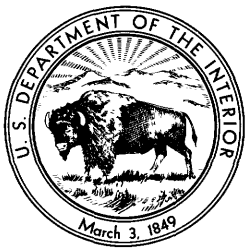
Late Paleozoic Gastropoda from Northern Alaska

By ELLIS L. YOCHELSON *and* J. THOMAS DUTRO, JR.

SHORTER CONTRIBUTIONS TO GENERAL GEOLOGY

GEOLOGICAL SURVEY PROFESSIONAL PAPER 334-D

Descriptions and illustrations of 34 species and 1 new genus, with brief discussion of their stratigraphic significance



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CONTENTS

ILLUSTRATIONS

[Plates follow p. 148]

TABLE

SHORTER CONTRIBUTIONS TO GENERAL GEOLOGY

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by ELLIS L. YOCHELSON and J. THOMAS DUTRO, Jr.

ABSTRACT

Late Paleozoic gastropods from northern Alaska occur in rocks of both Mississippian and Permian age; most of the fossils studied came from the Mississippian. Although the gastropods are of use for dating the rocks only in the broadest terms, locally they are useful in establishing informal faunal zonation. On the basis of predominant occurrence of certain gastropods, it is possible to distinguish rocks of Early Mississippian, Late Mississippian, and Permian age. Two divisions, based on the distribution of gastropods, are distinguished in the Upper Mississippian. One collection, consisting entirely of specimens of *Glabrocingulum* and *Trepospira*, may indicate the presence of rocks of Pennsylvanian age. Occurrence and distribution data are summarized in tabular form.

The gastropod faunule is composed primarily of euomphalaceans, platyceratacean, pleurotomariaceans, neritaceans, and bellerophontaceans, in that order of abundance. There is no indication that a distinct boreal fauna is represented. Many of the specimens are poorly preserved, though some well-preserved shells occur, particularly among the pleurotomariaceans.

Thirty-four species are recognized in the systematic treatment; nine of these are formally named as new species and one is referred to a previously described species. One new pleurotomariacean genus, *Nodospira*, is described. At least two other new genera may occur in the faunule but specimens are too incomplete for adequate taxonomic description. The occurrence of two scaphopod specimens is reported.

Most of the fossils were collected from the Brooks Range during fieldwork in connection with geologic investigations of Naval Petroleum Reserve No. 4 and adjacent areas. Some earlier collections from northern Alaska were restudied.

INTRODUCTION

This study deals primarily with specimens collected from 1944 to 1953 during the geologic exploration of Naval Petroleum Reserve No. 4. This is one of a series of papers by members of the U.S. Geological Survey planned to describe the various groups of Paleozoic fossils collected in northern Alaska. Mackenzie Gordon, Jr. (1957) has completed a study of the Mississippian cephalopods. Work on certain other fossil groups is in progress.

The philosophy that has guided this work was expressed by J. Brookes Knight (1953, p. 84) who, in describing a poorly preserved Permian gastropod fauna from Mexico, remarked: "* * * a collection of fossils from beds in a region previously unstudied may tell us much, even though the specimens themselves are too poorly preserved to warrant detailed descriptions or naming of species." Most of the fossil gastropods from northern Alaska are poorly preserved; nevertheless, their study contributes to our understanding of the classification and geographic distribution of Paleozoic gastropods. In addition, it presents detailed information useful in regional stratigraphic studies.

Mississippian gastropods were first collected from the Brooks Range by Philip S. Smith in 1911 (Smith, 1913). George H. Girty listed gastropods from northern Alaska in several U.S. Geological Survey Bulletins, but did not describe any of the species. Most of his identifications are summarized in a single chart (Smith and Mertie, 1930, facing p. 182). Specimens identified by Girty were reexamined during the present investigation. A few dozen specimens were collected by A. G. Maddren, J. M. Jessup, and G. L. Harrington during the geologic reconnaissance of the Alaska-Canada boundary (Maddren, 1912, p. 297–314). Finally, several gastropods were obtained by E. de K. Leffingwell (1919) from the Canning River district.

The paleontologic literature of Alaska is well indexed. Dutro (1956) compiled an annotated bibliography of Alaskan Paleozoic paleontology; in addition, Alaska is included in the excellent "Arctic Bibliography" (U.S. Department of Defense, 1953–57). Neither of these sources records late Paleozoic gastropods from Alaska. About half a dozen papers illustrate a few specimens from other parts of the Arctic, but all figures examined are small-size reproductions of poorly preserved specimens. These few specimens are either unnamed or are compared with species described from western Europe.

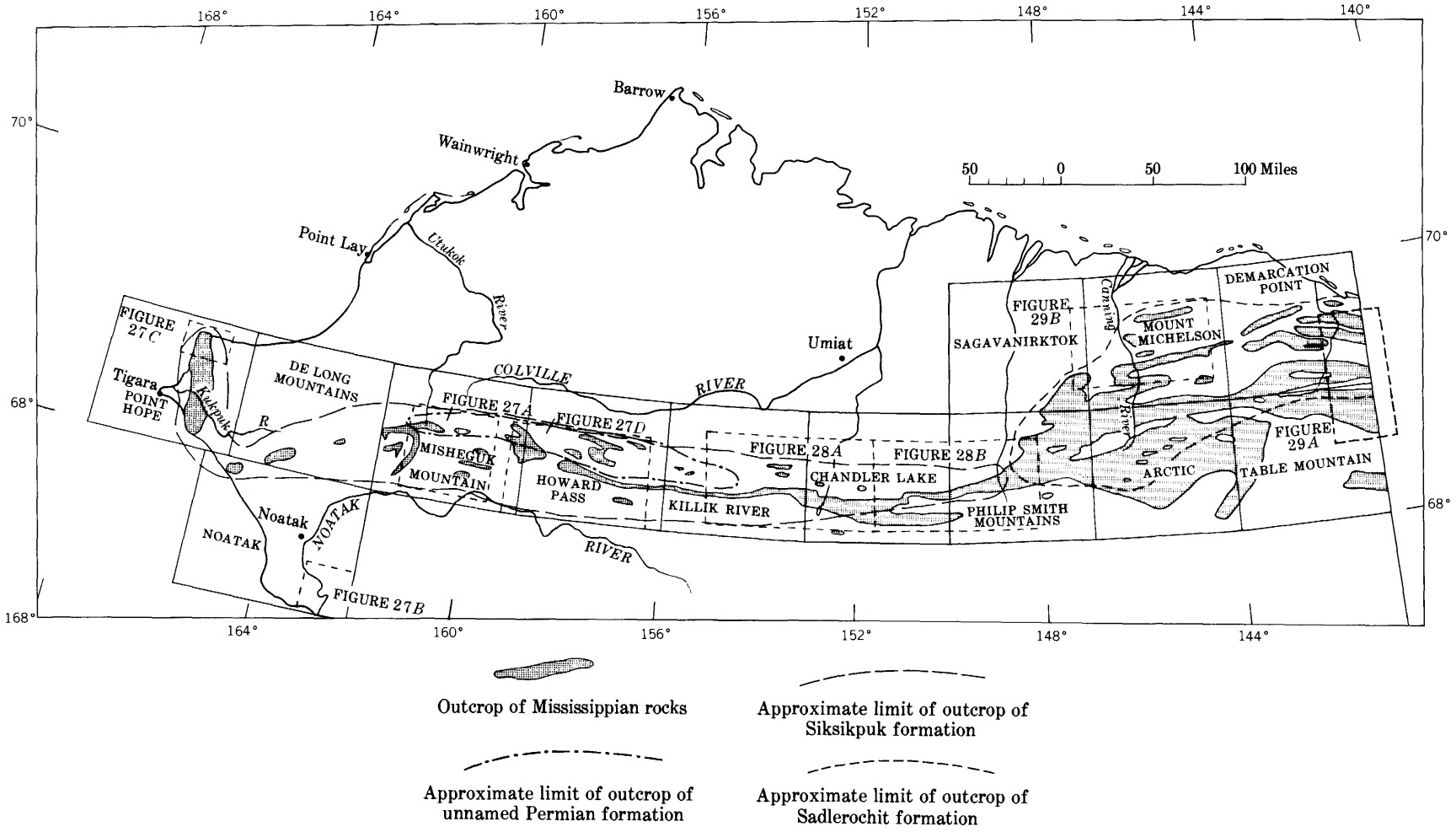


FIGURE 23.—Index map of northern Alaska showing quadrangles referred to in text, locations of figures 27, 28, and 29, generalized outcrop belt of Mississippian rocks, and approximate distribution of Permian rock units.

C. C. Branson's bibliographic index of Permian fossils described through 1941 (Branson, 1948) aids a search of the literature for previously named species. Mississippian fossils, on the other hand, have not been systematically indexed for many years. To the best of the writers' knowledge, the last major papers dealing with gastropods of Mississippian age or early Carboniferous, are those of Koninck (1881, 1883). Literature describing American Mississippian gastropods is scant.

The Brooks Range physiographic province includes several distinct groups of mountains extending from near the 165th meridian eastward to the Canadian boundary. For most of its length the range lies essentially along the 68th parallel, forming the backbone of Alaska and constituting the divide for drainage to the Pacific and Arctic Oceans. Eastward from the 150th meridian the range makes a crescentic bend northeastward until the mountain front is only about 25 miles south of the Arctic coast. The regional setting and topography were described in detail by Smith and Mertie (1930) and summarized by Payne and others (1951). The index map (fig. 23) shows the quadrangles from which gastropod specimens were collected.

The topography of the Brooks Range has been extensively modified by glacial action. Glaciers are not now common, but the climate remains severe. The isolated position of the region has complicated and handicapped fossil collecting. Many collections were backpacked by geologists from the collecting localities and cached in places accessible by airplane. This necessarily limited the number and size of the fossil collections. A few of the localities were visited more than once; most have been only casually sampled.

More than customary acknowledgment is due the fieldmen because fieldwork in northern Alaska is rigorous and requires physical effort not normally associated with fossil collecting. Members, or former members, of the U.S. Geological Survey who collected fossil material on which this paper is based are: A. L. Bowsher, W. P. Brosgé, R. M. Chapman, R. L. Detterman, J. T. Dutro, Jr., Allen Feder, W. A. Fischer, George Gryc, C. J. Gudim, A. S. Keller, B. H. Kent, C. E. Kirschner, A. H. Lachenbruch, M. D. Mangus, R. H. Morris, W. W. Patton, Jr., H. N. Reiser, E. G. Sable, I. L. Tailleur, and R. F. Thurrell, Jr.

Dr. J. Brookes Knight, Smithsonian Institution, retired, examined some of the specimens and made pertinent taxonomic suggestions. Photographs were taken by Nelson W. Shupe, U.S. Geological Survey.

STRATIGRAPHIC DISTRIBUTION OF THE GASTROPODS

The assemblage of gastropod genera dates the rocks as late Paleozoic, but the gastropods themselves are of little value in correlating individual stratigraphic units with rock sequences in regions outside Alaska. With the exception of *Portlockiella* sp., *Rhineoderma*? sp., and *Turbonellina*? *lata*, n. sp., no genera or species thought to be limited to rocks of Mississippian age are known. No species or genera diagnostic of Permian age were identified.

On the other hand, fieldwork has demonstrated that some of the gastropods are useful, locally, in providing supplementary evidence that helps determine the position of certain rock units. Units currently recognized in northern Alaska are discussed below on the basis of distribution of the gastropods.

ROCK UNITS

Rocks of late Paleozoic age in northern Alaska can be assigned to at least six formations. The Mississippian system, represented largely by a complex array of carbonate facies, is divided into two major parts. The nomenclature of Mississippian rock units in the central Brooks Range (fig. 24) has been revised by Bowsher and Dutro (1957, p. 3–7). The lower part, essentially a black shale with a sandstone member at the base and argillaceous limestone beds near the top, is designated as the Kayak shale. The upper part, the Lisburne group, consists of the Wachsmuth limestone below and the Alapah limestone above. Elsewhere in northern Alaska, the Lisburne group has been subdivided into several formations, not as yet formally published. The approximate limits of the Mississippian outcrop belt are shown in figure 23.

No rocks of undoubted Pennsylvanian age are known from northern Alaska. A carbonate rock sequence in the eastern Brooks Range, lying above the Alapah limestone, may represent some part of the Pennsylvanian system. Fossils are rare in these rocks and no gastropods have been collected from them.

The Permian is represented by three quite different formations, each of which represents a predominantly clastic facies. The approximate limits of outcrop of these units are shown in figure 23. The Sadlerochit formation of Permian and Early Triassic age in the eastern Brooks Range was first defined as the Sadlerochit sandstone by Leffingwell (1919, p. 103). Its fauna was studied by Girty and, although the formation was originally called Pennsylvanian, it was Girty who recognized affinities with faunas now considered to be of Permian age (Smith, 1939, p. 32). The Siksikpuk formation of Permian(?) age in the central Brooks Range was described recently by W. W. Pat-

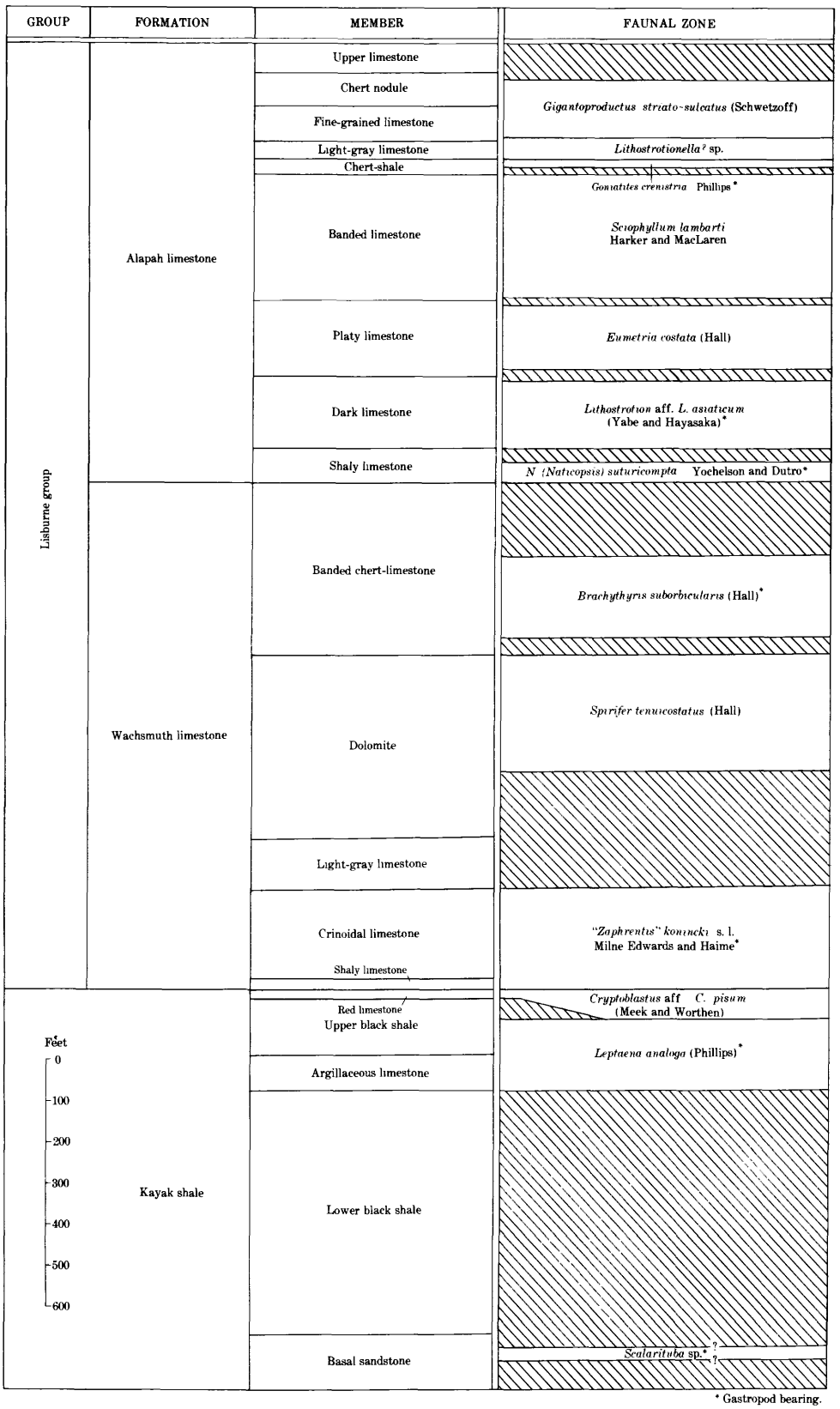


FIGURE 24.—Mississippian stratigraphic nomenclature and faunal zones in the Shainin Lake area, central Brooks Range (modified from Bowsher and Dutro, 1957).

ton, Jr. (1957, p. 41–43). It is essentially a fine-grained clastic facies of the Sadlerochit formation. In some areas a minor amount of silicification is recorded. The third formation of Permian age, as yet unnamed, is a thick sequence of sandstone, quartzose limestone, shale, chert, and conglomerate that crops out extensively in the western part of the Brooks Range. This unit has produced the greatest variety of Permian fossils in northern Alaska and is correlative, in part, with the Sadlerochit and Siksikpuk formations.

FAUNAL ZONES

Mississippian collections yielding gastropods are listed in table 1 according to the faunal zones from which they were collected. These faunal zones were established by Bowsher and Dutro (1957, p. 5 and 6). Gastropods were collected from zones characterized by *Scalarituba* sp., *Leptaena analoga* (Phillips), "*Zaphrentis*" *koninckі* Milne Edwards and Haime (sensu lato), *Brachythyris suborbicularis* (Hall), *N.* (*Naticopsis*) *suturicompta* Yochelson and Dutro, *Lithostrotion* cf. *L. asiaticum* (Yabe and Hayasaka), and *Goniatites crenistria* Phillips (fig. 24 and table 1).

Gastropods were the basis for the erection of one of the faunal zones of Bowsher and Dutro. The fauna of the *Naticopsis howi* Dawson zone (Bowsher and Dutro, 1957, p. 6) is essentially limited to gastropods. The species referred to as *N. howi* by Bowsher and Dutro is described in this paper as *Naticopsis* (*Naticopsis*) *suturicompta*, n. sp., and the name of the zone is changed accordingly.

By an analysis of the cephalopods of the *Goniatites crenistria* zone, these beds have been correlated with the latest Middle Viséan and early Upper Viséan by Gordon (1957, p. 15 and table 2). Regarding the cephalopod faunule, Gordon states (1957, p. 15):

> In the British section, forms identical with and closely related to the Alaskan species of the black chert and shale member are distributed through stratigraphic thicknesses of 150 to nearly 400 feet. In the northern Alaska section, the fossils are limited to the lower 60 feet of the black chert and shale member. Goniatites suggesting three different subzones (B_2, Pla and Plc) have been found at roughly the same stratigraphic level but each in a different river valley. Whether this means that the ranges of certain goniatite genera are somewhat telescoped in the Alaskan section, or whether the black chert and shale member transgresses the section rather irregularly, is not determinable on the basis of present evidence.

No faunal zones have been set up, as yet, for the Permian system in Alaska. The gastropod *Straparollus* (*Euomphalus*) *alaskensis*, n. sp. is commonly found in the lower part of the Siksikpuk formation, but has also been found in the other two Permian formations. Several informal faunal zones have been distinguished in Dutro's research on the younger Permian, particularly in the unnamed rocks of the western Brooks Range. The only zone pertinent to this gastropod study is one characterized by *Licharewia*, a spiriferoid brachiopod that is of widespread occurrence in the upper Permian of Russia and parts of Europe and Asia. The gastropod *Mourlonia? reloba*, n. sp. occurs in this zone in northern Alaska.

Stratigraphic position was assigned to the individual collections either by the collector or by Dutro. Dutro based certain of the assignments on observations made during fieldwork, knowledge of the lithology and regional stratigraphy, study of the general aspect of the fauna, and position of the collection within measured sections. These assignments are used in placing collections in the faunal or rock units listed in table 1. Within each unit, collections are listed in numerical order.

Principal causes of uncertainty as to stratigraphic placement of collections are increasing stratigraphic refinement as the fieldwork progressed, incomplete stratigraphic sequences, and poor preservation of fossils. Collections from measured type sections, or from closely associated sections on which considerable reliance as to correct stratigraphic assignment can be placed, are indicated by reference to footnote 1 preceding the locality number.

STRATIGRAPHIC DISTRIBUTION

LOWER MISSISSIPPIAN UNDIFFERENTIATED

The Lower Mississippian rocks of northern Alaska include the Kayak shale and the Wachsmuth limestone, each of which contains three faunal zones (fig. 24). The few snails collected from these zones provide, in themselves, no basis for distinguishing any one zone from another. Accordingly, most collections from localities other than type sections are treated as Lower Mississippian undifferentiated.

The most important difference between the Lower and Upper Mississippian gastropod faunules is the apparent abundance of platyceratacean in the earlier beds compared with a virtual absence in the later beds. This may be simply a matter of facies, *Platyceras* apparently being able to live only on pelmatozoan echinoderms (Bowsher, 1955). Suitable habitats for crinoids apparently were few in Late Mississippian seas of northern Alaska. Most platyceratid specimens occur in dark bioclastic limestone containing much crinoidal debris. Platyceratids do occur in Permian rocks and, rarely, in the Upper Mississippian of this region. Their presence is not, in itself, an index of an Early Mississippian age.

