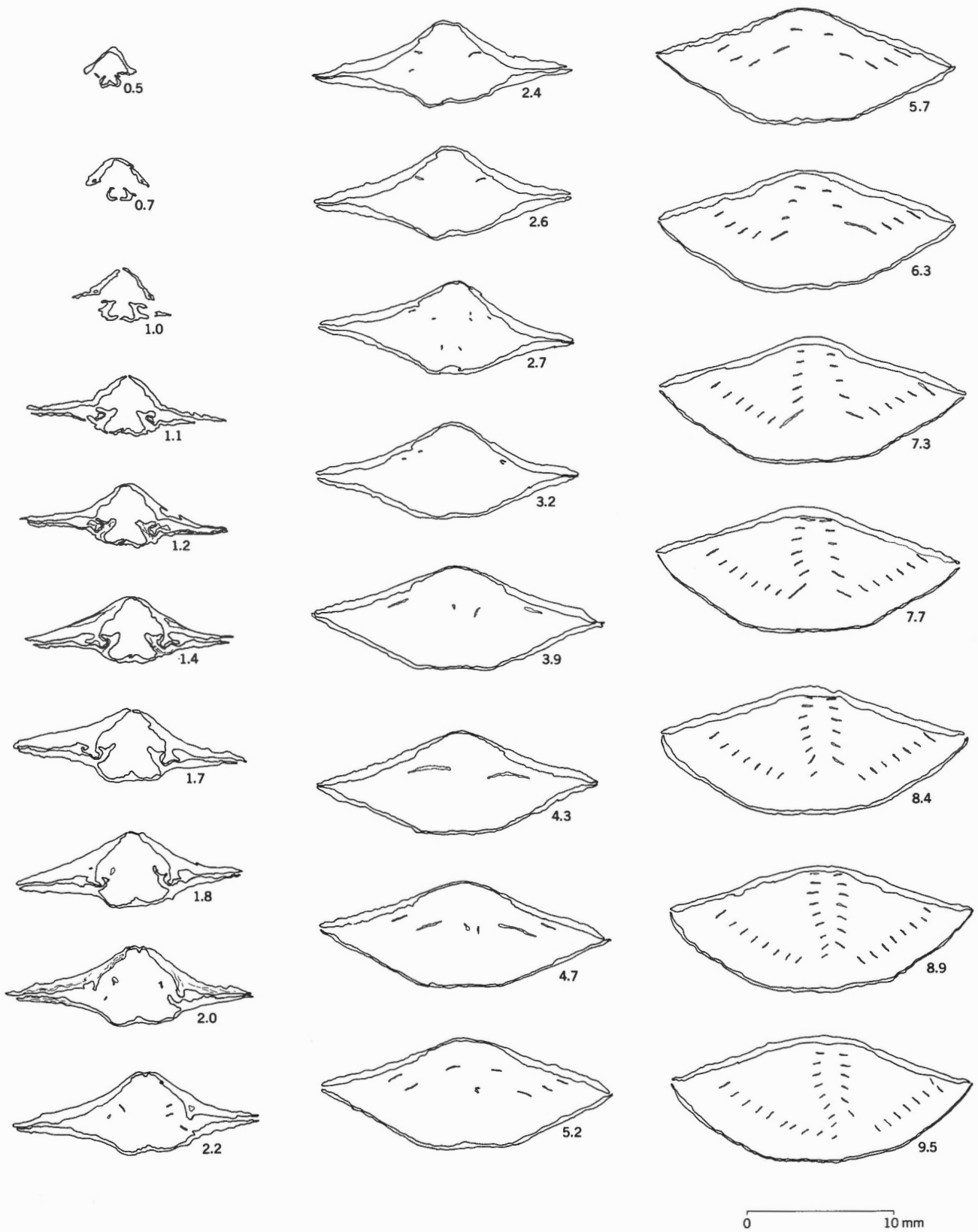
In the southwestern District of Mackenzie, *A. nieczlawiensis* was recorded by Perry (1974, p. 348) from his S-7 (latitude 62°28'50"N, longitude 124°47'00"W) and S-12 (latitude 62°16'N, longitude 125°00'W) sections, 408.43 and 717.81 m, respectively, below the top of the Delorme Formation. It was recovered also from his S-11 (approximately: latitude 63°58'N, longitude 126°33'W) section in beds 211.53 m above the top of the Whittaker Formation in a Road River-Delorme-Camsell transitional facies. These occurrences were dated by Perry (1974) as early Lochkovian.

In Nevada, Johnson et al. (1973) recorded this form as part of the upper "F" fauna of the Roberts Mountains Formation, which they dated as early Gedinnian.

In Podolia, *Atrypa nieczlawiensis* occurs typically in the Borszczow beds of Gedinnian age (Kozłowski, 1929).



Textfigure 6. *Atrypa nieczlawiensis* Kozłowski. Camera lucida drawings of serial transverse sections of a thick, rotund individual; distances are in millimetres forward from the crest of the pedicle umbo. GSC 53136. GSC locality C-57241.



Textfigure 7. *Atrypa nieczlawiensis* Kozłowski. Camera lucida drawings of serial transverse sections of a relatively thin, broad individual; distances are in millimetres forward from the crest of the pedicle umbo. GSC 53137. GSC locality C-57266.

