Late Jurassic Ammonites From Alaska

GEOLOGICAL SURVEY PROFESSIONAL PAPER 1190

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By RALPH W. IMLAY

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Studies of the Late Jurassic ammonites of Alaska enables fairly close age determinations and correlations to be made with Upper Jurassic ammonite and stratigraphic sequences elsewhere in the world

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CONVERSION FACTORS

Metric unit		Inch-Pound equivalent
Length		
millimeter (mm)	= 0.03937	inch (in)
meter (m)	= 3.28	feet (ft)
kilometer (km)	= .62	mile (mi)
Area		
square meter (m^2)	= 10.76	square feet (ft^2)
square kilometer (km^2)	= .386	square mile (mi^2)
hectare (ha)	= 2.47	acres
Volume		
cubic centimeter (cm^3)	= 0.061	cubic inch (in^3)
liter (L)	= 61.03	cubic inches
cubic meter (m^3)	= 35.31	cubic feet (ft^3)
cubic meter	= .00081	acre-foot (acre-ft)
cubic hectometer (hm^3)	=810.7	acre-feet
liter	= 2.113	pints (pt)
liter	= 1.06	quarts (qt)
liter	= .26	gallon (gal)
cubic meter	= .00026	million gallons (Mgal or 10^6 gal)
cubic meter	= 6.290	barrels (bbl) (1 bbl=42 gal)
Weight		
gram (g)	= 0.035	ounce, avoirdupois (oz avdp)
gram	= .0022	pound, avoirdupois (lb avdp)
metric tons (t)	= 1.102	tons, short (2,000 lb)
metric tons	= 0.9842	ton, long (2,240 lb)
Specific combinations		
kilogram per square centimeter (kg/cm^2)	= 0.96	atmosphere (atm)
kilogram per square centimeter	= .98	bar (0.9869 atm)
cubic meter per second (m^3/s)	= 35.3	cubic feet per second (ft^3/s)
Specific combinations—Continued		
liter per second (L/s)	= .0353	cubic foot per second
cubic meter per second per square kilometer [$(m^3/s)/km^2$]	= 91.47	cubic feet per second per square mile [$(ft^3/s)/mi^2$]
meter per day (m/d)	= 3.28	feet per day (hydraulic conductivity) (ft/d)
meter per kilometer (m/km)	= 5.28	feet per mile (ft/mi)
kilometer per hour (km/h)	= .9113	foot per second (ft/s)
meter per second (m/s)	= 3.28	feet per second
meter squared per day (m^2/d)	= 10.764	feet squared per day (ft^2/d) (transmissivity)
cubic meter per second (m^3/s)	= 22.826	million gallons per day (Mgal/d)
cubic meter per minute (m^3/min)	=264.2	gallons per minute (gal/min)
liter per second (L/s)	= 15.85	gallons per minute
liter per second per meter [(L/s)/m]	= 4.83	gallons per minute per foot [(gal/min)/ft]
kilometer per hour (km/h)	= .62	mile per hour (mi/h)
meter per second (m/s)	= 2.237	miles per hour
gram per cubic centimeter (g/cm^3)	= 62.43	pounds per cubic foot (lb/ft^3)
gram per square centimeter (g/cm^2)	= 2.048	pounds per square foot (lb/ft^2)
gram per square centimeter	= .0142	pound per square inch (lb/in^2)
Temperature		
degree Celsius (°C)	= 1.8	degrees Fahrenheit (°F)
degrees Celsius (temperature)	=[(1.8×°C)+32]	degrees Fahrenheit

LATE JURASSIC AMMONITES FROM ALASKA

By Ralph W. Imlay

ABSTRACT

Late Jurassic ammonites have been found in northeastern Alaska only in the Mt. Michelson Quadrangle from the East Fork of the Shaviovik River eastward about 40 miles (64 kilometers) to Fire Creek. Late Jurassic ammonites have been found in southern Alaska, from west to east: (1) in the northern part of the Alaska Peninsula north of Chignik Bay; (2) along the west side of Cook Inlet, but mostly on the Iniskin Peninsula; (3) in the Talkeetna Mountains; and (4) in the Wrangell Mountains.

The early to early middle Oxfordian is represented by *Cardioceras* in all the areas listed above except in the Wrangell Mountains. Intensive collecting on the Iniskin Peninsula shows that the lower part of the *Cardioceras*-bearing beds is characterized by *C.* (*Scarburgiceras*) *martini* Reeside and the upper part by *C.* (*C.*) *distans* (Whitfield) in association with *C.* (*Scoticardioceras*) *alaskense* Reeside. Some collections, however, contain both of the first two species listed, which suggests that the vertical ranges of the two species overlap. Associated with *Cardioceras* on the Iniskin Peninsula and in the Talkeetna Mountains are specimens of *Phylloceras iniskinense* Imlay, n. sp., in the lower part of its range.

