Middle Jurassic (Bajocian and Bathonian) Ammonites From Northern Alaska

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By RALPH W. IMLAY

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An ammonite succession nearly identical with that in northern Canada is correlated with a more varied ammonite succession in southern Alaska

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MIDDLE JURASSIC (BAJOCIAN AND BATHONIAN) AMMONITES FROM NORTHERN ALASKA

By RALPH W. IMLAY

ABSTRACT

Middle Jurassic ammonites of Bajocian and Bathonian Age occur in northern Alaska within the Kingak Shale throughout thicknesses ranging from 300 to 850 feet (90–255 m) or more. Bajocian ammonites have been identified as far west as the Point Barrow area. Bathonian ammonites have been identified as far west as the Canning River and are possibly present on the Saviukviayak River.

The Bajocian ammonite succession from the base upward consists of (1) *Pseudolioceras maclintocki* (Haughton); (2) *P. whiteavesi* (White) in association with *Erycitoides howelli* (White) and *Canavarella crassifalcata* Imlay, n. sp.; and (3) *Arkelloceras* cf. *A. tozeri* Frebold. *P. maclintocki* in northern Canada occurs at or near the base of the lower Bajocian; *P. whiteavesi* and *E. howelli* in southern Alaska occur at the top of the lower Bajocian; and *Arkelloceras* on the Alaska Peninsula occurs above ammonites representing the *Sonninia sowerbyi* zone and near the base of an ammonite sequence representing the *Otoites sauzei* zone. The lack of younger Bajocian ammonites anywhere in northern Alaska is indicative of an unconformity.

The Bathonian ammonite succession from the base upward consists of (1) *Cranocephalites* sp., (2) *C. ignekensis* Imlay, n. sp., (3) *Arctocephalites* cf. *A. elegans* Spath, and (4) *Arcticoceras ishmae* (Keyserling). These ammonites, in comparison with the Bathonian ammonite succession in East Greenland, do not represent the highest and lowest parts of the stage, as defined for Greenland, nor do they represent the zone of *Arctocephalites greenlandicus* just below the zone of *Arcticoceras ishmae*. Perhaps the lack of representation on Ignek Mesa and elsewhere may be partly due to poor exposures. Nonetheless, an unconformity at the top of the Bathonian sequence in northern Alaska is indicated by the nearness of *Arcticoceras* to the early Oxfordian ammonite *Cardioceras* on Ignek Mesa and by the scarcity of definite Callovian ammonites in northern Alaska.

The Bajocian and Bathonian ammonite faunules in northern Alaska are closely similar to those in northern Canada and lived in the same faunal province. The inclusion of some species in common with faunules of the same ages in southern Alaska shows that the northern and southern seas were connected, although specifically the northern Alaskan faunas are much less varied.

New species described herein include *Canavarella crassifalcata* Imlay and *Cranocephalites ignekensis* Imlay.

INTRODUCTION

Middle Jurassic ammonites, representing the Bajocian and Bathonian Stages, are described herein in order to present the latest available evidence concerning the stratigraphic and geographic distribution of the taxa and to show that the Bathonian Stage is well developed in northern Alaska. Much of the discussion concerning the Bajocian ammonites is a reinterpretation of the fossils described by the writer in 1955, but the discussion also includes some new fossil and stratigraphic data. All these new data, as well as most of the data concerning Bathonian ammonites, are based on fossils collected since 1955—by geologists of British Petroleum (Alaska), Inc., in 1964, by consulting geologist Marvin Mangus in 1963 and 1966, and by U.S. Geological Survey geologists R. L. Detterman in 1969–72 and H. N. Reiser in 1970. The author is grateful to all these geologists for collecting the fossils, for preparing accurate locality maps and descriptions, and for furnishing stratigraphic data.

BIOLOGIC ANALYSIS

Northern Alaska ammonites of Bajocian and Bathonian Age that are discussed herein number 220 specimens. Their distribution by genus, subfamily, and family is shown in table 1. Among the

TABLE 1.—*Ammonite genera and subgenera of Bajocian and Bathonian Age in northern Alaska*

Family	Subfamily	Genus and subgenus	Number of specimens
Hildoceratidae	Harpoceratinae	*Pseudolioceras*	65
	Tmetoceratinae	*Tmetoceras*	2
	Leioceratinae	*Canavarella*	25
Hammatoceratidae	Hammatoceratinae	*Erycitoides*	7
		Erycitoides?	5
Oppeliidae	Oppeliinae	*Oppelia (Liroxyites)*	1
Stephanoceratidae		*Arkelloceras*	46
Cardioceratidae	Cadoceratinae	*Cranocephalites*	22
		Arctocephalites	16
		Arctocephalites?	6
		Arcticoceras	24
Perisphinctidae	Pseudoperisphinctinae	*Choffatia?*	1

families, the Hildoceratidae composes two-fifths, the Cardioceratidae nearly one-third, and the Stephanoceratidae one-fifth of the total specimens. The Hildoceratidae is represented mostly by *Pseudolioceras* but also includes *Tmetoceras* and *Canavarella*. The

Cardioceratidae is represented by nearly equal numbers of *Arcticoceras, Arctocephalites,* and *Cranocephalites.*

The characteristics of most of the genera and subgenera present have been adequately discussed in fairly recent publications. *Pseudolioceras, Tmetoceras,* and *Erycitoides* have been discussed by Westermann (1964, p. 358–360, 426–432; 1969, p. 18, 52); *Liroxyites,* by Imlay (1962b, p. A8); *Arkelloceras,* by Frebold (1958, p. 9; 1961, p. 8–10; Frebold and others, 1967, p. 18–20); *Cranocephalites* and *Arctocephalites,* by Spath (1932, p. 14–16, 32, 33), Arkell and others (1957, p. L301), and Imlay (1962a, p. C2); *Arcticoceras,* by Spath (1932, p. 50–53), Callomon (1959, p. 508), and Arkell and others (1957, p. L302); and *Choffatia,* by Spath (1931, p. 325), Arkell and others (1957, p. L317), and Arkell (1958, p. 211).

The ammonites *Cranocephalites, Arctocephalites,* and *Arcticoceras* represent a biological and stratigraphic succession. *Cranocephalites* is characterized by a compressed to stout shell, a very small umbilicus on its septate whorls, a contracted body chamber, a terminal constriction, and high sharp ribbing that persists to the aperture but may be reduced in strength or interrupted on the venter of the adult body chamber. *Arctocephalites* differs from *Cranocephalites* mainly by having a body chamber that remains involute or only slightly contracted and that becomes abruptly smooth at a fairly small diameter. *Arctioceras* differs from *Arctocephalites* by attaining a much larger size and by having a sharpened venter, ribs that become sharper, coarser, and more strongly projected on the venter, and a body chamber that becomes smooth, or nearly smooth, and more involute. The small inner whorls of *Arcticoceras* greatly resemble *Pseudocadoceras* at the same size, but the middle and outer whorls are more involute, and the body whorl is much larger and is generally smooth.

The genus *Canavarella* Buckman (1904, Supp. p. CXXIX), not previously recorded from Arctic North America, is characterized by a moderately involute compressed shell, a low keel, and strong simple falcate ribs that project strongly forward on the venter. It differs from *Cyclicoceras* Buckman (1899, Supp., p. XLIX, pl. 5, figs. 5, 6; Arkell and others, 1957, p. L262, L263), mainly by having simple instead of biplicate ribs that project forward much more strongly on the venter. It differs from *Pseudolioceras,* with which it is associated in Alaska, by having a wider umbilicus, stronger ribs on its inner whorls, and falcate instead of falcoid ribs. *Canavarella* in England is recorded from the zone of *Tmetoceras scissum* (Arkell and others, 1957, p. L262) near the base of the Middle Jurassic. In northern Alaska, it is associated with *Pseudolioceras whiteavesi* (White) and *Erycitoides* cf. *E. howelli* (White).

STRATIGRAPHIC SUMMARY

Middle Jurassic beds in northern Alaska have been identified faunally in the subsurface of the Point Barrow–Cape Simpson area (Imlay, 1955, p. 82, 89), in a few outcrops between the Killik and Itkillik Rivers in north-central Alaska (Patton and Tailleur, 1964, p. 444), and in extensive outcrops between the Sagavanirktok and Aichilik Rivers in northeastern Alaska (Imlay and Detterman, 1973, p. 9, 12). At most places they consist of siltstone, silty shale, and pyritic clay shale that contain ironstone concretions and are mostly noncalcareous. In the Killik-Itkillik area, however, the beds consist of interbedded tuffaceous graywacke, siltstone, claystone, chert, and silty limestone.

In northeastern Alaska, the Bathonian and Bajocian parts of the Middle Jurassic are readily distinguished lithologically. The Bajocian part is typically dark gray to black, weathers nearly the same color, and contains some limy concretions. The Bathonian part differs by being mostly grayish green on fresh surfaces, by commonly weathering reddish brown, and by containing more siltstone beds, more ironstone concretions, and less pyritic and limy material.

Thickness of the Middle Jurassic beds ranges from about 300 feet (90 m) or less in north-central Alaska to 850 feet (255 m) or more in northeastern Alaska. Beds of Bathonian Age attain a maximum thickness of nearly 500 feet (150 m), are highly variable in thickness locally, extend west at least as far as the Canning River, and possibly extend to the Saviukviayak River. Beds of Bajocian Age attain a greater thickness than overlying Bathonian beds, are likewise highly variable in thickness locally, and extend much farther west.

Within the Middle Jurassic sequence in northeastern Alaska, an unconformity is demonstrated by the complete lack of ammonites of late middle and late Bajocian Age, by the highly variable thickness of earlier Bajocian beds within short distances, and by the close proximity of dated lower Bathonian to lower or lower middle Bajocian beds. In the Killik-Itkillik area of north-central Alaska, an even greater unconformity is demonstrated by an absence of Jurassic ammonites and beds between the beds containing *Arkelloceras*? sp. juv. of probable middle Bajocian Age and beds containing *Buchia fischeriana* (d'Orbigny) of late Tithonian Age.

STRATIGRAPHIC DISTRIBUTION OF AMMONITES

The stratigraphic distribution of Middle Jurassic ammonites in northern Alaska has been difficult to determine because of poor exposures, structural complications, presence of erosional disconformities, and the rather similar appearance of dark siltstones and shales ranging in age from Late Triassic to Early Cretaceous.

The best and most continuous Middle Jurassic exposures found to date are in the cliffs along the southwest side of the Canning River from Shublik Island southeastward for about 1½ miles (2.4 km). These exposures do not represent a continuous stratigraphic sequence, however, as shown by the presence of faults, contorted beds, and the repetition of some ammonite faunules. Nonetheless, in the northernmost mile of exposures is a sequence at least 4,160 feet (1,248 m) thick in which ammonites of early Bajocian to early Kimmeridgian Age occur in normal succession. (See fig. 1.) Thus, within this sequence of 4,160 feet (1,248 m), early to early middle Bajocian ammonites occur throughout the lower 2,400 feet (720 m), and late Oxfordian to early Kimmeridgian ammonites occur in the upper 1,040 feet (312 m). Between the Bajocian and Oxfordian occurrences are 720 feet (216 m) of beds from which the Bathonian ammonite *Arctocephalites* was collected about 120 feet (36 m) above the highest occurrence of the middle Bajocian ammonite *Arkelloceras*.

In addition to the Bajocian and Bathonian fossils listed in figure 1, the same cliff exposures near their south end have furnished single specimens of the late Bathonian ammonite *Arcticoceras ishmae* (Keyserling), preserved in a hard-worn siltstone nodule, and of the early Bajocian ammonite (*Pseudolioceras whiteavesi* (White), preserved in a pyritic nodule. These were collected (USGS Mesozoic loc. 21023) along with 20 specimens of *P. maclintocki* (Haughton) preserved in grayish-black siltstone. Presumably the specimens of *P. maclintocki* were collected in place, whereas those of *P. whiteavesi* and *Arcticoceras ishmae* were derived from float either from higher beds exposed on the cliffs or from another Jurassic exposure about a mile (1.6 km) southeast of the south end of Shublik Island. On the basis of stratigraphic data from other areas, *P. whiteavesi* should occur directly above *P. maclintocki*, and *Arcticoceras ishmae* should occur above *Arctocephalites*.

The next best exposure of Middle Jurassic rocks and the most complete Bathonian ammonite succession known in northern Alaska occur on Ignek Mesa about 22 miles (35.2 km) northeast of the sequence west of Shublik Island. On the northwest slope of that mesa, the entire Jurassic section, as measured and collected by R. L. Detterman, is about 750 feet (225 m) thick. The section appears to be unfaulted, but contains covered intervals that are more common toward the base. Detterman collected fossils of early Bajocian to early Oxfordian Age from six different beds or units. His collections, listed stratigraphically from highest to lowest, are as follows:

Cardioceras (*Scarburgiceras*) sp. (USGS Mesozoic loc. 29856)
Arcticoceras sp. (USGS Mesozoic loc. 29877)
Cranocephalites ignekensis Imlay, n. sp. (USGS Mesozoic loc. 29855)
Cranocephalites sp. (USGS Mesozoic loc. 29875)
Inoceramus cf. *I. ambiguus* Eichwald (USGS Mesozoic loc. 29854)
I. lucifer Eichwald (USGS Mesozoic loc. 29853)

From the same sequence, at the northwest end of Ignek Mesa, the following fossils, listed stratigraphically from highest to lowest, were collected by geologists of British Petroleum (Alaska) Inc.:

Arctocephalites cf. *A. elegans* Spath (USGS Mesozoic loc. 29144)
A. cf. *A. elegans* Spath and *Cranocephalites ignekensis* Imlay, n. sp. (USGS Mesozoic loc. 29143)
Inoceramus cf. *I. lucifer* Eichwald (USGS Mesozoic loc. 29149)
I. lucifer Eichwald and *Erycitoides*? sp. (USGS Mesozoic loc. 29148)

From a nearby sequence 200 feet (60 m) below the base of the Ignek Formation at the southwest end of Ignek Mesa, Marvin Mangus collected *Arctocephalites* cf. *A. elegans* Spath and *Cranocephalites ignekensis* Imlay, n. sp. (USGS Mesozoic loc. 29435). At the same stratigraphic position directly west of Ignek Mesa, he collected many specimens of *C. ignekensis* and *Inoceramus* cf. *I. ambiguus* Eichwald but did not find *Arctocephalites* (USGS Mesozoic loc. 28817).