TABLE 1.—*Distribution and number of Late Paleozoic gastropods in northern Alaska*

Taxon	Formation, faunal zone, and locality number																								
	Kayak shale										Wachsmuth limestone														
	Scalarituba zone		*Leptaena* zone								"*Zaphrentis*" zone										*Brachythyris* zone				
	13222 [1]	13245 [1]	3095 [1]	3247 [1]	13219	13231	13238	13247	13252	13258	3089 [1]	3091 [1]	3098 [1]	3100 [1]	3107 [1]	3110 [1]	3173 [1]	3279 [1]	14074	14965 [1]	3113 [1]	3115 [1]	13278 [1]	13286 [1]	14954 [1]
Bellerophontacea:																									
Euphemites sp.																									
Bellerophon sp.																									
Knightites (*Retispira*?) sp.																									
Indet. bellerophontacean		1								1												1			
Euomphalacea:																									
Straparollus (*Euomphalus*) *brooksensis*, n. sp.												[2]1			1										
alaskensis, n. sp.																									
Straparollus (*Euomphalus*) sp.																									1
Amphiscapha (*Cylicioscapha*) *grada*, n. sp.																									
Indet. euomphalacean		1			1			1						1				6	1					1	
Pleurotomariacea:																									
Rhineoderma? sp.																									
Turbonellina? *lata*, n. sp.			1																						
Trepospira (*Trepospira*) sp.																									
Trepospira (*Angyomphalus*?) sp.																									
Mourlonia minuta, n. sp.																									
Mourlonia? *reloba*, n. sp.																									
Nodospira ornata, n. sp.																									
Spiroscala cf. *S.* sp.																									
Bembexia? *inumbilicata*, n. sp.																									
Glabrocingulum (*Glabrocingulum*) sp.																									
Neilsonia? sp.																									
Portlockiella? sp.																									
Gosseletina? sp.																									
Phymatopleura sp.																									
New genus? A																1									
New genus? B																									
Indet. pleurotomariacean	1																3								
Platyceratacea:																									
Yunnania sp.																									
Platyceras (*Platyceras*) sp.																									
(*Orthonychia*) sp.			3	3		6	2		2	2	33			1			2	2		2	1				
Microdomatacea:																									
Anematina rockymontanum (Shimer)													1				[2]1						1		
Anematina? sp.																									
Anomphalacea:																									
Anomphalus sp.																									
Neritacea:																									
Naticopsis (*Naticopsis*) *suturicompta*, n. sp.																									
(*Naticopsis*) sp.																									
Indet. neritacean								1																1	
Murchisoniacea:																									
Murchisonia cf. *M.* sp.																									
Platyzona sp.																									
Indet. murchisoniacean																									
Loxonematacea:																									
Loxonema sp.																									
Indet. loxonematacean																									
Subulitacea:																									
Ianthinopsis? sp.																									
Scaphopoda:																									
Genus indet.																									
Total number of specimens	1	2	4	3	1	6	2	2	2	3	33	1	1	2	1	1	6	8	1	2	1	1	1	2	1

Taxon	Lower Mississippian, undifferentiated																												
	9186	11807	11808	11843	11858	11861	11867	11890	12700	12701	12709	12773	12785	12788	12798	13225	13228	13232	13234	13235	13236	13237	13240	13241	13242	13254	13255	13292	14097
Bellerophontacea:																													
Euphemites sp.																							2						
Bellerophon sp.		1	1																1	1									
Knightites (*Retispira*?) sp.				1																									
Indet. bellerophontacean							1																						
Euomphalacea:																													
Straparollus (*Euomphalus*) *brooksensis*, n. sp.								1												2			[2]1						
alaskensis, n. sp.																													
Straparollus (*Euomphalus*) sp.																													
Amphiscapha (*Cylicioscapha*) *grada*, n. sp.																													
Indet. euomphalacean		1			1	1				1			3						2					1					2
Pleurotomariacea:																													
Rhineoderma? sp.																													
Turbonellina? *lata*, n. sp.																			2	1									
Trepospira (*Trepospira*) sp.																													
Trepospira (*Angyomphalus*?) sp.				1																									
Mourlonia minuta, n. sp.																													
Mourlonia? *reloba*, n. sp.																													
Nodospira ornata, n. sp.																													
Spiroscala cf. *S.* sp.																													
Bembexia? *inumbilicata*, n. sp.																													
Glabrocingulum (*Glabrocingulum*) sp.																													
Neilsonia? sp.																													
Portlockiella? sp.																													
Gosseletina? sp.																					1								
Phymatopleura sp.																			1										
New genus? A																													
New genus? B																													
Indet. pleurotomariacean		1							1	3			3						1	2	1								
Platyceratacea:																													
Yunnania sp.													1																
Platyceras (*Platyceras*) sp.		3																											
(*Orthonychia*) sp.	1											1	2		1	1	1	2			1	2				4		1	
Microdomatacea:																													
Anematina rockymontanum (Shimer)			2							[2]1			1																
Anematina? sp.																									1				
Anomphalacea:																													
Anomphalus sp.																													
Neritacea:																													
Naticopsis (*Naticopsis*) *suturicompta*, n. sp.			[2]1							[2]1													[2]2						
(*Naticopsis*) sp.																				1									
Indet. neritacean										8	1		3	1					1	1						1	1		
Murchisoniacea:																													
Murchisonia cf. *M.* sp.																							1						
Platyzona sp.																													
Indet. murchisoniacean																							1						
Loxonematacea:																													
Loxonema sp.																													
Indet. loxonematacean	2																			5									
Subulitacea:																													
Ianthinopsis? sp.							1						1																
Scaphopoda:																													
Genus indet.																							1						
Total number of specimens	3	6	4	2	1	1	2	1	1	14	1	1	14	1	1	1	1	2	8	13	3	2	8	1	1	5	1	1	2

Taxon	Alapah limestone												
	Naticopsis zone								*Naticopsis* or *Lithostrotion* zone				
	3087a [1]	3088 [1]	3164 [1]	3170 [1]	3171 [1]	3182 [1]	12355 [1]	15408 [1]	406	976	994	997	1004
Bellerophontacea:													
Euphemites sp.													
Bellerophon sp.		9						2		8			
Knightites (*Retispira*?) sp.													
Indet. bellerophontacean									1				6
Euomphalacea:													
Straparollus (*Euomphalus*) *brooksensis*, n. sp.													
alaskensis, n. sp.													
Straparollus (*Euomphalus*) sp.												[2]1	
Amphiscapha (*Cylicioscapha*) *grada*, n. sp.													
Indet. euomphalacean	1						1			4			
Pleurotomariacea:													
Rhineoderma? sp.													
Turbonellina? *lata*, n. sp.													
Trepospira (*Trepospira*) sp.													
Trepospira (*Angyomphalus*?) sp.													
Mourlonia minuta, n. sp.													
Mourlonia? *reloba*, n. sp.													
Nodospira ornata, n. sp.													
Spiroscala cf. *S.* sp.													
Bembexia? *inumbilicata*, n. sp.													
Glabrocingulum (*Glabrocingulum*) sp.													
Neilsonia? sp.													
Portlockiella? sp.													
Gosseletina? sp.													
Phymatopleura sp.													
New genus? A													
New genus? B													
Indet. pleurotomariacean													
Platyceratacea:													
Yunnania sp.													
Platyceras (*Platyceras*) sp.													
(*Orthonychia*) sp.													
Microdomatacea:													
Anematina rockymontanum (Shimer)						1							
Anematina? sp.													
Anomphalacea:													
Anomphalus sp.													
Neritacea:													
Naticopsis (*Naticopsis*) *suturicompta*, n. sp.		20	1	2	1	[2]1	3				[2]1		
(*Naticopsis*) sp.													
Indet. neritacean										1		1	
Murchisoniacea:													
Murchisonia cf. *M.* sp.													
Platyzona sp.													
Indet. murchisoniacean													
Loxonematacea:													
Loxonema sp.													
Indet. loxonematacean										7			
Subulitacea:													
Ianthinopsis? sp.													
Scaphopoda:													
Genus indet.													
Total number of specimens	1	29	1	2	1	2	4	2	1	20	1	2	6

TABLE 1.—*Distribution and number of Late Paleozoic gastropods in northern Alaska*—Continued

Formation, faunal zone, and locality number—Continued

Taxon	Alapah limestone—Continued: *Naticopsis* or *Lithostrotion* zone—Continued								Alapah limestone—Continued: *Lithostrotion* zone							Alapah limestone—Continued: *Goniatites* zone							Alapah limestone—Continued: Probable *Goniatites* zone					Upper Mississippian, undifferentiated								?Upper Mississippian		Siksikpuk formation									Sadlerochit formation								Unnamed Permian formation				?Permian						Total Number of Specimens
	1014	1015	3272	9187	13287	14992	15430	15455	3087[1]	3167[1]	3169[1]	3172[1]	3186[1]	3188[1]	13288	10862[1]	10868[1]	11828[1]	12084	12779[1]	14150[1]	14151[1]	9184	11865	12340	12342	12348	971	972	975	996	10870	11799	14035	14984	13246	14947	11785[1]	11786[1]	11814[1]	11815[1]	11816[1]	14099[1]	14152[1]	14174	15453[1]	1008	1009	1010	7118b[1]	15813	15817[1]	15826[1]	15829[1]	11823	13215[1]	33216[1]	14169[1]	408a	960	979	982	987	989a	
Bellerophontacea:																																																																	
Euphemites sp.																			9							1																																							12
Bellerophon sp.					4							1																					4																																33
Knightites (*Retispira*?) sp.																																																											1						2
Indet. bellerophontacean						1																1								8	1	6																		1					1										29
Euomphalacea:																																																																
Straparollus (*Euomphalus*) *brooksensis*, n. sp.									2				1																																																				9
alaskensis, n. sp.																																						6	[2]3	12		7	4	9		[2]4					1				1							[2]1			48
Straparollus (*Euomphalus*) sp.																																																																	2
Amphiscapha (*Cylicioscapha*) *grada*, n. sp.																																																						1	3										4
Indet. euomphalacean		1					2	1		1	1			2								2						1					1								2								3							1								1	48
Pleurotomariacea:																																																																
Rhineoderma? sp.										1																																																							1
Turbonellina? *lata*, n. sp.																																																																	4
Trepospira (*Trepospira*) sp.																																													1																				1
Trepospira (*Angyomphalus*?) sp.																																																																	1
Mourlonia minuta, n. sp.																								7																																									7
Mourlonia? *reloba*, n. sp.																																										[2]1				[2]1												4							6
Nodospira ornata, n. sp.																					6				22		10																																						38
Spiroscala cf. *S.* sp.																																															1						1												2
Bemberia? *inumbilicata*, n. sp.																2				3		1				1																																							7
Glabrocingulum (*Glabrocingulum*) sp.																																													2																				2
Neilsonia? sp.																	25						50																																										75
Portlockiella? sp.										1																																																							1
Gosseletina? sp.																																																																	1
Phymatopleura sp.																																																																	1
New genus? A																																																																	1
New genus? B																																																								2									2
Indet. pleurotomariacean	1									5									2										1								13									1		1	1	3		1			1		1					1	4		52
Platyceratacea:																																																																
Yunnania sp.																																																																	1
Platyceras (*Platyceras*) sp.																																		5																															8
(*Orthonychia*) sp.																																			1													2												1	1				81
Microdomatacea:																																																																
Anematina rockymontanum (Shimer)			1	[2]2											1																																																		12
Anematina? sp.	1									1																				7																																			10
Anomphalacea:																																																																
Anomphalus sp.										1																																																								1
Neritacea:																																																																
Naticopsis (*Naticopsis*) *suturicompta*, n. sp.				3			1																										3																																40
(*Naticopsis*) sp.																																																																	1
Indet. neritacean										1																										1																													23
Murchisoniacea:																																																																
Murchisonia cf. *M.* sp.																							[2]1																																										2
Platyzona sp.																																				1																													1
Indet. murchisoniacean			2							1																																																							4
Loxonematacea:																																																																
Loxonema sp.																		3																																															3
Indet. loxonematacean																																																																	14
Subulitacea:																																																																
Ianthinopsis? sp.																																																																	2
Scaphopoda:																																																																
Genus indet.																																				1																													2
Total number of specimens	2	1	3	5	4	1	3	1	2	12	1	1	1	2	1	2	25	3	11	3	6	4	51	7	22	2	10	1	1	15	1	6	8	5	1	3	13	6	3	12	2	8	4	9	3	6	1	3	4	4	1	1	1	1	6	3	1	4	1	1	1	2	4	1	595

[1] Collection from a measured type section or closely associated section on which considerable reliance can be placed as to correct stratigraphic assignments.
[2] Tentative identification.

Turbonellina? lata n. sp. is found only in rocks of Early Mississippian age. Several other species are known from single specimens and little reliance can be placed on them for stratigraphic determinations. *Anematina rockymontanum* (Shimer) is more common in the Lower Mississippian than in the Upper Mississippian. Euomphalaceans, mostly indeterminate as to genus and species, are more common in the Lower Mississippian; bellerophontaceans, also mostly indeterminate as to species, are less abundant. Pleurotomareans are less common and individual specimens are smaller in the Lower Mississippian than in the Upper Mississippian. Finally, neritaceans are much rarer in the Lower Mississippian than in later beds.

UPPER MISSISSIPPIAN

Naticopsis *and* Lithostrotion *zones.*—Collections from the *Naticopsis* zone of the Upper Mississippian Alapah limestone, constitute a gastropod faunule composed primarily of large neritaceans and large bellerophontaceans. Most specimens are steinkerns in a blocky black limestone matrix. One specimen of *Anematina* and an indeterminate euomphalacean were also collected from rocks of this zone.

The *Lithostrotion* zone yields a more diversified gastropod faunule. Nearly half the specimens are euomphalaceans, a considerable number of which cannot be assigned to genus with any degree of confidence. Several specimens are identified as *Straparollus* (*Euomphalus*) *brooksensis*, n. sp. Other gastropods from this zone are single specimens of *Portlockiella?* sp., *Rhineoderma?* sp., *Anomphalus* sp., an indeterminate murchisoniacean, and an indeterminate neritacean. Two specimens each of *Anematina* and an indeterminate species of pleurotomariacean complete the faunule.

Neither zone can be distinguished solely on the basis of gastropod species present, although collections from the *Lithostrotion* zone show more taxonomic variety than those from the *Naticopsis* zone. In addition, many of the species and genera found in these two zones also occur in rocks of Early Mississippian age. Among these are *Bellerophon* sp., *Anematina rockymontanum* (Shimer), *Straparollus* (*Euomphalus*) *brooksensis*, n. sp., and, tentatively, *Naticopsis* (*Naticopsis*) *suturicompta*, n. sp. Nevertheless, fieldwork has demonstrated that the dark matrix and large size of the specimens from the *Naticopsis* zone are distinctive.

Certain collections from among those listed in table 1 as "*Naticopsis* or *Lithostrotion* zones" seem more likely to represent the *Naticopsis* zone. In this category are USGS (U.S. Geological Survey) localities 11799 and 13287. On much less certain grounds, collections from USGS localities 976 and 5430 may also represent the *Naticopsis* zone. Other collections cannot be assigned to either zone with any degree of confidence.

Goniatites *zone and probable* Goniatites *zone.*—This assemblage, dominated by the large pleurotomariaceans *Bembexia? inumbilicata*, n. sp. and *Nodospira ornata*, n. gen., n. sp., is the most distinctive of the gastropod faunules studied. With the exception of *Euphemites* and *Loxonema*, of which one and two specimens, respectively, occur in the Lower Mississippian, all specifically identifiable gastropods from rocks assigned to this zone are limited to it. Within this zone, cephalopods and gastropods occur together at USGS localities 11828, 11865, and 12084.

These gastropod studies suggest strongly that the collections listed as "probable *Goniatites* zone" in table 1 should be referred to that zone without question. *Neilsonia?* sp. and *Euphemites* sp. occur in both sets of collections, along with *Nodospira ornata*, n. sp. and *Bembexia? inumbilicata*, n. sp. In addition, *Mourlonia minuta*, n. sp. is present in collections questionably referred to the *Goniatites* zone and may be represented by a steinkern in a collection definitely from the *Goniatites* zone.

Upper Mississippian undifferentiated.—All specimens referred to this listing are exceedingly poorly preserved. No significant stratigraphic statement can be made on the basis of the available material.

PERMIAN

Euomphalaceans constitute nearly two-thirds of the Permian gastropod assemblage. Pleurotomariaceans, most of which are indeterminate as to genus and species, comprise much of the remainder but they are widely distributed and occur in nearly as many collections as the euomphalaceans. Several indeterminate bellerophontaceans and *Platyceras* complete the assemblage. The presence of *Platyceras* in beds of Permian age indicates that, in Alaska, the genus cannot be used as a guide to the Mississippian.

The euomphalacean species appear to be relatively reliable guide fossils to the Permian rocks. Two of these species, *Straparollus* (*Euomphalus*) *alaskensis*, n. sp. and *Amphiscapha* (*Cylicioscapha*) *grada*, n. sp. are described. Among the pleurotomariaceans, *Mourlonia? reloba*, n. sp. is the most common species. Many kinds of pleurotomariaceans seem to be represented in the poorly preserved material from the Permian of northern Alaska.

The gastropods suggest faunal relationships among the Siksikpuk, Sadlerochit, and unnamed Permian

formations. *Straparollus (Euomphalus) alaskensis*, n. sp. occurs in all three formations, and *Amphiscapha (Cylicioscapha) grada*, n. sp. is present in the latter two. Finally, *Mourlonia? reloba*, n. sp. occurs in the unnamed formation, is tentatively identified in collections from the Siksikpuk formation, and may be present in the Sadlerochit formation.

USGS locality 14174, assigned to the Siksikpuk formation on the basis of rock type, is atypical. The collection consists of two specimens of *Glabrocingulum (Glabrocingulum)* sp. and one specimen of *Trepospira (Trepospira)* sp. Except for one questionable occurrence, *Trepospira* is unknown in Permian faunas elsewhere in the world. Furthermore, the specimens of *Glabrocingulum* differ from Permian species known from the southwestern United States and other well-known areas of Permian exposures. It may be that this collection is actually of Pennsylvanian age. More fieldwork in northern Alaska and additional collections are needed to confirm the presence of Pennsylvanian rocks.

Known ranges of the more significant species are shown in figure 25.

ECOLOGICAL AND PALEOGEOGRAPHICAL DATA

Representatives of five superfamilies—euomphalaceans, platyceratacean, pleurotomariaceans, neritaceans, and bellerophontaceans, in that order of abundance—comprise virtually all the gastropods studied. The groups are represented by nearly equal numbers of specimens, with the euomphalaceans being perhaps half again as abundant as the bellerophontaceans. Although many of the pleurotomariaceans are poorly preserved, this group has considerably more generic diversity than the others.

Individual collections show little taxonomic variety. Less than 10 percent of the collections contain more than three taxa. This lack of diversification may reflect the small amount of collecting or it may, in part, reflect a time of unfavorable or relatively uniform environment. For example, fossils of Lower Mississippian strata of the western United States have been collected for nearly 100 years, but relatively few gastropods are known. It could be more than coincidence that both regions were the sites of predominantly clastic limestone deposition during the late Paleozoic.

Ecologic and paleogeographic inferences drawn from this study are listed below. Further work is needed before the generalizations can be applied to upper Paleozoic gastropods from other regions. These inferences involve examination of other fossil groups in the late Paleozoic faunas of the region. Documentation of some of the statements must necessarily await the publication of research by other specialists.

1. *Platyceras* commonly occurs here in crinoidal limestone. This partially supports the hypothesis concerning life relationships of platyceratids on pelmatozoan calyxes (Bowsher, 1955).
2. In the Lower Mississippian where *Platyceras* is common, the associated gastropods show less variety than in the Upper Mississippian. This suggests that areas of limestone deposition favorable for crinoids were unfavorable for most benthonic gastropods.
3. *Straparollus* occurs in limestone, sandstone, siltstone, and shale. This suggests that species of this genus had considerable ecologic tolerance.
4. Although large gastropods (an inch or more in height) are not confined to the coarse clastic facies, they are the only snails that have been collected from rocks of this facies. These large gastropods apparently lived in a zone of heavy surf, the probable sedimentary depositional environment of the coarse clastic material. Some of the large shells occur in a siliceous conglomeratic matrix containing pebbles half an inch in diameter.
5. Cephalopods are rarely associated with the gastropods; the 2 groups occur together at only 6 localities. Corals and gastropods also appear to be nearly mutually exclusive, although details of coral distribution have not been published as yet. On the other hand, except in the *Naticopsis suturicompta* zone, gastropods are commonly associated with numerous taxonomically diversified brachiopods. Apparently environments favorable for diversified brachiopod faunas afforded optimum conditions for abundant gastropods. Conversely, it seems that only certain kinds of gastropods were able to live in environments well suited for corals and cephalopods.
6. In the *Naticopsis suturicompta* zone, except for one collection, fossil assemblages consist entirely of gastropods. There is no obvious explanation for this apparent exclusion of other fossil invertebrates.