The late middle Oxfordian to early late Kimmeridgian is characterized and dated in northeastern Alaska and in the Wrangell Mountains by an abundance of the bivalve *Buchia concentrica* (Sowerby) in association with the ammonite *Amoeboceras* and its subgenera *Prionodoceras* and *Amoebites*. By contrast, from the Talkeetna Mountains southward to the middle of the Alaska Peninsula, that species of *Buchia* is not associated with *Amoeboceras* but with two successive species of *Phylloceras*. Of these species, *Phylloceras iniskinense* Imlay, n. sp., near the top of its range is dated by the presence of *Perisphinctes* (*Dichotomosphinctes*) as of late middle to late Oxfordian Age. The overlying beds containing *Buchia concentrica* are characterized by *Phylloceras alaskanum* Imlay, n. sp., which is likewise dated in the lower part of its range as late middle to late Oxfordian by its association with *P.* (*Dichotomosphinctes*). The next higher beds that contain *Phylloceras alaskanum* Imlay, n. sp., associated with the highest occurrences of *Buchia concentrica* are dated as early Kimmeridgian to early late Kimmeridgian on the basis of their stratigraphic position below beds containing *Buchia mosquensis* (von Buch) and *B. rugosa* (Fischer); these last two species are not known in Eurasia in beds older than early late Kimmeridgian and range as high as the early late Tithonian.

The uppermost Kimmeridgian and early Tithonian beds in Alaska are characterized by an abundance of *Buchia rugosa* (Fischer) and *B. mosquensis* (von Buch). These beds are widespread in northern, southeastern, southern, and southwestern Alaska and on the Alaska Peninsula but are absent west of Cook Inlet. Ammonites are scarce throughout all these areas except on the Alaska Peninsula, where *Phylloceras alaskanum* Imlay, n. sp., is common. Its association locally with the ammonites *Subplanites*? and *Aulacosphinctoides* is good evidence that the beds are at least in part of early Tithonian Age. The beds containing *B. rugosa* and *B. mosquensis* are also dated on the basis of their stratigraphic position above *Amoeboceras* and below *Buchia piochii* (Gabb) and on the known ranges of *B. rugosa* and *B. mosquensis* in Eurasia.

Upper Tithonian beds in Alaska, which are not as widespread as beds of earlier Jurassic age, are characterized by the presence of *Buchia piochii* (Gabb), *B.* cf. *B. fischeriana* (d'Orbigny), *B. unschensis* (Pavlow), and by an absence of ammonites, except for one specimen of *Phylloceras* from near Amber Bay on the Alaska Peninsula. This *Phylloceras* resembles *P. knoxvillensis* Stanton, which in California occurs with the ammonite *Parodontoceras* of late Tithonian Age (Imlay and Jones, 1970, p. B28, pl. 2, figs. 4–11). The species of *Buchia* present have been dated as late Tithonian in arctic Canada by their asssociation with the ammonite *Craspedites* and in California, by the ammonites *Parodontoceras* and *Kossmatia*.

The Late Jurassic ammonites present in Alaska are of diverse geographic origin. Certain genera including *Dichotomosphinctes*, *Subplanites*?, *Aulacosphinctoides*, *Phylloceras*, and *Lytoceras* are common in the Tethyan and Pacific Realms and apparently spread northeastward from the Pacific Ocean across the present site of the Alaska Peninsula, the Cook Inlet region, and the Talkeetna Mountains, but no farther east or north. Other genera, including *Cardioceras* and *Amoeboceras*, spread southward from the Arctic Ocean across arctic Canada and thence farther south along the Pacific Coast. *Cardioceras* also spread southwestward from arctic Canada across southern Alaska, at least as far as the Wide Bay area on the Alaska Peninsula and spread southeastward far into the interior of North America. From the Talkeetna Mountains southwestward, *Cardioceras* definitely intermingled with ammonite genera of the Pacific or Tethyan Realm. By

contrast, *Amoeboceras* has not been found west of the Wrangell Mountains in Alaska or in the western interior of the United States.

Associated with all these ammonite genera except *Cardioceras* is the bivalve *Buchia,* which in middle Oxfordian time spread southward from the Arctic Ocean at least as far as Mexico and attained maximum numbers on hard sandy to silty bottoms of shallow seas. Its presence suggests that the two different but contemporaneous ammonite faunules lived under similar environmental conditions. Their differences, however, could be reasonably ascribed to the fact that the marine waters southwest of the present site of the Talkeetna Mountains probably bordered a major ocean rather than a shallow sea, as attested by an abundance of *Phylloceras* as well as ammonite genera of Tethyan affinities. Apparently the scarcity of ammonites of latest Kimmeridgian and Tithonian Age throughout most of Alaska could be due to a slight shallowing of the sea that did not affect the area now represented by the Alaska Peninsula.

INTRODUCTION

Late Jurassic ammonites (table 1) obtained from one area in northeastern Alaska and from nine areas in southern Alaska (figs. 1–10) are described herein in order to present evidence concerning the stratigraphic and geographic distribution of genera and species (tables 1–6), to evaluate their faunal setting in relation to the Boreal and Mediterranean regions, to make correlations with Upper Jurassic sequences elsewhere in North America, and to correlate the Alaskan Upper Jurassic beds and ammonite sequences with the ammonite zones of western Europe (figs. 11, 12). Correlation of the Upper Jurassic lithologic units within Alaska has been depicted in considerable detail by Imlay and Detterman (1973, figs. 11*A*, *B*) and is not repeated herein.

FIGURE 1.—Upper Jurassic ammonite localities in Alaska. Numbers on map refer to listing in tables 4–7.