These records show that *Arctocephalites* definitely occurs above *Cranocephalites* at one locality and apparently with that genus at two localities. Their association does not seem natural, however. The fact that all the specimens of *Arctocephalites* are undeformed, whereas all the specimens of *Cranocephalites* are deformed or crushed, suggests that

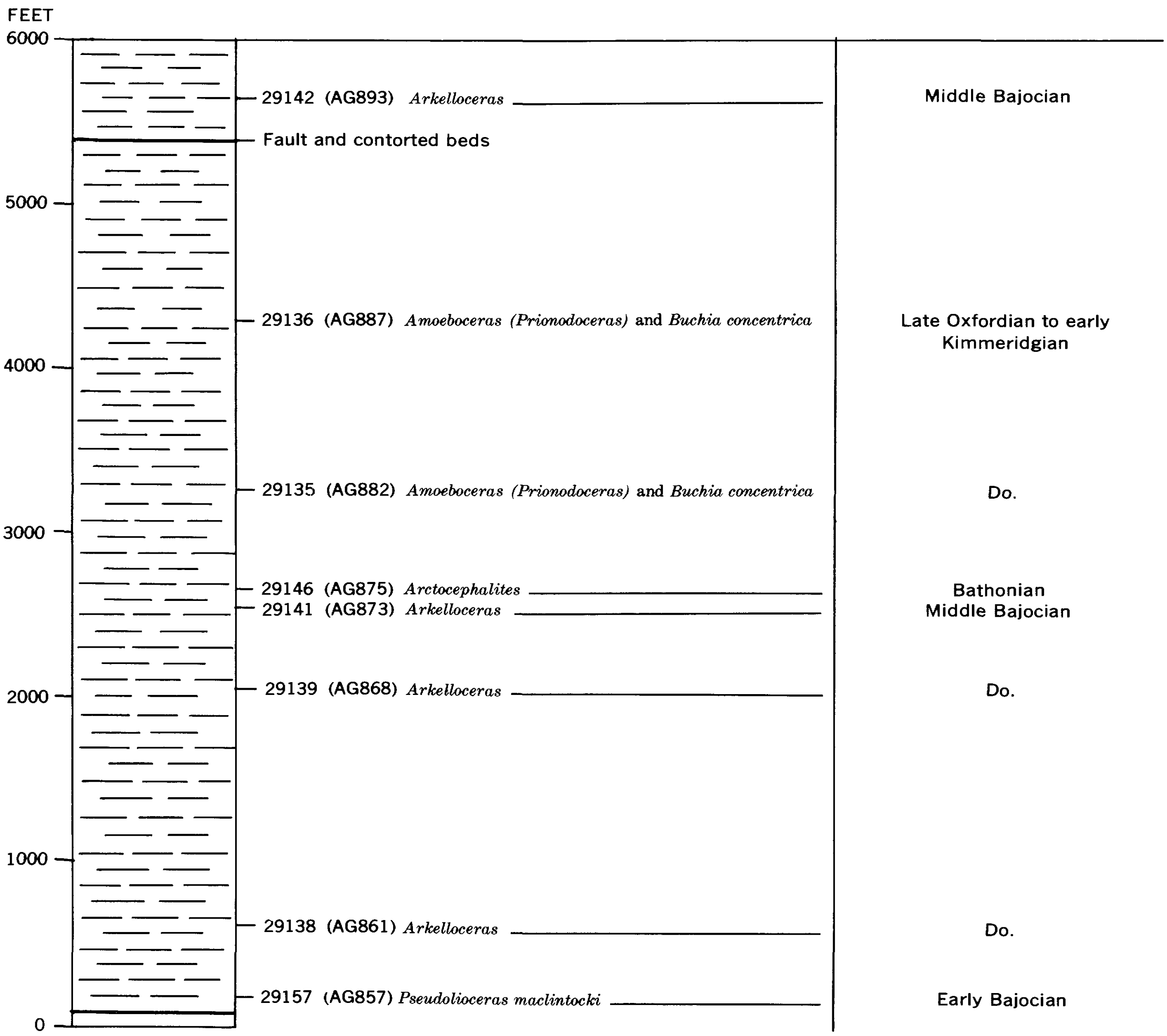

FIGURE 1.—Occurrences and ages of fossils in Kingak Shale exposed on Canning River west of Shublik Island, northern Alaska. Physical data furnished by British Petroleum (Alaska), Inc. Lower part of sequence probably duplicated by folding and faulting. USGS Mesozoic locality number is followed by collector's field number in parentheses.

the small round undeformed specimens of *Arctocephalites* have locally rolled down the slopes of Ignek Mesa onto older beds containing somewhat flattened specimens of *Cranocephalites*.

On the basis of these records, the Kingak Shale on Ignek Mesa includes a molluscan succession of Bajocian, Bathonian, and early Oxfordian Age, as shown in table 2. The Bajocian part of the lithologic sequence is probably 200–250 feet (60–75 m) thick, the Bathonian part at least 195 feet (58.5 m) thick, and the Oxfordian part at least 80 feet (24 m) thick. The sequence does not contain any ammonites of late middle and late Bajocian age or of Callovian age. Their absence suggests that those times may be represented by disconformities.

The faunal succession of Bajocian Age found on the Canning River near Shublik Island is supplemented by a partial sequence of Kingak Shale exposed at the head of Katakturuk Canyon which is nearly 7 miles (11.2 km) west-northwest of the west end of Ignek Mesa. At this place the ammonite *Canavarella*, in association with *Inoceramus lucifer* Eichwald (USGS Mesozoic locs. 30267–30270), occurs 110–320 feet (33–96 m) above the base of the Kingak Shale. Previous collections, made by geologists of British Petroleum (Alaska), Inc., consist of *Pseudolioceras maclintocki* (Haughton) (USGS Mesozoic loc. 29152) below beds containing *Canavarella* and *Erycitoides* (USGS Mesozoic loc. 29153).

TABLE 2.—*Stratigraphic position and age of fossils in Kingak Shale in exposures on northwest slope of Ignek Mesa, northern Alaska*

[Positions in feet determined by R. L. Detterman]

	Feet below base of Ignek Formation (metres in parentheses)	Age
Cardioceras (*Scarburgiceras*) sp.	80 (24)	Early Oxfordian.
Arcticoceras sp. juv	135 (40.5)	Late Bathonian.
Arctocephalites cf. *A. elegans* Spath.	Not known	Middle or late Bathonian.
Cranocephalites ignekensis Imlay, n. sp.	275 (82.5)	Early or middle Bathonian.
Cranocephalites sp	310–330 (93–99)	
Inoceramus cf. *I. ambiguus* Eichwald.	500 (150)	Middle Bajocian to Bathonian.
I. lucifer Eichwald	600 (180)	Early to early middle Bajocian.

Another partial Bajocian sequence, 150 feet (45 m) thick, exposed on the west bank of Kaviak Creek, about 3 miles (4.8 km) southwest of its junction with the Sadlerochit River, is interesting stratigraphically because it contains the crinoid *Pentacrinus subangularis alaska* Springer above, and probably also below, ammonites of early Bajocian Age. The evidence consists of *Canavarella crassifalcata* Imlay, n. sp., *Pseudolioceras whiteavesi* (White), and *Inoceramus* cf. *I. lucifer* Eichwald (USGS Mesozoic loc. 29884) in the lower 50 feet (15 m), of the crinoid species in the middle 50 feet, and of *Pseudolioceras* sp. and *Erycitoides*? sp. in the upper 50 feet (USGS Mesozoic loc. 29886).

This dating does not prove that all occurrences of *P. subangularis alaska* Springer are of early Bajocian Age. For example, an age as old as Pliensbachian is demonstrated by an occurrence near the Aichilik River of this crinoid species (USGS Mesozoic loc. 30073) at least 100 feet (30 m) below the ammonite *Amaltheus* (USGS Mesozoic loc. 30074). A similar age for the crinoid species at its type locality on the Canning River is supported by its association there with the same species of *Plicatula* that occurs with *Amaltheus* near the Aichilik River. In both localities the crinoid stems are much larger than those from lower Bajocian beds at Kaviak Creek (R. L. Detterman, written commun., 1973), a fact that may be of age significance.

This association of *Pseudolioceras whiteavesi* (White) with *Canavarella* substantiates another such association (USGS Mesozoic loc. 29147). It also shows indirectly, by comparison with the ammonite sequence near Katakturuk Canyon that *P. whiteavesi* (White), as well as *Canavarella*, occurs higher stratigraphically than *P. maclintocki* (Haughton).

The exact stratigraphic position of *Tmetoceras* in northern Alaska, where it has been found only in well cores, has not been determined with respect to species of *Pseudolioceras* or of *Canavarella*. In southern Alaska, however, *Tmetoceras* occurs with *Pseudolioceras whiteavesi* (White) and *Erycitoides howelli* (White) as well as in directly underlying beds as much as 300 feet (90 m) thick (Westermann, 1964, p. 344–347, fig. 5). As its worldwide range probably corresponds to the entire lower Bajocian (Aalenian) (Westermann, 1964, p. 432–435), its occurrences in northern Alaska could represent any part of that substage.

AGES AND CORRELATIONS

BAJOCIAN AMMONITES

All three Bajocian ammonite faunules obtained from outcrops in northern Alaska (fig. 2) are associated with *Inoceramus lucifer* Eichwald, which in southern Alaska ranges through the Bajocian as high as beds that correlate with the European *Otoites sauzei* zone (Imlay, 1964, p. 8–10, 18, 53). The lowest faunule, characterized by *Pseudolioceras maclintocki* Haughton, is tentatively correlated by Frebold (1960, p. 28) with the basal Bajocian zone of *Leioceras opalinum*, although it is not known from the same bed as that species. Apparently, *P. maclintocki* could represent either the lowest or the middle part of the lower Bajocian (Aalenian) or both. In southern Alaska, *P. maclintocki* and *Leioceras opalinum* are unknown, but the time that they represent probably corresponds in part to the development of an unconformity and the intrusion of the Aleutian Range batholith (Grantz and others, 1963, p. B58; Detterman and Hartsock, 1966, p. 63, 69, 71).

The second faunule above the base of the Jurassic is characterized by *Pseudolioceras whiteavesi* (White), by *Canavarella crassifalcata* Imlay, n. sp., and by *Erycitoides* similar to, or identical with, *E. howelli* (White). It is firmly dated as late early Bajocian because the same species of *Pesudolioceras* and *Erycitoides* occur in southern Alaska (Westermann, 1964, p. 345–352, fig. 5) directly below ammonite faunas characteristic of the *Sonninia sower-*

Stage		STANDARD ZONE IN NORTHWEST EUROPE	NORTHERN ALASKA (Imlay, 1955)		SOUTHERN ALASKA (Imlay, 1962a, b, 1964; Westermann, 1964, 1969)	
BATHONIAN	Upper	*Clydoniceras discus*			*Kepplerites*	*Parareineckeia*
		Oppelia aspidoides	*Arcticoceras ishmae*			
		Prohecticoceras retrocostatum				
	Middle	*Morrisiceras morrisi*	*Arctocephalites* cf. *A. elegans*		*Arctocephalites* cf. *A. elegans*	
		Tulites subcontractus	*Cranocephalites ignekensis*		*Cranocephalites* spp.	*Cobbanites*
		Procerites progracilis	*Cranocephalites* sp.			
	Lower	*Zigzagiceras zigzag*	*Inoceramus* cf. *I. ambiguus* Eichwald		*Cranocephalites costidensus*	
BAJOCIAN	Upper	*Parkinsonia parkinsoni*	No fossil evidence		Angular unconformity on Iniskin Peninsula	
		Garantiana garantiana				
		Strenoceras subfurcatum			*Megasphaeroceras rotundum*, *Leptosphinctes*, and *Sphaeroceras*	
	Middle	*Stephanoceras humphriesianum*			*Chondroceras allani*, *Normannites crickmayi*, and *Teloceras itinsae*	
		Otoites sauzei	*Arkelloceras*	*Inoceramus lucifer*	*Stephanoceras kirschneri*; *Parabigotites crassicostatus* and *Arkelloceras*	*Inoceramus lucifer*
		Sonninia sowerbyi	No fossil evidence		No fossil evidence; *Docidoceras widebayense*	
	Lower	*Graphoceras concavum*	*Erycitoides howelli*, *Pseudolioceras whiteavesi*, and *Canavarella crassifalcata*		*Erycitoides howelli*, *Pseudolioceras whiteavesi*, and *Tmetoceras scissum*	
		Ludwigia murchisonae	*Tmetoceras* (exact position unknown)		*Tmetoceras scissum*	
		Tmetoceras scissum	*Pseudolioceras maclintocki*			
		Leioceras opalinum			No fossil evidence	

FIGURE 2.—Correlation of Bajocian and Bathonian faunas in northern Alaska.

byi zone (Westermann, 1969, p. 18, 22–30, figs. 6 and 7) and with ammonite genera not known above the *Graphoceras concavum* zone (Westermann, 1969, fig. 8 on p. 18).

The third faunule above the base of the Jurassic in northern Alaska is characterized by the ammonite *Arkelloceras* which has been recorded previously from the Canadian Arctic Islands (Frebold, 1957, p. 9–11, pl. 9, figs. 1–3, pl. 10, figs. 1, 2, pl. 11, figs. 1, 2; 1961, p. 8–10; 1964b, p. 18, pl. 4, fig. 4), Jasper Park in Alberta (Westermann, 1964, p. 405–409, fig. 2), the northern Richardson Mountains in Yukon Territory (Frebold and others, 1967, p. 10, 17–20, pl. 3, figs. 8a, b), and Wide Bay on the Alaska Peninsula (Imlay, 1964, p. B53, pl. 28, figs. 7–9). Most of these occurrences have not been dated closely because of lack of stratigraphic or faunal control. The specimen from Alberta, however, is associated with *Stemmatoceras*, which in Europe ranges from the *Otoites sauzei* zone into the lower part of the upper Bajocian and is most common in the middle Bajocian. The specimen from the Alaska Peninsula was found near the base of a sequence containing many ammonites indicative of the *Oto-*

ites sauzei zone (Imlay, 1964, p. B18) and above a sequence containing ammonites indicative of the *Sonninia sowerbyi* zone (Westermann, 1969, p. 17–22).

BATHONIAN AMMONITES

Bathonian ammonites have been collected from four different beds or units on Ignek Mesa, as shown in table 2. The lowest unit contains crushed fragments of a moderately ribbed species of *Cranocephalites*. The next higher unit, about 35 feet higher, contains many well-preserved but crushed specimens of a finely to moderately ribbed new species of *Cranocephalites* that differs appreciably from described species in the arctic region but shows considerable resemblance to one specimen from southern Alaska (Imlay, 1962a, pl. 1, figs. 9, 11–13). The third highest unit contains a finely ribbed species of *Arctocephalites* identical with a species in Canada described as *A. elegans* Spath by Frebold (1961, p. 10; 1964a, p. 3; 1964b, p. 4). The highest unit contains immature specimens of *Arcticoceras* that resemble the inner whorls of specimens of *A. ishmae* (Keyserling) that have been found much farther east in northeastern Alaska near the Aichilik River.