Mississippian collections include genera known to be common in the lower Carboniferous elsewhere in the world. Heretofore they have not been reported from the American Arctic, and knowledge of their stratigraphic occurrence and geographic distribution fills an important gap in our information on paleogeographic distribution. There is no evidence at the family level, and most probably none at the generic level, that any of the groups is conspicuously present or absent because of cold-water conditions. So far as can be interpreted from this study, a boreal marine invertebrate fauna did not exist in Mississippian time. The snail faunule is not particularly different, in gen-

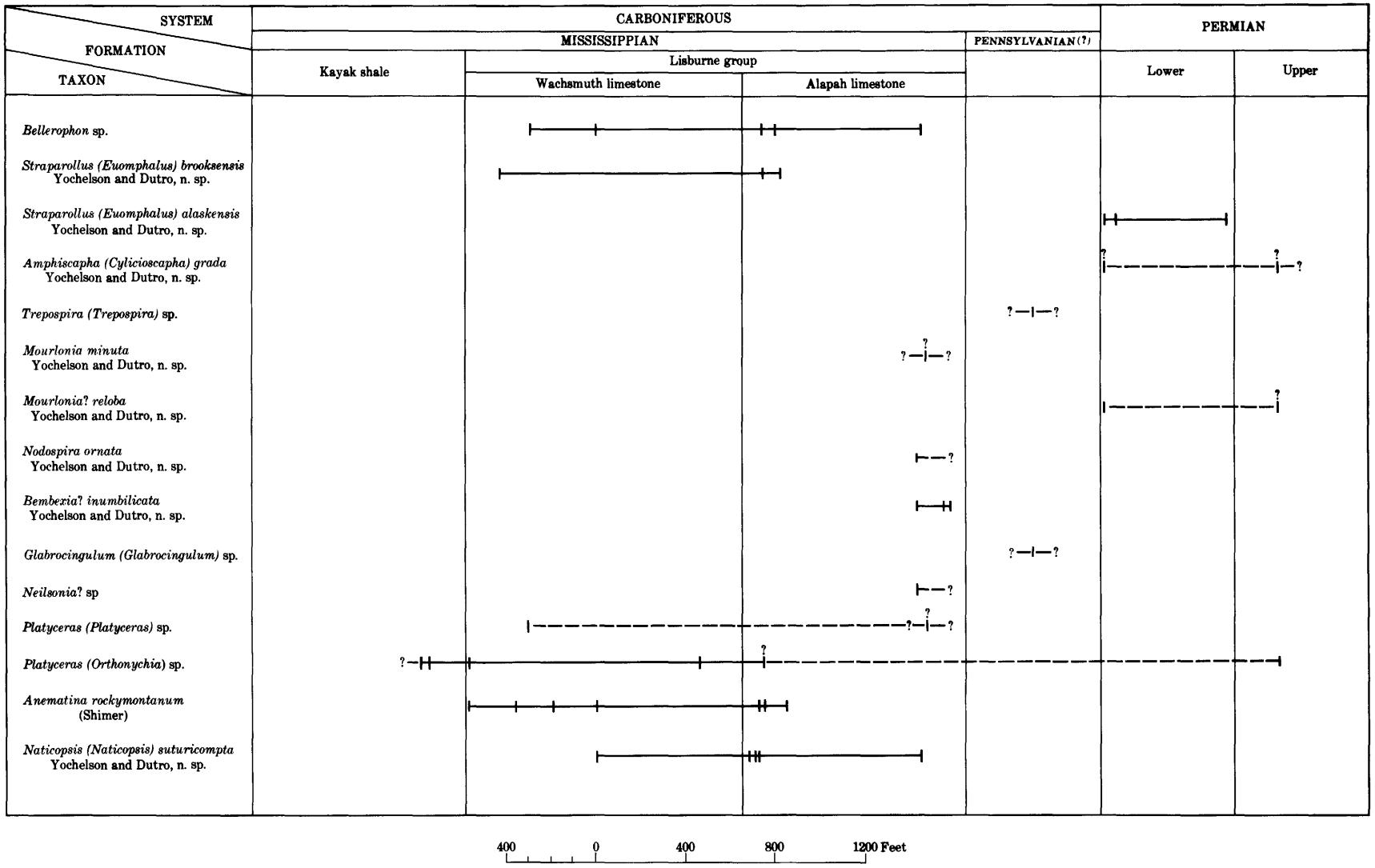


FIGURE 25.—Known ranges of the more significant late Paleozoic gastropod species in northern Alaska. Thickness of Mississippian rocks plotted to scale of type sections; Pennsylvanian(?) and Permian thicknesses diagrammatic. Known occurrences indicated by vertical lines; question marks indicate doubt as to precise position with respect to type sections. Stratigraphic range, controlled by two or more occurrences, shown by horizontal bar; dashed bar indicates questionable range.

eral aspect, from faunules found in Mississippian limestones of the western United States.

The abundance of many kinds of rugose corals, including both solitary and colonial forms, is contributing evidence to the consideration of the Mississippian in northern Alaska as a time of relatively warm shallow seas.

Permian collections are, unfortunately, too small and too scattered geographically to give any indication about climatic zonation. Stehli (1957) suggests that tropical and temperate zones occupied wider belts of latitude in Permian time than at the present.

GENERAL CONSIDERATIONS

A new classification of Paleozoic gastropods was completed recently by Knight, Batten, and Yochelson (in press). That classification is employed in this paper, except that *Amphiscapha* Knight is treated as a distinct genus rather than as a subgenus of *Straparollus* Montfort. Systematic descriptions are arranged in biologic order rather than in stratigraphic order.

Morphologic terminology employed is that of Knight (1941, p. 23–28) and Cox (1955). Three terms not in common usage, referring to the course of growth lines over the shell, are "opisthocline," a course forward and downward; "orthocline," essentially straight downward; and "prosocline," backward and downward with reference to the aperture of the shell and the axis of coiling. These are shown diagrammatically in figure 26. Linear measurements in millimeters are given for the types of new species. Angular measurements were made with the axis of coiling vertical. They represent approximate rather than precise slope angles. Most ornament can be classed as either "colabral," parallel to the outer lip and growth lines, or "spiral," revolving around the whorls and parallel to the suture.

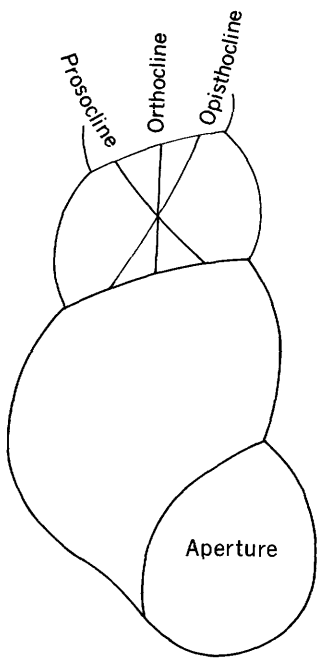


FIGURE 26.—Schematic representation of terms for direction of growth lines.

Because most of the collections contain few individuals, it is difficult to determine the variation within what might be considered a single population. More than one-third of the collections include only one gastropod specimen, and about three-fourths of the collections have less than five gastropod specimens. The number of specimens identified in each taxon is listed on table 1.

The collection from USNM (U.S. National Museum) locality 3089 differs from the others in that it consists of silicified shells recovered by dissolving limestone blocks in hydrochloric acid. Commonly, more and better preserved specimens can be obtained by this method than can be collected by mechanical preparation from limestone. Further collecting in the region should be directed particularly toward a search for silicified fossils.

Most of the specimens are not well preserved; the illustrated specimens constitute a significant percentage of the better specimens. Taxonomic and stratigraphic conclusions based on poorly preserved material are necessarily less satisfactory than those based on better material.

Preservation seems to be related directly to two factors. First, most of the collections are from relatively compact limestone. Because of the structure of the molluscan shell, exfoliated specimens are commonly produced when material is broken from a dense carbonate matrix. By way of contrast, identifiable brachiopods, and other types of fossils, commonly may be broken from a limestone matrix. Second, the severe climate of the high latitudes apparently permits little chemical weathering of shales and shaly limestones. In addition, an insignificant amount of disintegration appears related to frost action. In other regions, limy shales often produce the most abundant and best preserved molluscan shells. The small amount of weathering also seems to limit the actual number of specimens available at any one outcrop.

Because few specimens are available for study, an open system of nomenclature has been adopted, and formal names have been applied only to well-preserved material. Specific names are applied to 10 of the 34 forms recognized. In addition, because this is the

first study of gastropods from northern Alaska, the authors have proposed new names in every case but one, rather than use the terms "cf." or "aff." to compare these specimens with species described from distant localities. Future studies based on new collections may place some of these names in synonymy with species described from regions far removed from northern Alaska. As a general principle, however, it seems wiser to erect new species. Indiscriminate identification of material with previously named species can imply unwarranted correlations.

This study suggests that several new generic categories are needed for Mississippian gastropods. With one exception the number of specimens available is too small or the specimens themselves are too poorly preserved to serve as a suitable basis for establishing new genera. Revision of the Mississippian gastropods, particularly the pleurotomariaceans, is needed to make them more useful for stratigraphic and biologic studies.

One unorthodox treatment is incorporated in this taxonomic study. Following each superfamily a brief section is devoted to material which would normally be considered as indeterminate. The possible systematic placement of some of the specimens is discussed briefly. It is recognized that these suggested identifications are not well founded, and, accordingly, they are clearly separated from the rest of the systematic study. These should be considered only as first approximations. Because of the considerable effort and relatively great expense involved in collecting the material from nothern Alaska, we feel that this attempt to obtain the maximum amount of stratigraphic information is justified. These scraps of additional information, together with suggestions of age significance based on studies of other elements of the total fauna, may eventually lead to the solution of some of the local stratigraphic problems. All specimens briefly mentioned are listed as indeterminate on table 1.

REGISTER OF LOCALITIES

Locality Nos. 3087 through 3279 refer to collections in the possession of the U.S. National Museum. Following them, localities of the U.S. Geological Survey are listed. Except for types and figured specimens transferred to the National Museum, these collections are in the possession of the Geological Survey. Locality 7118b is a "green" number in an old general register of Paleozoic localities. All other numbers refer to the "blue" register of localities currently being maintained by the Upper Paleozoic Unit, Paleontology and Stratigraphy Branch. Collections 406 through 1015 were made by members of earlier surveys. Collections from localities 9184 through 15829 were made by members of the Navy Oil Unit, Alaskan Geology Branch.

Latitude and longitude given for the localities are based on the best data available to the collectors at the time this register was compiled (January 1957). Many geographic positions were plotted on the 1:250,000-scale quadrangle map series published by the Geological Survey. Other positions were taken from the 1:48,000-scale preliminary map series compiled for the Geological Survey program of geologic mapping in Navy Petroleum Reserve No. 4 and adjacent areas.

Index maps (figs. 27, 28, and 29) showing the approximate positions of the localities are based on the World Aeronautical Chart series (maps 62–64, and 76) published by the U.S. Coast and Geodetic Survey, (scale 1:1,000,000).

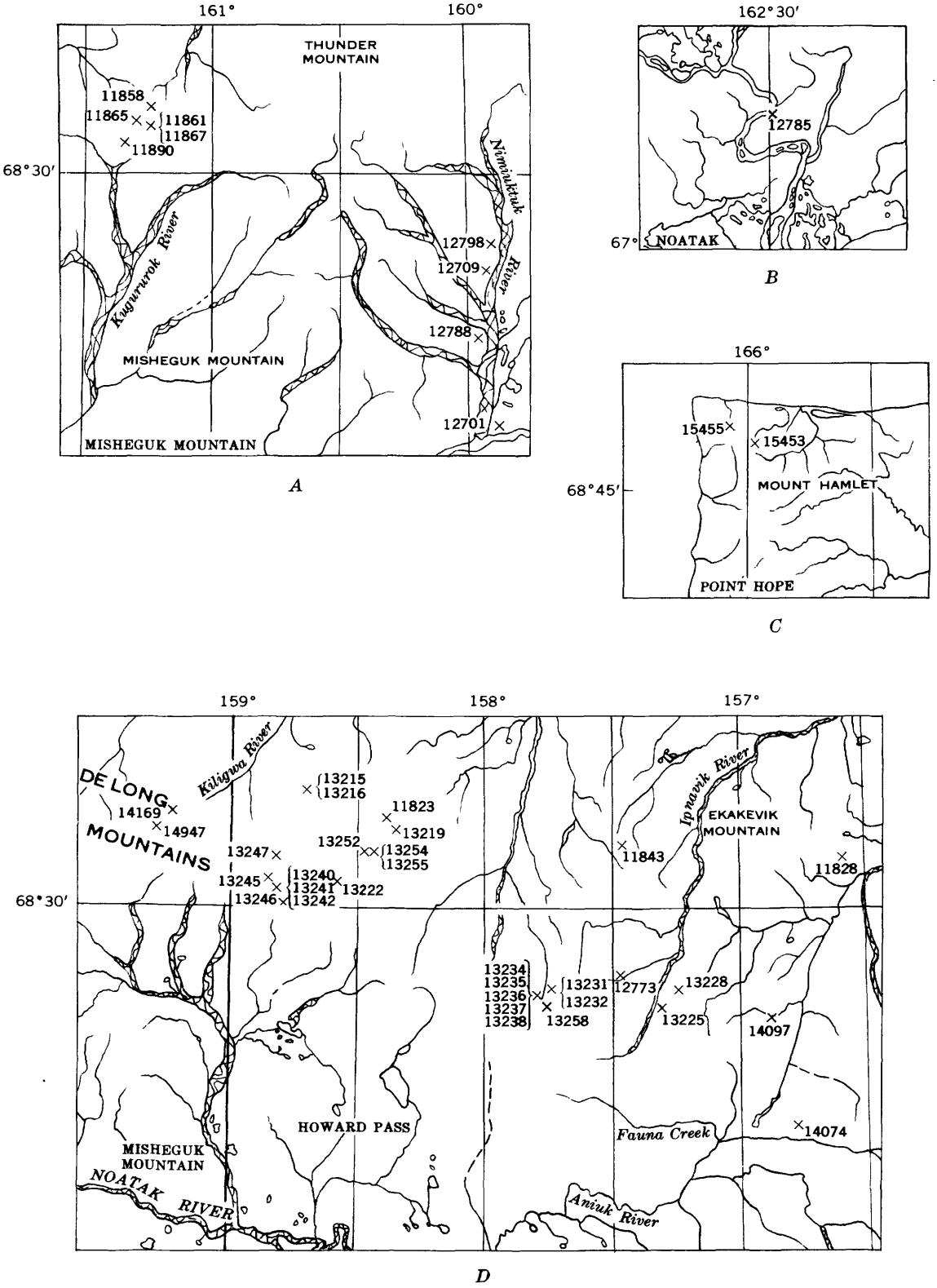
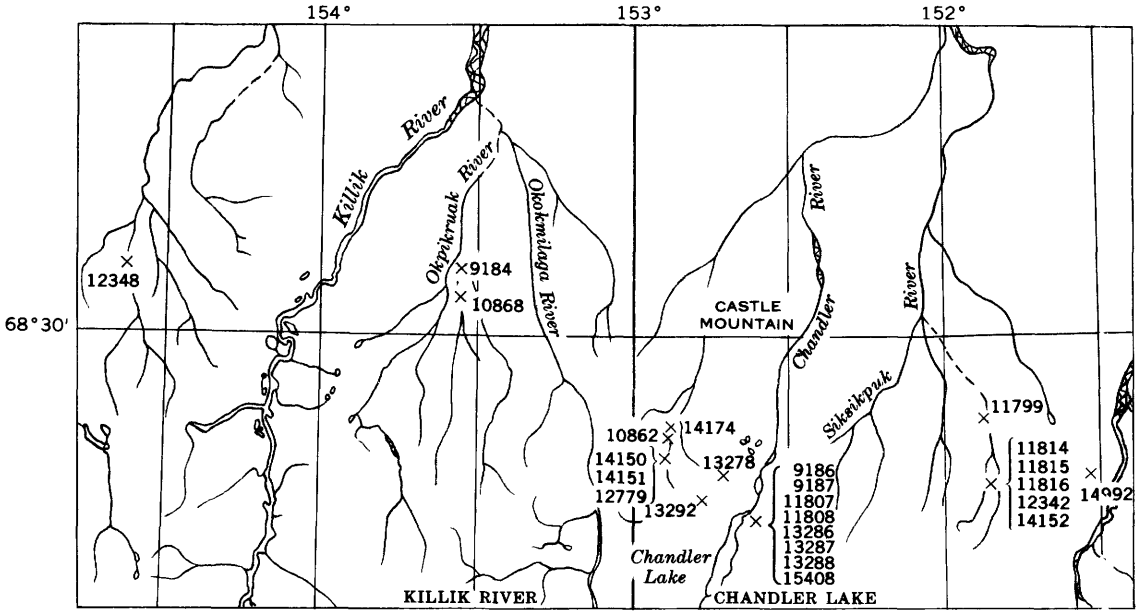
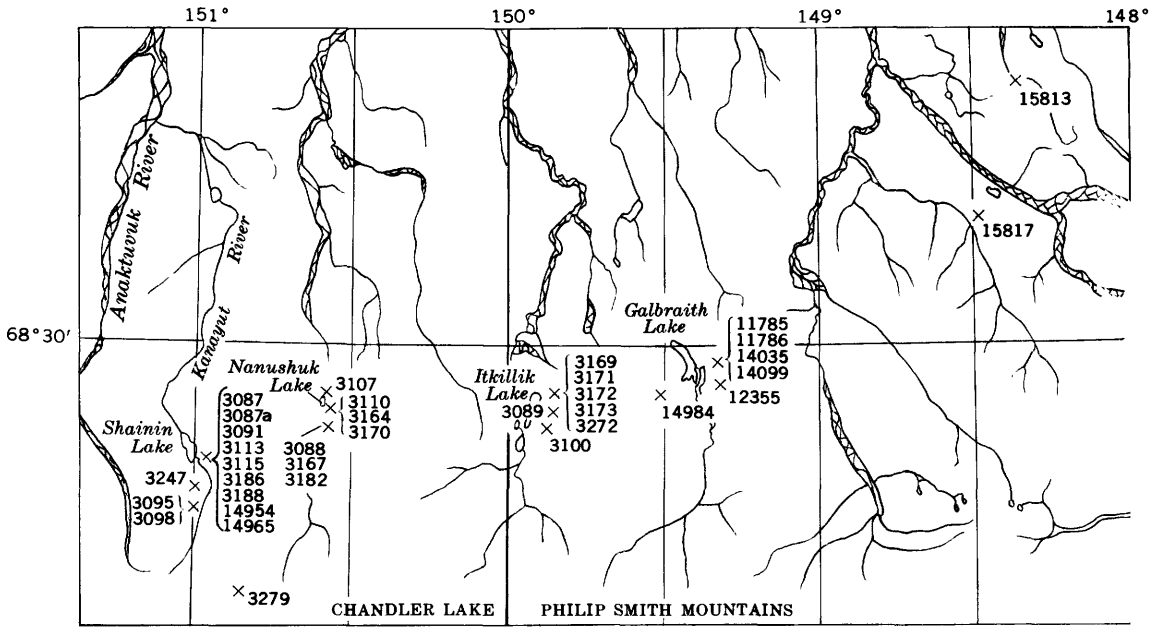


FIGURE 27.—Fossil-collecting localities in parts of the Misheguk Mountain quadrangle (*A*), the Noatak quadrangle (*B*), the Point Hope quadrangle (*C*), and the Howard Pass and Misheguk Mountain quadrangles (*D*), Alaska.

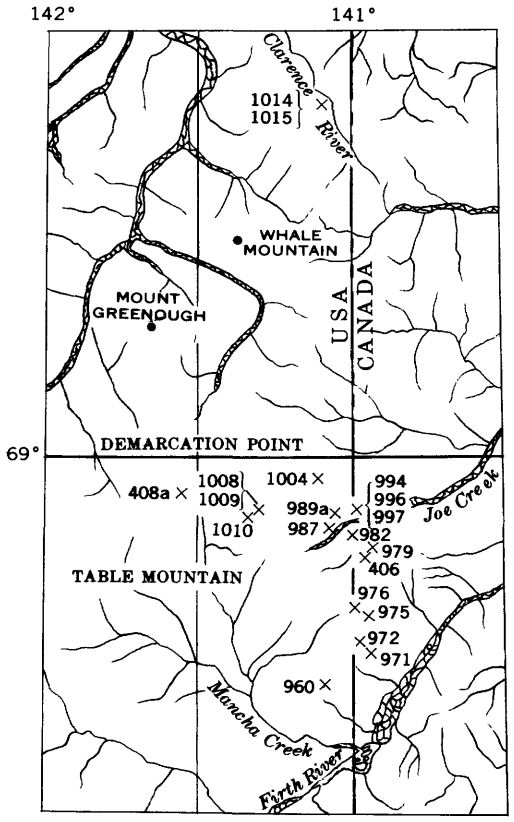


A

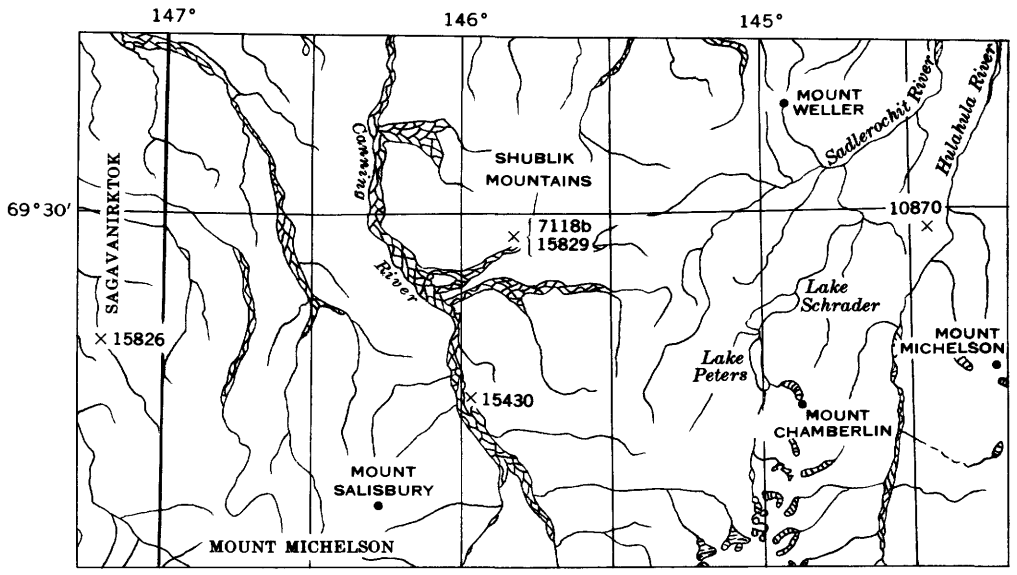


B

FIGURE 28.—Fossil-collecting localities in parts of the Killik River and Chandler Lake quadrangles (*A*) and the Chandler Lake and Philip Smith Mountains quadrangles (*B*), Alaska.



A



B

FIGURE 29.—Fossil-collecting localities in parts of the Demarcation Point and Table Mountain quadrangles, Alaska, and adjacent parts of Canada (*A*) and the Sagavanirktok and Mount Michelson quadrangles, Alaska (*B*).