Figured specimens. GSC 53115 to 53119 from GSC locality C-57241; GSC 53122 from GSC locality C-57248; GSC 53120 from GSC locality C-57250; and GSC 53121 and 53123 from GSC locality C-57265. Serially sectioned specimens GSC 53136 and 53137 from GSC localities C-57241 and C-57266, respectively.

Family Ambocoelidae George, 1931

Genus *Metoplasia* Hall and Clarke, 1894

Type species: *Spirifer pyxidatus* Hall, 1859, p. 428

Metoplasia lenzi Johnson, Boucot, and Murphy, 1973

Plate 4, figures 31 - 33

1970 *Metoplasia* sp., Lenz, p. 497, Pl. 87, figs. 5 - 15

1973 *Metoplasia lenzi* Johnson, Boucot, and Murphy, p. 68, Pl. 31, figs. 20 - 28

Diagnosis. Ambocoeliinids bearing a fold on the brachial valve flanked laterally by low, broad plications (Boucot, 1959, p. 16).

Material. Represented by five incomplete specimens.

Dimensions.

GSC No.	53124	53125
	(mm)	
Length of pv (Lp)	+5.25	+4.00
Length of bv (Lb)	—	—
Width (W)	+4.95	+4.35
Depth of Shell (D)	—	—

Description. Shells very small, transverse in outline and roughly triangular. In lateral profile they are very unequally biconvex, having an almost flat to gently convex brachial valve about half as thick as the deep pedicle valve. Greatest width of shell at or posterior to midlength. Hinge line relatively long and straight. Cardinal angles rounded.

Pedicle valve has a conspicuous high palintrope. The latter is moderately curved and has a triangular apsacline interarea approaching the catacline position. Interarea is cleft by an open narrow triangular delthyrium. Pedicle sulcus, which becomes deeper and wider anteriorly, commences immediately anterior to or over the umbo. Flanking the sides of the sulcus are two weakly developed, broad, low plications that accentuate its depth.

Brachial valve bears a relatively broad, low fold. Each of its flanks bears one or two very weak, broad plications.

Closely spaced concentric growth lamellae are well preserved on the pedicle valve of one specimen (GSC 53124).

Interiors of valves not evident.

Comparison. The Cathedral Mountain specimens, insofar as comparison is possible on the limited material, bear a close similarity to *Metoplasia lenzi* in size, shape outline, fold and sulcus, and lateral plications.

Occurrence. From GSC localities C-57235, C-57237, and C-57238 from the lower unit and GSC locality C-57248 from the upper unit of the 'Delorme' Formation.

Figured specimens. GSC 53124 and 53125, both from GSC locality C-57237

Suborder Spiriferoidea
Superfamily Delthyridacea Phillips, 1841
Family Delthyrididae Phillips, 1841
Subfamily Delthyridinae Phillips, 1841

Genus *Howellella* Kozłowski, 1946

Type species: *Delthyris elegans* Muir-Wood, 1925 (= *Terebratula crista* Hisinger, 1827, Pl. 7, fig. 4); not Linnaeus, 1758

Howellella sp.

Plate 4, figures 34 - 37; Plate 5, figures 1 - 3

Material. Represented by five pedicle valves and two brachial valves.

Dimensions.

GSC No.	53126	53127	53128	53129	53130	53131	53132
	(mm)						
Length of pv (Lp)	6.90	ca. 7.1	9.10	ca. 3.1	ca. 5.4	—	—
Length of bv (Lb)	—	—	—	—	—	ca. 10.05	ca. 10
Width (W)	9.25	10.90	13.8	ca. 3.5	ca. 8.6	16.8	14.8
Depth of shell (D)	—	—	—	—	—	—	—
Ratio Lp/W	0.74	0.65	0.65	0.88	0.62	ca. 0.59	ca. 0.67
Ratio Lp/D	—	—	—	—	—	—	—
Plications on flanks of pv	3-3	2-2	?-3	1-1	?-2	—	—
Plications on flanks of bv	—	—	—	—	—	?-4	?-2

Description. Shells of small to moderate size, transversely suboval in outline and unequally biconvex in lateral profile, the pedicle valve being two or three times as deep as the brachial valve. Cardinal angles broadly rounded. Maximum width posterior to midlength.

Pedicle valve strongly and evenly convex along the midline, its maximum depth at about midlength. Pedicle beak and umbo strongly curved. Interarea low, triangular, slightly curved, and apsacline. The delthyrium is open and triangular and is bounded by thin deltidial plates projecting posteriorly. The pedicle valve bears a broad, shallow, U-shaped sulcus that widens anteriorly. The sulcus is bordered by strong plications, which are sharply delineated from those on the flanks. Flanks of pedicle valve have from one to three broadly rounded weak plications; those toward the posterior-lateral margins are barely perceptible.

Brachial valve is weakly to moderately convex along the midline. Dorsal interarea is poorly defined and appears to be nearly linear and broadly rounded and gradually widens anteriorly to near the anterior margin, where it abruptly flares out. One specimen (GSC 53132) shows a narrow groove along the midline of the umbo. Lateral flanks showing two to four broad, weak plications separated by narrower interspaces.