These ammonite taxa should represent most of the arctic Bathonian as defined by Callomon (1959, p. 505–512, table 1) for East Greenland. Thus, the species of *Cranocephalites* should correspond, at least in part, to the *Cranocephalites pompeckji* zone in East Greenland; the finely ribbed *Arctocephalites* cf. *A. elegans* Spath, to the *Arctocephalites nudus* zone; and *Arcticoceras ishmae* (Keyserling), clearly to the *A. kochi* zone. Correlation of these ammonites with the Bathonian seems reasonable, but precise correlation with its subdivisions must await future faunal discoveries.

AMMONITE FAUNAL SETTING

The Bajocian and Bathonian ammonites found in northern Alaska belong mostly to the same genera and species as those found in northern Canada except for the absence to date of *Leioceras* and the presence of *Canavarella* and of different species of *Cranocephalites*. In both regions, ammonites of these ages are few in numbers: only *Arkelloceras* represents the middle Bajocian, and no taxon is definitely of late Bajocian Age. Evidently the Bajocian and Bathonian ammonites of both regions lived in the same faunal province.

Bajocian ammonites in northern Alaska as compared with ammonites of that age in southern Alaska are much impoverished in numbers of individuals and of genera and species (compare table 3 herein with lists in Imlay, 1964, p. B11–B30) and do not represent nearly as much of Bajocian time. Taxa not yet found in southern Alaska include *Pseudolioceras maclintocki* (Haughton) and *Canavarella*. Taxa in common with southern Alaska include *Arkelloceras*, *Tmetoceras*, *Erycitoides howelli* (White), and *Pseudolioceras whiteavesi* (White). Apparently the seas in northern and southern Alaska were connected, but conditions in the southern seas were much more favorable for ammonite development.

Bathonian ammonites in northern Alaska are likewise less numerous and less varied than ammonites of that age in southern Alaska, but these differences are not nearly as great as during Bajocian time. Resemblances include a succession of at least two species of *Cranocephalites* followed by a finely ribbed species of *Arctocephalites* similar to *A.* cf. *A. elegans* Spath. Differences to date with southern Alaska include the presence of *Arcticoceras* and the absence of *Kepplerites*, *Cobbanites*, *Parareineckeia*, *Macrophylloceras*, *Holcophylloceras*, *Siemiradzkia*?, *Xenocephalites*, *Oecotraustes*, and *Oppelia* (*Oxycerites*).

These differences are too great to be explained entirely by collection failure, even should some genera now known only in one region be found eventually in the other. It seems evident that Bathonian ammonites in southern Alaska lived under more favorable conditions than the Bathonian ammonites in northern Alaska but that the seas were connected, as shown by the presence of a *Cranocephalites*-*Arctocephalites* succession in both regions.

Ammonites characteristic of the Boreal realm apparently include *Kepplerites*, *Arcticoceras*, *Arctocephalites*, and *Cranocephalites*, but no proof exists that they actually originated in arctic seas. Ammonites characteristic of the Pacific realm include *Xenocephalites*, *Cobbanites*, and *Parareineckeia*. Most of the other genera listed occur also in the Tethyan realm.

GEOGRAPHIC DISTRIBUTION

The geographic occurrences of the Bajocian and Bathonian ammonites from northern Alaska described herein are shown in table 3 and figures 3–5. Detailed descriptions of the occurrences are given in table. 4.

TABLE 3.—*Geographic distribution of ammonites of Bajocian and Bathonian Age in northern Alaska*

[Generalized positions of Bajocian fossil localities are shown in fig. 3 and Bathonian localities in fig. 4. Detailed positions of Middle Jurassic fossil localities listed under numbers 5, 11, 14–17, are shown in fig. 5]

	Bajocian fossil localities																																						Bathonian fossil localities													
	1	2	3	4	5											6	7									8	9	10					11					12	13	14			15	16							17	18
	South Barrow test well 2	Topagoruk test well 1	21552	22591	21023 (part)	21024	22596	22597	24033	29138	29139	29141	29142	29157	30266	24035	29152	29153	29154	29155	29156	30267	30268	30269	30270	29148	29852	29150	29880	29884	29886	29887	10307	10308	10309	29147	29151	30135	22745	21023 (part)	22596	29146	29145	28817	29143	29144	29436	29655	29675	29677	22083	30075
Tmetoceras sp	X	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pseudolioceras maclintocki (Haughton)	--	--	--	--	X	--	X	--	--	--	--	--	--	X	--	X	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--
P. cf. *P. maclintocki* (Haughton)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	X	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
P. whiteavesi (White)	--	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	X	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
P. sp	--	--	?	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	X	--	--	X	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Canavarella crassifalcata Imlay, n. sp	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	X	X	X	X	X	X	X	--	--	--	--	X	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Canavarella? sp	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Erycitoides howelli (White)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
E. cf. *E. howelli* (White)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	X	X	--	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
E.? sp	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	X	--	X	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Oppelia (Liroxyites) n. sp. undet	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--
Arkelloceras cf. *A. maclearni* Frebold	--	--	--	--	--	X	--	X	X	X	X	X	X	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arkelloceras? sp. juv	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cranocephalites ignekensis Imlay, n. sp	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	X	--	X	X	--	--	--	--
C. sp	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--
Arctocephalites cf. *A. elegans* Spath	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	X	--	X	X	X	--	--	--	--	--
A. cf. *A. arcticus* (Newton and Teall)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	--
A.? sp	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--
Arcticoceras ishmae (Keyserling)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	X	--	--	--	--	--	--	--	--	--	--	X
A. sp. juv	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	?	--	--	--	--	--	--	--	--	--	--	X	--	--
Choffatia? sp	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X

TABLE 4.—*Description of some Middle Jurassic fossil localities in northern Alaska*

Locality No. (figs. 3, 4)	USGS Mesozoic loc. No.	Collector's field No.	Collector, year of collection, description of locality, and stratigraphic assignment
1			South Barrow test well 2, lat 71°15′51″N., long 156°37′ 55″W. Kingak Shale at depth of 2,391 ft (717.3 m). Early Bajocian.
2			Topagoruk test well 1, lat 70°37′30″N., long 155°53′36″W. Kingak Shale at depth of 8,113 ft (2433.9m).
3	21552	49ATr352	I. L. Tailleur, 1949. Cutbank on Fortress Creek about 5 miles (8 km) south-southeast of Fortress Mountain, lat 68°31′N., long 153°03′W. Medium-dark-green fine-grained graywacke containing much volcanic material. Early Bajocian.
4	22591	50AKe263	A. S. Keller, 1956, Cutbank on Tigluk-puk Creek, lat 68°20′N., long 151°50′W. From tuffaceous graywacke. Probably middle Bajocian.
5	21023 (part)	47AGr202	George Gryc, 1947. Canning River, west bank, opposite mouths of Eagle and Cache Creeks, lat 69°23′N., long 146°06′W. From base of exposure of pyritic black shale that contains nodules and lenses of ironstone. Early Bajocian and Bathonian.
5	21024	47AGr205	George Gryc, 1947. Canning River, west bank, lat 69°21′50″N., long 146°01′50″W. Black shale containing ironstone beds. Middle Bajocian.
5	22595	50AGr9	George Gryc, R. W. Imlay, and Allan Kover, 1950. Canning River, west bank. Same place as USGS Mesozoic loc. 21023, but 150 ft (45m) above base of exposure. Early Bajocian.
5	22597	50AGr24	George Gryc, R. W. Imlay, and Allan Kover, 1950. Canning River, west bank. Same place as USGS Mesozoic loc. 21024. Black shale containing beds and nodules of ironstone about 200 ft (60m) below top of exposed section. Middle Bajocian.
5	24033	52AKe37	A. S. Keller, 1952. Cutbank on west side of Canning River. Same as USGS Mesozoic loc. 21024. Shale and limy concretions. Middle Bajocian.
5	29138	AG861	British Petroleum (Alaska) Inc., 1964. West bank of Canning River west of Shublik Island, lat 69°24′N., long 146°10′W. Middle Bajocian.
5	29139	AG868	British Petroleum (Alaska) Inc., 1964. Canning River west of Shublik Island, lat 69°24′N., long 146°10′W. Middle Bajocian.
5	29141	AG873	Same data as locality 29139 but about 500 ft (150m) higher in sequence. Middle Bajocian.
5	29142	AG893	Same data as locality 29139 but about 3,900 ft (1,170 m) higher in sequence above a fault. Middle Bajocian.
5	29157	AG857	British Petroleum (Alaska) Inc., 1964. Canning River west of Shublik Island, lat 69°24′N., long 146°10′W. Early Bajocian.
5	30266	72ADt377	R. L. Detterman, 1972. Canning River, west bank opposite Shublik Island, lat 69°24′N., long 146°10′W. Siltstone and shale with limy concretions. Middle Bajocian.
6	24035	52AKe46	A. S. Keller, 1952. Canning River, cutbank on west side, lat. 69°34′N., long 146°23′W., Ironstone beds, concretions, and shales 1,000—1,500 ft (300–450m) below top of Kingak Shale. Early Bajocian.
7	29152	AG807	British Petroleum (Alaska) Inc., 1964. West end of Ignek Valley near Katakuruk River, lat 69°35′N., long 145°36′W., Early Bajocian.
7	29153	AG808	British Petroleum (Alaska) Inc., 1964. Same description as USGS Mesozoic loc. 29152. Early Bajocian.
7	29154	AG812	British Petroleum (Alaska) Inc., 1964. West end of Ignek Valley, lat 69°33′N., long 145°43′W. Early Bajocian.
7	29155	AG812A	British Petroleum (Alaska) Inc., 1964. Same description as USGS Mesozoic loc. 29154. Early Bajocian.
7	29156	AG812B	British Petroleum (Alaska) Inc., 1964. Same description as USGS loc. 29154. Early Bajocian.
7	30267	72ADt378 #1	R. L. Detterman, 1972. Head of Katakturuk Canyon in Ignek Valley, lat 69°35′N., long 145°36′30″W. Fissile silty shale containing ironstone concretions, 110 ft (33m) above base of Kingak Shale. Early Bajocian.
7	30268	72ADt378 #2	R. L. Detterman, 1972. Same place as USGS Mesozoic loc. 30267. Siltstone and shale containing ironstone beds, 240 ft (72m) above base of Kingak Shale. Early Bajocian.
7	30269	72ADt378 #3	R. L. Detterman, 1972. Same place as USGS Mesozoic loc. 30267. Siltstone and shale containing ironstone beds, 295 ft (88.5m) above base of Kingak Shale. Early Bajocian.
7	30270	72ADt378 #4	R. L. Detterman, 1972. Same place as USGS Mesozoic loc. 30267. Siltstone and shale containing ironstone beds, 320 ft (96m) above base of Kingak Shale. Early Bajocian.
8	29148	AG22	British Petroleum (Alaska) Inc., 1964. Northwest side of Ignek Mesa in central part of Ignek Valley, lat 69°34′N., long 145°20″W. Slightly northwest and lower in sequence of Kingak Shale than USGS Mesozoic loc. 29148. Early Bajocian.
9	29852	69ADt144	R. L. Detterman, 1969. Marsh Creek, 4 miles north of Mt. Weller in Sadlerochit Mountains, lat 69°41′05″N., long 144°50′30″W. About 500 ft (150m) above base of Kingak Shale. Probably early Bajocian.
10	29150	AG25	British Petroleum (Alaska) Inc., 1964. At Fire Creek in central part of Ignek Valley, lat 69°32′N., long 145°09′W. Early Bajocian.
10	29880	70ADt167	R. L. Detterman, 1970. Fire Creek, 5.6 miles (9 km) northwest of junction with Sadlerochit River, lat 69°32′20″N., long 145°12′30″W. Black fissile clay shale containing siltstone beds and ironstone concretions. Kingak Shale, about 500 ft (150m) above base. Early Bajocian.
10	29884	70ARr414 #3	H. N. Reiser, 1970. Kaviak Creek, about 0.7 (1.12 km) south-southwest of confluence with Sadlerochit River in Mt. Michelson B–2 quadrangle, lat 69°29′N, long 145°03′W. From lower 50 ft (15m) of 150-ft (45-m) sequence within the Kingak Shale. Early Bajocian.
10	29886	70ARr414 #1	H. N. Reiser, 1970. Same place as USGS Mesozoic loc. 29884 but from upper 50 (15m) of 150-ft sequence. Probably early Bajocian.
10	29887	70ARr240	H. N. Reiser, 1970. East side of Sadlerochit River. High cutbank exposing more than 500 ft (150m) of black clay shale and minor amounts of silty ironstone beds. NW¼ NW¼ sec. 32, T. 2 N., R. 29 E. (unsurveyed) lat 145°04′25″N., long 69°29′30″W. Early Bajocian.
11	10307	110	E. de K. Leffingwell, 1911. Sadlerochit River, cut on north side, probable lat 69°33′N., long 144°43′W. In friable black shale containing pyrite concretions about 3,000 ft (900m) above base of Kingak Shale. Early Bajocian.
11	10308	114a	E. de K. Leffingwell, 1911. Sadlerochit River, half a mile up Camp 263 Creek, lat 69°33′N., long 144°47′W. Fossils from concretions in black shale at foot of exposure and probably in lower 100 ft (30m) of Kingak Shale. Early Bajocian.
11	10309	114b	E. de K. Leffingwell, 1911. Sadlerochit River, north side, about a quarter of a mile downstream from Camp 263 Creek, lat 69°33′N., long 144°46′W., about 1,000 ft (300m) above base of Kingak Shale. Probably early Bajocian.
11	29147	AG 19	British Petroleum (Alaska) Inc., 1964. At junction of Sadlerochit and Kekiktuk Rivers, lat 69°33′N., long 144°43′W. Early Bajocian.
11	29151	AG 538	British Petroleum (Alaska) Inc., 1964. At junction of Sadlerochit and Kekiktuk Rivers, lat 69°33′N., long 144°43′W. Probably early Bajocian.