Register of localities

Locality No.	Field No.	Collector, year of collection, and description of locality	Stratigraphic position and age
USNM 3087	F 7 of 11 June F 1 of 13 June F 3 of 16 June	Bowsher, A. L., Dutro, J. T., Jr., Gudim, C. J.; 1949; Chandler Lake quadrangle; Shainin Lake area, southwest corner of ridge, top of Sugarloaf Hill; lat 68°19′20″ N., long 150°55′30″ W.; measured section J, 84.5–93.3 ft above base of Alapha limestone.	Dark limestone member, Alapah limestone *Lithostrotion* aff. *L. asiaticum* zone; Upper Mississippian.
3087a	F 1 of 16 June	Bowsher, A. L., Dutro, J. T., Jr., Gudim, C. J.; 1949; same locality as 3087; 49 ft above base of Alapah limestone.	Shaly limestone member, Alapah limestone; *Naticopsis suturicompta* zone; Upper Mississippian.
3088	F 5 of 24 July	Bowsher, A. L., Dutro, J. T., Jr., Gudim, C. J.; 1949; Chandler Lake quadrangle; Nanushuk Lake area, along west side of main ridge southeast of lake; lat 68°22′20″ N., long 150°29′34″ W., 80 ft above base of Alapah limestone.	Shaly limestone member, Alapah limestone; *Naticopsis suturicompta* zone; Upper Mississippian.
3089	F 2 of 27 August	Bowsher, A. L., Dutro, J. T., Jr.; 1949; Philip Smith Mountains quadrangle; Itkillik Lake area, north slope of hill about 11,100 ft S. 85° E. of Itkillik Lake camp; lat 68°24′15″ N., long 149°43′20″ W.; 139–145 ft above base of Wachsmuth limestone.	Crinoidal limestone member, Wachsmuth limestone; *"Zaphrentis" konincki* zone; Lower Mississippian.
3091	F 1 of 3 June	Bowsher, A. L., Dutro, J. T., Jr.; 1949; Chandler Lake quadrangle; Shainin Lake area, top of lower massive cliff, southwest slope of Mount Wachsmuth; lat 68°18′50″ N., long 150°55′25″ W.; measured section I, 141.6–148 ft above base of Wachsmuth limestone.	Crinoidal limestone member, Wachsmuth limestone; *"Zaphrentis" konincki* zone; Lower Mississippian.
3095	F 3 of 22 June	Bowsher, A. L., Dutro, J. T., Jr.; 1949; Chandler Lake quadrangle; Shainin Lake area, head of small creek about 14,700 ft. S. 8° E. of Shainin Lake camp; lat 68°16′25″ N. long 150°57′25″W.; 720–777 ft above base of Kayak shale.	Argillaceous limestone member, Kayak shale; *Leptaena analoga* zone; Lower Mississippian.
3098	F 1 of 22 June	Bowsher, A. L., Dutro, J. T., Jr., Gudim, C. J., Feder, A.; 1949; Chandler Lake quadrangle; Shainin Lake area, north side of first valley south of Pinnacles; lat 68°17′ N., long 150°55′15″ W., 187–198 ft above base of Wachsmuth limestone.	Crinoidal limestone member, Wachsmuth limestone; *"Zaphrentis" konincki* zone; Lower Mississippian.
3100	F 2 of 20 August	Bowsher, A. L., Dutro, J. T. Jr.; 1949; Philip Smith Mountains quadrangle; Itkillik Lake area, 8,500 ft S. 40° E. of Itkillik Lake camp; lat 68°23′15″ N., long 149°45′50″ W.; 73–75 ft above base of Wachsmuth limestone.	Crinoidal limestone member, Wachsmuth limestone *"Zaphrentis" konincki* zone; Lower Mississippian.
3107	F 2 of 21 July	Bowsher, A. L., Dutro, J. T., Jr., Gudim, C. J.; 1949; Chandler Lake quadrangle; Nanushuk Lake area, south side of ridge, 10,000 ft N. 12° W. of Nanushuk Lake camp; lat 68°25′10″ N., long 150°30′15″ W.	Crinoidal limestone member, Wachsmuth limestone; *"Zaphrentis" konincki* zone; Lower Mississippian.
3110	F 6 of 23 July	Bowsher, A. L., Dutro, J. T., Jr., Gudim, C. J.; 1949; Chandler Lake quadrangle; Nanushuk Lake area, 6,800 ft east of Nanushuk Lake camp; lat 68°23′30″ N., long 150°26′20″ W.	Crinoidal limestone member, Wachsmuth limestone; *"Zaphrentis" konincki* zone; Lower Mississippian.
3113	F 3 of 3 August	Bowsher, A. L., Dutro, J. T., Jr.; 1949; Chandler Lake quadrangle; Shainin Lake area, south face of Sugarloaf Hill; lat 68°18′50″ N., long 150°55′35″ W.; 957 ft above base of Wachsmuth limestone.	Banded limestone member, Wachsmuth limestone; *Brachythyris suborbicularis* zone; Lower Mississippian.
3115	F 1 of 12 July	Bowsher, A. L., Dutro, J. T., Jr.; 1949; same locality as 3113; 845–849 ft above base of Wachsmuth limestone.	Banded limestone member, Wachsmuth limestone; *Brachythyris suborbicularis* zone; Lower Mississippian.
3164	F 2 of 24 July	Bowsher, A. L., Dutro, J. T., Jr., Gudim, C. J.; 1949; Chandler Lake quadrangle; Nanushuk Lake area, about 1,800 ft S. 34°E. of Nanushuk Lake camp; lat 68°23′10″ N., long 150°28′45″ W.; lower 30 ft of Alapah limestone.	Shaly limestone member, Alapah limestone; *Naticopsis suturicompta* zone; Upper Mississippian.
3167	F 6 of 24 July	Bowsher, A. L., Dutro, J. T., Jr., Gudim, C. J.; 1949; Chandler Lake quadrangle; Nanushuk Lake area, about 6,900 ft S. 6° W. of Nanushuk Lake camp; lat 68°22′15″ N., long 150°29′35″ W.; 97–113 ft above base of Alapah limestone.	Dark limestone member, Alapah limestone; *Lithostrotion* aff. *L. asiaticum* zone; Upper Mississippian.
3169	F 1 of 28 August	Bowsher, A. L., Dutro, J. T., Jr., Gudim, C. J.; 1949; Philip Smith Mountains quadrangle; Itkillik Lake area, about 13,900 ft N.60° E. of Itkillik Lake camp; lat 68°25′25″ N., long 149°43′40″ W.; 86.3 ft above base of Alapah limestone.	Dark limestone member, Alapah limestone; *Lithostrotion* aff. *L. asiaticum* zone; Upper Mississippian.
3170	F 1 of 23 July	Bowsher, A. L., Dutro, J. T., Jr., Gudim, C. J.; 1949; Chandler Lake quadrangle; Nanushuk Lake area, about 2,500 ft N. 65° E. of Nanushuk Lake camp; lat 68°23′40″ N., long 150°28′ W.; about 60 ft above base of Alapah limestone.	Shaly limestone member, Alapah limestone; *Naticopsis suturicompta* zone; Upper Mississippian.

Register of localities—Continued

Locality No.	Field No.	Collector, year of collection, and description of locality	Stratigraphic position and age
USNM 3171	F 4 of 11 August	Bowsher, A. L., Dutro, J. T., Jr.; 1949; Philip Smith Mountains quadrangle; Itkillik Lake area, about 13,600 ft N. 60° E. of Itkillik Lake camp; lat 68°20′25″ N., long 149° 43′05″ W.; 63 ft above base of Alapah limestone.	Shaly limestone member, Alapah limestone; *Naticopsis suturicompta* zone; Upper Mississippian.
3172	F 3 of 23 August	Bowsher, A. L., Dutro, J. T., Jr., Gudim, C. J.; 1949; same locality as 3171; about 140 ft above base of Alapah limestone.	Dark limestone member, Alapah limestone; *Lithostrotion* aff. *L. asiaticum* zone; Upper Mississippian.
3173	F 2 of 25 August	Bowsher, A. L., Dutro, J. T., Jr., Gudim, C. J.; 1949; Philip Smith Mountains quadrangle; Itkillik Lake area, about 12,200 ft N. 65° E. of Itkillik Lake camp; lat 68°25′12″ N., long 149°43′10″ W.; float at base of section.	Crinoidal limestone member, Wachsmuth limestone; *"Zaphrentis" konincki* zone; Lower Mississippian.
3182	F 1 of 26 July	Bowsher, A. L., Dutro, J. T., Jr.; 1949; Chandler Lake quadrangle; Nanushuk Lake area, about 6,900 ft S. 6° W. of Nanushuk Lake camp; lat. 68°22′25″ N., long 149°43′40″ W.; 80 ft above base of Alapah limestone.	Shaly limestone member, Alapah limestone; *Naticopsis suturicompta* zone; Upper Mississippian.
3186	F 4 of 7 August	Bowsher, A. L., Gryc, G., Fischer, W.; 1949; Chandler Lake quadrangle; Shainin Lake area, near south end of Sugarloaf Hill; lat 68°19′25″ N., long 150°55′30″ W.; 172 ft above base of Alapah limestone.	Dark limestone member, Alapah limestone; *Lithostrotion* aff. *L. asiaticum* zone; Upper Mississippian.
3188	F 5 of 7 August	Bowsher, A. L., Gryc, G., Fischer, W.; 1949; same locality as 3186; 0.3 ft above locality 3186.	Dark limestone member, Alapah limestone; *Lithostrotion* aff. *L. asiaticum* zone; Upper Mississippian.
3247	F 6 of 6 July	Bowsher, A. L., Dutro, J. T., Jr.; 1949; Chandler Lake quadrangle; Shainin Lake area, about 8,000 ft S. 32° W. of Shainin Lake camp; lat 68°17′45″ N., long 150°56′30″ W.; 795.3–798 ft above base of Kayak shale.	Argillaceous limestone member Kayak shale; *Leptaena analoga* zone; Lower Mississippian.
3272	F 3 of 24 August	Bowsher, A. L., Dutro, J. T., Jr.; 1949; Philip Smith Mountains quadrangle; Itkillik Lake area; lat 68°25′30″ N., long 149°42′40″ W.; 91 ft above base of Alapah limestone.	Dark limestone member, Alapah limestone; *Lithostrotion* aff. *L. asiaticum* zone; Upper Mississippian.
3279	F 1 of 20 June	Bowsher, A. L.; 1950; Chandler Lake quadrangle; upper Alapah Creek, about 600 ft S. 80° E. of Alapah Creek camp; lat 68°10′18″ N., long 150°46′20″ W.; lower 44 ft of Wachsmuth limestone.	Shaly limestone member(?), Wachsmuth limestone; *"Zaphrentis" konincki* zone; Lower Mississippian.
USGS 7118b (Green)	19 D	Leffingwell, E. de K.; 1908; Mount Michelson quadrangle, Ikiakpaurak valley; approximate lat 69°28′ N., long 145°50′ W.	Sadlerochit formation; Permian.
USGS 406	11 Md 26	Maddren, A. G.; 1911; International Boundary Survey; about 4 mi south of east camp on Joe Creek of Firth River; lat 68°53′40″ N., long 140°57′30″ W.	Alapah limestone(?), Lisburne group; Upper Mississippian(?).
408a	11 Md 28a	Maddren, A. G.; 1911; International Boundary Survey; about 2 mi west of west camp on Joe Creek; lat 68°57′ N., long 141°22′30″ W.	Permian(?).
960	12 Md 31	Jessup, J. M.; 1912; International Boundary Survey; west side of You Creek, north end of ridge; lat 68°44′ N., long 141°04′25″ W.	Permian(?).
971	12 Md 40	Jessup, J. M.; 1912; International Boundary Survey; northeast slope of main fork of Incog Creek; lat 68°46′30″ N., long 140°56″ W.	Lisburne group; Upper Mississippian.
972	12 Md 41	Jessup, J. M.; 1912; International Boundary Survey; northeast slope of main fork of Incog Creek, near head of creek; lat 68°47′10″ N., long 140°57′55″ W.	Alapah limestone, Lisburne group; Upper Mississippian.
975	12 Md 44	Jessup, J. M.; 1912; International Boundary Survey; southwest slope of Turner Mountain; lat 68°48′50″ N., long 140°56′W.	Alapah limestone, Lisburne group; Upper Mississippian.
976	12 Md 46	Maddren, A. G.; 1912; International Boundary Survey; west end of Turner Mountain, on east slope of upper Boulevard Creek; lat 68°49′50″ N., long 140°58′35″ W.	Alapah limestone, Lisburne group; Upper Mississippian.
979	12 Md 49	Harrington, G. L.; 1912; International Boundary Survey; mountain spur 2½ mi southeast of Joe Creek camp; lat 68°53′40″ N., long 140°56′ W.	Permian(?).
982	12 Md 53	Jessup, J. M.; 1912; International Boundary Survey; 1 mi south of Joe Creek and ⅕ mi east of 141st meridian; lat 68°54′30″ N., long 140°59′30″ W.	"Pennsylvanian shales" (of Maddren); Permian(?).
987	12 Md 59	Maddren, A. G.; 1912; International Boundary Survey; 1$\frac{1}{10}$ mi west of 141st meridian, south of Joe Creek; lat 68°55′ N., long 141°03′ W.	"Pennsylvanian shales" (of Maddren); Permian(?).
989a	12 Md 61	Maddren, A. G.; 1912; International Boundary Survey; north bank of Joe Creek, ¾ mi west of 141st meridian; lat 68°55′30″ N., long 141°02′ W.	"Pennsylvanian shales" (of Maddren); Permian(?)

Register of localities—Continued

Locality No.	Field No.	Collector, year of collection, and description of locality	Stratigraphic position and age
USGS 994	12 Md 66	Harrington, G. L.; 1912; International Boundary Survey; ridge north of Joe Creek, from bed above reddish-weathering slaty limestone; lat 68°56′10″ N., long 140°57′15″ W.	Alapah limestone, Lisburne group; Upper Mississippian.
996	12 Md 68	Jessup, J. M.; 1912; International Boundary Survey; east slope of gulch north of Joe Creek, about ¾ mi east of 141st meridian; lat 68°56′10″ N., long 140°58′ W.	Alapah limestone, Lisburne group; Upper Mississippian.
997	12 Md 69	Jessup, J. M.; 1912; same locality as 996; about 250 ft north of 996, along strike.	Alapah limestone, Lisburne group; Upper Mississippian.
1004	12 Md 76	Maddren, A. G.; 1912; International Boundary Survey; northwest corner of limestone outcrop west of Tub Mountain; lat 68°58′50″ N., long 141°06′35″ W.	Alapah limestone, Lisburne group; Upper Mississippian.
1008	12 Md 79	Harrington, G. L.; 1912; International Boundary Survey; south side Joe Creek, about 6½ mi west of 141st meridian; lat 69°56′30″ N., long 141°18′ W.	"Artinskian limestone" (of Maddren); Permian.
1009	12 Md 80	Harrington, G. L.; 1912; same locality as 1008; about ⅒ mi west.	"Artinskian limestone" (of Maddren); Permian.
1010	12 Md 81	Jessup, J. M.; 1912; International Boundary Survey; north side Joe Creek valley about 7½ mi west of 141st meridian; lat 68°56′ N., long 141°21′ W.	"Artinskian limestone" (of Maddren), Permian.
1014	12 Md 85	Jessup, J. M.; 1912; International Boundary Survey; north slope of gulch on west side Clarence River, about 1⅝ mi west of 141st meridian; lat 69°25′ N., long 141°04′ W.	Alapah limestone(?), Lisburne group; Upper Mississippian.
1015	12 Md 85a	Harrington, G. L.; 1912; same locality as 1014, from talus below outcrop.	Alapah limestone(?), Lisburne group; Upper Mississippian.
9184	45 AKr 58	Kirschner, C. E.; 1945; Killik River quadrangle; east bank of Okpikruak River, 16⅗ mi S. 4° W. from forks of Killik River; lat 68°34′30″ N., long. 153°31′ W.	Alapah limestone, Lisburne group; Upper Mississippian.
9186	45 AGr 1	Gryc, G.; 1945; Chandler Lake quadrangle; bluffs west of northernmost tip of Chandler Lake; lat 68°17′30″ N., long 152°36′ W.	Lisburne group; Lower Mississippian(?).
9187	45 AGr 2	Gryc, G.; 1945; Chandler Lake quadrangle; bluffs west of northernmost tip of Chandler Lake; lat 68°17′ N., long 152°36′ W.	Alapah limestone(?), Lisburne group; Upper Mississippian.
10862	49 APa 384	Patton, W. W., Jr.; 1949; Chandler Lake quadrangle; cutbank on north side of Monotis Creek; lat 68°22′-35″ N., long 152°54′ W.; from limestone bed overlying chert-shale member of Alapah limestone.	Alapah limestone; *Goniatites crenistria* zone; Upper Mississippian.
10868	49 ATr 399	Tailleur, I. L.; 1949; Killik River quadrangle; cutbank on east side of Middle Fork of Okpikruak River; lat 68°33′ N., long 153°31′ W.; near top of Alapah limestone.	Alapah limestone *Goniatites crenistria* zone; Upper Mississippian.
10870	48 ASa 47	Sable, E. G., Lachenbruch, A. H.; 1948; Mount Michelson quadrangle; north slope of Kikittut Mountain about 1 mi west of Hulahula River; lat 69°28′ N., long 144°25′ W.	Lisburne group; Upper Mississippian.
11785	50 ABe 201	Brosgé, W. P.; 1950; Philip Smith Mountains quadrangle; Galbraith Lake area; approximate lat 68°29′ N., long 149°13′ W.; about 560 ft above base of Siksikpuk formation.	Siksikpuk formation; Permian(?).
11786	50 ABe 200	Brosgé, W. P.; 1950; same locality and level as 11785	Siksikpuk formation; Permian(?).
11799	50 ARr 49	Reiser, H. N.; 1950; Chandler Lake quadrangle; Siksikpuk River area; approximate lat 68°20′ N., long 151°50′ W.; about 800 ft above base of Alapah limestone.	Alapah limestone (middle part); Upper Mississippian.
11807	50 ABe 115	Reiser, H. N.; 1950; Chandler Lake quadrangle; Chandler Lake area, about 10,000 ft S. 85° E. of astronomical point on Little Chandler Lake; lat 68°16′40″ N., long 152°36′50″ W.; 280 ft above base of Wachsmuth limestone.	Wachsmuth limestone; Lower Mississippian.
11808	50 ABe 44	Brosgé, W. P.; 1950; same locality as 15408; 575 ft above base of Wachsmuth limestone.	Wachsmuth limestone; Lower Mississippian.
11814	50 AKe 238	Keller, A. S.; 1950; Chandler Lake quadrangle; cutbank on east side of Skimo Creek, a tributary of Tiglukpuk Creek; lat 68°17′ N., long 151°53′ W.; basal 60 ft of Siksikpuk formation.	Siksikpuk formation; Permian(?).
11815	50 AKe 240	Keller, A. S.; 1950; same locality as 11814; possibly slightly different stratigraphic level.	Siksikpuk formation; Permian(?).
11816	50 AKe 242	Keller, A. S.; 1950; same locality as 11814; possibly slightly different stratigraphic level.	Siksikpuk formation; Permian(?).
11823	50 AKt 329	Kent, B. H.; 1950; Howard Pass quadrangle; station K 280; lat 68°36′ N., long. 158°22′ W.; in structurally complex area, stratigraphic position unknown.	Unnamed Permiar formation (?); Permian(?).

Register of localities—Continued

Locality No.	Field No.	Collector, year of collection, and description of locality	Stratigraphic position and age
USGS 11828	50 ATr 45	Tailleur, I. L.; 1950; Howard Pass quadrangle; Etivluk River valley; lat 68°35′ N., long 156°38′ W.	Lisburne group; *Goniatites crenistria* zone; Upper Mississippian.
11843	50 ATr 189	Tailleur, I. L.; 1950; Howard Pass quadrangle; Ipnavik River valley; lat 68°35′ N., long 157°29′ W.	Lisburne group(?); Lower Mississippian.
11858	50 ASa 227	Sable, E. G.; 1950; Misheguk Mountain quadrangle; station Sa 350, Utukok River valley; 2 mi north of west fork of Utukok River; lat 68°34′40″ N., long 161°10′30″ W.	Lisburne group (lower formation); Lower Mississippian.
11861	50 ASa 235	Sable, E. G.; 1950; Misheguk Mountain quadrangle; 2,800 ft southeast of locality 11858; lat 68°34′20″ N., long 161°10′ W.	Lisburne group (lower formation); Lower Mississippian.
11865	50 ASa 150	Sable, E. G.; 1950; Misheguk Mountain quadrangle; station Sa 249, head of west fork of Utukok River; lat 68°34′40″ N., long 161°16′50″ W.	Lisburne group (upper formation); Upper Mississippian.
11867	50 ASa 236	Sable, E. G.; 1950; Misheguk Mountain quadrangle; station Sa 350(15), north side of Kogruk Mountain, Utukok River valley; about 400 ft south of locality 11861; lat 68°34′20″ N., long 161°10′ W.	Lisburne group (lower formation; Lower Mississippian.
11890	50 AMg 149	Mangus, M. D.; 1950; Misheguk Mountain quadrangle; divide between Iligluruk Creek and Kugururok River; lat 68°34′ N., long 161°20′30″ W.	Lisburne group (lower formation); Lower Mississippian.
12084	F3 of 12 June	Bowsher, A. L., Gryc, G.; 1950; Chandler Lake quadrangle; Anaktuvuk River valley; 1,500 ft east of Kanakutk Lake; lat 68°18′ N., long 151°21′ W.	Chert-shale member, Alapah limestone; *Goniatites crenistria* zone Upper Mississippian.
12340	50 ACh 41	Chapman, R.; 1950; Killik River quadrangle; Colamnagavik River valley; lat 68°35′ N., long 154°32′ W.	Alapah limestone(?); Upper Mississippian(?).
12342	50 AKe 226	Keller, A. S.; 1950; Chandler Lake quadrangle; 100 ft south of locality 11814; lat 68°17′ N., long 151°53′ W.; upper 75 ft of Alapah limestone.	Alapah limestone; Upper Mississippian.
12348	46 ATh 8	Thurrell, R.; 1946; Killik River quadrangle; upper Oolamnagavik River valley; lat 68°35′ N., long 154°32′ W.	Alapah limestone(?); Upper Mississippian(?).
12355	50 ABe 112	Gudim, C. J; 1950; Philip Smith Mountains quadrangle; Galbraith Lake area; approximate lat 68°28′30″ N., long 149°21′ W.; about 60 ft above base of Alapah limestone.	Shaly limestone member, Alapah limestone; *Naticopsis suturicompta* zone; Upper Mississippian.
12700	11 AS 46	Smith, P. S.; 1911; Misheguk Mountain quadrangle; central Noatak River valley; cutbank on south side of river; approximate lat 68°01′ N., long 159°02′ W.	Lisburne group (lower formation?); Lower Mississippian.
12701	11 AS 51	Smith, P. S.; 1911; Misheguk Mountain quadrangle; central Noatak River valley, cutbank on north side of river; approximate lat 68°07′48″ N., long 159°53′ W.	Lisburne group; Lower Mississippian.
12709	50 ADu 16	Dutro, J. T., Jr.; 1950; Misheguk Mountain quadrangle; Nimiuktuk River valley; lat 68°22′18″ N., long 159°53′45″ W.	Lisburne group (lower formation); Lower Mississippian.
12773	51 ATr 14	Tailleur, I. L.; 1951; Howard Pass quadrangle; Ipnavik River valley; approximate lat 68°22′ N., long 157°28′ W.	Lisburne group; Lower Mississippian.
12779	51 ABe 5	Brosgé, W. P.; 1951; Chandler Lake quadrangle; Monotis Creek section; lat 68°20′ N., long 152°50′15″ W. upper 100 ft of Alapah limestone.	Chert-shale member, Alapah limestone; *Goniatites crenistria* zone; Upper Mississippian.
12785	11 AS 77	Smith, P. S.; 1911; Noatak quadrangle; lower Noatak River valley; approximate lat 67°14′30″ N., long 162°30′ W.	Lisburne group; Lower Mississippian.
12788	50 ADu 77	Dutro, J. T., Jr.; 1950; Misheguk Mountain quadrangle; Nimiuktuk River valley; lat 68°16′23″ N., long 159°57′36″ W.	Lisburne group; Lower Mississippian.
12798	50 ADu 44	Dutro, J. T., Jr.; 1950; Misheguk Mountain quadrangle; Nimiuktuk River valley; lat 68°24′ N., long 159°53′ W.	Lisburne group; Lower Mississippian.
13215	51 ARr 100	Reiser, H. N.; 1951; Howard Pass quadrangle; station 79d, Kiligwa River valley; lat 68°39′ N., long 158°38′ W.	Unnamed. Permian formation; Permian.
13216	51 ARr 101	Reiser, H. N.; 1951; same locality as 13215; station 79e.	Unnamed. Permian formation; Permian.
13219	51 ARr 84	Reiser, H. N.; 1951; Howard Pass quadrangle, Kiligwa River valley; lat 68°35′ N., long 158°20′ W.	Kayak shale(?); *Leptaena analoga* zone(?); Lower Mississippian.
13222	51 ARr 107	Reiser, H. N.; 1951; Howard Pass quadrangle; same locality as 13219.	Kayak shale(?); *Scalarituba* zone(?); Lower Mississippian.
13225	51 ATr 1	Tailleur, I. L.; 1951; Howard Pass quadrangle; Ipnavik River valley, lat 68°21′ N., long 157°18′ W.	Lisburne group; Lower Mississippian.
13228	51 ATr 10	Tailleur, I. L.; 1951; Howard Pass quadrangle; Ipnavik River valley; lat 68°22′30″ N., long 157°15′ W.	Lisburne group; Lower Mississippian.
13231	51 ATr 346	Tailleur, I. L.; 1951; Howard Pass quadrangle; Kuna River valley; lat. 68°22′ N., long 157°42′ W.	Kayak shale; *Leptaena analoga* zone; Lower Mississippian.