Somewhat thin dental lamellae that join the base of the shell on the lateral sides of the prominent plications flanking the sulcus can be seen on broken specimens of the pedicle umbo. These diverge slightly from the midline as they are traced anteriorly. There is a suggestion of a threadlike myophragm along the midline of the umbonal cavity. There is no thickening in the umbonal cavity.

Interior of brachial valve is not evident.

Shell ornament consists of closely spaced, relatively coarse, concentric growth lamellae crossed by very fine radial striae suggestive of capillae becoming fimbriate at anterior edges of growth lamellae.

Comparison. *Howellella* sp. from Cathedral Mountain is closely similar in shape outline to a form designated by Perry (1974) as *Howellella* sp. 1, from Delorme beds of probable early Lochkovian age in the southwestern District

of Mackenzie. The lateral plications on the Cathedral Mountain form do not appear to be as strongly developed as those on the form illustrated by Perry (1974, Pl. 39, figs. 8 - 25).

In development of lateral plications, *Howellella* sp. appears to be intermediate between *H. laeviplicatus* and *H. angustiplicatus*, described by Kozłowski (1929) from lower Lochkovian beds of Podolia. The micro-ornament on the shells of the two species from Podolia as illustrated by Kozłowski (1929, Pl. 10, figs. 16, 27) also appears to be closely similar to that on the Cathedral Mountain form.

In its external shape and development of flank plications, *Howellella* sp. from Cathedral Mountain is somewhat similar to shells from lower Lochkovian strata of Nevada assigned to *Undispirifer* cf. *U. laeviplicatus* by Johnson et al. (1973). Poor preservation of the Nevada shells precluded the possibility of observing fine radial ornamentation, if any.

Occurrence. From GSC localities C-57235, C-57237, and C-57238 from the lower unit; and from GSC locality C-57248 from the upper unit of the 'Delorme' Formation.

Figured specimens. GSC 53126 to 53132, all from GSC locality C-57237

Superfamily Cyrtinacea Frederiks, 1912
(*nom. transl.* Johnson, 1966, ex. Cyrtininae
Frederiks, 1912)

Family Cyrtinidae Frederiks, 1912

Genus *Cyrtina* Davidson, 1858

Type species: *Calceola heteroclita* DeFrance, 1828, p. 306

Cyrtina sp.
Plate 5, figure 4

Material. Specimen consists of an incomplete pedicle valve.

Dimensions.

GSC No.	53133
	(mm)
Length of pv	+6.00
Width	+7.85

Description. The pedicle valve is subpyramidal and has slightly curved lateral slopes. Beak appears to be twisted very slightly to one side. Pedicle valve bears a narrow U-shaped sulcus bounded by strong plications, which originate over the umbo and gradually widen anteriorly to near the anterior margin, where the sulcus abruptly widens. Each flank of pedicle valve and the two rounded plications is separated by relatively broad U-shaped interspaces. Plications appear to become obsolescent toward the anterior lateral margins. Traces of concentric lamellose markings. Shell material is punctate.

Interior not evident.

Discussion. Although *Cyrtina* is reported by Perry (1974, p. 448) to be comparatively common in beds of the Delorme Formation in the southwestern District of Mackenzie, this form is exceedingly rare in the Cathedral Mountain section. Perry (1974, p. 448) noted a wide range of variability in shape of *Cyrtina* even within collections from a single locality and horizon.

In Nevada, Johnson et al. (1973) recorded the presence of *Cyrtina* in Pridolian beds but noted that the specimen possibly was misplaced. In northwestern Canada, *Cyrtina* has not been recorded in beds older than the Lochkovian.

Occurrence. From GSC locality C-57237 in the upper part of the lower unit of 'Delorme' Formation.

Figured specimen. GSC 53133

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PLATE 1

Figure 1. *Lingula* sp.

Interior view of valve embedded in matrix; X1; GSC 53086; GSC locality C-57265.

Figures 2 - 10. *Resserella* sp. cf. *R.elegantuloides*(Kozłowski)

(2 - 4) Pedicle, brachial, and anterior views; X1; GSC 53087; GSC locality C-57250.

(5) Brachial view; X2; GSC 53088; GSC locality C-57265. (6 - 10) Pedicle, brachial, lateral, anterior, and posterior views; X2; GSC 53089; GSC locality C-57248.

Figures 11 - 25 . *Schizophoria paraprima* Johnson, Boucot, and Murphy

(11 - 14) Pedicle, brachial, lateral, and posterior views; X2; GSC 53090; GSC locality C-57250.

(15 - 17) Pedicle, lateral, and anterior views; X1; GSC 53091; GSC locality C-57264. (18 - 20) Pedicle, brachial, and anterior views; X1; GSC 53092; GSC locality C-57258. (21 - 25) Pedicle, brachial, lateral, anterior, and posterior views; X2; GSC 53093; GSC locality C-57265.

Figures 26, 27. *Mesodouvillina?* sp.

Impression of brachial valve in rock matrix and latex positive of the same impression; X2; GSC 53094; GSC locality C-57239.

Figures 28-32. *Iridistrophia* sp. cf. *I.umbella* (Barrande)

(28, 29) Pedicle views of specimen embedded in rock matrix; X1 and X2; GSC 53095; GSC locality C-57235. (30) Brachial view of a young individual embedded in matrix; X3; GSC 53096; GSC locality C-57235. (31, 32) Brachial views of an adult individual embedded in matrix; X1 and X2; GSC 53097; GSC locality C-57235.