TABLE 4.—*Description of some Middle Jurassic fossil localities in northern Alaska*—Continued

Locality No. (figs. 3, 4)	USGS Mesozoic loc. No.	Collector's field No.	Collector, year of collection, description of locality, and stratigraphic assignment
12	30135	71ADt368	R. L. Detterman, 1971. On ridge west of Okerokovik River, 7.6 miles (12.16 km) S. 80°W. of (benchmark) VABM ATTE, lat 69°29'45"N., long 143°26'W. Early Bajocian.
13	22745	51ADt134	R. L. Detterman, 1951. Cutback on east side of Saviukviayak River, lat 69°00'N., long 148°04'39"W. From concretion in hard splintery silty shale 160 ft (48 m) above base of Kingak Shale.
14	21023 (part)	47AGr202	George Gryc, 1947. Canning River, west bank, opposite mouths of Eagle and Cache Creek, lat 69°23'N., long 146°06'W. From base of exposure of pyritic black shale that contains nodules and lenses of ironstone. Early Bajocian and Bathonian.
14	22596	50AGr18	George Gryc, R. W. Imlay, and Allan Kover, 1950. Canning River, west side, lat 69°22'10"N., long 146°02'W. Black shale containing ironstone lenses and nodules, about 2,300 ft (690 m) above base of exposed section. Bathonian.
14	29146	AG875	British Petroleum (Alaska) Inc., 1964. West side of Canning River, near Shublik Island, lat 69°24'N., long 146°10'W. Bathonian.
15	29145	AG60	British Petroleum (Alaska) Inc., 1964. West end of Ignek Valley on northern base of Shublik Mountains, lat 69°33'N., long 145°50'W. NE¼ sec. 6, T. 2 N., R. 26 E. (unsurveyed). Bathonian.
16	28817	63AMg6	Marvin Mangus, 1963. Central part of Ignek Valley, near middle of sec. 6, T. 2 N., R. 28 E. (unsurveyed), west end of Ignek Mesa, lat 69°33'30"N., long 145°20'W. Kingak Shale, 200 ft (60 m) below base of Ignek Formation. Bathonian.
16	29143	AG24	British Petroleum (Alaska) Inc., 1964. Central part of Ignek Valley, near west end of north side of Ignek Mesa, lat 69°34'N., long 145°20'W. NE¼ sec. 6, T. 2 N., R. 28 E. (unsurveyed). Kingak Shale. Bathonian.
16	29144	AG27	British Petroleum (Alaska) Inc., 1964. Central part of Ignek Valley. Same place as USGS Mesozoic loc. 29143 near northwest end of Ignek Mesa, but slightly higher in Kingak Shale. Bathonian.
16	29435	66AMg29f	Marvin Mangus, 1966. Central part of Ignek Valley south of Ignek Mesa, near USGS Mesozoic loc. 28817. SE¼ sec. 6, T. 2 N., R. 28 E. (unsurveyed), lat 69°33'30"N., long 145°20'W., Kingak Shale, about 200 ft (60 m) below base of Ignek Formation. Bathonian.
16	29855	69ADt41A	R. L. Detterman, 1969. Central part of Ignek Valley, 6.5 miles (10.40 km) S.75°E. of Katakturuk Canyon at northwest end of mesa capped with Ignek Formation, lat 69°33'35"N., long 145°20'15"W. Near USGS Mesozoic loc. 29143. Kingak Shale, concretions in black clay shale about 275 ft (82.5 m) below base of Ignek Formation. Bathonian.
16	29875	70ADt215, unit 4	R. L. Detterman, 1970. Central part of Ignek Valley, near USGS Mesozoic loc. 29855, lat 69°33'30"N., long 145°20'W. Siltstone and silty shale containing clay ironstone nodules. Kingak Shale, about 310–330 ft (93–99 m) below base of Ignek Formation. Bathonian.
16	29877	70ADt215, unit 2	R. L. Detterman, 1970. Same place as USGS Mesozoic loc. 29875. From black fissile clay shale containing clay ironstone concretions. Kingak Shale, 135 ft (40.5 m) below base of Ignek Formation and 55 ft (16.5 m) below *Cardioceras* at USGS Mesozoic loc. 29856. Bathonian.
17	22033	48AWh132	C. L. Whittington, 1948. North bank of river between Gravel and Fire Creeks, lat 69°31'N., long 145°02'W. Dull black earthy shale. Bathonian.
18	30075	71ADt330D	R. L. Detterman, 1971. Cutbank on west side of Aichilik River, about 2 miles (3.2 km) N. 30° E. of VABM ATTE on northern front of Brooks Range, lat 69°33'N., long 143°05'W., Demarcation Point quad. From 1,200–1,400 ft (360–420 m) above base of Kingak Shale and about 200 ft (60 m) higher than beds containing *Amaltheus*. Bathonian.

SYSTEMATIC DESCRIPTIONS

Family HILDOCERATIDAE Hyatt, 1867
Genus TMETOCERAS Buckman, 1891

Tmetoceras sp.

Specimens of *Tmetoceras* have been found in northern Alaska only in the South Barrow test well 2 at 2,391 feet and the Topagoruk test well 1 at 8,113 feet (Imlay, 1955, p. 89, pl. 12, figs. 1–10).

Genus PSEUDOLIOCERAS Buckman, 1889

Pseudolioceras maclintocki (Haughton)

Plate 1, figures 1–5, 7

Ammonites m'clintocki Haughton, 1858, Royal Dublin Soc. Jour., v. 1, p. 244, pl. 9, figs. 2–4.

Harpoceras m'clintocki Haughton. Neumayr, 1885, K. Akad. Wiss. Wien Denkschr., Math.-naturh. Kl., v. 50, p. 85, pl. 1, figs. 5–8.

Ludwigella? cf. *L. rudis* (Buckman). Imlay, 1955, U.S. Geol. Survey Prof. Paper 274-D, pl. 11, figs. 1–3.

Pseudolioceras whiteavesi (White). Imlay, 1955, U.S. Geol. Survey Prof. Paper 274–D, p. 89, pl. 12, figs. 15, 16.

Ludwigia m'clintocki (Haughton). Frebold, 1958, Canada Geol. Survey Bull. 41, p. 7, pl. 5, figs. 3, 4.

Pseudolioceras m'clintocki Haughton. Frebold, 1960, Canada Geol. Survey Bull. 59, p. 20, pl. 8, pl. 9, figs. 2–4.

Pseudolioceras m'clintocki Haughton. Frebold, 1964a, Canada Geol. Survey Paper 63–4, p. 5, pl. 10, figs. 4a–8b, 9.

Pseudolioceras m'clintocki (Haughton). Westermann, 1964, Bulls. Am. Paleontology, v. 47, no. 216, p. 422–424.

Pseudolioceras m'clintocki (Haughton). Dagis and Dagis, 1967, Akad. Nauk SSSR, Sibirskoye Otdel., Inst. Geologii i Geofiziki, p. 56–58, pl. 3, figs. 1a, b.

Pseudolioceras m'clintocki (Haughton). Westermann, 1969, Bulls. Am. Paleontology, v. 47, no. 216, p. 52.

Pseudolioceras maclintocki (Haughton) is represented in northern Alaska by 50 specimens which show the same range of variation in rib coarseness and curvature described by Frebold (1960, p. 20) for specimens from northernmost Canada. These Alaska specimens are preserved in dark-gray to black claystone or in silty claystone; most have been crushed laterally, and none shows the complete adult body chamber. The species is characterized by a highly compressed involute shell, flattened flanks that converge gradually to the venter, a high hollow keel, a very steep umbilical wall that rounds

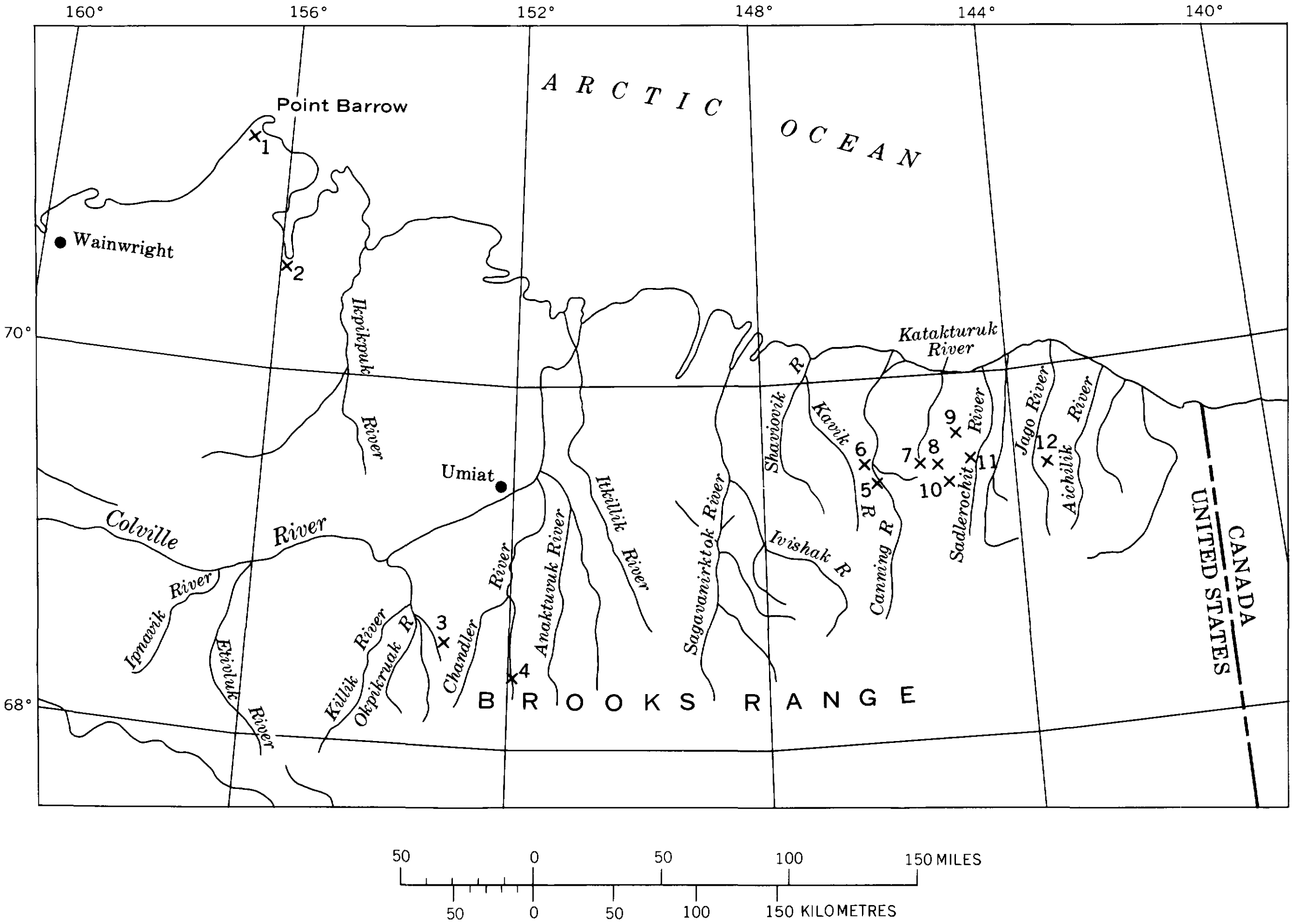

FIGURE 3.—Generalized index map of Bajocian ammonite localities in northern Alaska.

abruptly or sharply into the flanks, and variably weak to strong falcate ribs that become stronger ventrally but fade out before reaching the keel.

Types.—Hypotypes, USNM 192125–192130.

Occurrences.—Kingak Shale at USGS Mesozoic locs. 21023, 22595, 24035, 30135, 29152, and 29157. The species is possibly represented also at USGS Mesozoic locs. 10307, 29880, and 29887. It is associated with *Oxytoma jacksoni* (Pompeckj) at USGS Mesozoic loc. 24035 and with *Inoceramus lucifer* Eichwald at USGS Mesozoic loc. 21023. In northernmost Canada, *O. jacksoni* has been found with, and a little below, *Pseudolioceras maclintocki* (Haughton) (Frebold, 1960, p. 28).

Pseudolioceras whiteavesi (White)

Plate 1, figures 16–18

Ammonites (*Amaltheus*) *whiteavesi* White, 1889, U.S. Geol. Survey Bull. 51, p. 69–90, pl. 13, figs. 1–5.

Harpoceras whiteavesi (White). Kellum, Daviess, and Swinney, 1945, U.S. Geol. Survey Prelim. Rept. on geology and oil possibilities of the southwestern part of the Wide Bay anticline, figs. 4e, f.

Not *Pseudolioceras whiteavesi* (White). Imlay, 1955, U.S. Geol. Survey Prof. Paper 274–D, p. 89, pl. 12, figs. 15, 16.

Pseudolioceras m'clintocki whiteavesi (White). Westermann, 1964, Bulls. Am. Paleontology, v. 47, p. 421–425, pl. 68, fig. 2, pl. 69, figs. 1–6, pl. 70, figs. 1–5, pl. 71, figs. 1, 2, text-figs. 30, 31.

Turgites whiteavesi (White). Kalacheva and Sey, 1970, Akad. Nauk SSSR Doklady, v. 193, no. 2, p. 450–451, pl. 1, figs. 1–3.

This species, represented in northern Alaska by only four specimens, differs from *P. maclintocki* (Haughton) solely by having a narrow raised umbilical edge (Frebold, 1960, p. 21; Westermann, 1964, p. 423). Associated mollusks include *Inoceramus lucifer* Eichwald and *Canavarella crassifalcata* Imlay, n. sp.

Types.—Hypotypes, USNM 192131–192133.

Occurrences.—Kingak Shale at USGS Mesozoic locs. 10307, 21023, 29147 and 29884. The species is associated with *Inoceramus lucifer* Eichwald at USGS Mesozoic locs. 10307 and 21023.