Register of localities—Continued

Locality No.	Field No.	Collector, year of collection, and description of locality	Stratigraphic posit'on and age
USGS 13232	51 ATr 347	Tailleur, I. L.; 1951; same locality as 13231	Lisburne group; Lower Mississippian.
13234	51 ATr 350	Tailleur, I. L.; 1951; same locality as 13231	Lisburne group; Lower Mississippian.
13235	51 ATr 351	Tailleur, I. L.; 1951; same locality as 13231	Lisburne group; Lower Mississippian.
13236	51 ATr 352	Tailleur, I. L.; 1951; same locality as 13231	Lisburne group; Lower Mississippian.
13237	51 ATr 353	Tailleur, I. L.; 1951; same locality as 13231	Lisburne group; Lower Mississippian.
13238	51 ATr 354	Tailleur, I. L.; 1951; same locality as 13231	Kayak shale(?); *Leptaena analoga* zone; Lower Mississippian.
13240	51 ATr 392	Tailleur, I. L.; 1951; Howard Pass quadrangle; Kiligwa River valley; lat 68°32′ N., long 158°51′ W.	Lisburne group; Lower Mississippian.
13241	51 ATr 393	Tailleur, I. L.; 1951; same locality as 13240	Lisburne group; Lower Mississippian.
13242	51 ATr 394	Tailleur, I. L.; 1951; same locality as 13240	Lisburne group; Lower Mississippian.
13245	51 ATr 406	Tailleur, I. L.; 1951; Howard Pass quadrangle; Kiligwa River valley; lat 68°33′ N., long 158°53′ W.	Kayak shale(?); *Scalarituba* zone(?); Lower Mississippian.
13246	51 ATr 412	Tailleur, I. L.; 1951; Howard Pass quadrangle; Kiligwa River valley; lat 68°30′30″ N., long 158°48′ W.	Lisburne group; Upper Mississippian(?).
13247	51 ATr 162	Reiser, H. N.; 1951; Howard Pass quadrangle; Kiligwa River valley; lat 68°33′ N., long 158°54′ W.	Kayak shale(?); *Leptaena analoga* zone; Lower Mississippian.
13252	51 ATr 323	Tailleur, I. L.; 1951; Howard Pass quadrangle; station T–91, Kiligwa River valley; lat 68°25′ N., long 158°26′ W.	Kayak shale(?); *Leptaena analoga* zone(?); Lower Mississippian.
13254	51 ATr 328	Tailleur, I. L.; 1951; Howard Pass quadrangle; station T–92, Kiligwa River valley; lat. 68°25′ N., long 158°27′ W.	Lisburne group; Lower Mississippian.
13255	51 ATr 329	Tailleur, I. L.; 1951; same locality as 13254	Lisburne group; Lower Mississippian.
13258	51 AKt 124	Kent, B. H.; 1951; Howard Pass quadrangle; Kuna River valley; lat 68°22′ N., long 157°42′ W.	Kayak shale; *Leptaena analoga* zone(?); Lower Mississippian.
13278	50 ABe 31	Brosgé, W. P.; 1950; Chandler Lake quadrangle; Chandler Lake area; lat 68°18′30″ N., long 152°40′30″ W.; section B–20, 40 ft above base of Wachsmuth limestone.	Wachsmuth limestone; *Brachythyris suborbicularis* zone; Lower Mississippian.
13286	50 ABe 43	Brosgé, W. P.; 1950; Chandler Lake quadrangle; 11,000 ft N. 86° E. of astronomical point on Little Chandler Lake; lat 68°17′ N., long 152°36′30″ W.; about 500–550 ft above base of Wachsmuth limestone.	Wachsmuth limestone; *Brachythyris suborbicularis* zone(?); Lower Mississippian.
13287	50 ABe 45	Brosgé, W. P.; 1950; same locality as 13286; from float about 800 ft above base of Lisburne group (may be basal Alapah limestone).	Alapah limestone(?); *Naticopsis suturicompta* zone or *Lithostrotion* zone; Upper Mississippian.
13288	50 ABe 46	Brosgé, W. P.; 1950; same locality as 13286; from about 200 ft above base of Alapah limestone.	Alapah limestone; *Lithostrotion* aff. *L. asiaticum* zone; Upper Mississippian.
13292	50 ABe 117	Gudim, C. J., Reiser, H. N.; 1950; Chandler Lake quadrangle; 5 mi west of Little Chandler Lake, from southern Lisburne klippe; lat 68°18′ N., long 152°45′ W.; about 250 ft above base of Wachsmuth limestone.	Wachsmuth limestone; Lower Mississippian.
14035	50 ARr 18	Reiser, H. N.; 1950; Philip Smith Mountains quadrangle; Galbraith Lake area; lat 68°29′ N., long 149°13′ W., possibly from upper part of formation.	Alapah limestone (upper part?); Upper Mississippian.
14074	49 AMg 91	Mangus, M. D.; 1949; Howard Pass quadrangle; about 5 mi east of Howard Pass Lake; lat 68°12′ N., long 156°38′ W.	Wachsmuth limestone; *"Zaphrentis" koninckı* zone(?); Lower Mississippian.
14097	49 ALa 5	Lachenbruch, A. H.; 1949; Howard Pass quadrangle; Etivluk River valley, cutbank in Fay Creek, 5 mi west of Etivluk River; lat 68°20′ N., long 156°53′ W.	Wachsmuth limestone; Lower Mississippian.
14099	50 ARr 23	Reiser, H. N.; 1950; Philip Smith Mountains quadrangle; Galbraith Lake area; lat 68°29′ N., long 149°13′ W.; basal bed of Siksikpuk formation.	Siksikpuk formation (basal part); Permian(?).
14150	53 APa 105	Patton, W. W., Jr., Bowsher, A. L., 1953; Chandler Lake quadrangle; cutbank near head of Kiruktagiak River; lat 68°20′30″ N., long 152°54′ W.; top of Alapah limestone.	Chert-shale member(?); Alapah limestone; *Goniatites crenistria* zone; Upper Mississippian.
14151	53 ABo	Patton, W. W., Jr., Bowsher, A. L.; 1953; same locality as 14150.	Chert-shale(?) member; Alapah limestone; *Goniatites crenistria* zone; Upper Mississippian.
14152	53 APa 122	Patton, W. W., Jr., 1953; same locality as 11814	Siksikpuk formation (basal part); Permian(?).
14169	53 ASa 43	Sable, E. G.; 1953; Misheguk Mountain quadrangle; Nuka River valley; lat 68°39′30″ N., long 159°16′ W.	Unnamed Permian formation; Permian.

Register of localities—Continued

Locality No.	Field No.	Collector, year of collection, and description of locality	Stratigraphic position and age
USGS 14174	49 ATr 449A	Tailleur, I. L.; 1949; Chandler Lake quadrangle; rubble west of Kiruktagiak River; lat 68°23′ N., long 152°54′ W.	Siksikpuk(?) formation; Permian(?).
14947	53 ATr 79	Tailleur, I. L.; 1951; Misheguk Mountain quadrangle, Nuka River valley; lat 68°36′ N., long 159°18′ W.	Lisburne group; Upper Mississippian(?).
14954	F4 of 2 June	Bowsher, A. L.; 1950; Chandler Lake quadrangle; Shainin Lake area; lat 68°19′21″ N., long 150°55′ W.	Banded limestone member, Wachsmuth limestone; *Brachythyris suborbicularis* zone; Lower Mississippian.
14965	F3 of 10 June	Bowsher, A. L.; 1950; Chandler Lake quadrangle; Shainin Lake area; lat 68°19′20″ N., long 150°53′30″ W.	Crinoidal limestone member, Wachsmuth limestone; "*Zaphrentis*" *konincki* zone; Lower Mississippian.
14984	50 ABe 22	Brosgé, W. P.; 1950; Philip Smith Mountain quadrangle; Galbraith Lake area; lat 68°26′ N., long 149°22′ W.	Alapah limestone (lower part) Upper Mississippian.
14992	50 ABe 3	Brosgé, W. P.; 1950; Chandler Lake quadrangle; Anaktuvuk River valley; lat 68°16′30″ N., long 151°34′ W.	Alapah limestone (lower part); Upper Mississippian.
15408	50 ABe 33	Brosgé, W. P.; 1950; Chandler Lake quadrangle; Chandler Lake area; lat 68°17′ N., long 152°36′30″ W.; from section B–17.	Alapah limestone; *Naticopsis suturicompta* zone; Upper Mississippian.
15430	47 AGr 182	Gryc, G.; 1947; Mt. Michelson quadrangle; Canning River area; lat 69°17′ N., long 145°59′ W.	Alapah limestone; Upper Mississippian.
15453	53 ASa 247	Sable, E. G.; 1953; Point Hope quadrangle; Cape Lisburne area, north side of Lisburne Hills; lat 68°49′ N., long 165°58′ W.	Siksikpuk formation; Permian(?).
15455	53 ABo 18	Bowsher, A. L.; 1953; Point Hope quadrangle; Cape Lisburne area; approximate lat 68°52′ N., long 166°08′ W.	Lisburne group; Upper Mississippian.
15813	51 ADt 147	Detterman, R. L.; 1951; Philip Smith Mountains quadrangle; Lupine River; lat 68°49′ N., long 148°22′30″ W.	Sadlerochit formation (basal part); Permian.
15817	51 AKe 162	Keller, A. S.; 1951; Philip Smith Mountains quadrangle; Ribdon River, about 3 mi southwest of Elusive Lake; lat 68°40′10″ N., long 148°27′45″ W.; 100 ft above base of Sadlerochit formation.	Sadlerochit formation; Permian.
15826	52 AMo 5	Morris, R. H.; 1952; Sagavanirktok quadrangle; Kemik Creek; lat 69°20′30″ N., long 147°02′ W.; 10 ft above base of Sadlerochit formation.	Sadlerochit formation; Permian.
15829	52 AMo 37	Morris, R. H.; 1952; Mt. Michelson quadrangle; Cache Creek, Canning River; lat 69°28′ N., long 145°49′ W.	Sadlerochit formation (basal part); Permian.

SYSTEMATIC PALEONTOLOGY

Class GASTROPODA
Superorder PROSOBRANCHIA
Order ARCHAEOGASTROPODA
Superfamily BELLEROPHONTACEA
Family SINUITIDAE
Subfamily EUPHEMITINAE
Genus EUPHEMITES Warthin, 1930

Euphemites sp.

Plate 12, figures 2–4

Discussion.—Several specimens retain patches of shell showing the spiral lirae characteristic of the genus. One specimen has at least 18 lirae from one umbilicus to near the selenizone; all other specimens are less complete and lirae cannot be counted. The selenizone is relatively wide and slightly depressed. At least the first third of the body whorl is secondarily smoothed by a thin inductural layer or layers. Most specimens are of uniform size, about 12 mm across the axis of coiling. All are regularly and smoothly coiled.

Steinkerns, or internal fillings of the shells, have been referred to this species in one instance. These steinkerns are of the same general size and shape and occur in the same collection as identifiable specimens of *Euphemites*. To check this identification, an artificial steinkern was prepared by removing the shell from a specimen. This steinkern and the naturally occurring ones all show slightly wider umbilici with steeper walls than do steinkerns referred to *Bellerophon*.

Illustrated specimens.—USNM 136507a, 136507b; USGS locality 12084.

Occurrence and abundance.—Lower Mississippian undifferentiated: USGS locality 12340, two. Alapah limestone: USGS locality 12084, nine.

Family BELLEROPHONTIDAE
Subfamily BELLEROPHONTINAE
Genus BELLEROPHON Montfort, 1808

Bellerophon sp.

Plate 12, figures 5–9

Discussion.—Bellerophontacean steinkerns are common; three of these retain patches of shell showing

growth lines and a selenizone characteristic of *Bellerophon*. Other steinkerns were identified as *Bellerophon* by comparison with these three specimens. Most identifications of steinkerns as *Bellerophon* were based on the character of the umbilical openings. Among the Alaskan specimens at least, the umbilical openings are relatively narrower and have more arched walls and a slightly less abrupt juncture of side and umbilical opening than in umbilici in steinkerns referred to *Euphemites*. It is to be emphasized that these are not characters of the shell; there is suggestive evidence that the shell itself may have been anomphalous. Some of the steinkerns that exceed the size of the largest known specimens of *Euphemites* are called *Bellerophon* sp. even though the umbilical characters of the steinkern are not certainly known.

Although some specimens are well rounded along the dorsum, having only a faint ridge at the position of the selenizone, others have flattened sides and a more prominent crestlike dorsum. In several, the dorsum is wide and depressed in the center. It is possible that these bellerophontaceans with flattened sides represent another taxon. Until better specimens are obtained so that this hypothesis can be tested, all the material is assigned to one species with some of the specimens presumed to have been compressed during deformation of the enclosing strata.

Several of the specimens are quite large for the genus; such an individual, measuring over 70 mm across the aperture, is shown on plate 12, figure 9. The only described American late Paleozoic species that approaches this size is the poorly known *Bellerophon giganteus* Worthen. Slightly larger specimens of *Bellerophon* have been illustrated by Koninck (1883) from the Carboniferous of Belgium.

In most cases steinkerns are of little use in paleontology and, indeed, specific identification of them can often do more harm than good. It may well be that several biologic species are included here under *Bellerophon* sp. However, inasmuch as many of these specimens come from a single stratigraphic unit, it seems reasonable to conclude that these specimens belong to a single species. The occurrence of bellerophontacean steinkerns of this sort has been shown to be a good field guide to rocks of the lower part of the Alapah limestone and its equivalents. Because of the occurrence of similar steinkerns in both older and younger rocks in northern Alaska, caution is urged in their use for age determination. At best, these steinkerns should be used only to supplement more positive evidence of the age of a rock unit.

Illustrated specimens.—USNM 136508a, 136509b, USNM locality 3088; USNM 136509, USGS locality 11799; USNM 136510, USGS locality 15408.

Occurrence and abundance.—Lower Mississippian undifferentiated: USGS locality 11807, one; 11808, one; 13234, one; 13235, one. Alapah limestone: USGS locality 976, eight; 13287, four; 15408, two; USNM locality 3088, nine; 3172, one. Upper Mississippian undifferentiated: USGS locality 11799, four.

Subfamily KNIGHTITINAE
Genus KNIGHTITES Moore, 1941
Subgenus RETISPIRA Knight, 1945a

Knightites (Retispira?) sp.

Plate 12, figure 1

Discussion.—Identification is based on a single incomplete Mississippian specimen, showing spiral lirae and a raised selenizone. Uncertainty as to identification arises from two sources. First, the specimen is so incomplete that apertural characters, particularly the presence or absence of a ridge on the floor of the aperture, cannot be determined. Second, there is a slight chance that the specimen may be a pleurotomariacean, genus indeterminate, with the upper part of the shell destroyed. Orienting plate 12 with the left margin downward shows the basis for this possible identification.

A second small poorly preserved specimen, of questionable Permian age, is more certainly referable to the subgenus. It cannot be determined if it is conspecific with the other specimen, and it is too poorly preserved to be illustrated or treated separately.

Illustrated specimen.—USNM 136506, USGS locality 11843.

Occurrence and abundance.—Lower Mississippian undifferentiated: USGS locality 11843, one. ?Permian: USGS 408a, one.

INDETERMINATE BELLEROPHONTACEANS

Discussion.—In addition to the material discussed above, other poorly preserved and indeterminate specimens may represent this superfamily. For a few of them, however, it is possible to assay a generic assignment. Collections not commented upon below can be determined only to the superfamily level.

Occurrence and abundance.—Kayak shale: USGS locality 13245, may be *Euphemites* sp.; 13258, one, may be a *Bellerophon*, matrix differs from that yielding *Bellerophon* sp. Wachsmuth limestone: USNM locality 3115, one, may be a *Bellerophon*, matrix differs from that yielding *Bellerophon* sp. Lower Mississippian undifferentiated: USGS locality 11867, not a *Bellerophon*, in gross form this specimen resembles *Sinuitina* Knight, 1945a. Alapah limestone: USGS locality 406, one; 1004, six; 14151, one; 14992, one. Upper Mississippian undifferentiated: USGS locality 975, eight, slight indication this may be *Bellerophon* sp.; 996, one, slight indication this may be *Bellerophon* sp.; 10870, one. Sadlerochit formation: USGS locality 7118b (green), one, probably a bellerophontid, form approaches *Bellerophon* sp., but collection is known to be of

Permian rather than Mississippian age. Unnamed Permian formation: USGS locality 11823, one, similar to *Bellerophon* sp., but collection is known to be of Permian rather than Mississippian age.

Superfamily EUOMPHALACEA
Family EUOMPHALIDAE
Genus STRAPAROLLUS Montfort, 1810
Subgenus EUOMPHALUS Sowerby, 1814

Straparollus (Euomphalus) brooksensis Yochelson and Dutro, n. sp.

Plate 12, figures 15, 20–23

Description.—Low-spired euomphalids having a sharp upper angulation and rounded umbilical whorls; juvenile whorls well rounded and discoidal, sutures impressed only in this growth stage; mature shell low spired with body whorl embracing penultimate whorl at periphery; upper whorl surface flattened, inclined upward nearly 10° from horizontal in early growth stages, nearly horizontal to upper shoulder at maturity; upper shoulder angulated in most growth stages but not bearing a carina, the angulation becoming less distinct with age so that large specimens show a differentiation of upper and outer whorl faces but no sharp angulation; outer whorl face distinctly arched with periphery near midwhorl, becoming steeper and with a lower periphery in the gerontic stage; basal whorls well rounded in all growth stages, the profile following the arc of a circle from outer whorl face to umbilicus; umbilical sutures distinct; growth lines gently prosocline on upper whorl surface, gently prosocline to orthocline from upper angulation to periphery, seemingly gently prosocline below on outer whorl face, on basal whorl surface and up into umbilicus.

Discussion.—The low spire, relatively large size, and rounded umbilical whorls differentiate *Straparollus (Euomphalus) brooksensis* from other Alaskan Euomphalidae. Several specimens bridge the gap from the discoidal earliest stages to the low-spired adult. In view of the long stratigraphic range of this form, it may very well be that more than one species is included. The number of specimens is so small and preservation is such that attempts to differentiate Lower Mississippian from Upper Mississippian forms have been unsuccessful. Pending study of additional specimens, it is assumed that this is a single species.

Several incomplete specimens have been tentatively referred to the species. These are indicated by the reference to footnote 2 in the proper column of the distribution chart (table 1).

Numerous low-spired euomphalids with rounded whorls have been named, particularly in European literature. Until these named forms have been systematically restudied, no comparison between them and *S. (Euomphalus) brooksensis* is warranted.

Illustrated specimens.—Holotype: USNM 136515, USNM locality 3186; paratypes: USNM 136514, USGS locality 11890, and USNM 136513, USGS locality 13235.

Measurements.—Measurements of the illustrated specimens (in mm) are given below:

Specimen	Height	Width	Height of aperture	Width of aperture
USNM 136513	5.4	13.0	------	-------
136514	[1] 23	41.7	14.6	[1] 16
136515	10.7	21.0	------	-------

[1] Estimated.

Occurrence and abundance.—Wachsmuth limestone: USNM locality 3107, one; 3091, cf. one. Lower Mississippian undifferentiated: USGS locality 11890, one; 13235, two; 13240, cf. one. Alapah limestone: USNM locality 3087, two; 3186, one.

Straparollus (Euomphalus) alaskensis Yochelson and Dutro, n. sp.

Plate 12, figures 10–14, 16–19

Description.—Very low spired euomphalids with nearly vertical umbilical walls; sutures distinct, relatively deep in early growth stages; nucleus and juvenile whorls discoidal with rounded whorls, the upper angulation being poorly developed on largest juvenile whorl; mature whorl produced downward slightly so that it embraces penultimate whorl above midwhorl; upper whorl surface distinctly flattened, inclined 5°–10° from horizontal to a sharp, distinct, noncarinate outer angulation, the inclination of the upper whorl face increasing with age; outer whorl face inclined outward and downward following a concave outward curve for the upper one-third of face, the lower edge of the curve being at the periphery, below which the outer whorl face is inclined inward 20°–30° from vertical for most of distance below the periphery, curving more strongly near base; basal whorl face distinctly flattened, set off from the umbilicus by a sharp circumbilical angulation in all except the late mature and gerontic stages; umbilical walls turning abruptly from circumbilical angulation to nearly vertical; umbilicus wide and relatively deep for size and height of shell; growth lines gently prosocline from suture to upper angulation, on outer whorl face very gently opisthocline to periphery, there turning to prosocline and continuing straight down the lower part of the face across the base and into the umbilicus.