Figures 33 - 47. *Gypidula pelagica lux* Johnson, Boucot, and Murphy

(33 - 38) Pedicle views, X1 and X2, and brachial, posterior, anterior, and lateral views of a young, narrow, elongate individual, X2; GSC 53098; GSC locality C-57241. (39 - 42) Pedicle views, X1 and X2, and brachial views, X1 and X2, of a young, relatively broad, individual; GSC 53099; GSC locality C-57241. (43 - 47) Pedicle, brachial, anterior, lateral, and posterior views of a young adult individual; X1; GSC 53100; GSC locality C-57241.

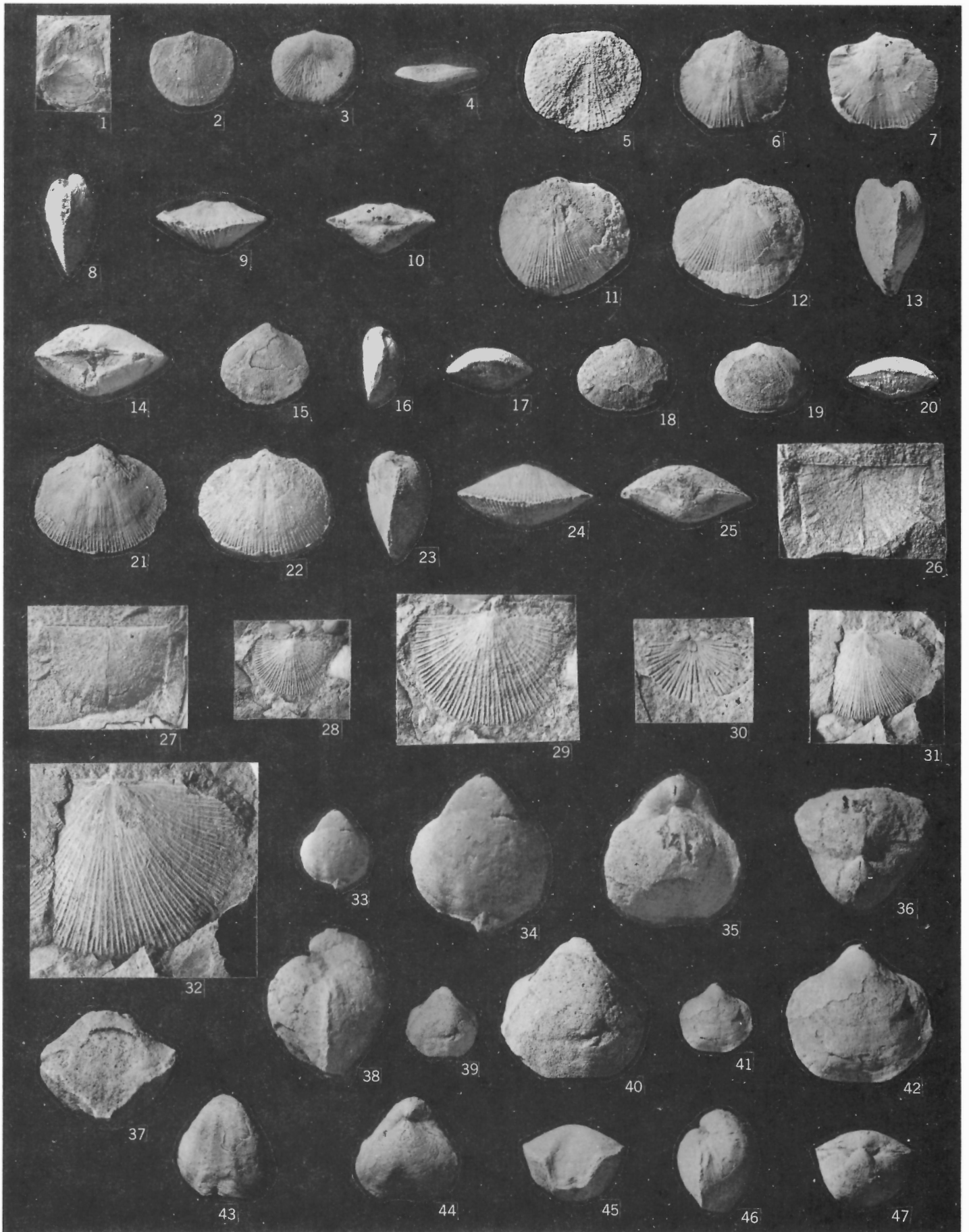


PLATE 2

Figures 1 - 18. *Gypidula pelagica lux* Johnson, Boucot, and Murphy

(1-3) Pedicle, brachial, and anterior views of a rather broad, adult individual; X1; GSC 53101; GSC locality C-57241. (4-8) Pedicle, brachial, lateral, posterior, and anterior views of a very broad, adult individual; X1; GSC 53102; GSC locality C-57241. (9-13) Pedicle, lateral, brachial, posterior, and anterior views of an elongate, adult individual; X1; GSC 53103; GSC locality C-57241. (14-18) Pedicle, lateral, brachial, posterior, and anterior views of a very narrow, elongate, adult individual; X1; GSC 53104; GSC locality C-57241.