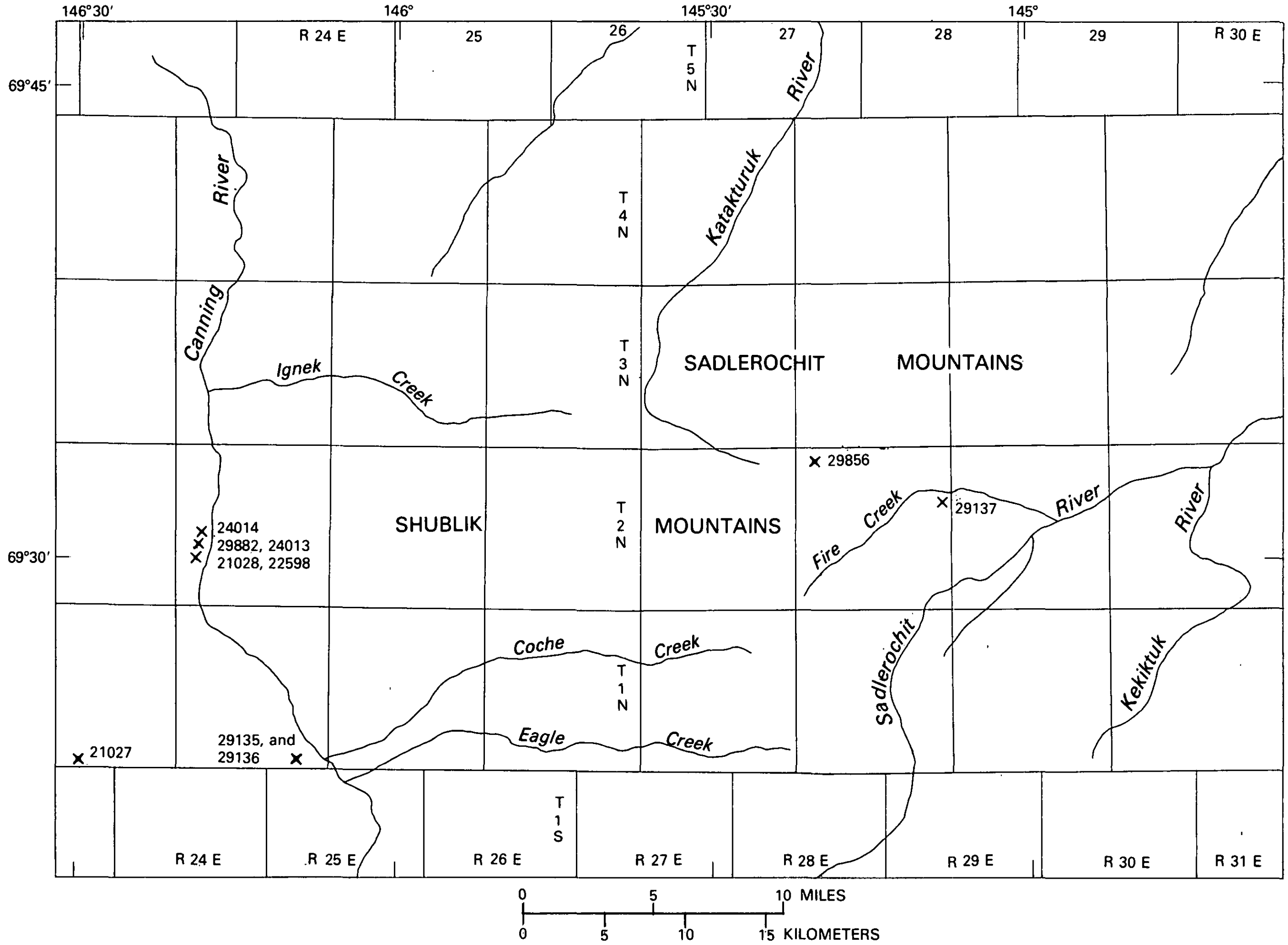

FIGURE 2.—Upper Jurassic ammonite localities in the central part of the Mt. Michelson Quadrangle between the Canning and Sadlerochit Rivers, northern Alaska. Numbers on map refer to listing in tables 4 and 7.