Discussion.—The nearly vertical walls of the umbilicus readily distinguish *Straparollus (Euomphalus) alaskensis* from other known Permian species. The umbilical walls are even steeper than those of *S. (Euomphalus) levicarinatus* Yochelson from the middle Permian of the southwestern United States (1956.

p. 217). Most cross sections do not appear to show the two shell layers characteristic of the family (Knight, 1934, pl. 26), but they can be observed on a few of the well-preserved specimens. The seeming lack of an outer shell layer, coupled with the poor development of the upper angulation in the earlier growth stages, suggested at first that specimens were only subinternal molds, that is, specimens lacking the outer shell layer. Subsequent finding of large specimens with a reasonably well developed upper angulation ruled out this possibility.

As in the case of other species described herein, some poorly preserved specimens have been tentatively referred to this species. These are distinguished by reference to footnote 2 in the appropriate column of the distribution chart (table 1).

Illustrated specimens.—Holotype: USNM 136512, USGS locality 11823; Paratypes: USNM 136511a, 136511b, and 136511c, USGS locality 11814.

Measurements.—Measurements of three of the illustrated specimens (in mm) are given below:

Specimen	Height	Width	Height of aperture	Width of aperture
USNM 136511b	6.0	14.1	------	-------
136511c	6.0	13.9	5.0	5.1
136512	12	27.7	9.1	8.8

Occurrence and abundance.—Siksikpuk formation: USGS locality 11785, six; 11814, twelve; 11816, seven; 14099, four, 14152, nine; 11786, cf. three; 15453, cf. four. Sadlerochit formation: USGS locality 15813, one. Unnamed Permian formation: USGS locality 11823, one. ?Permian: USGS locality 982, one.

Straparollus (Euomphalus) sp.

Plate 12, figures 24–26

Discussion.—A third species of *Euomphalus* in the Alaskan collections differs from the other two in being discoidal, with the earliest whorls depressed rather than low spired. The upper whorl surface is distinctly inclined upward to a carina on the outer angulation. The outer whorl face is slightly crushed in the specimen, but it appears to be arched outward to the periphery, located below midwhorl, and then less strongly curved inward to a basal angulation. Below this angulation, the basal whorl surface is flattened, except near the wide shallow umbilicus. The umbilical walls are steep, but no circumbilical angulation is present; the juncture with the basal surface is smoothly rounded. Growth lines are orthocline on the upper surface, essentially radial from the suture. On the outer whorl face they are gently opisthocline to the periphery, prosocline below, and finally straight, gently prosocline on the basal surface.

It does not seem appropriate to give a formal name to this single specimen. In some respects, particularly in the character of the umbilicus, this species is similar to *Straparollus* (*Euomphalus*) *crateriformis* (Koninck) from the Tournaisian of Belgium, but in that species the base is distinctly wider than the upper surface. A second incomplete small specimen has been tentatively referred to this species.

Illustrated specimen.—USNM 136516, USGS locality 14954.

Occurrence and abundance.—Wachsmuth limestone: USGS locality 14954, one. Alapah limestone: USGS locality 997, cf. one.

Genus AMPHICAPHA Knight, 1945
Subgenus CYLICIOSCAPHA Yochelson, 1956

Amphiscapha (Cylicioscapha) grada Yochelson and Dutro, n. sp.

Plate 12, figures 27–29

Description.—Discoidal euomphalids with a shelf on outer whorl face and a prominent basal angulation; juvenile whorls rounded, depressed slightly below general upper surface of shell; sutures impressed in all growth stages; upper whorl surface distinctly inclined, following a curve gently concave upward from suture to a carinate angulation at the outer edge of upper surface; outer whorl face inclined outward and strongly downward below sharp carina for about one-third of its total width, then bending abruptly to nearly horizontal for a short distance, next abruptly flexed downward forming a step in the profile of the outer whorl face; below this step the outer whorl face is gently arched outward for a short distance to the periphery which is located just below midwhorl; below the periphery the face steadily curves inward to the base, there being some evidence that in later growth stages a shallow groove and essentially vertical segment of the face occur just above the basal angulation; basal angulation distinct, slightly more than 90°, noncarinate; basal whorl surface flattened, nearly horizontal, curving gently inward as umbilicus is approached, then bending more abruptly into nearly vertical-walled wide umbilicus without, however, developing a circumbilical angulation; growth lines orthocline, radial from suture across inner half of upper whorl face, then gently curving prosocline to angulation, being nearly straight opisthocline on upper part of outer whorl face, but straight gently prosocline below the shelf, across the base, and into the umbilicus.

Discussion.—The characteristic "step" on the outer whorl face readily distinguishes members of this subgenus from specimens of *Euomphalus*. In detail, *Amphiscapha* (*Cylicioscapha*) *grada* is discoidal, rather than low spired as are *Straparollus* (*Euomphalus*) *brooksensis* and *S.* (*Euomphalus*) *alaskensis*. In basal view it is most similar to *S.* (*Euomphalus*) sp.,

but the basal angulation of that species is sharper and the basal whorl surface somewhat more inclined.

A. (Cylicioscapha) grada lacks the nodes or rugosities on the upper angulation that are characteristic of other described species of the subgenus.

Illustrated specimen.—Holotype: USNM 136517, USGS locality 11823.

Measurements.—Measurements of the illustrated specimen (in mm) are as follows: height, 5.1; width, 16.2; height of aperture, 5.2; and width of aperture, 5.0.

Occurrence and abundance.—Sadlerochit formation: USGS locality 15829, one. Unnamed Permian formation: USGS locality 11823, three.

INDETERMINATE EUOMPHALACEANS

Discussion.—As in the case of the bellerophontaceans, many specimens referable to this superfamily are poorly preserved, but most of these are relatively more poorly preserved than are the bellerophontaceans. Accordingly, for less than one-third of these specimens is it possible to express an opinion as to what species they represent.

Occurrence and abundance.—Kayak shale: USGS locality 13219, one; 13245, one; 13247, one. Wachsmuth limestone: USNM locality 3100, one; 3279, six, may be *Straparollus (Euomphalus) brooksensis;* USGS locality 13286, one; 14074, one, may be a distinct species from any described or discussed above. Lower Mississippian undifferentiated: USGS locality 11807, one; 11858, one; 11861, one, may be *Straparollus (Euomphalus) brooksensis;* 12701, one; 12785, three; 13234, two; 13241, one; 14097, two, may be *Straparollus (Euomphalus) brooksensis.* Alapah limestone: USNM locality 3087a, one; 3167, one; 3169, one; 3188, two; USGS locality 976, four, may be *Straparollus (Euomphalus) brooksensis;* 1015, one, may be *Straparollus (Euomphalus) brooksensis;* 12355, one; 14151, two; 15430, two, may be *Straparollus (Euomphalus) brooksensis;* 15455, one, may be *Straparollus (Euomphalus) brooksensis.* Upper Mississippian undifferentiated: USGS locality 971, one; 11799, one may be *Straparollus (Euomphalus) brooksensis.* Siksikpuk formation: USGS locality 11815, two. Sadlerochit formation: USGS locality 1010, three. Unnamed Permian formation: USGS locality 13215, one, may be *Straparollus (Euomphalus) alaskensis.* ?Permian: USGS locality 989a, one.

Superfamily PLEUROTOMARIACEA
Family SINUOPEIDAE
Subfamily TURBONELLININAE
Genus RHINEODERMA Koninck, 1883

Rhineoderma? sp.

Plate 12, figure 34

Discussion.—A single specimen is questionably referred to this genus. The specimen is compressed and its original shape cannot be determined. There is some indication that the peripheral selenizone acted as a zone of weakness during compression, because growth lines are prosocline from suture to edge of specimen and are seemingly orthocline below. The specimen is phaneromphalous. The upper surface is ornamented by spiral lirae, six major ones being present with finer lirae intercalated. The ornament and the presumed low-spired conical shape suggest a possible reference to *Rhineoderma.*

Illustrated specimen.—USNM 136520, USNM locality 3167.

Occurrence and abundance.—Alapah limestone: USNM locality 3167, one.

Genus TURBONELLINA Koninck, 1881

Turbonellina? lata Yochelson and Dutro, n. sp.

Plate 12, figures 30–33

Description.—Beehive-shaped phaneromphalous gastropods with a strong circumbilical angulation; nucleus and earliest whorls planispiral, more mature whorls moderately high spired; sutures distinct, slightly impressed; outer whorl face inclined outward and strongly downward, gently arched throughout its length, the flattened nearly horizontal base being set off from the outer whorl face by a relatively narrow well-rounded periphery, the angle between outer face and base approximately 60°; narrowly phaneromphalous, with steeply inclined circumbilical walls, the umbilicus being set off by a sharp circumbilical angulation; growth lines on upper part of outer whorl surface prosocline, nearly 15° from vertical, their course below not certainly known, but seemingly with a sinus on the periphery; shell polished and unornamented.

Discussion.—This species has a flattened nucleus and general whorl shape similar to that of the type species *Turbonellina lepida* (Koninck) from the Visé̊n of Belgium. It differs in being smooth rather than elaborately ornamented. In addition, there is some question as to the course of the growth lines in *T.? lata.* Until better specimens are available, the generic placement of the species must be questioned.

Illustrated specimens.—Holotype: USNM 136518, USGS locality 13235; paratype: USNM 136519, USGS locality 13234.

Measurements.—Measurements of the illustrated specimens (in mm) are given below:

Specimen	Height	Width
USNM 136518	4.0	5.2
136519	10	10

Occurrence and abundance.—Kayak shale: USNM locality 3095, one. Lower Mississippian, undifferentiated: USGS locality 13234, two; 13235, one.

Family RAPHISTOMATIDAE
Subfamily LIOSPIRINAE
Genus TREPOSPIRA Ulrich and Scofield, 1897
Subgenus TREPOSPIRA Ulrich and Scofield, 1897

Trepospira (Trepospira) sp.

Plate 13, figures 1–3

Discussion.—A single specimen referable to this subgenus has been found in the Siksikpuk formation.

It is low spired and has a sharp keel. Ornament consists of short lirae radial from the suture. Unfortunately, most of the rest of the shell surface is lacking and details of the selenizone and other ornament cannot be determined. It appears likely that the shell is missing from the base and that the specimen originally had the umbilicus filled with callus.

Illustrated specimen.—USNM 136522, USGS locality 14174.

Occurrence and abundance.—Siksikpuk formation: USGS locality 14174, one.

Subgenus ANGYOMPHALUS Cossmann, 1915

Trepospira (Angyomphalus?) sp.

Plate 12, figures 35, 36

Discussion.—A second species of *Trepospira*, from the Mississippian, appears to have a true umbilicus. The single specimen is a juvenile and cannot be contrasted with the preceding species except in the character of the umbilicus.

Illustrated specimen.—USNM 136521, USGS locality 11843.

Occurrence and abundance.—Lower Mississippian undifferentiated: USGS locality 11843, one.

Family EOTOMARIIDAE
Subfamily EOTOMARIINAE
Tribe MOURLONIDES
Genus MOURLONIA Koninck, 1883

Mourlonia minuta Yochelson and Dutro, n. sp.

Plate 13, figures 4, 5

Description.—Turbiniform gastropods with colabral ornament and a wide raised selenizone on the periphery; nucleus unknown; body whorl embracing penultimate whorl at lower edge of selenizone; upper whorl surface inclined outward and downward, slightly more arched near the selenizone, below which the whorl surface curves more strongly inward than above so that the upper whorl surface is distinctly more inclined toward vertical than the lower; base anomphalous; growth lines prosocline from suture, approximately 30° from the vertical, proceeding straight for most of the distance across the upper surface, curving more strongly backward near the selenizone, opisthocline below the selenizone for a short distance then turning to nearly orthocline; selenizone relatively wide, unbordered, raised slightly above the general level of the whorl surface, and bearing numerous lunulae; narrow parietal inductura in the upper part of the columellar lip; colabral ornament consisting of low rounded lirae above selenizone, somewhat weaker below, the interspaces being twice the width of the lirae.

Discussion.—The relatively wide raised selenizone distinguishes *Mourlonia minuta* from other pleurotomariaceans in the Alaskan faunas. The ornament appears to be somewhat finer than that of other species having strong colabral ornament. This slight difference may be a reflection of the small size of the specimens of *M. minuta*, compared to the other pleurotomariaceans described.

Mourlonia minuta appears to be slightly higher spired with less well rounded whorls than other species referred to *Mourlonia*. More significantly, the selenizone of this species is also relatively wider than that of other species currently placed in the genus. Further study of additional material may show that this represents a distinct genus.

Illustrated specimen.—Holotype: USNM 136523, USGS locality 11865.

Measurements.—Measurements of the illustrated specimen (in mm) are as follows: height, 9; width, 8.6; height of aperture, 5.4; and width of aperture, 5.

Occurrence and abundance.—Alapah limestone: USGS locality 11865, seven.

Mourlonia? reloba Yochelson and Dutro, n. sp.

Plate 13, figures 6–9

Description.—Turbiniform gastropods with globose whorls and a narrow, bordered selenizone at periphery; shell moderately high spired; whorls embracing at upper edge of selenizone, the line of contact lowering very slightly with increasing maturity; sutures gently impressed; whorls well rounded from suture to peripheral selenizone, being somewhat less rounded below; anomphalous; growth lines orthocline at suture but, after leaving suture, prosocline, about 30° from vertical along upper whorl face to near edge of selenizone where they bend a little more strongly backward, below selenizone opisthocline for a short distance then turning to gently prosocline and proceeding straight to base of columella; selenizone relatively narrow, with closely spaced lunulae, and bordered by lirae; a narrow parietal inductura present on upper part of columellar lip, unknown below; colabral ornament of strong lirae above selenizone, slightly finer below, with fine colabral lirae intercalated near the columella, the ornament becoming less prominent with age.

Discussion.—*Mourlonia? reloba* differs from other pleurotomariacean species described herein in having a narrow, bordered selenizone at the periphery and a globose whorl profile. The strong colabral ornament is not an important taxonomic character as several unrelated pleurotomariacean lineages possess similar ornamentation. Specimens from localities 11816 and 15453, are poorly preserved; these have been referred tentatively to the species.

The *Mourlonia? reloba* form of shell with its narrow selenizone and globose whorls may be a distinct phylogenetic line. A Mississippian specimen in the U.S. National Museum collections, from near Fort Gibson, Okla., is remarkably similar to the specimens illustrated. Revision of the genus must be delayed, however, until more well-preserved specimens are at hand. No previously described Permian pleurotomareans are known that are comparable to *M.? reloba.*

Illustrated specimens.—Holotype: USNM 136525, USGS locality 14169; paratype: USNM 136524, USGS locality 14169.

Measurements.—Measurements of the illustrated specimens (in mm) are given below:

Specimen	Height	Width	Height of aperture	Width of aperture
USNM 136524	[1] 37	29	[1] 22	17
136525	[1] 20	17. 0	[1] 14	11. 9

[1] Estimated.

Occurrence and abundance.—Unnamed Permian formation: USGS locality 14169, four. Siksikpuk formation: USGS locality 11816, cf. one; 15453, cf. one.

NODOSPIRA Yochelson and Dutro, n. gen.

Type species.—Nodospira ornata Yochelson and Dutro, n. sp.

Diagnosis.—Moderately high spired ornamented pleurotomariaceans with a bordered peripheral selenizone and well-rounded whorls; shell moderately high spired, the body whorl embracing the penultimate whorl at the lower edge of the selenizone; whorls relatively well rounded, with periphery near midwhorl; concave selenizone on periphery bordered by strong flanges; distinct colabral lirae.

Discussion.—The genus *Mourlonia* Koninck appears to be much in need of revision for, as presently interpreted, it includes species from Middle Ordovician through Permian in age. *Nodospira* is proposed in an attempt to separate some species from the *Mourlonia* complex. The well-rounded whorls and the selenizone bordered by distinct strong flanges serve to distinguish *Nodospira* from *Mourlonia.* The colabral lirate ornament of this genus is similar to that of *Ptychomphalina* Fischer, which has been placed, perhaps improperly, in the synonymy of *Mourlonia. Nodospira* differs from *Ptychomphalina* in having the selenizone at midwhorl rather than below, and in having well-rounded whorls.

In the literature examined, no species have been found that can be referred to this genus. *Mourlonia*-like forms occur in most Mississippian faunas. That no previously described species can be attributed to this genus is a reflection of the inadequacy of published illustrations and a lack of comparative material for study.

Nodospira ornata Yochelson and Dutro, n. sp.

Plate 13, figures 14–17

Description.—Conical pleurotomariaceans with strong subsutural protuberances and pronounced colabral lirae; earlier whorls unknown; shell moderately high spired with body whorl embracing penultimate whorl at lower edge of selenizone; upper whorl surface distinctly arched from suture, turning abruptly to horizontal at periphery and forming a relatively wide flange marking the upper border of the selenizone; below the selenizone the whorl surface is well curved, the profile following a curve nearly the arc of a circle; anomphalous; outer lip gently prosocline almost to selenizone, then sweeping strongly opisthocline for a short distance below selenizone and then swinging to distinctly prosocline on most of basal surface; columellar lip reflexed with a thin, narrow inductura; selenizone concave between strong bordering flanges; ornament of strong colabral lirae on upper whorl surface in all growth stages known, the lirae somewhat finer below the selenizone; strong closely spaced, elongate, subsutural protuberances periodically interrupting the smooth profile of the upper whorl surface.

Discussion.—The presence of the subsutural protuberances immediately distinguishes *Nodospira ornata* from other large pleurotomariaceans. In addition, the selenizone is wider than in *Mourlonia? reloba*, and is raised. Colabral lirae are thicker than on *Bembexia? inumbilicata*, and the gross shape differs, with the body whorl of this species embracing higher on the penultimate whorl. These same features, and the lack of an umbilicus, distinguish *N. ornata* from new genus? B.

Illustrated specimens.—Holotype: USNM 136528, USGS locality 14150; paratype: USNM 136529, USGS locality 14150.

Measurements.—Measurements of the illustrated specimens (in mm) are given below:

Specimen	Height	Width	Height of aperture	Width of aperture
USNM 136528	32	27. 3	18. 7	15. 4
136529	57	51	[1] 37	28

[1] Estimated.

Occurrence and abundance.—Alapah limestone: USGS locality 14150, six; 12340, twenty-two; 12348, ten.

Genus SPIROSCALA Knight, 1945

cf. Spiroscala sp.

Plate 13, figure 10

Discussion.—Two specimens are tentatively referred to this genus. The first shows a conical, relatively high spired form with a peripheral flangelike selenizone. The second specimen, not illustrated, is mashed

and incomplete, but shows an eavelike overhang of the selenizone and an absence of ornament near the suture. Lack of ornament distinguishes these specimens from a Mississippian form in the collections referred to *Phymatopleura*.

Illustrated specimen.—USNM 136526, USGS locality 1008.

Occurrence and abundance.—Sadlerochit formation: USGS locality 1008, one; 15826, one.

Tribe EOTOMARIIDES
Genus BEMBEXIA Oehlert, 1888

Bembexia? inumbilicata Yochelson and Dutro, n. sp.

Plate 13, figures 30, 31

Description.—Large conical anomphalous gastropods with bordered selenizone forming periphery; earlier whorls unknown; sutures impressed; body whorl embracing penultimate whorl below periphery; upper whorl surface inclined outward approximately 35° from vertical and gently inflated, turning abruptly to horizontal and forming the upper bordering flange of the selenizone at the periphery; whorl profile below selenizone inclined steeply downward for approximately one-half of its length, then curving more strongly inward to the anomphalous base; concave selenizone located on the periphery between strong bordering flanges, the upper flange overhanging the lower; lunulae faint; growth lines prosocline from suture, approximately 20°, bending more abruptly backward just above the selenizone, below the selenizone opisthocline for a short distance then curving to prosocline, about 20° from vertical, and continuing straight downward; columellar lip with a narrow inductura; ornament of impressed growth lines alone.

Discussion.—*Bembexia? inumbilicata* appears to be most similar, superficially, to *Tropidostropha* Longstaff, 1912, but lacks both an umbilicus and pitting in the shell. It differs from *Bembexia larteti* (Munier-Chalmas), the type species, in being higher spired and in having the upper flange of the selenizone, rather than the lower flange, at the periphery. Because the significance of these differences cannot now be evaluated, generic placement of the species is questioned.

In addition to gross shape, *Bembexia? inumbilicata* differs from Alaskan specimens referred to *Mourlonia* in lacking strong colabral ornament. It lacks nodes on the upper surface as are found in *Nodospira ornata*. The species is most similar in shape to specimens referred to as New genus? B., and at one time the two forms were confused. They differ however in the nature of the umbilicus, *B.? inumbilicata* being clearly anomphalous.

The spire of the holotype is incomplete and the aperture is slightly crushed. No meaningful measurements of the species can be presented.

Illustrated specimen.—Holotype: USNM 136536, USGS locality 10862.

Occurrence and abundance.—Alapah limestone: USGS locality 10862, two; 12779, three; 14151, one; 12342, one.

Genus GLABROCINGULUM Thomas, 1940
Subgenus GLABROCINGULUM Thomas 1940

Glabrocingulum (Glabrocingulum) sp.

Plate 13, figures 11–13

Discussion.—This species is represented by two specimens from the Siksikpuk formation. They are moderately low spired, conical, and have the selenizone located at the periphery. The upper whorl surface bears a row of coarse nodes at the suture and at least three rows of fine nodes. The narrow selenizone is concave and bordered by sharp lirae. The arched basal surface bears at least seven spiral carinae, all of which are noded. The base is anomphalous. The species does not warrant specific naming in view of the small number of specimens available.

Illustrated specimen.—USNM 136527, USGS locality 14174.

Occurrence and abundance.—Siksikpuk formation: USGS locality 14174, two.

Subfamily NEILSONIINAE
Genus NEILSONIA Thomas, 1940

Neilsonia? sp.