Figures 19 - 22. *Gypidula* sp. (costate form)

(19, 20) Brachial and pedicle views; X1; GSC 53105; GSC locality C-57241. (21, 22) Pedicle and brachial views; X1; GSC 53106; GSC locality C-57241.

Figures 23 - 32. *Ancillotoechia* sp. cf. *A. gutta* Johnson, Boucot, and Murphy

(23-28) Pedicle views, X2 and X3; brachial view, X3; posterior, lateral, and anterior views, X2; GSC 53107; GSC locality C-57268. (29-32) Pedicle, lateral, brachial, and anterior views; X3; GSC 53108; GSC locality C-57268.

Figures 33 - 39. *Spirigerina marginaliformis* Alekseeva

(33-37) Pedicle, brachial, posterior, anterior, and lateral views; X2; GSC 53109; GSC locality C-57250. (38, 39) Pedicle views; X2 and X1; GSC 53110; GSC locality C-57250.

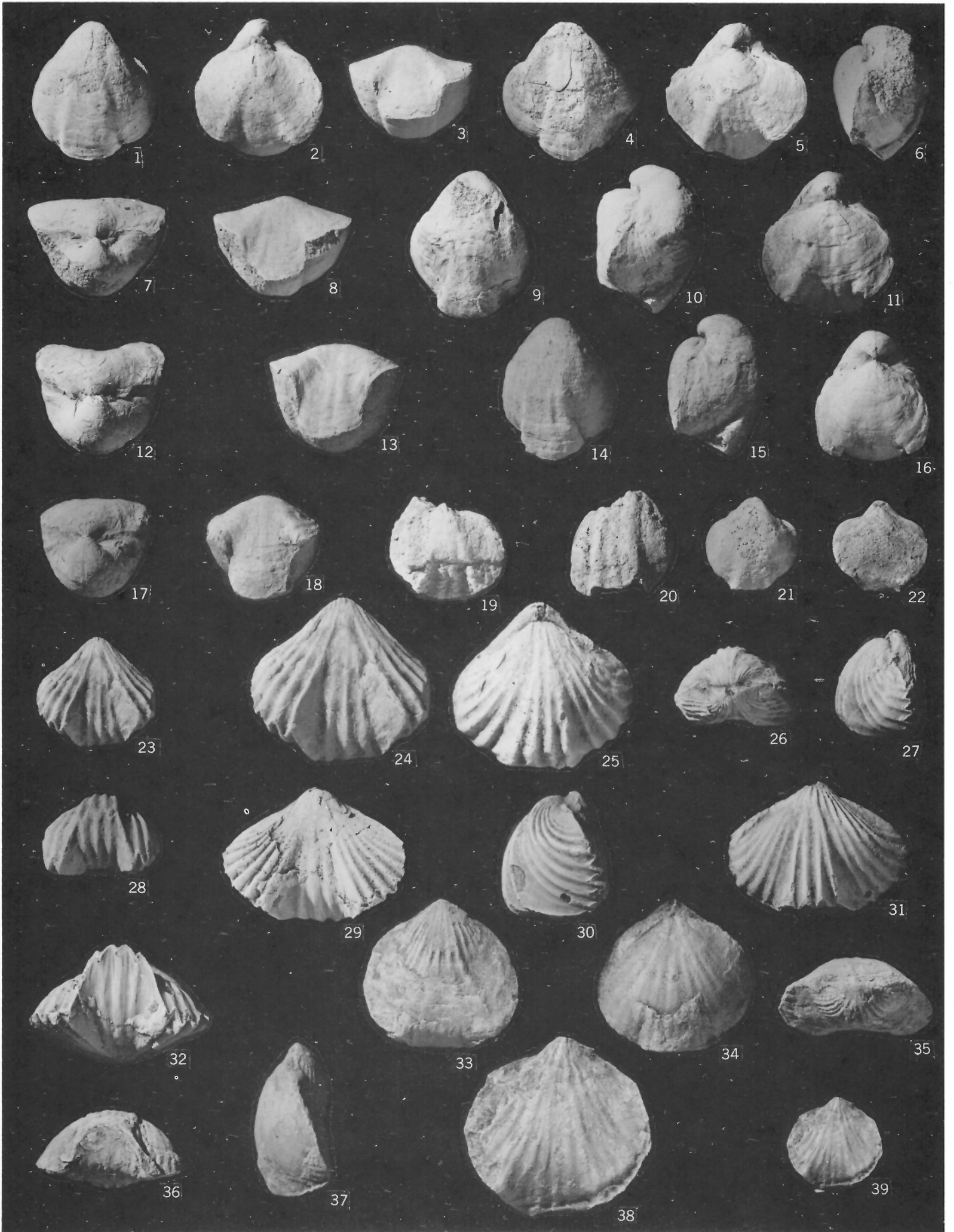


PLATE 3

Figures 1 - 21. *Spirigerina marginaliformis* Alekseeva

(1 - 7) Pedicle views, X2 and X3; brachial view, X2; lateral views, X3 and X2; anterior view, X2; GSC 53111; GSC locality C-57244. (8 - 10) Views of pedicle valve with attached matrix showing part of marginal frill, X2 and X3; brachial view, X2; GSC 53112; GSC locality C-57244. (11 - 15) Pedicle, brachial, lateral, posterior, and anterior views; X2; GSC 53113; GSC locality C-57245. (16 - 21) Pedicle views, X2 and X3; brachial views, X2 and X3; posterior and lateral views, X2; GSC 53114; GSC locality C-57268.