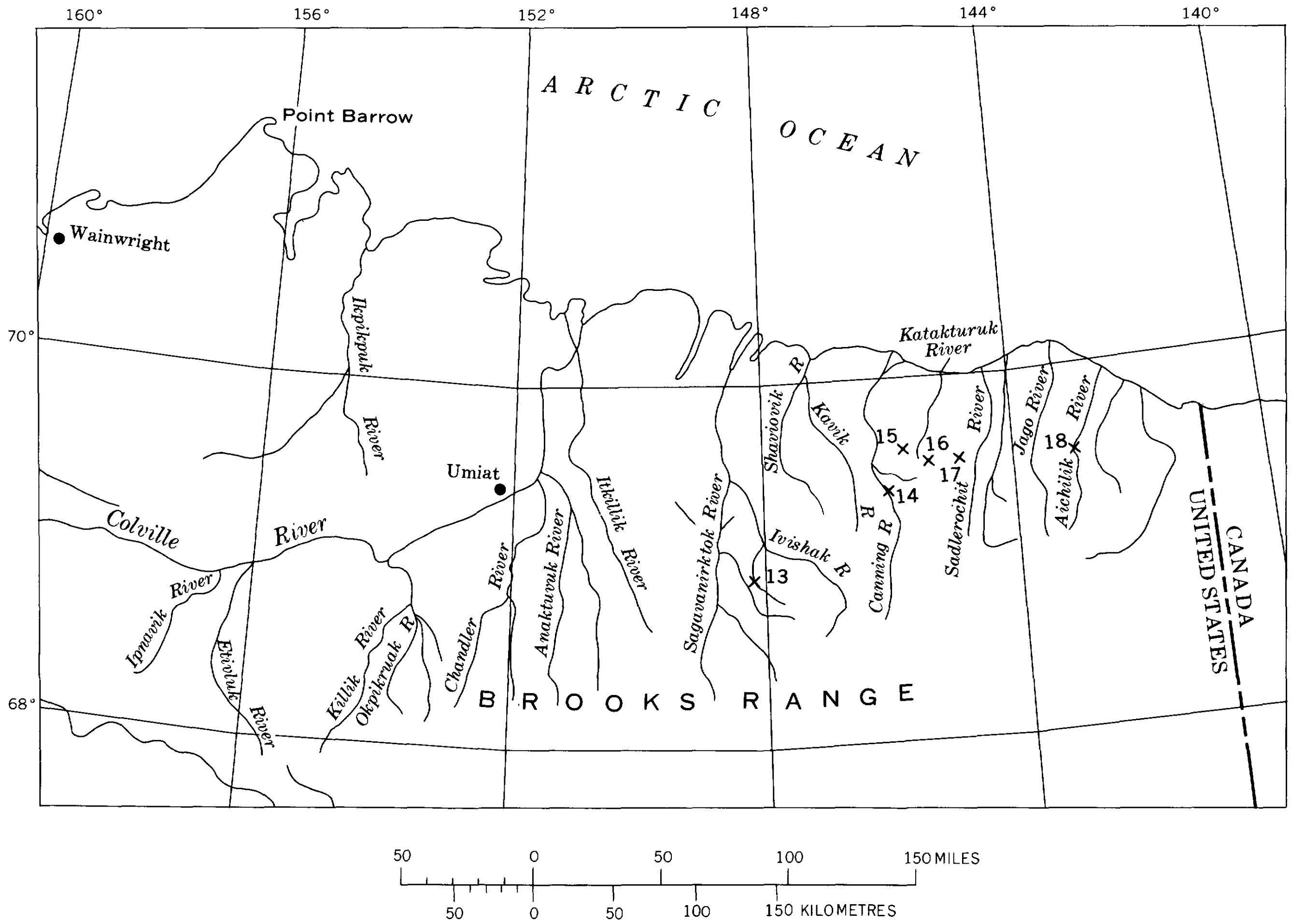

FIGURE 4.—Generalized index map of Bathonian ammonite localities in northern Alaska.

Family GRAPHOCERATIDAE Buckman, 1905
Genus CANAVARELLA Buckman, 1904
Canavarella crassifalcata Imlay, n. sp.
Plate 1, figures 6, 8–14

The species is represented by 25 laterally compressed internal molds that show various growth stages. It is characterized by a moderately involute, compressed shell; gently rounded flanks that pass gradually into the umbilical slope and the venter; a low keel; and strong simple falcate ribs. These ribs begin at the umbilical seam, become stronger ventrally, are strongest on the ventral margin, and then fade out before reaching the keel. Fairly strong falcate ribbing is visible on some specimens at diameters of only 8–10 mm. The body chamber is not completely preserved but occupies at least half a whorl.

Meaningful measurement cannot be made because of deformation. The suture line is simple, has broader saddles than lobes, and its auxiliaries ascend to the umbilical seam.

This species of *Canavarella* from northern Alaska is similar in appearance to *C. belophora* Buckman (1904, Supp. p. CXXIX, pl. 22, figs. 22–24) from England, but has much stouter ribs on its body chamber and slightly broader saddles.

Canavarella differs from *Pseudolioceras*, with which it is associated in Alaska, by having a wider umbilicus, stronger ribs on its inner whorls, and more falcate ribs that project forward more strongly on the venter.

Types.—Holotype, USNM 192134; paratypes, USNM 192135–192140.

Occurrences.—Kingak Shale, USGS Mesozoic locs. 29147, 29153–29156, 29884, and 30267–30270. The species ranges from 110 to 320 feet above the base of the Kingak Shale exposed near the head of Katakturuk Canyon in the western part of Ignek Valley. In that sequence it is associated throughout with *Inoceramus lucifer* Eichwald and locally with *Erycitoides* (Mesozoic loc. 29153).

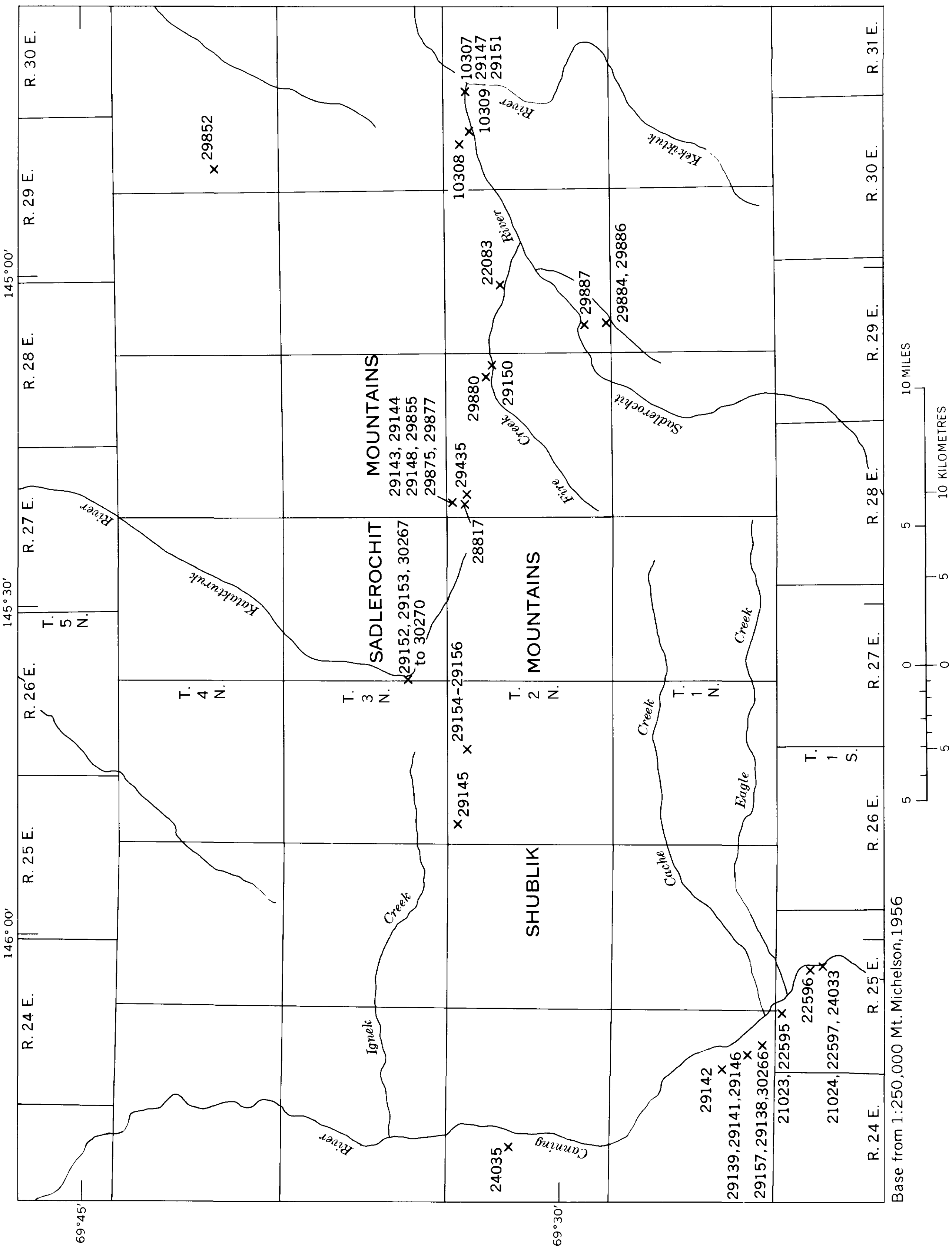

FIGURE 5.—Detailed index map of Middle Jurassic ammonite localities in central part of Mt. Michelson quadrangle between the Canning and Sadlerochit Rivers.

Family HAMMATOCERATIDAE Buckman, 1887
Genns ERYCITOIDES Westermann, 1964

Erycitoides cf. E. howelli (White)

Plate 3, figures 5, 6, 10

Erycitoides is definitely represented in northern Alaska by five fragments of outer septate whorls. Of these, the best preserved has been illustrated previously as *E. howelli* (White) Imlay, 1955, pl. 13, figs. 12, 13) because it closely resembles comparable-sized specimens of that species from the Alaska Peninsula (White, 1889, pl. 12, figs. 1, 2, pl. 14, figs. 1–3; Westermann, 1964, pls. 44–57). The other four specimens are more fragmentary and are, therefore, only compared herein with that species. One of these (pl. 3, figs. 5, 6) appears to be a typical representative of the species. The other (pl. 3, fig. 10) has long weak primary ribs and closely spaced secondary ribs as in a specimen figured by Westermann (1964, pl. 58, fig. 1).

Figured specimens.—USNM 192141, 180730.

Occurrences.—Kingak Shale at USGS Mesozoic loc. 10308. The species is probably represented also at Mesozoic locs. 29150, 29153, and 29880.

Family OPPELIIDAE Bonarelli, 1894
Genus OPPELIA Waagen, 1869
Subgenus LIROXYITES Imlay, 1961

Oppelia (Liroxyites) n. sp. undet.

Plate 1, figure 15

The subgenus is represented by one laterally compressed internal mold that bears some shelly material and represents an adult body whorl. It has a discoidal, highly involute compressed shell; a fairly sharp keel that is pinched basally; a body chamber that occupies about three-fifths of a whorl; an aperture that terminates abruptly in a forwardly inclined falcoid curve; falcoid ribs that arise near the middle of the flanks, are fairly strong on the last septate whorl, become lower and broader adorally, and persist almost to the aperture; fine falcoid striae that cover the entire surface; and a faint spiral band that occurs at about three-fifths of the height of the whorl.

The preservation of the specimen is not sufficient to make accurate measurements or to trace the suture line. This species differs from *O.* (*Liroxyites*) *kellumi* Imlay (1962b, p. A8, pl. 2) in having somewhat coarser ribbing on its body chamber and much coarser ribbing on the septate part of its body whorl. In this respect it shows more resemblance to a specimen from Canada described by Frebold (1957, p. 54, pl. 28, fig. 2) as *Oppelia* (*Oxycerites*) ex. gr. *fallax* Gueranger.

Figured specimen.—USNM 192142.

Occurrence.—Kingak Shale at USGS Mesozoic loc. 29435 in association with *Cranocephalites* and rare *Arctocephalites.*

Family STEPHANOCERATIDAE Neumayr, 1875
Genus ARKELLOCERAS Frebold, 1957

Arkelloceras cf. A. maclearni Frebold

Plate 1, figures 21–26

Reineckeia (*Reineckeites*) cf. *R.* (*R.*) *stuebeli* Steinmann. Imlay, 1955, U.S. Geol. Survey Prof. Paper 274–D, p. 91, pl. 13, figs. 1–7.

This species, represented by 46 laterally crushed specimens from the banks of the Canning River, is nearly identical in side view with described species of that genus from northern Canada. Some finely ribbed specimens match very well in side view with *A. tozeri* Frebold (1958, p. 10, pl. 9, figs. 1a–d, 2a, b, 3a, b; pl. 10, figs. 1a–c, 2a, b; pl. 11, figs. 1a–c, 2a, b; 1961, p. 8, pl. 3, fig. 1, pl. 4, figs. 1, 2a, b, pl 5, figs. 1a–c) and with *A. elegans* Frebold, in Frebold, Mountjoy, and Templeman-Kluit (1967, p. 17. pl. 3, figs. 8a, b). Other coarsely ribbed specimens match closely in side view with *A. maclearni* Frebold (1958, p. 11, pl, 12, figs. 1a–c, 2a–g, 3a–c, pl. 13, figs. 1a–d, 2a–c, 3a, b; 1961, p. 8, pl. 4, figs. 3a, b). As these specimens occur in the same collections and are associated with others bearing ribbing of intermediate coarseness, all are herein considered to represent a single species. On the whole they resemble *A. maclearni* more than *A. tozeri* in coiling, coarseness of ribbing, and in the presence of swelling or tubercles at the ventral ends of the primary ribs.

Definite identification of this species with any of the described species of *Arkelloceras* from Canada will not be possible until specimens are found that show the characteristics of the venter. A venter similar to that on *Arkelloceras* (Frebold, 1958, p. 9) is suggested, however, by the fact that the ribs on several small specimens pass ventrally into weak tubercles or into laterally compressed swellings.

One feature that may differentiate the species of *Arkelloceras* found near the Canning River, Alaska, from those found in northern Canada is the presence of lateral tubercles on the small septate whorls of the coarsely ribbed Alaskan specimens. These tubercles are conical on the innermost septate whorls, become radially elongate and weaker dorsally, and are absent at diameters greater than about 50 mm. In contrast, on the described specimens from Canada, only slight or moderate swellings at the ventral ends of the primary ribs were reported by Frebold (1958, p. 12, pl. 12, figs. 2a, g; Frebold and others, 1967, p. 18, pl. 3, fig. 8a).

The present assignment of the specimens under discussion to *Arkelloceras* instead of *Reineckeia* (*Reineckeites*) is based on the lack of constrictions and on the presence of tubercles on the venters of several small specimens. The alternate arrangement of ribs on the venters of small specimens of *Arkelloceras*, as described by Frebold (1958, p. 9), is quite different from the arrangement on the venter of *Reineckeia* (*Reineckeites*).

The presence of *Arkelloceras* implies an early middle Bajocian Age (Frebold, in Frebold and others, 1967, p. 20), which is in accord with its stratigraphic position above *Pseudolioceras* on the Canning River (fig. 1).

Figured specimens.—USNM 192143–192148.

Occurrences.—Kingak Shale at USGS Mesozoic locs. 21024, 22597, 24033, 29138, 29139, 29141, 29142, and 30266.

Arkelloceras? sp. juv.

Plate 1, figures 19, 20

One small external mold shows one flank and part of the venter of a small immature ammonite. Its primary ribs are strong, trend radially and terminate ventrally in weak tubercles or swellings a little below the middle of the flanks. From the swellings pass pairs of slightly weaker secondary ribs, some of which are weakly connected with the primary ribs. All secondary ribs become fairly strong ventrally and then weaken abruptly along the margin of the venter. The midventral area is apparently nearly smooth.

The characteristics of this specimen suggest that it may be an immature form of *Arkelloceras* Frebold (1958, p. 9). It resembles the inner whorls of *A. maclearni* Frebold (1958, p. 11, pl. 12, figs. 2d–g, 3a, b) rather than those of *A. tozeri* Frebold (1958, p. 10, pl. 9, figs. 1b, c, 3a) in having fairly strong primary ribs that terminate ventrally in swellings or tubercles. It also resembles *A. elegans* Frebold in Frebold, Mountjoy, and Tempelman-Kluit (1967, p. 17–20, pl. 3, figs. 8a, b) in strength of ribbing and in that its ribs fork below the middle of the flanks.