Plate 13, figure 25

Discussion.—Two collections from northern Alaska contain small, moderately high spired pleurotomariceans. All are poorly preserved, but enough remains of the shell to show the main features. The upper surface is distinctly inclined, but little arched. The selenizone forms the outer whorl face and is nearly vertical, the lower edge being at the periphery. The selenizone proper is concave and distinctly bordered. Below the selenizone the basal whorl surface is nearly straight, inclined inward for a distance about the width of the selenizone, at which place there is a distinct though slight angulation, below which the basal whorl surface curves inward and strongly downward. The base is anomphalous. The columellar lip is slightly reflexed. The upper whorl surface appears to have strong colabral ornament. No specimen is complete enough to show all the details given above, and a formal name does not appear justified.

Illustrated specimen.—USNM 136533, USGS locality 9184.

Occurrence and abundance.—Alapah limestone: USGS locality 9184, fifty; 10868, twenty five.

Family PORTLOCKIELLIDAE
Genus PORTLOCKIELLA Knight, 1945

Portlockiella? sp.

Plate 13, figures 18, 19

Discussion.—A single specimen is questionably placed in this genus. It is a low-spired, relatively wide form. The specimen is either narrowly phaneromphalous or pseudoumbilicate. Ornament consists of five widely spaced, low, spiral carinae. A selenizone probably occurs just below the last carina, below midwhorl, but just above the periphery. Growth lines, however, are not clear. On the base, below this presumed selenizone, ornament consists of revolving lirae, the exact number not determinable.

Illustrated specimen.—USNM 136530, USNM locality 3167.
Occurrence and abundance.—Alapah limestone: USNM locality 3167, one.

Family GOSSELETINIDAE
Subfamily GOSSELETININAE
Genus GOSSELETINA Fischer, 1885

Gosseletina? sp.

Plate 13, figures 20, 21

Discussion.—A single specimen is characterized by a narrow selenizone high on the whorl, a distinctive feature of *Gosseletina*. The selenizone is concave and strongly bordered. Below the selenizone the whorl is ornamented by numerous spiral lirae. Whorls are moderately rounded and the specimen is relatively high spired for a pleurotomariacean. Except in the position of the selenizone, none of the features described are found on the low-spired smooth type species of *Gosseletina*. It may be that this form represents a new genus but, as with many of the specimens discussed, formal systematic treatment must be deferred until more specimens are available.

Illustrated specimen.—USNM 136531, USGS locality 13236.
Occurrence and abundance.—Lower Mississippian undifferentiated: USGS locality 13236, one.

Family PHYMATOPLEURIDAE
Genus PHYMATOPLEURA Girty, 1939

Phymatopleura sp.

Plate 13, figures 22–24

Discussion.—A single well preserved specimen of *Phymatopleura* was collected from the Lower Mississippian. It shows the characteristic conical shape with a narrow, bordered, peripheral selenizone. The flattened base is ornamented by six revolving lirae. Ornament of the upper whorl surface is unusual in showing pronounced ontogenetic change. The penultimate whorl and earlier whorls bear five sharp spiral lirae. The body whorl, on the other hand, is smooth except for growth lines and a noded subsutural lira.

Illustrated specimen.—USNM 136532, USGS locality 13234.
Occurrence and abundance.—Lower Mississippian undifferentiated: USGS locality 13234, one.

Family uncertain

New genus? A

Plate 13, figures 26–28

Discussion.—A new genus of pleurotomariaceans may occur in the Wachsmuth limestone. It is represented by a single distorted specimen and, therefore, the taxon is not formally named. The specimen does show several interesting morphological details.

The shell is conical and moderately low spired, and has a peripheral selenizone located well below midwhorl. Sutures are distinct and impressed. Because of distortion the shape of the upper whorl surface cannot be determined with certainty, but it appears to have been essentially flattened from near the suture almost to the selenizone. The selenizone is narrow, raised and rounded, strongly convex outward. Below the periphery, the basal surface bends sharply inward. The base is anomphalous. Ornament consists of two elements, a series of short lirae normal to the suture and fine threads normal to the growth lines. The intersections of these two sets form a reticulate pattern on the upper whorl surface. Growth lines are prosocline, about 30°, curving back more strongly near the selenizone. Below the selenizone, growth lines are orthocline, abruptly curving to prosocline on the base. In gross shape the specimen resembles *Phymatopleura*, but the convex selenizone of this specimen is distinctive. It is possible that this convexity is a result of distortion; more specimens are needed to determine this point. Phylogenetic position of this form within the Pleurotomariacea is most uncertain.

Illustrated specimen.—USNM 136534, USGS locality 3110.
Occurrence and abundance.—Wachsmuth limestone: USNM locality 3110, one.

New genus? B

Plate 14, figures 26, 27

Discussion.—Two specimens from the unnamed Permian formation, may represent another new genus. One specimen is exceedingly fragmentary. The second, illustrated, was partially cleaned from a very resistant matrix. This specimen is incomplete and the body whorl has been offset by a small fracture.

The specimens are quite similar to *Bembexia? inumbilicata*. They appear to be slightly lower spired, and have the body whorl embracing lower on the penultimate whorl. As there are only slight differ-

ences between the two forms, incomplete specimens could be readily confused. They differ in that this form has a depression in the base. Unfortunately, it cannot be determined if a true umbilicus is present. There is some similarity to the Mississippian genus *Tropidostropha* Longstaff, 1912, but comparisons must be delayed until more complete specimens are available. So far as is known, this occurrence is unique in the Permian.

Illustrated specimen.—USNM 136551, USGS locality 13215.

Occurrence and abundance.—Unnamed Permian formation: USGS locality 13215, two.

INDETERMINATE PLEUROTOMARIACEANS

Discussion.—Numerous poorly preserved specimens can be referred to the Pleurotomariacea. Some few can be placed questionably in the taxa previously described. Others appear to represent additional genera and species too poorly preserved to discuss in detail. Still others are so incomplete that they cannot be placed in any taxon satisfactorily.

Occurrence and abundance.—Kayak shale: USGS locality 13222, one, identification as pleurotomariacean uncertain. Wachsmuth limestone: USNM locality 3173, three, two genera present, one with spiral ornament suggestive of *Rhineoderma*? sp., the other moderately high with a conical shape and possibly a genus not otherwise recorded in the fauna. Lower Mississippian undetermined: USGS locality 11807, one, may be *Phymatopleura* sp.; 12700, one, pleurotomariacean; 12701, three, with spiral ornament suggestive of *Rhineoderma*? sp.; 12785, three, moderately low spired and ornamented by spiral lirae, possibly a genus not otherwise recorded in the fauna; 13234, one, identification as pleurotomariacean uncertain; 13235, two, two genera present, one a pleurotomariacean, the other, so incomplete that identification as pleurotomariacean is uncertain; 13236, one, identification as pleurotomariacean uncertain. Alapah limestone: USNM locality 3167, five, two genera present, similar, respectively, to those listed for USNM locality 3173; USGS locality 1014, one, with spiral ornament suggestive of *Rhineoderma*? sp.; 12084, two, may be *Mourlonia minuta.* Upper Mississippian undifferentiated: USGS locality 972, one, conical with sutures little impressed and ornamented by spiral lirae, possibly a genus not otherwise recorded in the fauna. ?Upper Mississippian: USGS locality 14947, thirteen, moderately high spired with a peripherial selenizone and colabral ornament, may be a genus not otherwise recorded in the fauna. Siksikpuk formation: USGS locality 15453, one, pleurotomariacean with spiral ornament on base. Sadlerochit formation: USGS locality 7118t green, three, possibly *Mourlonia*? *reloba;* 1009, one, pleurotomariacean; 1010, one, may be cf. *Spiroscala* sp.; 15817, one, doubtfully *Mourlonia*? *reloba.* Unnamed Permian formation: USGS locality 11823, one moderately high spired with a concave selenizone near periphery, and spiral lirae on base, possibly a genus not otherwise recorded in the fauna; 13216, one, may be *Mourlonia*? *reloba.* Permian: USGS locality 982, one, pleurotomariacean; 987, four, two genera present, one moderately high spired with a vertical outer whorl face, a selenizone at the juncture of upper and outer whorl faces, and spiral ornament, and may be a genus not otherwise recorded in the fauna, the other, identification of pleurotomariacean uncertain.

Superfamily PLATYCERATACEA
Family HOLOPEIDAE
Genus YUNNANIA Mansuy, 1912

Yunnania sp.

Plate 13, figure 29

Discussion.—One specimen is placed in this genus. It is moderately high spired with the upper whorl surface flattened, inclined outward and downward; sutures are not impressed. The outer whorl face is nearly vertical, and the basal surface is flattened, inclined inward and more strongly downward. The specimen is anomphalous. Ornament consists of spiral lirae on all three whorl faces, there being at least ten on the body whorl. The specimen is a steinkern retaining only one small patch of shell which does not show growth lines. It may be that this species is actually a pleurotomariacean, but slight evidence suggests that the outer lip did not possess a slit.

Illustrated specimen.—USNM 136535, USGS locality 12785.

Occurrence and abundance.—Lower Mississippian undifferentiated: USGS locality 12785, one.

Family PLATYCERATIDAE
Genus PLATYCERAS Conrad, 1840
Subgenus PLATYCERAS Conrad, 1840

Platyceras (Platyceras) sp.

Plate 14, figure 28

Discussion.—The genus *Platyceras* has been divided into several subgenera (Knight, Batten, and Yochelson, in press), the typical subgenus being restricted to those forms which have at least the earliest whorls in contact. This feature can be shown with certainty only for two collections of specimens, one from the Lower Mississippian and one from the Upper Mississippian. Except for the earlier whorls, the specimens are poorly

preserved and in other respects are similar to those identified as *Platyceras* (*Orthonychia*) sp. As used here, the grouping of *Platyceras* (*Platyceras*) sp. probably has no biologic meaning.

Numerous species of *Platyceras* have been described, particularly from rocks of Mississippian age, but no synthesis of the family has been attempted. Individual variation is great and definitive work on *Platyceras* should properly discuss the host echinoderms of the several species. Additional species names would only further complicate study of this family.

Illustrated specimen.—USNM 136552, USGS locality 14035.

Occurrence and abundance.—Lower Mississippian undifferentiated: USGS locality 11807, three. Upper Mississippian undifferentiated: USGS locality 14035, five.

Subgenus ORTHONYCHIA Hall, 1843

Platyceras (Orthonychia) sp.

Plate 14, figures 17–19

Discussion.—*Orthonychia* differs from the typical subgenus of *Platyceras* in having all growth stages, including the earliest, out of contact so that a mature specimen does not complete as much as one whorl. Specimens in nine of the collections preserve the earliest whorls, and in six others enough of the shell is preserved to indicate that it is unlikely that the early growth stages were coiled. Other incomplete specimens have been referred to this taxon as a convenience rather than having them listed separately as indeterminate platyceratacean.

Most of the specimens are tubelike, but a few are flattened, patelliform. None of the specimens is well enough preserved to warrant detailed description; almost all lack the aperture. A detailed study of the shape of the apertures of some specimens might reveal information about the host echinoderms (Bowsher, 1956), but poor preservation makes this extremely unlikely.

The platyceratids show considerable individual variation because of their life attachment to echinoderm calices. Variation results from the orientation of the gastropod on the calyx and the shape of the tegmen. Little is known of specific limits of platyceratids. The grouping used here probably does not reflect a biologically valid species. *Orthonychia* is of little value in dating rocks because it is known from beds of Devonian through Permian age.

Illustrated specimens.—USNM 136544a, 136544b, USNM locality 3089; USNM 136545, USGS locality 9186.

Occurrence and abundance.—Kayak shale: USNM locality 3095, three; 3247, three; USGS locality 13231, six; 13238, two; 13252, two; 13258, two. Wachsmuth limestone: USNM locality 3089, thirty three; 3100, one; 3113, one; 3173, two; 3279, two; USGS locality 14965, two. Lower Mississippian undifferentiated: USGS locality 9186, one; 12773, one; 12785, two; 12798, one; 13225, one; 13228, one; 13232, two; 13237, one; 13237, two; 13254, four; 13292, one. Upper Mississippian undifferentiated: USGS locality 14984, one. Sadlerochit formation: USGS locality 1009, two. ?Permian: USGS locality 960, one 979, one.

Superfamily MICRODOMATACEA
Family ELASMONEMATIDAE
Genus ANEMATINA Knight, 1933

Anematina rockymontanum (Shimer)

Plate 14, figures 10–16

Loxonema rockymontanum Shimer 1926, Canada Geol. Survey Museum Bull. 42, p. 81–82, pl. 4, figs. 9a, b; 10.

Description.—High-spired subtrochiform gastropods with a flattened outer whorl face; in early growth stages sutures distinct and impressed; outer whorl face straight, little arched in juvenile stages, with increasing age developing a low spiral ridge at suture, below which the whorl face is slightly concave to near midwhorl, becoming slightly convex to the periphery located low on the whorl, the overall face being strongly inclined downward; in maturity the whorl face gently but distinctly arched; below the periphery the whorl curving strongly and rather abruptly inward to base in early growth stages, the base itself being flattened to about 10° or 15° from horizontal, becoming slightly arched and less clearly set off from the upper whorl face with increasing maturity; base probably anomphalous but, doubtfully, minutely phaneromphalous; growth lines on outer whorl face straight, prosocline at about 15°, crossing periphery and forming a wide shallow sinus on the base; columellar lip not reflexed; ornamented by numerous spiral lirae which are finer than the fine growth lines, the lirae becoming more obscure with increasing size; shell thin.

Discussion.—The flattened outer whorl face and flattened base of the early growth stages, combined with the large size, mark this as a distinct species The type species, *Anematina proutana* (Hall), is characterized by extremely small size and by rounded whorls in all growth stages. *Anematina rockymontanum* (Shimer) seems to be closely related to *A. laqueata* (Koninck) from the Viséan of Belgium, but differs in lacking a spiral ridge on the base.

Through the kindness of Dr. Hans Frebold, Chief of the Section of Stratigraphic Palaeontology, Geological Survey of Canada, we were able to examine H. W. Shimer's original specimens of *Loxonema rockymontanum* (Shimer, 1926, p. 81). Geological Survey of Canada No. 5093 is the holotype, the original of

Shimer's figures 9a and 9b. Geological Survey of Canada No. 5093a is a figured paratype, the original of Shimer's figure 10. The specimens were numbered some years after the original description was published. Four additional specimens are included in 5093. They are poorly preserved but may belong to this species. Shimer also studied two specimens from lot 5095, an associated locality. These are so poorly preserved that they cannot be referred even questionably to this species. With the exception of one natural cross section, all of Shimer's specimens were broken from limestone.

There is no doubt that the specimens from northern Alaska are conspecific with Shimer's species. The close similarity between the types and the Brooks Range material is illustrated on plate 14. Unfortunately, many of the Alaskan specimens have been distorted. Others are incomplete or are steinkerns. This less well preserved material is only tentatively referred to the species.

Small steinkerns of *Anematina* can be separated from those of *Loxonema* by two characters. First, the more angular whorl face and flattened base are reflected in the steinkern; the profile of *Loxonema* is relatively well rounded. Second, the *Anematina* shell is thinner than that of *Loxonema*. This feature results in a relatively smaller gap between whorls of the steinkern.

In the holotype, the outer whorl face is flattened and set off rather abruptly from the flattened basal whorl surface. The slightly larger paratype, on the other hand, has a somewhat more rounded body whorl with the outer and basal faces distinctly arched and not so clearly separated. Although the whorl profiles of mature specimens of *Loxonema* and *Anematina* are not too dissimilar, the growth lines are fundamentally different. Poorly preserved specimens of the two genera could be confused.

Illustrated specimens.—Holotype: GSC 5093; paratype: GSC 5093a; hypotype: USNM 136542, USGS locality 13288; hypotype: USNM 136543, USGS locality 11808.

Measurements.—Measurements of the illustrated specimens (in mm) are given below:

Specimen	Height	Width
GSC 5093	20. 5	[1] 10
5093a	------	[1] 14
USNM 136542	[1] 26	[1] 12
136543	[1] 14	5. 9

[1] Estimated.

Occurrence and abundance.—Wachsmuth limestone: USNM locality 3098, one; 3173, cf. one; USGS locality 13278, one. Lower Mississippian undifferentiated: USGS locality 11808, two; 12785, one; 12701, cf. one. Alapah limestone: USNM locality 3182, one, 3272, one; USGS locality 13288, one; 9187, cf. two.

Anematina? sp.

Discussion.—Ten high-spired specimens listed below are questionably placed in *Anematina* because of the poor quality of preservation. In spite of the present uncertainty it seems reasonable to suggest that further collecting will indicate that only a single species of the genus is present in Mississippian rocks of northern Alaska.

Occurrence and abundance.—Lower Mississippian undifferentiated: USGS locality 13242, one. Alapah limestone: USNM locality 3167, one; USGS locality 1014, one. Upper Mississippian undifferentiated: USGS locality 975, seven.

Superfamily ANOMPHALACEA
Family ANOMPHALIDAE
Genus ANOMPHALUS Meek and Worthen, 1867

Anomphalus sp.

Plate 14, figures 7–9

Discussion.—One small well-preserved rotelliform gastropod is placed in this genus. The shell surface is typically polished and smooth except for two faint spiral lirae near the suture. Sutures are impressed. Growth lines are gently opisthocline on the upper surface to nearly halfway between suture and periphery, where they swing backward becoming distinctly prosocline on the lower part of the outer whorl face. The umbilicus is relatively wide and seemingly without any sort of an inductural constriction or filling, although preservation is such that the possibility of a pseudoumbilicate condition cannot be ruled out.

The species lacks the short radial ornament at the suture which apparently characterizes *Anomphalus nerviensis* Koninck, from the Lower Carboniferous of Belgium.

Illustrated specimen.—USNM 136547, USNM locality 3167.

Occurrence and abundance.—Alapah limestone: USNM locality 3167, one.

Superfamily NERITACEA
Family NERITOPSIDAE
Subfamily NATICOPSINAE
Genus NATICOPSIS M'Coy, 1844
Subgenus NATICOPSIS M'Coy, 1844

Naticopsis (Naticopsis) suturicompta Yochelson and Dutro, n. sp.

Plate 14, figures 20–25

Description.—Well-rounded neritopsids with ornament on a subsutural ramp developed in intermediate growth stages; sutures distinct, becoming more impressed with age; shell low spired, the body whorl embracing the penultimate whorl above the periphery; whorls relatively well rounded, "apple shaped," a narrow subsutural ramp in all intermediate growth stages, followed by a smooth curve which near the

periphery approaches the arc of a circle, and a slight elongation of the whorl below the periphery; growth lines straight, gently prosocline from suture to columella; inductura and other apertural features unknown; ornamented by distinct subsutural lirae which appear after the earliest growth stages, coincidentally with the development of the subsutural ramp, and disappear at maturity simultaneously with disappearance of the ramp.

Discussion.—The subsutural ornament of *Naticopsis* (*Naticopsis*) *suturicompta* is similar to that of species referred to *N.* (*Jedria*) Yochelson, 1953. The relatively high-spired, elongate shape of the latter, however, is quite distinct from the well-rounded "apple shape" of the typical subgenus. As closely as can be determined, this combination of well-rounded whorls and subsutural ornament is confined to this species. Certain American and Belgian species approach the shape of *N.* (*Naticopsis*) *suturicompta*, but ornament either is not present or was overlooked and not figured by earlier workers.

This species characterizes the "*Naticopsis howi* zone" of Dutro and Bowsher (1957) and is the same form referred to by them.

Partially exfoliated specimens show the presence of two shell layers. They also show, on the inner layer, growth lines parallel to those on the outer layer. These lines have not been observed on silicified specimens from the Permian of west Texas. Rather, the inner shell layer of those forms is characterized by structures essentially normal to the growth lines.

As with most of the gastropods from northern Alaska, preservation of specimens presents problems with the taxonomic treatment. The type of this species and a few other smaller specimens show the characteristic ornament. Most of the specimens do not preserve the early whorls or, if they are present, they are partially exfoliated or are steinkerns. However, in these specimens the shape of the mature body whorl agrees closely with the type. The alternatives of regarding these less well preserved specimens as a separate species or only tentatively comparing them to this species have been considered but rejected, and all Upper Mississippian specimens of fair preservation are placed in one species.

Several specimens from the Lower Mississippian are tentatively referred to the species. These are all small nearly globular shells possessing subsutural ornament but lacking a subsutural ramp. Some neritacean species are known to undergo considerable ontogenetic change. Further collections may show that the mature stage of these Lower Mississippian forms distinguishes them from the Upper Mississippian species. If they do represent another species, it would indicate that ornament alone is an unreliable criterion for identification of poorly preserved or immature specimens.

Illustrated specimens.—Holotype: USNM 136549, USGS locality 9187; paratypes: USNM 136548, USNM locality, 3088; and USNM 136550, USNM locality 3170.

Measurements.—Measurements of the illustrated specimens (in mm) are given below:

Specimen	Height	Width	Height of aperture	Width of aperture
USNM 136548	[1] 55	55	47	43
136549	26	24	20	16
136550	[1] 25	26	20	18

[1] Estimated.

Occurrence and abundance.—Lower Mississippian undifferentiated: USGS locality 11808, cf. one; 12701, cf. one; 13240, cf. two. Alapah limestone: USNM locality 3088, twenty; 3164, one; 3170, two; 3171, one; 3182, cf. one; USGS locality 9187, three; 12355, three; 15430, one; 994, cf. one. Upper Mississippian undifferentiated: USGS locality 11799, three.

Naticopsis (Naticopsis) sp.

Plate 14, figure 5

Discussion.—A single small specimen from the Mississippian Lisburne group differs from juvenile specimens of *Naticopsis* (*Naticopsis*) *suturicompta*. It is markedly higher spired, and has an elongate, poorly rounded body whorl with the periphery well below midwhorl. No subsutural ramp is developed. The specimen has fainter subsutural ornament than is characteristic of *N.* (*Naticopsis*) *suturicompta*, but this may be a feature of immaturity. The specimen is too poorly preserved to warrant a formal specific name.

Illustrated specimen.—USNM 136540, USGS locality 13235.

Occurrence and abundance.—Lower Mississippian undifferentiated: USGS locality 13235, one.

INDETERMINATE NERITACEANS

Discussion.—As with most of the other superfamilies treated herein, there are some specimens referable to the superfamily that are quite poorly preserved. Unlike the material from the other groups, most of these are not steinkerns, but are either distorted specimens or juveniles. It seems probable that most of these specimens are referable to *Naticopsis* in the broad sense. Specific identification is not possible.