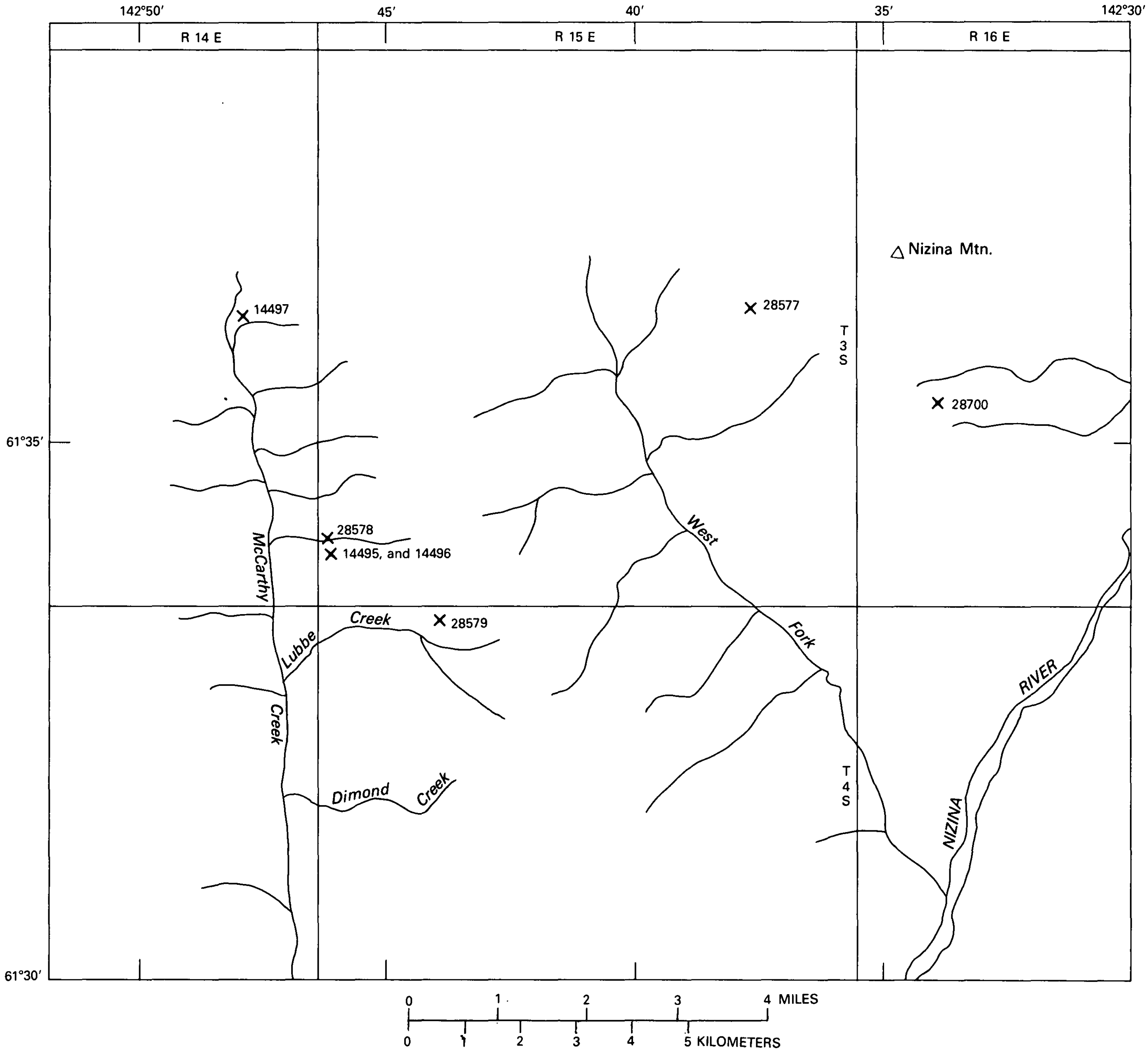

FIGURE 3.—Upper Jurassic ammonite localities in the McCarthy (C–5) Quadrangle, Wrangell Mountains, southern Alaska. Numbers on map refer to listing in tables 4 and 7.