Figures 22 - 40. *Atrypa nieczlaviensis* Kozłowski

(22 - 28) Pedicle views, X1 and X2; brachial views, X2 and X1; posterior, anterior, and lateral views, X2; GSC 53115; GSC locality C-57241. (29 - 34) Pedicle views, X1 and X2; brachial views, X1 and X2; anterior views, X1 and X2; GSC 53116; GSC locality C-57241. (35 - 40) Pedicle, posterior, anterior, and lateral views, X1; brachial views, X1 and X2; GSC 53117; GSC locality C-57241.

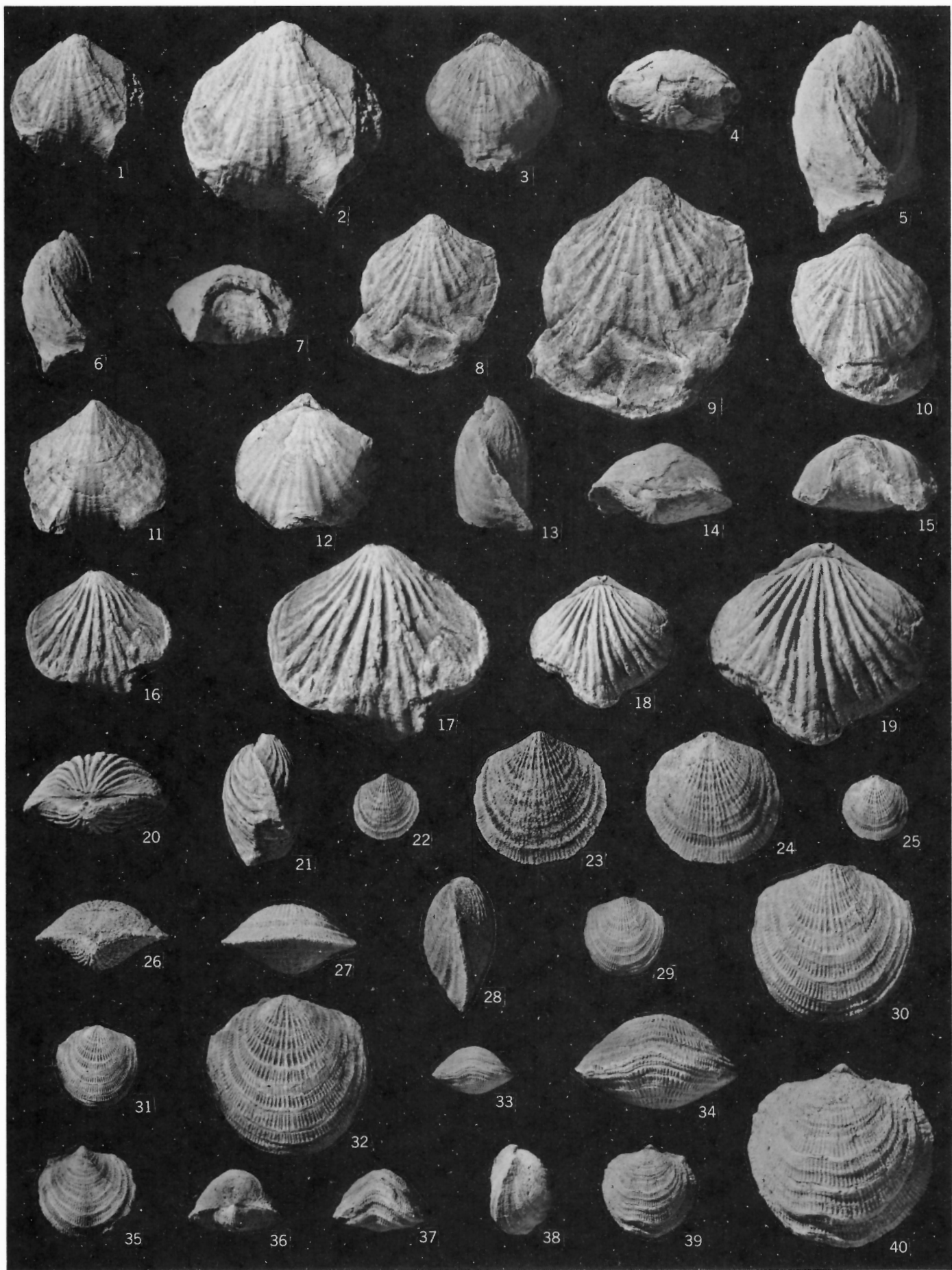


PLATE 4

Figures 1 - 30. *Atrypa nieczlawiensis* Kozłowski

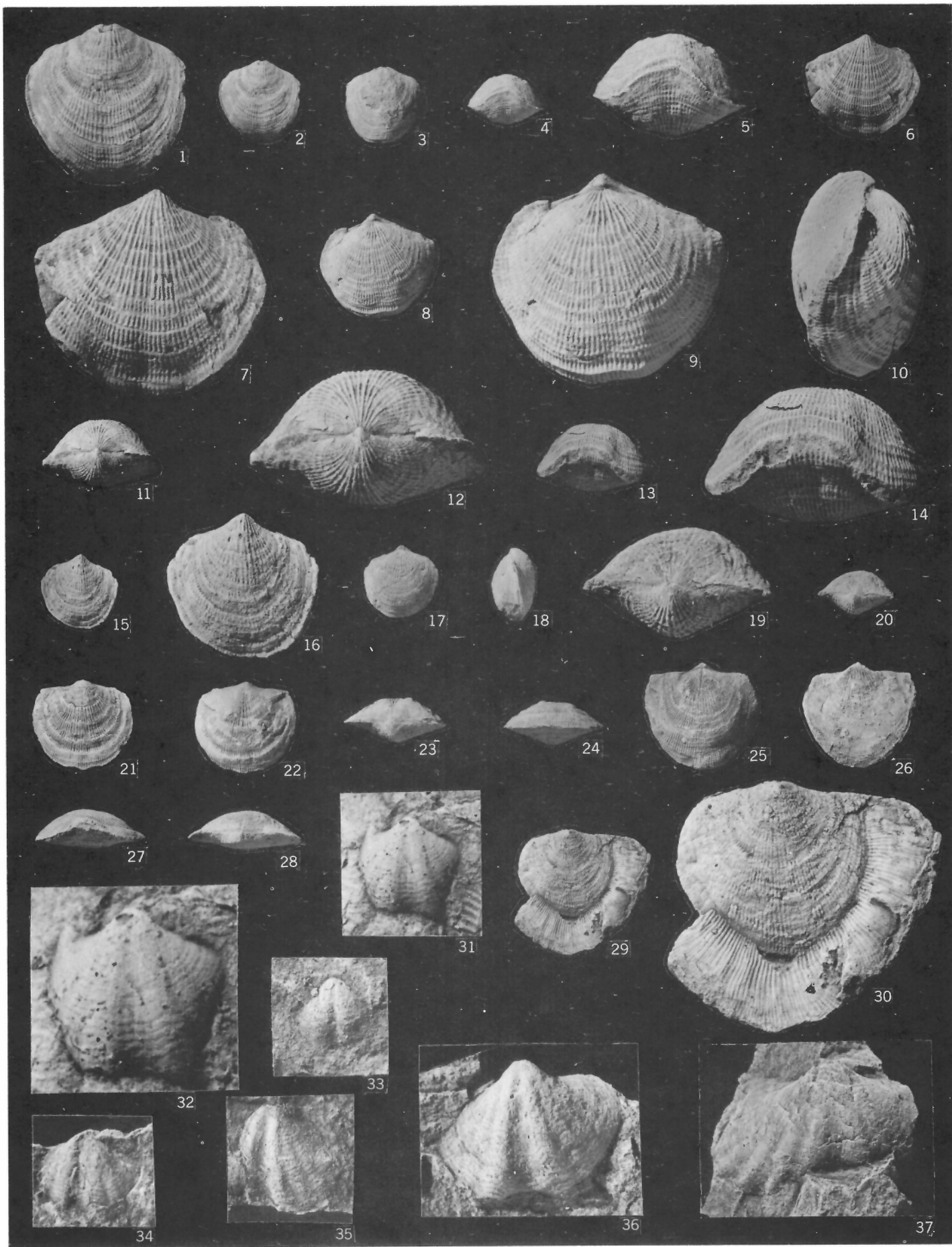
(1 - 5) Pedicle views, X1 and X2; brachial view, X1; anterior views, X1 and X2; GSC 53118; GSC locality C-57241. (6 - 14) Pedicle and brachial views, X1 and X2; lateral view, X2; posterior and anterior views, X1 and X2; GSC 53119; GSC locality C-57241. (15 - 20) Pedicle views, X1 and X2; brachial and lateral views, X1; posterior views, X2 and X1; GSC 53120; GSC locality C-57250. (21 - 24) Pedicle, brachial, posterior, and anterior views of a thick broad individual; X1; GSC 53121; GSC locality C-57265. (25 - 28) Brachial, pedicle, anterior, and posterior views of a very thin, slightly elongate individual; X1; GSC 53122; GSC locality C-57248. (29, 30) Views of pedicle valve attached to matrix showing marginal frill; X1 and X2; GSC 53123; GSC locality C-57265.

Figures 31 - 33. *Metaplasia lenzi* Johnson, Boucot, and Murphy

(31, 32) Latex positive impression of pedicle valve of specimen embedded in matrix; X4 and X7; GSC 53124; GSC locality C-57237. (33) Pedicle view of specimen embedded in matrix; X4; GSC 53125; GSC locality C-57237.

Figures 34 - 37. *Howellella* sp.

(34) Pedicle view of specimen embedded in matrix; X6; GSC 53129; GSC locality C-57237. (35) Oblique pedicle view of specimen embedded in matrix; X4; GSC 53130; GSC locality C-57237. (36) Pedicle view of specimen embedded in matrix; X4; GSC 53126; GSC locality C-57237. (37) Oblique pedicle view of specimen embedded in matrix; X4; GSC 53127; GSC locality C-57237.