Figured specimen.—USNM 192149.

Occurrence.—Kingak Shale at USGS Mesozoic loc. 22591.

Family CARDIOCERATIDAE Siemiradzki, 1891
Genus CRANOCEPHALITES Spath, 1932

Cranocephalites ignekensis Imlay, n. sp.

Plate 2, figures 1–9, 11, 12

This species is represented in collections from the central part of Ignek Valley by 22 internal and external molds, most of which are laterally compressed. It is characterized by a very small umbilicus on septate whorls, a contracted body chamber that occupies nearly three-fourths of a whorl, a fairly deep apertural constriction that inclines forward and is bordered adorally by a swelling, and distinct forwardly inclined ribs that become stronger adorally and persist to the apertural constriction without fading.

These ribs vary considerably in strength and density, incline adapically on the umbilical wall, incline adorally on the flanks, cross the venter transversely or with a gentle forward arching, and generally bifurcate at one-fourth to one-third the height of the flanks. Some primary ribs remain simple, and some secondary ribs arise freely a little below the middle of the flanks. The primary ribs are higher and sharper than the secondary ribs along the furcation zone. The secondary ribs, however, become broader and higher ventrally and adorally, are strongest on the venter, and near the aperture are wider than the interspaces on some specimens. Among the 22 specimens available, five have ribs that are fine and fairly closely spaced, five have ribs that are coarse and fairly widely spaced, and 14 have ribs that are intermediate or moderate in coarseness and spacing.

The suture line has broad saddles and fairly short lobes, and its auxiliaries ascend toward the umbilical seam.

Meaningful measurements cannot be made because all specimens are deformed or crushed.

These specimens, in spite of appreciable differences in coarseness of ribbing, are herein considered to represent a single species because all three variants occur together at two localities (USGS Mesozoic locs. 28817 and 29143), two variants occur together at two other localities (USGS Mesozoic locs. 29435 and 29885), and both finely and moderately ribbed variants occur on opposite sides of a single slab (pl. 2, figs. 1, 7).

The most coarsely ribbed specimens (pl. 2, figs. 11, 12) of *Cranocephalites ignekensis* Imlay, n. sp., show some resemblance to *C. pompeckji* (Madsen) (1904, p. 189, pl. 8, figs. 5, 6; Spath, 1932, p. 16, pl. 4, figs. 9a, b, 10, pl. 5, figs. 6a, 7, pl. 13, figs. 1a, b; Donovan, 1953, pl. 17, figs. 2, 3) except for having slightly broader ribs on their septate whorls, appreciably broader ribs on their body chambers, and a deeper apertural constriction. The moderately ribbed specimen (pl. 2, figs. 5–7, 9) has ribs that are much finer than on any described specimen of *C. pompeckji* (Madsen) but are similar to those on one septate specimen of *C. vulgaris* Spath (1932, pl. 4, figs. 3a, b) from East Greenland. The typical finely ribbed specimens (pl. 2, figs. 1–4) likewise resemble a Greenland variant of *C. vulgaris* Spath (1932, pl. 4, fig. 1) in fineness and density of ribbing on their septate whorls. All three variants from northern Alaska differ markedly from *C. vulgaris* in retaining distinct ribbing on all parts of the adult body whorl and in having stronger ribbing on the venter than on the flanks of the body whorl.

The moderate to coarsely ribbed variants of *C. ignekensis* Imlay, n. sp., also resemble a certain specimen of *Cranocephalites* from southern Alaska (Imlay, 1962a, pl. 1, figs. 9, 11–13) except that they attain a smaller adult size and have a more complicated suture line. They could represent the same species.

Type.—Holotype, USNM 192151; paratypes, USNM 192152–192160.

Occurrences.—Kingak Shale at USGS Mesozoic locs. 28817, 29143, 29435, and 29855. These were collected 200–275 feet below the top of the formation in the central part of Ignek Valley. The highest occurrences (Mesozoic locs. 29143, 29435) also contain *Arctocephalites* that are undeformed, whereas all the specimens of *Cranocephalites* are deformed or crushed.

Genus ARCTOCEPHALITES Spath, 1928

Arctocephalites cf. A. elegans Spath

Plate 4, figures 1–8

cf. *Arctocephalites elegans* Spath, 1932, Medd. Grønland, v. 87, no. 7, p. 37, pl. 10, figs. 4a, b.

Arctocephalites elegans Spath. Frebold, 1961, Canada Geol. Survey Bull. 74, p. 10, pl. 9, fig. 1, pl. 10, figs. 1, 2; pl. 11, figs. 1–4.

Arctocephalites elegans Spath. Frebold, 1964b, Canada Geol. Survey Bull. 119, p. 3, pl. 1, figs. 1–3, pl. 2, figs. 1, 2.

Arctocephalites elegans Spath. Frebold, 1964a, Canada Geol. Survey Paper 63–4, p. 4, pl. 23, figs. 1, 2, 4.

?*Arctocephalites* aff. *A. elegans* Spath. Efimova and others, 1968, Polevoy atlas Yurshoy fauny i flory Severo-Vostoka SSSR, p. 125, pl. 94, figs. 1a, b, 2a–c.

This species in northern Alaska is represented by seven specimens that closely resemble and show the same range of variation as the specimens of *A. elegans* Spath described by Frebold (1961, p. 10; 1964b, p. 3) from the Arctic region of Canada. One finely ribbed specimen (pl. 4, figs. 1–3) is nearly identical in ribbing with one Canadian specimen (Frebold, 1961, pl. 11, figs. 1a, b). The other six specimens from northern Alaska bear slightly coarser ribbing, similar to that on several Canadian specimens (Frebold, 1961, pl. 10, figs. 1, 1a, pl. 11, figs. 2, 3; 1964b, pl. 1, figs. 1a, b, 2a, b).

All these specimens from the Arctic region of Alaska are characterized by a medium size for the genus, a moderately compressed shell, a very narrow umbilicus, and sharp forwardly inclined ribs that bifurcate or trifurcate below the middle of the flanks and cross the venter nearly transversely. Also, in all specimens the adult body chamber becomes abruptly smooth or nearly smooth near its adapical end and then terminates adorally in a pronounced forwardly inclined constriction.

Assignment of these finely ribbed specimens to *Arctocephalites elegans* Spath seems reasonable when comparison is made with the monotypic holotype from East Greenland (Spath, 1932, pl. 10, figs. 4a, b). Nonetheless, the validity of that assignment must await studies showing the range of variation within the species of *Arctocephalites* in Greenland. The possibility that *A. elegans* Spath may be a variant of some earlier named species is suggested by the fact that it was obtained from the same locality (Spath, 1932, p. 135) and ammonite zone (Callomon, 1959, p. 508) as several other described species of the genus.

Figured specimens.—USNM 192160–192162.

Occurrences.—Kingak Shale at USGS Mesozoic locs. 29143, 29144, 29145, 29146, and 29435.

Arctocephalites cf. A. arcticus (Newton and Teall)

Plate 4, figure 10

One compressed fragment bears sharp fairly sparse ribbing like that on the outermost septate whorl of *A. arcticus* (Newton and Teall, 1897, pl. 40, figs. 1a, b; Whitfield, 1906, pl. 18, fig. 2; Spath, 1932, pl. 12, fig. 2). Its ribbing appears to be a little weaker and less sparse than that on *A. pilaeformis* Spath (1932, p. 33; Newton and Teall, 1897, pl. 40, figs. 2, 2a) and *A. callomoni* Frebold (1964b, pl. 5, fig. 3, pl. 7, fig. 3).

Figured specimen.—USNM 192163.

Occurrence.—Kingak Shale at USGS Mesozoic loc. 29146.

Genus ARCTICOCERAS Spath, 1924

Arcticoceras ishmae (Keyserling)

Plate 3, figures 7–9, 11–22

Ammonites ishmae Keyserling, 1846, Wissenschaftliche Beobachtungen auf einer Reise in das Petschora-Land im Jahre 1843, p. 331, pl. 20, figs. 8–10.

Macrocephalites ishmae Keyserling. Sokolov, 1912, Com. géol. St. Petersbourg Mém., new ser., v. 76, p. 15, 49, pl. 1, fig. 1, pl. 3, fig. 12.

Arcticoceras ishmae (Keyserling). Spath, 1932, Medd. Grønland, v. 87, no. 7, p. 50, pl. 15, figs. 7a, b.

Arcticoceras sp. Imlay, 1955, U.S. Geol. Survey Prof. Paper 274–D, p. 90, pl. 12, figs. 11, 19.

Arcticoceras kochi Spath, 1932, Medd. Grønland, v. 87, no. 7, p. 53–56, pl. 12, fig. 1, pl. 13, figs. 4, 5, pl. 14, figs. 1–3, pl. 15, figs. 1, 4–6.

Arcticoceras kochi Spath. Frebold, 1961, Canada Geol. Survey Bull. 74, p. 16, pl. 9, fig. 3, pl. 12, figs. 1a, b, pl. 13, figs. 4, 5, pl. 14, figs. 1–3, pl. 15, figs 1, 4–6.

Arcticoceras ishmae Keyserling. Frebold, 1961, Canada Geol. Survey Bull. 74, pl. 10, fig. 3, pl. 13, figs. 1a, b, pl. 14, figs. 1, 3a, b.

Arcticoceras kochi Spath. Frebold, 1964a, Canada Geol. Survey Bull. 63–4, pl. 25, figs. 1, 2.

This species is represented by 22 specimens, of which 18 are from USGS Mesozoic locality 30075. Most of them are small and septate, and only one (Imlay, 1955, pl. 12, fig. 19) represents an adult body chamber. Among the septate specimens, six have fine closely spaced ribs (pl. 3, figs. 7–9, 11, 12), eight have coarse broadly spaced ribs (pl. 3, figs. 19–22), and seven have ribs of intermediate coarseness and spacing (pl. 3, figs. 13–18). The ribs are sharp, trend radially or incline slightly backward on the umbilical wall, incline forward on the flanks, and project strongly forward on the venter. Most ribs bifurcate near or below the middle of the flanks, but some ribs remain simple and are separated by short ribs that arise near the middle of the flanks. The venter is narrowly arched on most of the septate specimens and apparently becomes less so during growth, except on the smallest whorls.

In comparisons with *Arcticoceras* in East Greenland, the finely ribbed variant from northern Alaska is similar to specimens that Spath (1932, p. 55, pl. 14, figs. 2, 3, pl. 15, fig. 6) considered to be a variant of *A. kochi* Spath and named *pseudolamberti.* The moderately ribbed variant from Alaska greatly resembles certain Greenland specimens described as *A.* aff. *A. kochi* Spath (1932, p. 55, pl. 15, figs. 4a, b, 5). The most coarsely ribbed variant from Alaska bears ribbing comparable with that on the adapical part of the outer whorl of the holotype of *A. kochi* Spath (1932, pl. 15, fig. 1). In addition, the nearly smooth body chamber of one Alaska specimen (Imlay, 1955, pl. 12, fig. 19) resembles that of an adult of *A. kochi* Spath (1932, pl. 14, fig. 1) which that author suggested belonged to the variant *pseudolamberti.*

The moderately ribbed variant from Alaska also resembles *A. ishmae* (Keyserling) (1846, p. 331, pl. 20, figs. 8–10; Sokolov, 1912, p. 17, 49, pl. 1, fig. 1; Spath, 1932, pl. 15, figs. 7a, b) from Petchora-Land as well as ammonites from northern Canada that are assigned to that species by Frebold (1961, pl. 10, fig. 3, pl. 13, figs. 1a, b, pl. 15, figs. 3a, b).

In summation, the specimens of *Arcticoceras* described herein show the same rib characteristics and variations as *A. kochi* Spath from East Greenland but also closely resemble *A. ishmae* (Keyserling) from Petchora-Land and Canada. This agrees with the observations of John Callomon (written commun., 1972) that in East Greenland the topotypes of *A. kochi* Spath occur in the same bed as *A. ishmae* (Keyserling) and are within the range of variation of that species.

Hypotypes.—USNM 192164–192176.

Occurrences.—Kingak Shale at USGS Mesozoic locs. 21023, 22596, and 30075. The specimen of *Arcticoceras* from loc. 21023 is considered to be float because it is preserved in a hard brown siltstone, whereas most of the other specimens from that locality are preserved in a softer black shale and consist mostly of *Pseudolioceras maclintocki* (Haughton) and *Inoceramus lucifer* Eichwald of early Bajocian Age (Imlay, 1955, p. 80, 86).

Arcticoceras sp. juv.

Plate 3, figures 1, 2

Two immature specimens of *Arcticoceras* from Ignek Mesa (see table 2) have ribbing and a sharpened venter identical with those on immature specimens of the moderately ribbed variant of *Arcticoceras ishmae* (Keyserling) as just described. These specimens also resemble an even smaller ammonite (pl. 3, figs. 3, 4) from the Saviukviayak River. That ammonite was once described as *Pseudocadoceras grewingki* (Pompeckj) because of its resemblance to immature specimens of that species in southern Alaska (Imlay, 1955, p. 90, pl. 12, fig. 1). It now appears, however, that small immature specimens of *Pseudocadoceras* and *Arcticoceras* are very much alike, a resemblance which was discussed by Spath (1932, p. 57) and confirmed by John Callomon (written commun., 1972). In contrast, adult specimens of *Pseudocadoceras* differ from adult specimens of *Arcticoceras* in the following ways: (1) they are much smaller and more evolute; (2) their ribs project forward less strongly on the venter; and (3) the adult body whorl remains strongly ribbed instead of becoming smooth.

The specimen in question from the Saviukviayak River probably belongs to *Arcticoceras* rather than *Pseudocadoceras*, but its certain generic identification will have to await the discovery of larger specimens. The specimens from Ignek Mesa, however, are large enough for their assignment to *Arcticoceras* to be certain.

These identifications, plus the reassignment to *Arkelloceras* of ammonites formerly identified as *Reineckeia* (*Reineckeites*) (Imlay, 1955, p. 91, pl.

13, figs. 1–7), show that the Callovian is poorly represented in northern Alaska. The only positive evidence consists of one worn *Cadoceras* found as float (USGS Mesozoic loc. 30136) near the Aichilik River in extreme northeastern Alaska.

Figured specimens.—USNM 180732, 108781.

Occurrences.—Kingak Shale at USGS Mesozoic loc. 29877 on Ignek Mesa. The genus is probably present at Mesozoic loc. 22745 on the Saviukviayak River.

Family PERISPHINCTIDAE Steinmann, 1890
Genus CHOFFATIA Siemeradzki, 1898
Choffatia? sp.