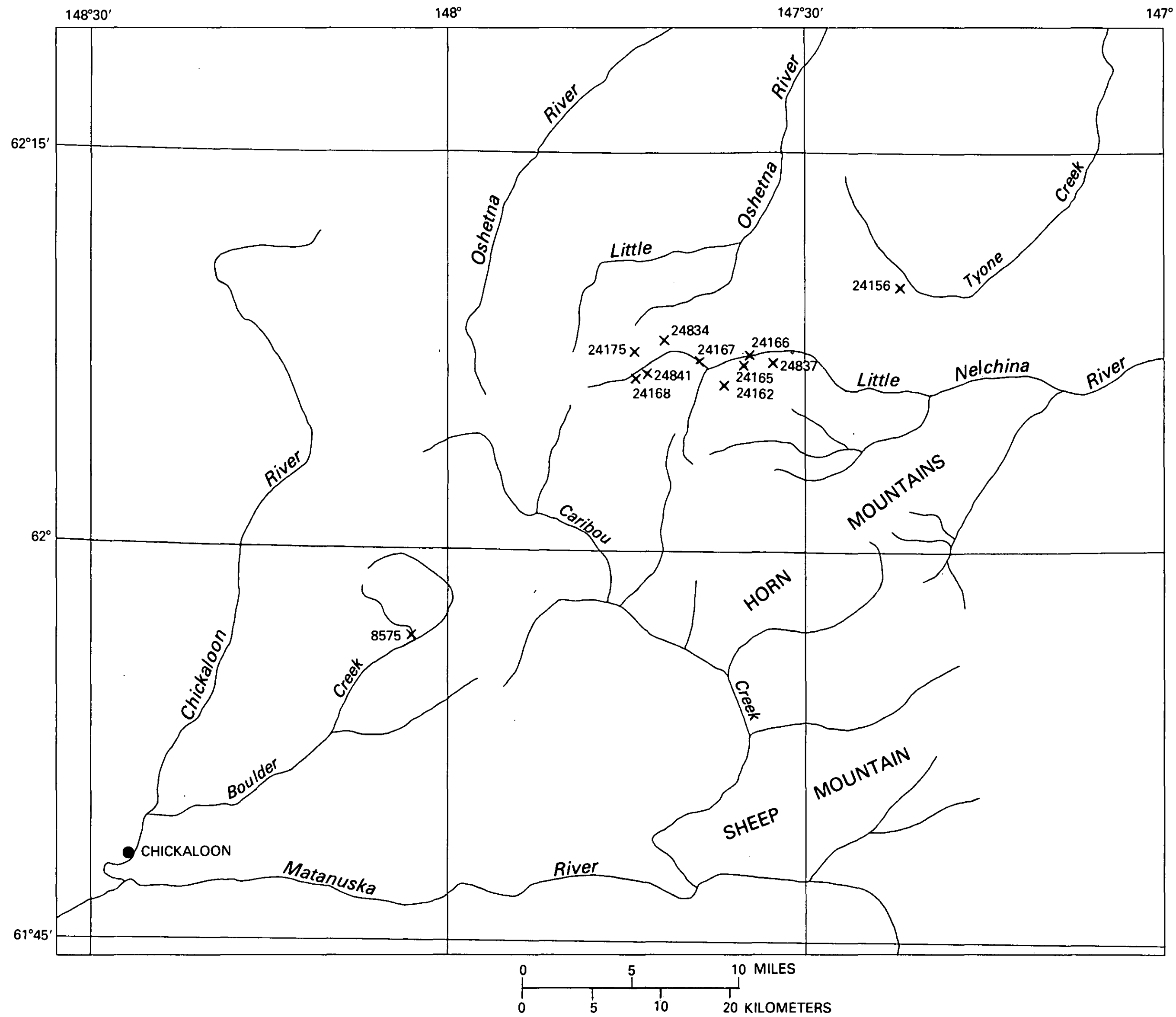

FIGURE 4.—Upper Jurassic ammonite localities in the Nelchina area of the Talkeetna Mountains, southern Alaska. Numbers on map refer to listing in tables 5 and 7.

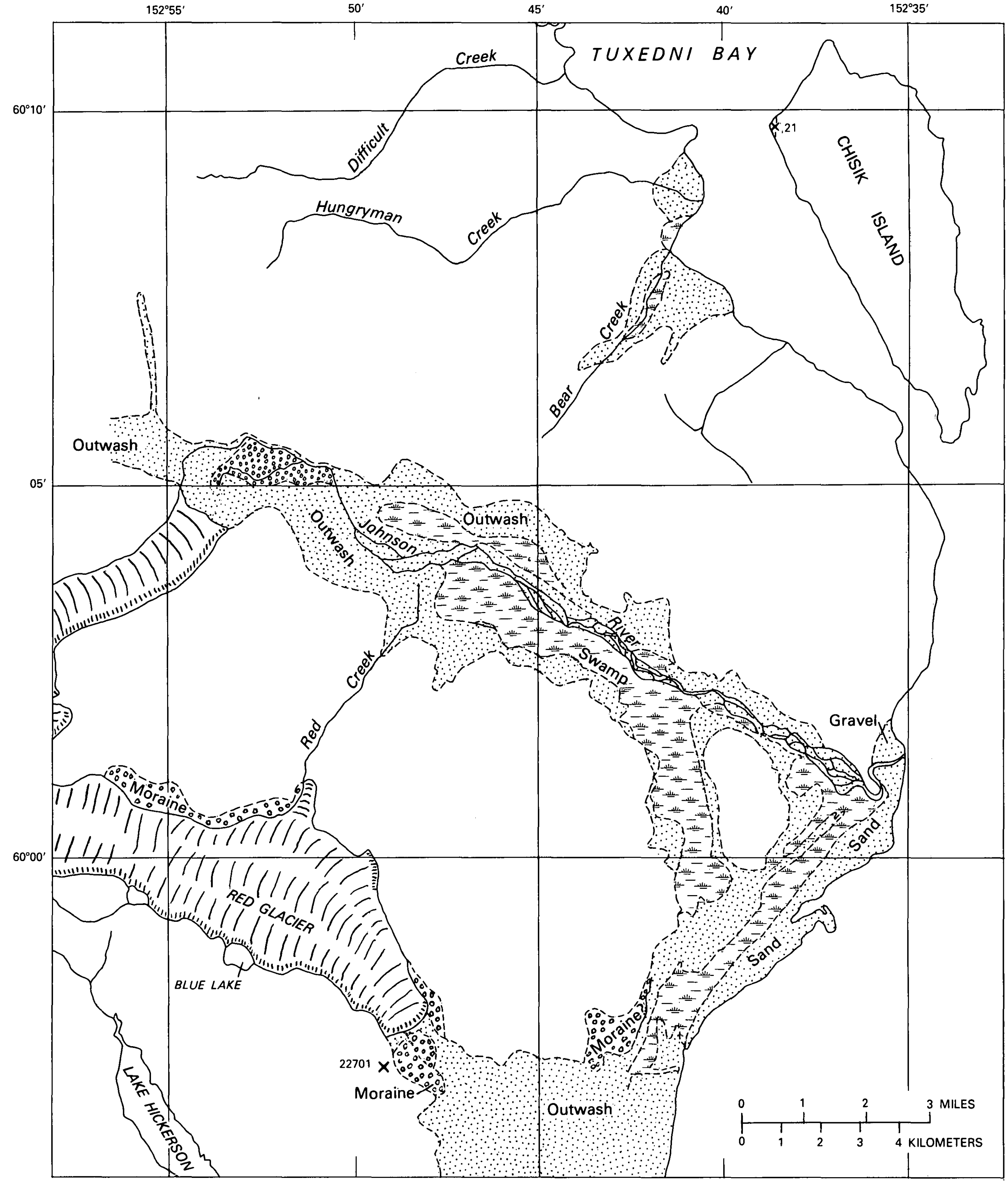

FIGURE 5.—Upper Jurassic ammonite locality on the peninsula between Tuxedni Bay and Chinitna Bay, west of Cook Inlet, southern Alaska. Numbers on map refer to listing in tables 5 and 7.