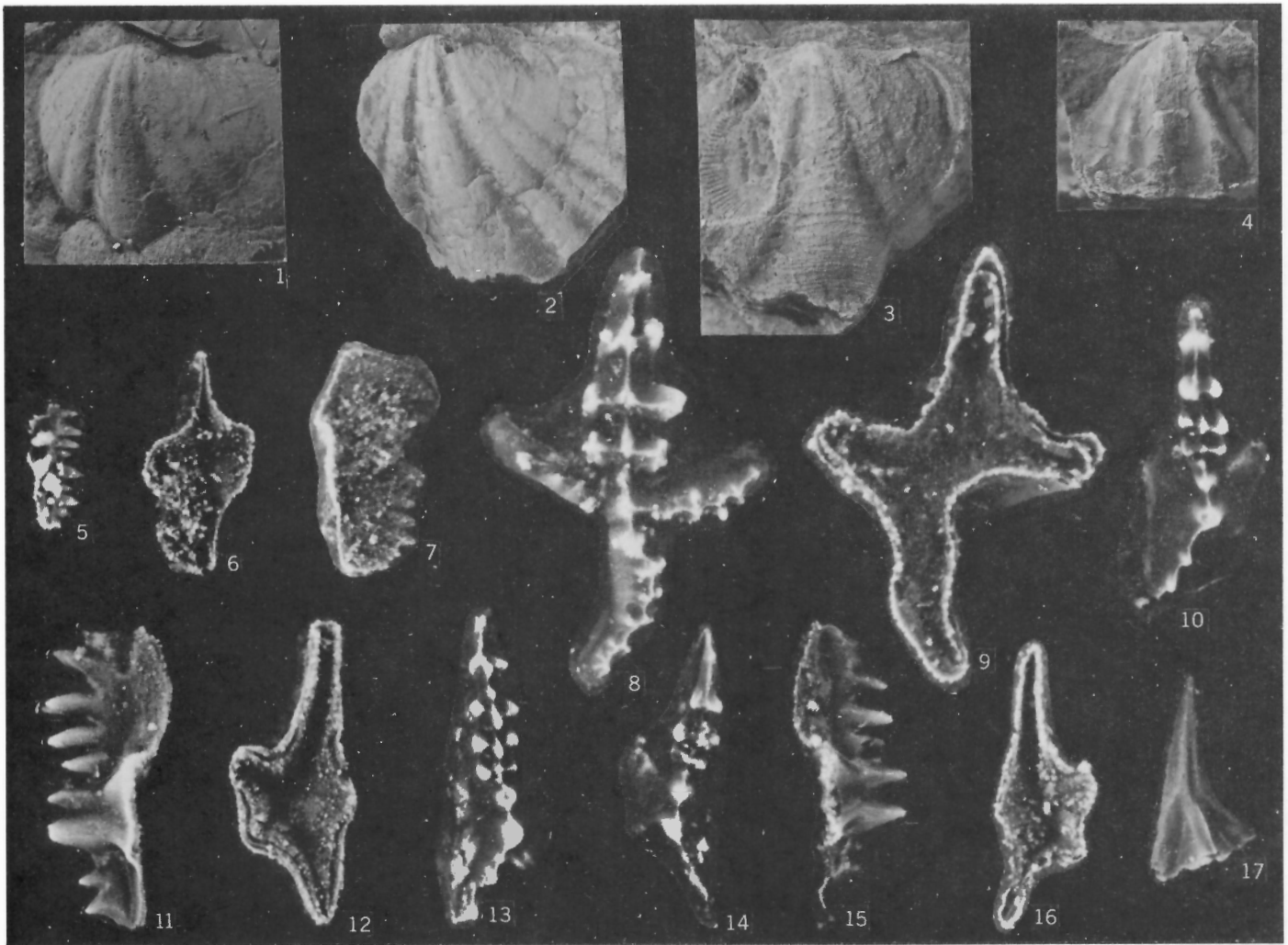


PLATE 5

Figures 1 - 3. *Howellella* sp.

(1) Latex positive impression of brachial valve embedded in matrix; X4; GSC 53128; GSC locality C-57237. (2) Oblique brachial view of valve embedded in matrix; X4; GSC 53131; GSC locality C-57237. (3) View of part of brachial valve embedded in matrix; X4; GSC 53132; GSC locality C-57237.

Figure 4. *Cyrtina* sp.

Oblique pedicle view of fragmentary specimen embedded in matrix; X4; GSC 53133; GSC locality C-57237.

Figure 5. *Ozarkodina* sp.

Lateral view of Pa element; X40, GSC 53466; GSC locality C-57221

Figures 6, 7. *Ozarkodina* n. sp. G of Uyeno (1977)

Lower and lateral views of Pa element; X40; GSC 53467; GSC locality C-57242.

Figures 8, 9. *Pedavis* n. sp.

Upper and lower views of I element; X40; GSC 53468; GSC locality C-57242.

Figures 10 - 17. *Caudicriodus woschmidti* (Ziegler)

(10) Upper view of I element; X40; GSC 53469; GSC locality C-57249. (11 - 13) Inner lateral, lower, and upper views of I element; X40; GSC 53470; GSC locality C-57249. (14 - 16) Upper, inner lateral, and lower views of I element; X40; GSC 53471; GSC locality C-57249. (17) Lateral view of S₂ element; X40; GSC 53472; GSC locality C-57249.