Plate 2, figure 10; plate 4, figures 9, 11

One internal mold shows parts of three corroded septate whorls of a perisphinctid ammonite. The outermost whorl is represented only by a small fragment, but its umbilical imprint is preserved slightly below the middle of the next smaller whorl. That whorl is subovate near its adoral end, has a whorl height of 31 mm, a whorl thickness of 24 mm, and an umbilical width of 39 mm. Its primary ribs trend radially, are widely spaced, are swollen near the umbilicus, and fade out ventrally below the middle of the flanks. Its secondary ribs are faint, closely spaced, arise near the middle of the flanks, incline slightly forward, cross the venter transversely where they become slightly stronger, and outnumber the primary ribs about 6 to 1. The next smaller whorl, as exposed in the umbilicus, has weak broad rather widely spaced primary ribs. Corrosion accounts in part for the weakness of the primary ribs.

This species is assigned to *Choffatia* rather than to *Procerites* because of its fairly evolute coiling and because its primary ribs are widely spaced and are swollen near the umbilicus. Its rib pattern is essentially the same as in *Choffatia sakuntata* Spath (1931, p. 351, pl. 68, figs. 4a, b) from India except for having shorter and less sharply defined primary ribs. *C. balinensis* (Neumayr) (Waagen, 1875, p. 163, pl. 45, figs. 2a, b; Spath, 1931, p. 348, pl. 48, figs. 5a, b) is also similar but has even sharper primary ribs. These differences may in part reflect the poor preservation of the Alaskan specimen.

Figured specimen.—USNM 180733.

Occurrence.—Kingak Shale at USGS Mesozoic loc. 30075 in association with *Arcticoceras.*

REFERENCES CITED

Arkell, W. J., 1950–58, Monograph of the English Bathonian ammonites: London, Palaeontographical Soc., 8 v., 33 pls., 83 figs.

Arkell, W. J., and others, 1957, Mesozoic Ammonidea, *in* Moore, R. C., ed., Treatise on invertebrate paleontology, Part L, Mollusca 4, Cephalopoda, Ammonoidea: New York and Lawrence, Kans., Geol. Soc. America and Univ. Kansas Press, p. L80–L437.

Buckman, S. S., 1887–1907, Monograph of the ammonites of the Inferior Oolite Series: London, Palaeontographical Soc., 456 p., 103 pls. (1887–1894); Supplement, 262 p., 24 pls. (1898–1907).

Callomon, J. H., 1959, The ammonite zones of the Middle Jurassic beds of East Greenland: Geol. Mag., v. 96, no. 6, p. 505–513, pls. 17, 18.

Dagis, A. A., and Dagis, A. S., 1967, Stratigrafiya Toarskikh otlozheniy Vilyuyskoy sineklizy [Stratigraphy of Toarsk deposits from the Vilyuysk syncline], *in* Saks, V. N., ed., Problemy paleontologicheskogo obosnovaniya detal'-noy stratigrafii Mezozoya Sibiri i Dal'nego Vostoka [Problems of paleontological criteria for the detailed Mesozoic stratigraphy of Siberia and the Far East]: Leningrad, Akad. Nauk SSSR, Sibirskoye Otdel., Inst. Geologii i Geofiziki, p. 41–60, pls. 1, 2.

Detterman, R. L., and Hartsock, J. K., 1966, Geology of the Iniskin-Tuxedni region, Alaska: U.S. Geol. Survey Prof. Paper 512, 78 p., 6 pls., 7 figs.

Donovan, D. T., 1953, The Jurassic and Cretaceous stratigraphy and paleontology of Traill Ø, East Greenland: Medd. Grønland, v. 111, no. 4, 150 p., 25 pls., 14 figs.

Efimova, A. F., Kinasov, V. P., Parakestov, K. V., Polubatko, I. V., Repin, Yu. S., and Dagis, A. S., 1968, Polevoy atlas Yurskoy fauny i flory Severo-Vostoka SSSR [Field atlas of Jurassic fauna and flora from northeast USSR]: Magadan, Knigoizdat, 382 p., 114 pls., 12 figs.

Frebold, Hans, 1957, The Jurassic Fernie group in the Canadian Rocky Mountains and foothills: Canada Geol. Survey Mem. 287, 197 p., 44 pls., 5 figs.

——— 1958, Fauna, age and correlation of the Jurassic rocks of Prince Patrick Island: Canada Geol. Survey Bull. 41, 69 p., 18 pls. 1 fig.

——— 1960, The Jurassic faunas of the Canadian Arctic—Lower Jurassic and lowermost Middle Jurassic ammonites: Canada Geol. Survey Bull. 59, 33 p., 15 pls., 8 figs.

——— 1961, The Jurassic faunas of the Canadian Arctic—Middle and Upper Jurassic ammonites: Canada Geol. Survey Bull. 74, 43 p., 21 pls., 3 figs.

——— 1964a, Illustrations of Canadian fossils—Jurassic of western and Arctic Canada: Canada Geol. Survey Paper 63–4, 107 p., 51 pls.

——— 1964b, The Jurassic faunas of the Canadian Arctic—Cadoceratinae: Canada Geol. Survey Bull. 119, 27 p., 20 pls., 1 fig.

Frebold, Hans, Mountjoy, E. W., and Templeman-Kluit, D. J., 1967, New occurrences of Jurassic rocks and fossils in central and northern Yukon Territory: Canada Geol. Survey Paper 67–12, 35 p., 3 pls., 2 figs.

Grantz, Arthur, Thomas, Herman, Stern, T. W., and Sheffey, N. B., 1963, Potassium-argon and lead-alpha ages for stratigraphically bracketed plutonic rocks in the Talkeetna Mountains, Alaska: U.S. Geol. Survey Prof. Paper 475–B, p. B56–B59.

Haughton, Samuel, 1858, [Geological notes and illustrations in M'Clintock's reminiscences of Arctic ice travel]: Royal Dublin Soc., Jour., v. 1, p. 183–250, illus., map.

Imlay, R. W., 1955, Characteristic Jurassic mollusks from northern Alaska: U.S. Geol. Survey Prof. Paper 274–D, p. 69–96, pls. 8–13, 1 fig.

——— 1962a, Jurassic (Bathonian or early Callovian) ammonites from Alaska and Montana: U.S. Geol. Survey Prof. Paper 374–C, 32 p., 8 pls., 7 figs.

——— 1962b, Late Bajocian ammonites from the Cook Inlet region, Alaska: U.S. Geol. Survey Prof. Paper 418–A, 15 p., 5 pls., 4 figs.

——— 1964, Middle Bajocian ammonites from the Cook Inlet region, Alaska: U.S. Geol. Survey Prof. Paper 418–B, 61 p., 29 pls., 5 figs.

Imlay, R. W., and Detterman, R. L., 1973, Jurassic paleobiogeography of Alaska: U.S. Geol. Survey Prof. Paper 801, 32 p., 15 figs.

Kalacheva, E. D., and Sey, I. I., 1970, *Tugurites*—novyy pozdneaalenskiy Severotikhookeanskiy rod [*Tugurites*—a new late Aalenian genus from the North Pacific Ocean]: Akad. Nauk SSSR Doklady, v. 193, no. 2, p. 449–452, pl. 1.

Kellum, L. B., Daviess, S. N., and Swinney, C. M., [1945?], Geology and oil possibilities of the southwestern part of the Wide Bay anticline, Alaska: U.S. Geol. Survey 17 p., 9 pls.

Keyserling, Alexander, 1846, Wissenschaftliche Beobachtungen auf einer Reise in das Petschora-Land im Jahre 1843: St. Petersburg, Carl Krey, 465 p.

Madsen, Victor, 1904, On Jurassic fossils from East Greenland: Medd. Grønland, v. 29, no. 6, p. 157–210, pls. 6–10.

Neumayr, Melchior, 1885, Die geographische Verbreitung der Jura-formation: K. Akad. Wiss., Wien, Denkschr. Math.-naturh. Kl., v. 50, p. 57–144, 1 pl.

Newton, E. T., and Teal, J. J. H., 1897, Notes on a collection of rocks and fossils from Franz Josef Land, made by the Jackson-Harmsworth Expedition during 1894–96; Geol. Soc. [London] Quart. Jour., v. 53, p. 477–519, pls. 37–41.

Patton, W. W., Jr., and Tailleur, I. L., 1964, Geology of the Killik-Itkillik region, Alaska: U.S. Geol. Survey Prof. Paper 303–G, p. 409–500, pls. 50–51, figs. 66–91.

Sokolov, D. N., 1912, Zur Ammonitenfauna des Petschoraschen Jura: Com. géol. St. Petersbourg Mém. new ser., Livr. 76, p. 1–65, 3 pls., 11 figs.

Spath, L. F., 1927–33, Revision of the Jurassic cephalopod fauna of Kachh (Cutch): India Geol. Survey, Palaeontologia Indica, new ser., v. 9, 6 pts., 945 p., 130 pls.

——— 1932, The invertebrate faunas of the Bathonian-Callovian deposits of Jameson Land (East Greenland): Medd. Grønland, v. 87, no. 7, 158 p., 26 pls., 14 figs.

Waagen, W. H., 1873–75, Jurassic fauna of Kutch. The Cephalopoda: India Geol. Survey, Palaeontologia Indica, vol. 1, pt. 1, p. 1–22, pls. 1–4 (1873); Pt. 2, p. 23–76, pls. 5–14 (1875); Pt. 3, p. 77–106, pls. 15–24 (1875); Pt. 4, p. 107–247, pls. 25–40 (1875).

Westermann, G. E. G., 1964, The ammonite fauna of the Kialagvik Formation at Wide Bay, Alaska Peninsula—Part I, Lower Bajocian (Aalenian): Bulls. Am. Paleontology, v. 47, no. 216, p. 327–503, pls. 44–76, 37 figs.

——— 1969, The ammonite fauna of the Kialagvik Formation at Wide Bay, Alaska Peninsula—Part 2. *Sonninia sowerbyi* Zone (Bajocian): Bulls. Am. Paleontology, v. 57, no. 255, 226 p., 47 pls., 56 figs.

White, C. A., 1889, On invertebrate fossils from the Pacific coast: U.S. Geol. Survey Bull. 51, 102 p.

Whitfield, R. P., 1906, Notes on some Jurassic fossils from Franz Josef Land, brought back by a member of the Ziegler Exploring Expedition: Am. Mus. Nat. History Bull., v. 22, p. 131–134, pls. 18, 19.

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[Italic page numbers indicate major references and descriptions]

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PLATES 1-4

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

PLATE 1

[Figures natural size unless otherwise indicated]

FIGURES 1–5, 7. *Pseudolioceras maclintocki* (Haughton) (p. 10).

1. Hypotype, USNM 192130 from USGS Mesozoic loc. 21023.
2. Hypotype, USNM 192129 from USGS Mesozoic loc. 22595.
3. Hypotype, USNM 192127 from USGS Mesozoic loc. 24035.
4. Rubber imprint of external mold of hypotype, USNM 192126 from USGS Mesozoic loc. 21023.
5. Hypotype, USNM 192125 from USGS Mesozoic loc. 29152.
7. Hypotype, USNM 192128 from USGS Mesozoic loc. 21023.

6, 8–14. *Canavarella crassifalcata* Imlay, n. sp. (p. 12).

6. Paratype, USNM 192136 from USGS Mesozoic loc. 29153.
8, 9. Lateral view and suture line (× 3) drawn at whorl height of 8 mm. Paratype, USNM 192138 from USGS Mesozoic loc. 29884.
10. Paratype, USNM 192135 from USGS Mesozoic loc. 29153.
11. Holotype, USNM 192134 from USGS Mesozoic locs. 29154 and 29156. Shows nearly half a whorl of body chamber. Note that the two parts of the holotype were collected at two localities.
12. Rubber imprint of external mold of paratype, USNM 192137 from USGS Mesozoic loc. 30267.
13. Paratype, USNM 192139 from USGS Mesozoic loc. 29154.
14. Paratypes, USNM 192140 from USGS Mesozoic loc. 30268. Shows that falcate ribbing develops at a small size.

15. *Oppelia* (*Liroxyites*) n. sp. undet. (p. 14).

Adult body whorl of specimen USNM 192142 from USGS Mesozoic loc. 29435.

16–18. *Pseudolioceras whiteavesi* (White) (p. 11).

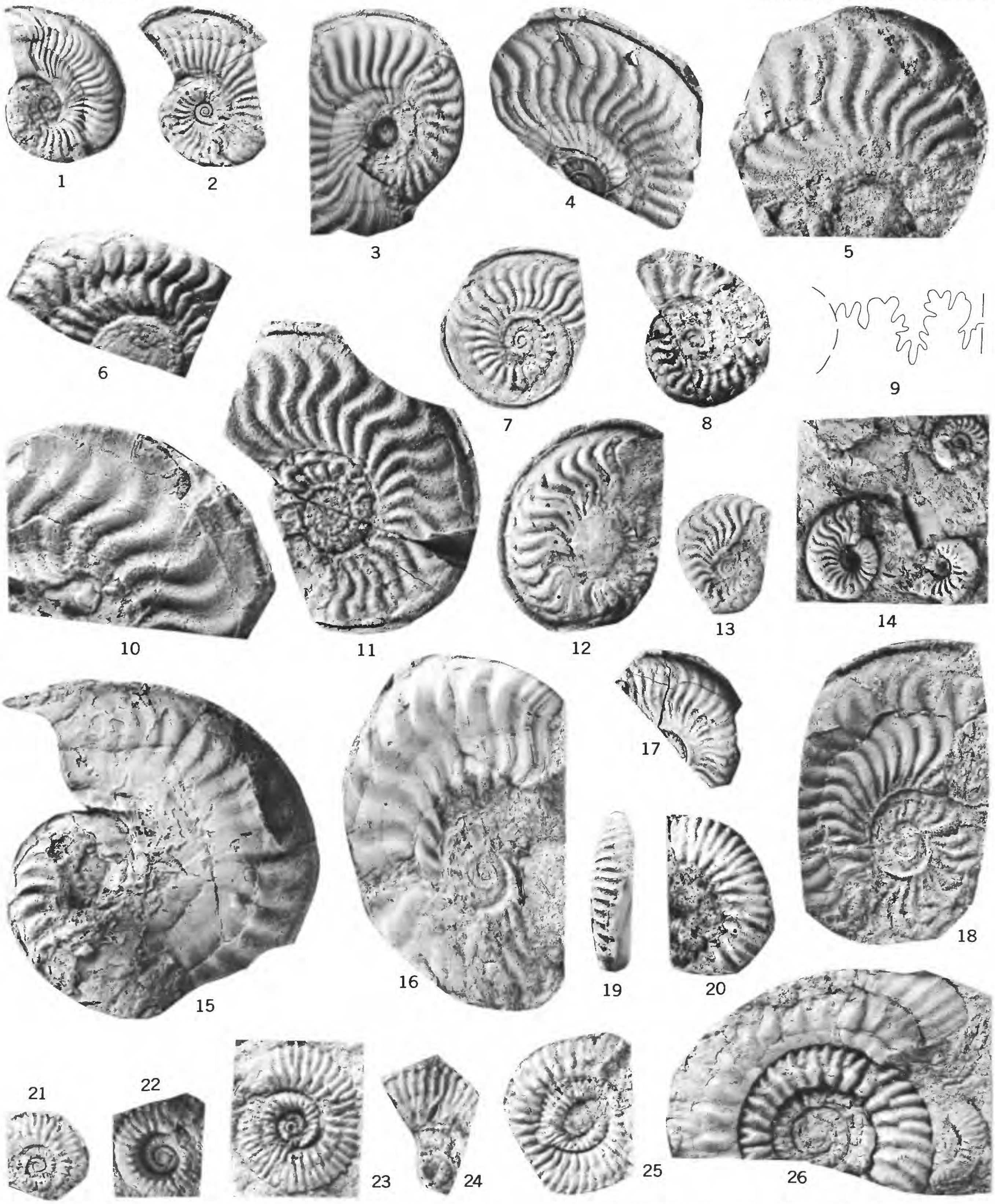
16. Rubber imprint of external mold (× 2). Hypotype USNM 192131 from USGS Mesozoic loc. 29147.
17. Small pyritic hypotype, USNM 192133 from USGS Mesozoic loc. 21023.
18. Internal mold (× 2). Hypotype, USNM 192132 from USGS Mesozoic loc. 10307. Note sharp raised umbilical edge in figures 16–18.