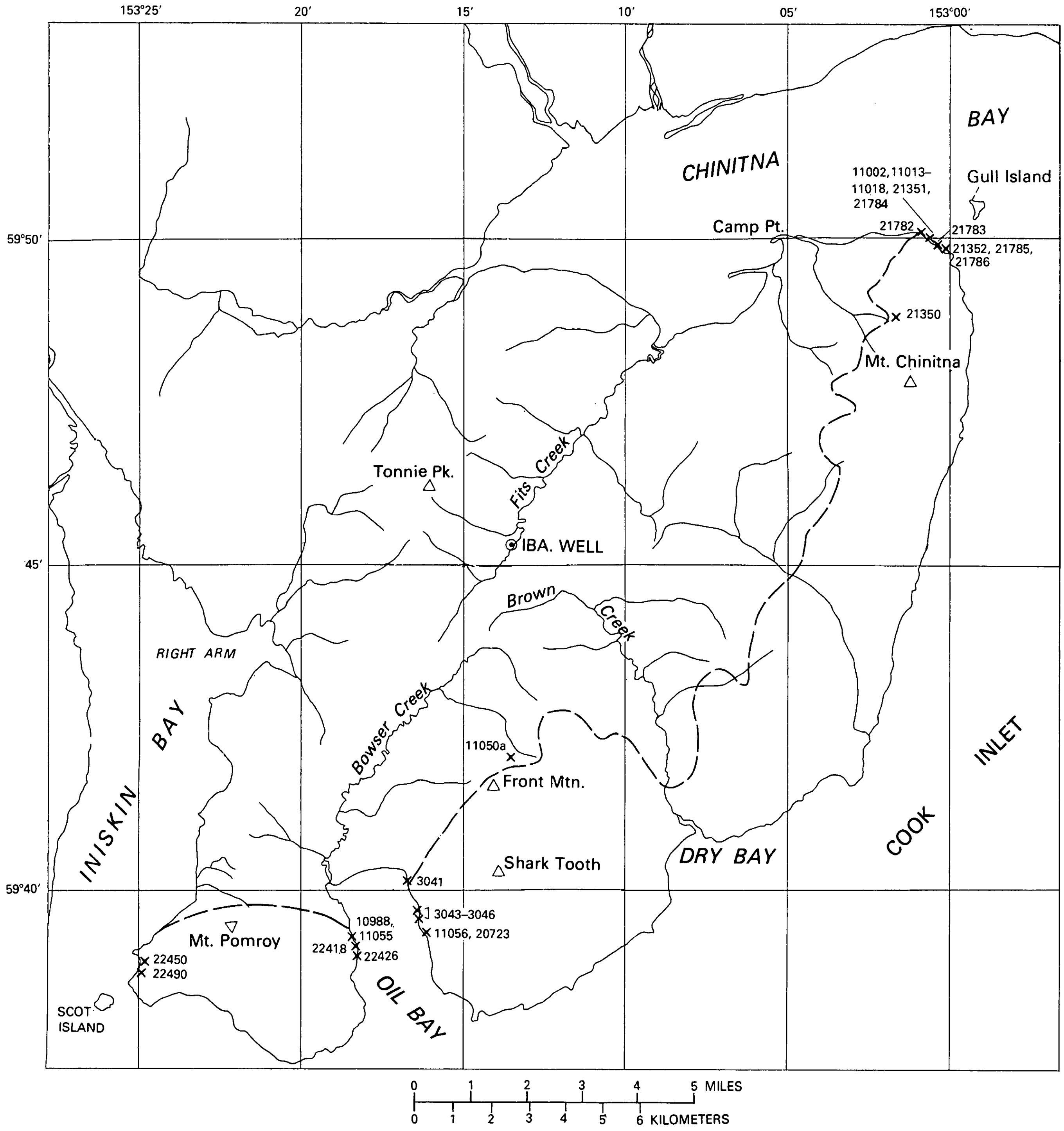

FIGURE 6.—Upper Jurassic ammonite localities on the Iniskin Peninsula, west of Cook Inlet, southern Alaska. Basal boundary of Naknek Formation is indicated by dashed line. Numbers on map refer to listing in tables 5 and 7.