Occurrence and abundance.—Kayak shale: USGS locality 13247, one. Wachsmuth limestone: USGS locality 13246, one. Lower Mississippian undifferentiated: USGS locality 12701, eight; 12709, one; 12785, three; 12788, one; 13234, one; 13235, one; 13254, one; 13255, one. Alapah limestone: USGS locality 976, one; 997, one; USNM locality 3167, one. ?Upper Mississippian: USGS locality 13246, one.

Order MESOGASTROPODA
Superfamily MURCHISONIACEA
Family MURCHISONIIDAE
Genus MURCHISONIA Archiac and Verneuil, 1841

cf. Murchisonia sp.

Plate 14, figure 1

Discussion.—A single specimen is tentatively referred to this genus, as used in the broadest sense. The specimen is high spired, has impressed sutures and apparently well-rounded whorls. There is a spiral lira below the periphery forming what appears to be the lower border of a gently concave selenizone. The specimen is exceedingly poorly preserved, but it is unique in the fauna and has been figured.

A second, even more poorly preserved specimen is questionably placed in this taxon.

Illustrated specimen.—USNM 136537, USGS locality 13240.
Occurrence and abundance.—Lower Mississippian undifferentiated: USGS locality 13240, one. Alapah limestone: USGS locality 9184, cf. one.

Family PLETHOSPIRIDAE
Subfamily PITHODEINAE
Genus PLATYZONA Knight, 1945

Platyzona sp.

Plate 14, figure 2

Discussion.—This species, identified from a single specimen, is not named. The specimen is fairly well preserved, but is incomplete. The shell is moderately high spired. Sutures are impressed and whorls are relatively broad and well rounded, being flattened near the suture. A broad concave selenizone is located on the periphery. Growth lines on the upper whorl surface are prosocline, sweeping backward from the suture to the selenizone. Below the selenizone they are gently opsithocline for about the upper third of the lower whorl surface. Details of the aperture and base are unknown.

Illustrated specimen.—USNM 136538, USGS locality 13246.
Occurrence and abundance.—?Upper Mississippian: USGS locality 13246, one.

INDETERMINATE MURCHISONIACEANS

Discussion.—Four specimens are placed in this grouping. The first is a steinkern retaining patches of shell. The other three are incompletely silicified shells.

Occurrence and abundance.—Lower Mississippian undifferentiated: USGS locality 13240, one, whorls ornamented by several spiral lirae; more angular than cf. *Murchisonia* sp. Alapah limestone: USNM locality 3167, one, may show evidence of a selenizone; 3272, two, may show evidence of a selenizone.

Superfamily LOXONEMATACEA
Family LOXONEMATIDAE
Genus LOXONEMA Phillips, 1841

Loxonema sp.

Plate 14, figure 6

Discussion.—Specimens referred to this species are typical of the genus. They are exceedingly high spired, have deep sutures and well-rounded whorls. Growth lines are arcuate, forming a wide, quite shallow sinus, the most posterior portion of which is near midwhorl. This sinus distinguishes the specimens from those called cf. *Murchisonia* sp. All the specimens are small and it is assumed that they are immature.

Illustrated specimens.—USNM 136541, USGS locality 11828.
Occurrence and abundance.—Alapah limestone: USGS locality 11828, three.

INDETERMINATE LOXONEMATACEANS

Discussion.—Specimens placed here are poorly preserved steinkerns. It should be pointed out that reference to cf. *Murchisonia* sp. would be nearly as feasible, because either of these fundamentally different shells, when exfoliated, produce almost identical steinkerns.

Occurrence and abundance.—Lower Mississippian undifferentiated: USGS locality 9186; two, possibly *Loxonema;* 13235, five, four to five times size of specimens of *Loxonema* sp.; Alapah limestone: USGS locality 976, seven, doubtfully *Loxonema.*

Order NEOGASTROPODA
Superfamily SUBULITACEA
Family SUBULITIDAE
Subfamily SOLENISCINAE
Genus IANTHINOPSIS Meek and Worthen, 1866

Ianthinopsis? sp.

Plate 14, figure 3

Discussion.—Two specimens from the Lower Mississippian show the low-spired subglobular shape characteristic of some of the soleniscinids. They are questionably placed in *Ianthinopsis*, this being the most common upper Paleozoic genus. Neither shows features of the columellar lip, critical for more exact placement. The specimens are in part exfoliated; the rest of the shell has been recrystallized.

Illustrated specimen.—USNM 136539, USGS locality 12785.
Occurrence and abundance.—Lower Mississippian undifferentiated: USGS locality 11867, one; 12785, one.

Class SCAPHOPODA
Genus indeterminate

Plate 14, figure 4

Discussion.—A single, incomplete scaphopod is present in the collection from USGS locality 13246. Faint

traces of annular growth lines can be seen, but if other ornament was originally present, it is not preserved. The specimen does not warrant description and is included here only because Mississippian scaphopods are relatively rare and occurrences should be recorded. A second specimen from USGS locality 13240 seems to lack transverse ornament, and in that respect is similar to *Plagioglypta* Pilsbry and Sharp (1897).

Illustrated specimen.—USNM 136546, USGS locality 13246.

Occurrence and abundance.—Lower Mississippian undifferentiated: USGS locality 13240, one. ?Upper Mississippian: USGS locality 13246, one.

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INDEX

[Italic numbers indicate descriptions]

PLATES 12–14

PLATE 12

FIGURE 1. *Knightites* (*Retispira*?) sp. (p. 132)
Oblique top view, × 2; USNM 136506, from USGS loc. 11843, Lower Mississippian.

2–4. *Euphemites* sp. (p. 131)
2. Oblique front view, × 2; USNM 136507a, from USGS loc. 12084, *Goniatites* zone, Alapah limestone. Oblique top view and side view, respectively, × 2; USNM 136507b, from USGS loc. 12084, *Goniatites* zone, Alapah limestone.

5–9. *Bellerophon* sp. (p. 131)
5. Side view of small steinkern, × 2; USNM 136508a, from USNM loc. 3088, *Naticopsis* zone, Alapah limestone.
6. Front view showing selenizone, × 2; USNM 136509, from USGS loc. 11799, *Naticopsis* zone, Alapah limestone.
7, 8. Side and top views, respectively, of a steinkern, × 1; USNM 136508b, from USNM loc. 3088, *Naticopsis* zone, Alapah limestone.
9. Top view of a large steinkern, × 1; USNM 136510, from USGS loc. 15408, *Naticopsis* zone, Alapah limestone.

10–14. *Straparollus* (*Euomphalus*) *alaskensis* Yochelson and Dutro, n. sp. (p. 133)

16–19. 10. Section showing two shell layers, × 2; paratype, USNM 136511a, from USGS loc. 11814, Siksikpuk formation.
11. Slightly oblique side view, × 2; paratype, USNM 136511b, from USGS loc. 11814, Siksikpuk formation.

Straparollus (*Euomphalus*) *alaskensis* Yochelson and Dutro, n. sp. (p. 133)
12–14. Side, top, and basal views, respectively, × 2; paratype, USNM 136511c, from USGS loc. 11814, Siksikpuk formation.
16–19. Side, apertural, basal, and top views, respectively, × 1; holotype, USNM 136512, from USGS loc. 11823, unnamed Permian formation(?).

15, 20–23. *Straparollus* (*Euomphalus*) *brooksensis* Yochelson and Dutro, n. sp. (p. 133)
15, 20. Basal and top views, respectively, of small specimen, × 2; paratype, USNM 136513, from USGS loc. 13235, Lower Mississippian.
21. Apertural view, × 1; paratype, USNM 136514, from USGS loc. 11890, Lower Mississippian.
22, 23. Side and top views, respectively, × 2; holotype, USNM 136515, from USNM loc. 3186, *Lithostrotion* zone, Alapah limestone.

24–26. *Straparollus* (*Euomphalus*) sp. (p. 134)
Top, basal, and apertural views, respectively, × 2; USNM 136516, from USGS loc. 14954, *Brachythyris* zone, Wachsmuth limestone.

27–29. *Amphiscapha* (*Cylicioscapha*) *grada* Yochelson and Dutro, n. sp. (p. 134)
Side, top, and basal views, respectively, × 2; holotype, USNM 136517, from USGS loc. 11823, unnamed Permian formation(?).

30–33. *Turbonellina*? *lata* Yochelson and Dutro, n. sp. (p. 135)
30–32. Side, basal, and oblique top views, respectively, × 2; holotype, USNM 136518, from USGS loc. 13235, Lower Mississippian.
33. Basal view, × 4; paratype, USNM 136519, from USGS loc. 13234, Lower Mississippian.

34. *Rhineoderma*? sp. (p. 135)
Top view, × 2; USNM 136520, from USNM loc. 3167, *Lithostrotion* zone, Alapah limestone.

35–36. *Trepospira* (*Angyomphalus*?) sp. (p. 136)
Top and basal views, respectively, × 4; USNM 136521, from USGS loc. 11843, Lower Mississippian.

LATE PALEOZOIC GASTROPODA

PLATE 13

FIGURES 1–3. *Trepospira* (*Trepospira*) sp. (p. 135)
Basal, top, and side views, respectively, × 1; USNM 136522, from loc. USGS 14174, Siksikpuk(?) formation.

4–5. *Mourlonia minuta* Yochelson and Dutro, n. sp. (p. 136)
Side, and top views, respectively, × 2; holotype USNM 136523, from USGS loc. 11865, Lisburne group (upper formation).

6–9. *Mourlonia? reloba* Yochelson and Dutro, n. sp. (p. 136)
6, 7. Side and basal views, respectively, × 1; paratype, USNM 136524, from USGS loc. 14169, unnamed Permian formation.
8, 9. Top and adapertural views, respectively, × 2; holotype, USNM 136525, from USGS loc. 14169, unnamed Permian formation.

10. cf. *Spiroscala* sp. (p. 137)
Side view, × 2; USNM 136526, from USGS loc. 1008, Sadlerochit(?) formation.

11–13. *Glabrocingulum* (*Glabrocingulum*) sp. (p. 138)
Top, adapertural, and basal views, respectively, × 2; USNM 136527, from USGS loc. 14174, Siksikpuk formation.

14–17. *Nodospira ornata* Yochelson and Dutro, n. sp. (p. 137)
14–16. Top, apertural, and basal views, respectively, × 1; holotype, USNM 136528, from USGS loc. 14150, *Goniatites* zone, Alapah limestone.
17. Apertural view, × 1; paratype, USNM 136529, from USGS loc. 14150, *Goniatites* zone, Alapah limestone.

18, 19. *Portlockiella*? sp. (p. 139)
Adapertural and top views, respectively, × 3; USNM 136536, from USNM loc. 3167, *Lithostrotion* zone, Alapah limestone.

20, 21. *Gosseletina*? sp. (p. 139)
Basal and side views, respectively, × 2; USNM 136531, from USGS loc. 13236, Lower Mississippian.

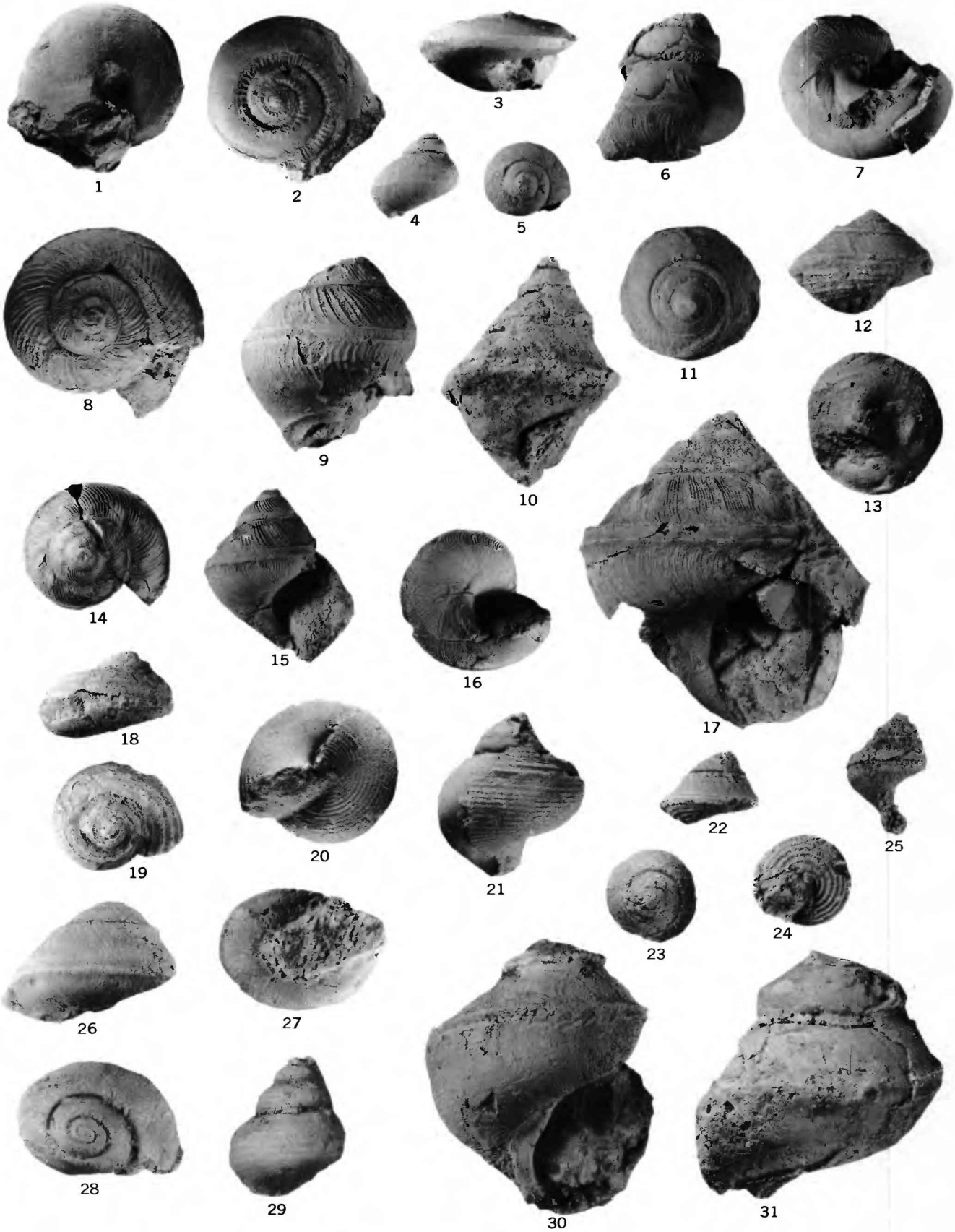
22–24. *Phymatopleura* sp. (p. 139)
Adapertural, top, and basal views, respectively, × 3; USNM 136532, from USGS loc. 13234, Lower Mississippian.

25. *Neilsonia*? sp. (p. 138)
Side view, × 4; USNM 136533, from USGS loc. 9184, Alapah limestone.

26–28. New genus? A (p. 139)
Adapertural, basal and top views, respectively, × 4; USNM 136534, from USNM loc. 3110, "*Zaphrentis*" zone Wachsmuth limestone.

29. *Yunnania* sp. (p. 140)
Adapertural view of steinkern, × 6; USNM 136535, from USGS loc. 12785, Lower Mississippian.

30–31. *Bembexia*? *inumbilicata* Yochelson and Dutro, n. sp. (p. 138)
Apertural and side views, respectively, × 1; Holotype: USNM 136536, from USGS loc. 10862, *Goniatites* zone, Alapah limestone.



LATE PALEOZOIC GASTROPODA

PLATE 14

FIGURE 1. *cf. Murchisonia* sp. (p. 144)
Side view, × 4; USNM 136537, from USGS loc. 13240, Lower Mississippian.

2. *Platyzona* sp. (p. 144)
Side view, × 2; USNM 13658, from USGS loc. 13246, probably Upper Mississippian.

3. *Ianthinopsis*? sp. (p. 144)
Side view, × 2; USNM 13659, from USGS loc. 12785, Lower Mississippian.

4. Scaphopod, genus indeterminate (p. 144)
Side view, × 2; USNM 136546 from USGS loc. 13246, probably Upper Mississippian.

5. *Naticopsis* (*Naticopsis*) sp. (p. 143)
Side view, × 2; USNM 136540 from USGS loc. 13235, Lower Mississippian.

6. *Loxonema* sp. (p. 144)
Side view, showing growth lines, × 4; USNM 136541, from USGS loc. 11828, *Goniatites* zone, Lisburne group.

7–9. *Anomphalus* sp. (p. 142)
Adapertural, top, and basal views, respectively, × 3; USNM 136547, from USNM loc. 3167, *Lithrostrotion* zone, Alapah limestone.

10–16. *Anematina rockymontanum* (Shimer) (p. 141)
10, 12, 13. Two side and basal views, respectively, × 2; holotype, GSC 5093, from Lower Mississippian of Lake Minnewanka Alberta.
11. Side view, × 2; paratype, GSC 5093a, from Lower Mississippian at Lake Minnewanka, Alberta.
14. Adapertural view, × 2; USNM 136542, from USGS loc. 11808, Lower Mississippian.
15, 16. Adapertural and apertural views, respectively, × 2; USNM 136543, from USGS loc. 13288, *Lithostrotion* zone, Alapah limestone.

17–19. *Platyceras* (*Orthonychia*) sp. (p. 141)
17. Side view, × 1; USNM 136544a, from USNM loc. 3089, *"Zaphrentis"* zone, Wachsmuth limestone.
18. Side view, × 1; USNM 136545, from USGS loc. 9186, Lower Mississippian.
19. Side view, × 1; USNM 136544b, from loc. 3089, *"Zaphrentis"* zone, Wachsmuth limestone.

20–25. *Naticopsis* (*Naticopsis*) *suturicompta* Yochelson and Dutro, n. sp. (p. 142)
20, 21. Enlargement showing shell layers, and adapertural view, respectively, × 4 and × 1; paratype: USNM 136548, from USNM loc. 3088, *Naticopsis* zone, Alapah limestone.
22–24. Side, apertural, and top views, respectively × 1; holotype, USNM 136549, from USGS loc. 9187, Alapah limestone(?).
25. Adapertural view, × 1; paratype, USNM 136550 from USNM loc. 3170, *Naticopsis* zone, Alapah limestone.

26, 27. New genus? B (p. 139)
Basal and side views, respectively, × 1; USNM 136551, from USGS loc. 13215, unnamed Permian formation.

28. *Platyceras* (*Platyceras*) sp. (p. 140)
Top view showing early whorls, × 4; USNM 136552, from USGS loc. 14035, Upper Mississippian.

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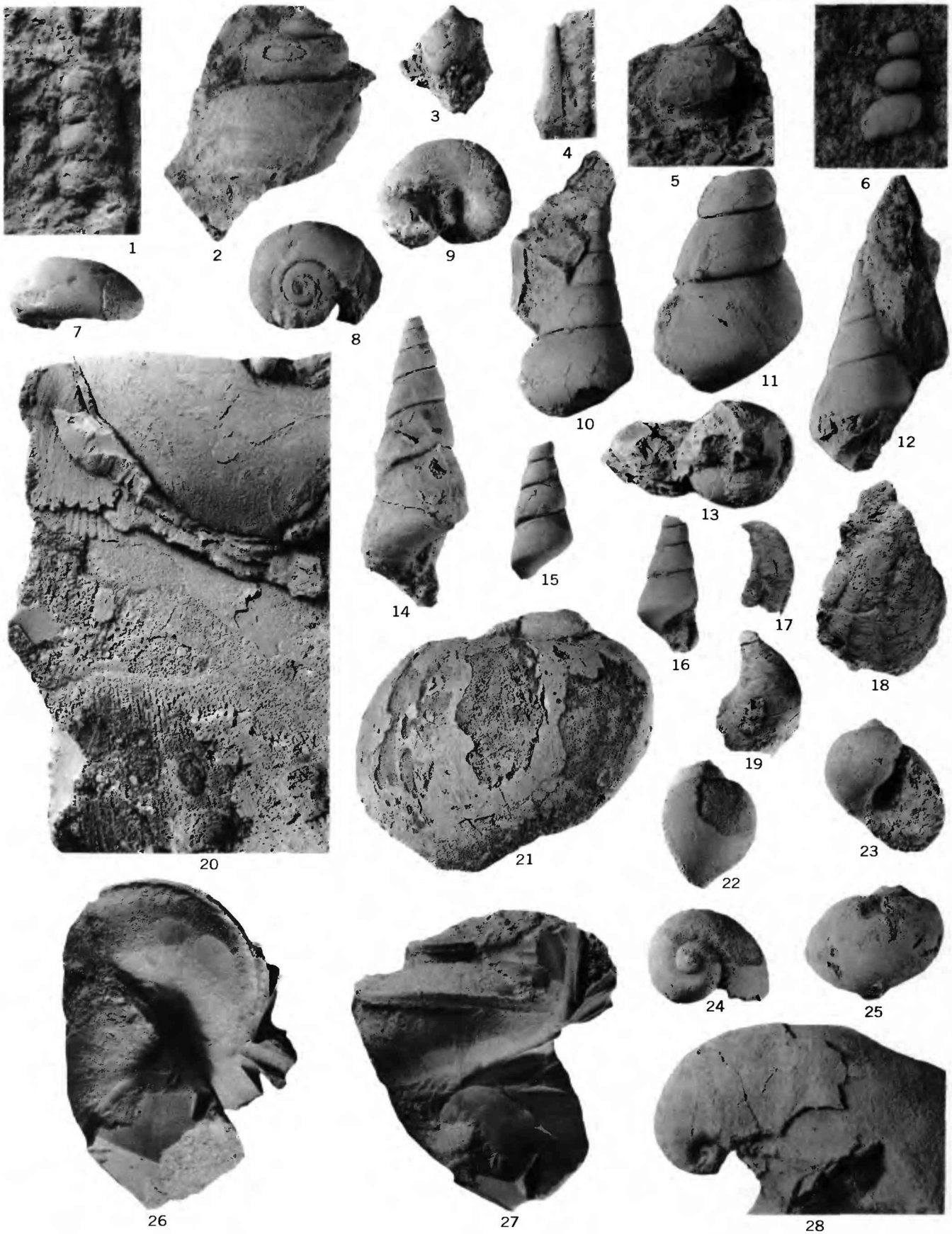

LATE PALEOZOIC GASTROPODA