19, 20. *Arkelloceras*? sp. juv. (p. 15).

Rubber imprint of external mold (× 2) of specimen, USNM 192149 from USGS Mesozoic loc. 22591.

21–26. *Arkelloceras* cf. *A. maclearni* Frebold (p. 14).

21. Rubber imprint of external mold, specimen USNM 192147 from USGS Mesozoic loc. 29141.
22. Specimen, USNM 192148 from USGS Mesozoic loc. 24033. Shows prominent lateral tubercles at an early growth stage.
23. Specimen, USNM 192144 from USGS Mesozoic loc. 21024.
24. Specimen, USNM 192145 from USGS Mesozoic loc. 22597. Shows ventral tubercles or swellings.
25. Specimen, USNM 192146 from USGS Mesozoic loc. 22597.
26. Specimen, USNM 192143 from USGS Mesozoic loc. 24033. Two-fifths of outer whorl is nonseptate.



PSEUDOLIOCERAS, CANAVARELLA, OPPELIA (LIROXYITES), ARKELLOCERAS?, AND *ARKELLOCERAS*

PLATE 2

[All figures except suture line are natural size]

FIGURES 1–9, 11, 12. *Cranocephalites ignekensis* Imlay, n. sp. (p. 15).

1, 8. Complete adult body chamber and final suture line (× 2) of finely ribbed holotype, USNM 192151 from USGS Mesozoic loc. 28817.

2. Finely ribbed paratype, USNM 192155 from USGS Mesozoic loc. 28817.

3. Finely ribbed paratype, USNM 192154 from USGS Mesozoic loc. 29435.

4. Finely ribbed paratype, USNM 192153 from USGS Mesozoic loc. 29143.

5. Moderately ribbed adult body chamber of paratype, USNM 192156 from USGS Mesozoic loc. 28817.

6. Rubber imprint of external mold of moderately ribbed paratype, USNM 192157 from USGS Mesozoic loc. 28817.

7. Rubber imprint of external mold of moderately ribbed paratype, USNM 192152 from USGS Mesozoic loc. 28817. This specimen occurs on same slab as the finely ribbed holotype.

9. Fragment of inner whorl of moderately ribbed paratype, USNM 192158 from USGS Mesozoic loc. 29855.

11. Rubber imprint of external mold of coarsely ribbed paratype, USNM 192160 from USGS Mesozoic loc. 29435.

12. Rubber imprint of coarsely ribbed paratype, USNM 192159 from USGS Mesozoic loc. 29143.

10. *Choffatia*? sp. (p. 18).

Internal mold of specimen, USNM 180733 from USGS Mesozoic loc. 30075. See other views on plate 4, figures 9, 11.

CRANOCEPHALITES AND *CHOFFATIA*?

PLATE 3

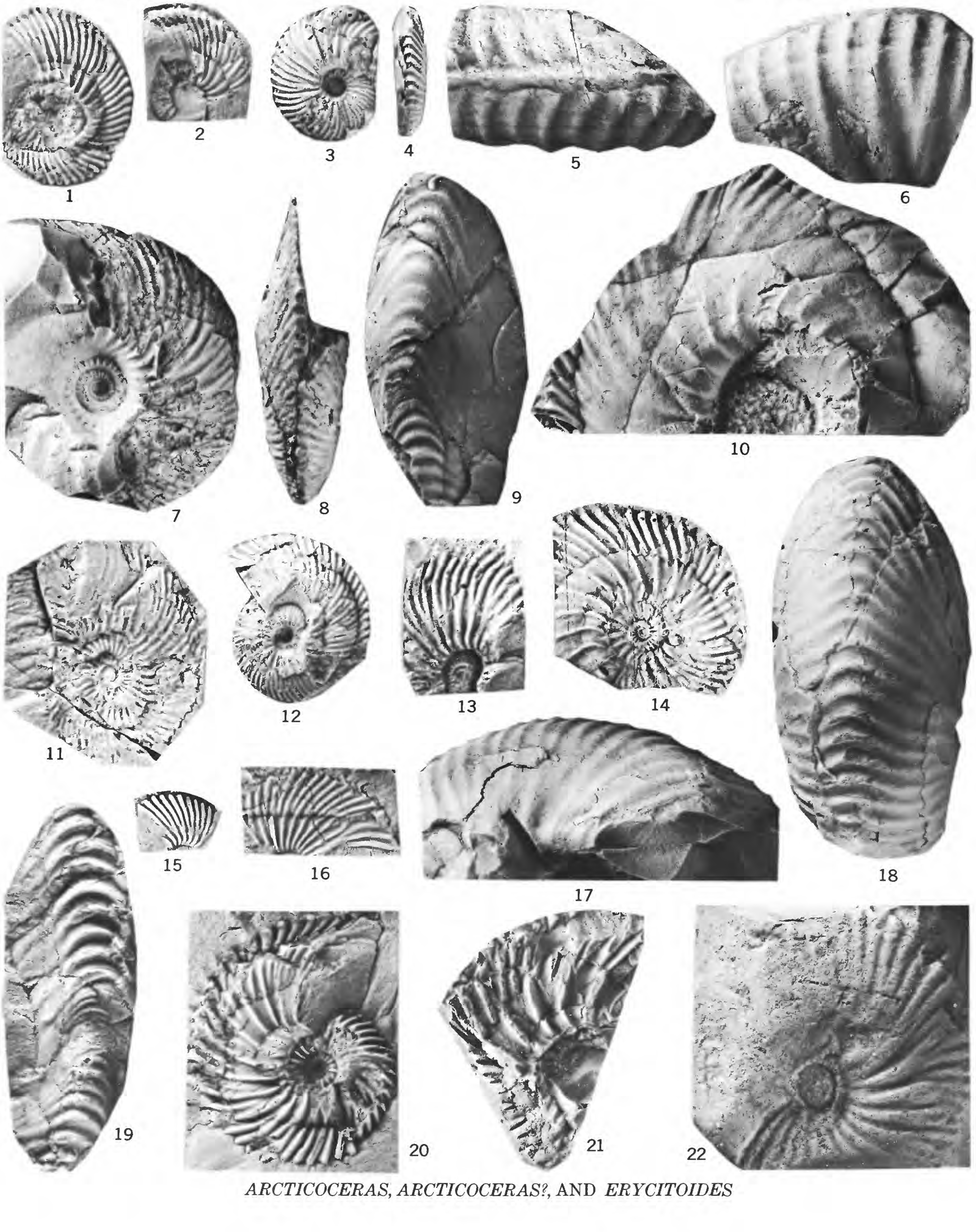
[All figures are natural size]

FIGURES 1, 2. *Arcticoceras* sp. juv. (p. 17).
Immature specimens, USNM 180732 from USGS Mesozoic loc. 29877.

3, 4. *Arcticoceras*? sp. juv. (p. 17).
Rubber imprint of external mold of specimen formerly described as ***Pseudocadoceras grewingki*** (Pompeckj) by Imlay (1955, p. 90, pl. 12, fig. 1). USNM 108781 from USGS Mesozoic loc. 22745.

5, 6, 10. *Erycitoides* cf. *E. howelli* (White) (p. 14).
5, 6. Ventral and lateral views of specimen, USNM 192141 from USGS Mesozoic loc. 29153.
10. Laterally crushed specimen, USNM 180730 from USGS Mesozoic loc. 29150.

7–9, 11–22. *Arcticoceras ishmae* (Keyserling) (p. 16).
All specimens from USGS Mesozoic loc. 30075 unless indicated otherwise.
7, 8. Lateral and ventral views of septate finely ribbed hypotype, USNM 192164.
9. Ventral view of finely ribbed body chamber. Hypotype, USNM 192167.
11. Laterally crushed finely ribbed hypotype, USNM 192165.
12. Immature finely ribbed hypotype, USNM 192166.
13. Moderately ribbed hypotype, USNM 192170.
14. Moderately ribbed hypotype, USNM 192168.
15. Moderately ribbed inner whorls. Hypotype, USNM 192172.
16. Moderately ribbed inner whorls. Hypotype, USNM 192171.
17, 18. Moderately ribbed, lateral and ventral views of hypotype, USNM 192169.
19. Coarsely ribbed venter of hypotype, USNM 192173.
20. Coarsely ribbed laterally crushed hypotype, USNM 192174.
21. Coarsely ribbed laterally crushed hypotype, USNM 192175.
22. Coarsely ribbed, worn hypotype, USNM 192176 from USGS Mesozoic loc. 21023.



ARCTICOCERAS, *ARCTICOCERAS?*, AND *ERYCITOIDES*

PLATE 4

[All figures are natural size]

FIGURES 1–8. *Arctocephalites* cf. *A. elegans* Spath (p. 16).

1–3. Ventral and lateral views of adult specimen, USNM 192160 from USGS Mesozoic loc. 29145. Note smoothness of body chamber.

4, 5. Adult smooth body chamber of specimen, USNM 192161 from USGS Mesozoic loc. 29143.

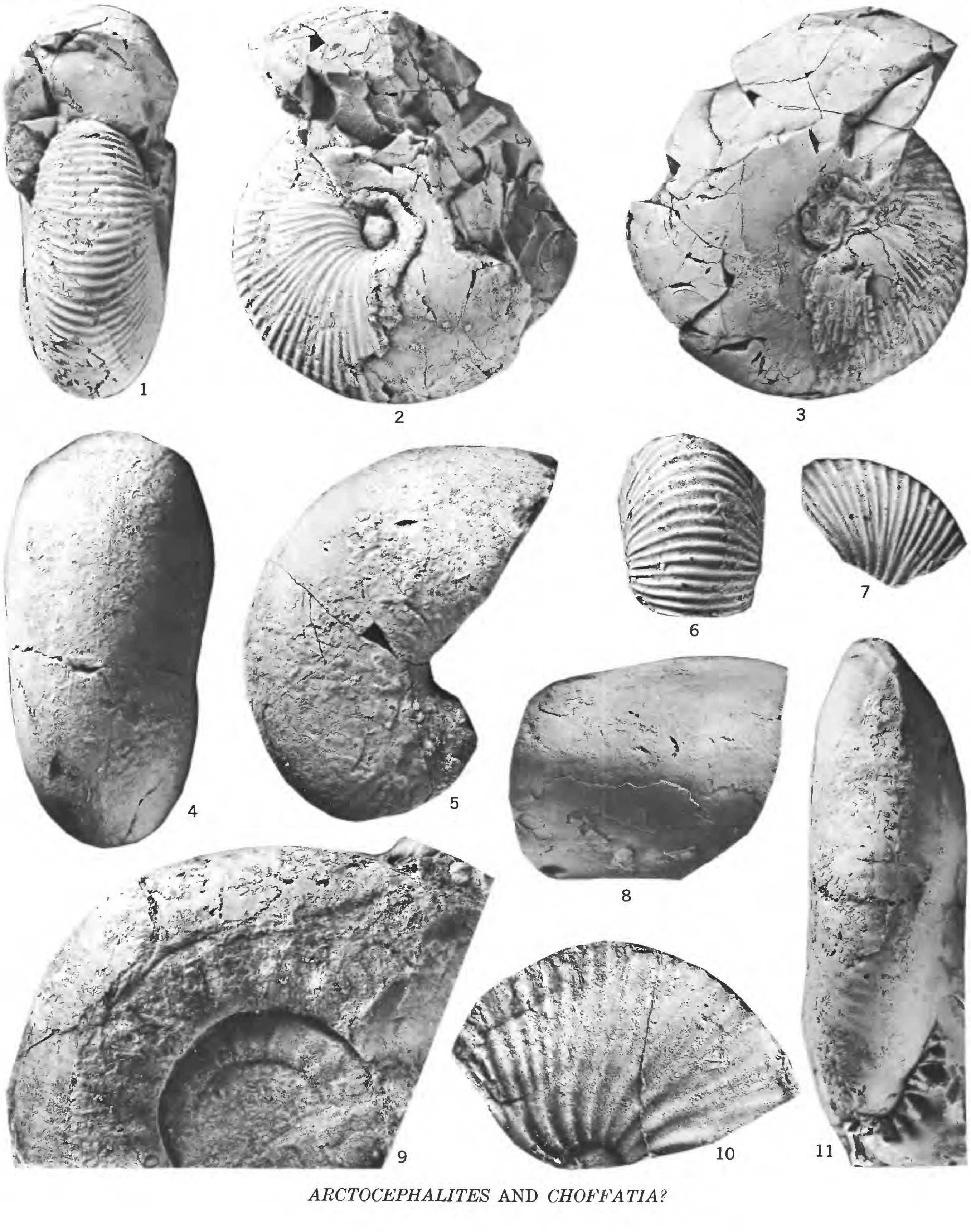
6–8. Rubber imprint of ribbed inner whorl and ventral view of smooth outer whorl of same specimen, USNM 192162 from USGS Mesozoic loc. 29435.

9, 11. *Choffatia*? sp. (p. 18).

Lateral and ventral views of septate whorls. Specimen, USNM 180733 from USGS Mesozoic loc. 30075. Other view shown on plate 2, figure 10.

10. *Arctocephalites* cf. *A. arcticus* (Newton and Teall) (p. 16).

Rubber imprint of laterally crushed specimen, USNM 192163 from USGS Mesozoic loc. 29146.



ARCTOCEPHALITES AND *CHOFFATIA?*