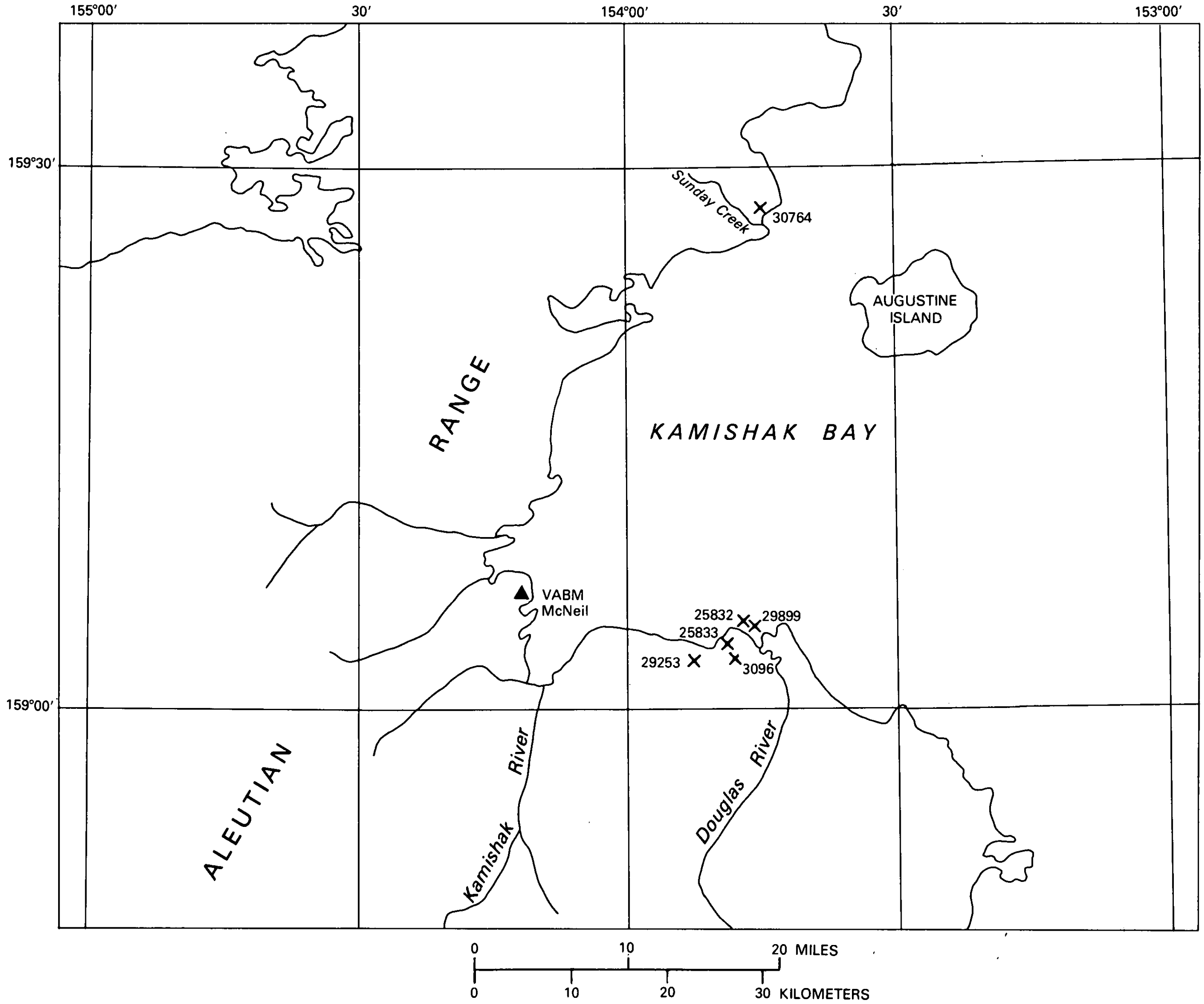

FIGURE 7.—Upper Jurassic ammonite localities on the Alaska Peninsula south of Kamishak Bay and west of Cook Inlet northwest of Augustine Island, southern Alaska. Numbers on map refer to listing in tables 6 and 7.

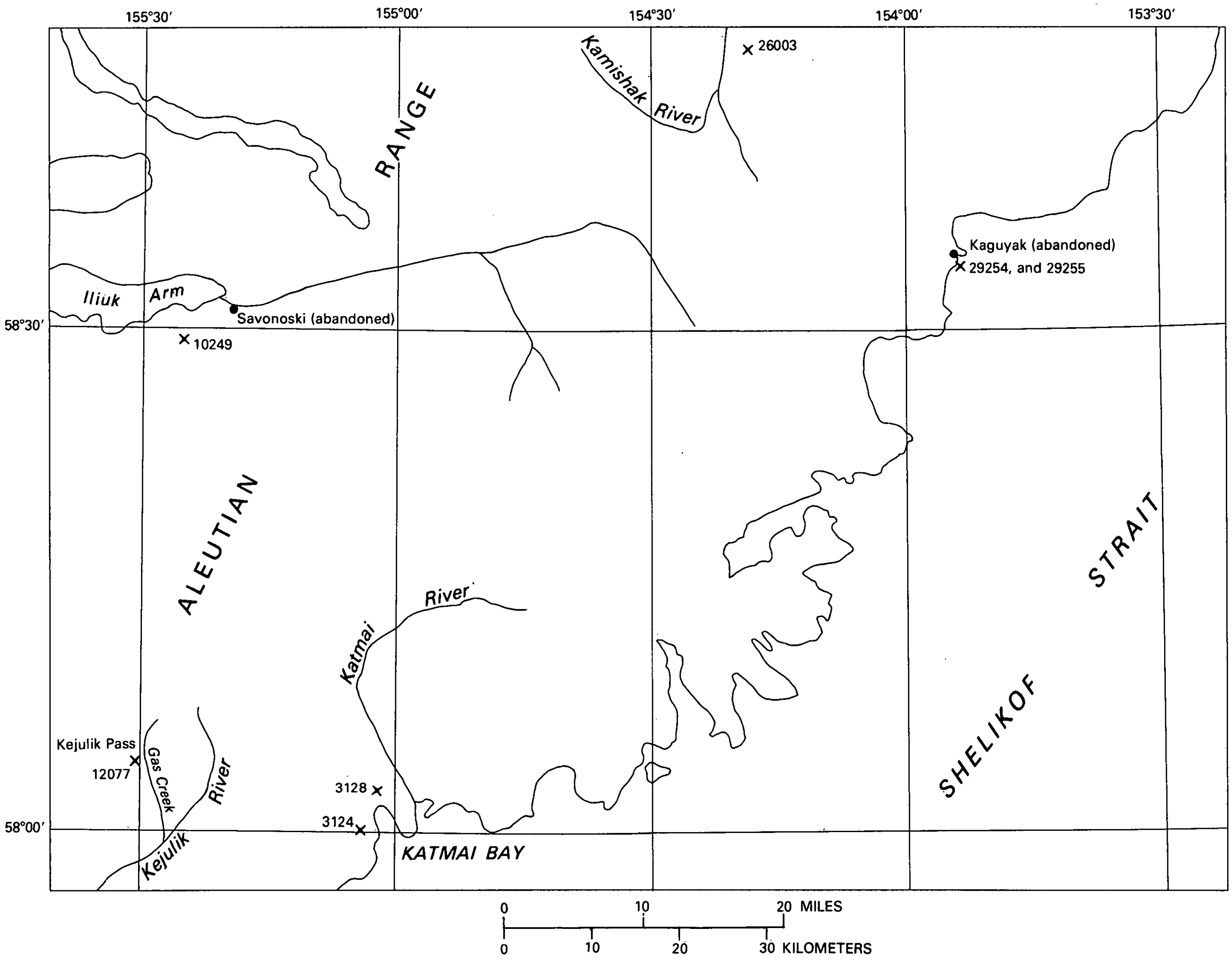

FIGURE 8.—Upper Jurassic ammonite localities in the Mt. Katmai area, Alaska Peninsula. Numbers on map refer to listing in tables 6 and 7.

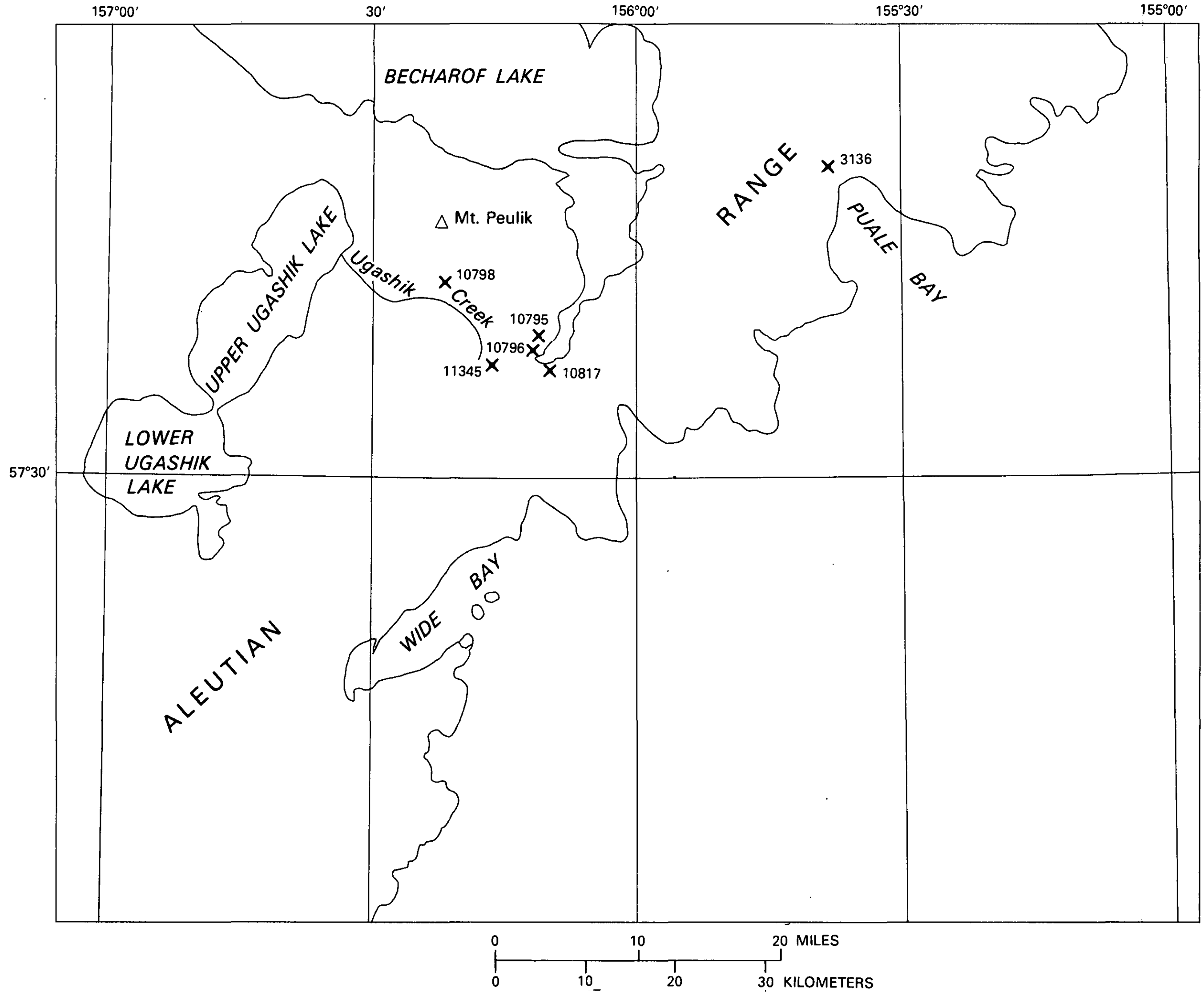

FIGURE 9.—Upper Jurassic ammonite localities in the Puale Bay–Mt. Peulik–Wide Bay area, Alaska Peninsula. Numbers on map refer to listing in tables 6 and 7.

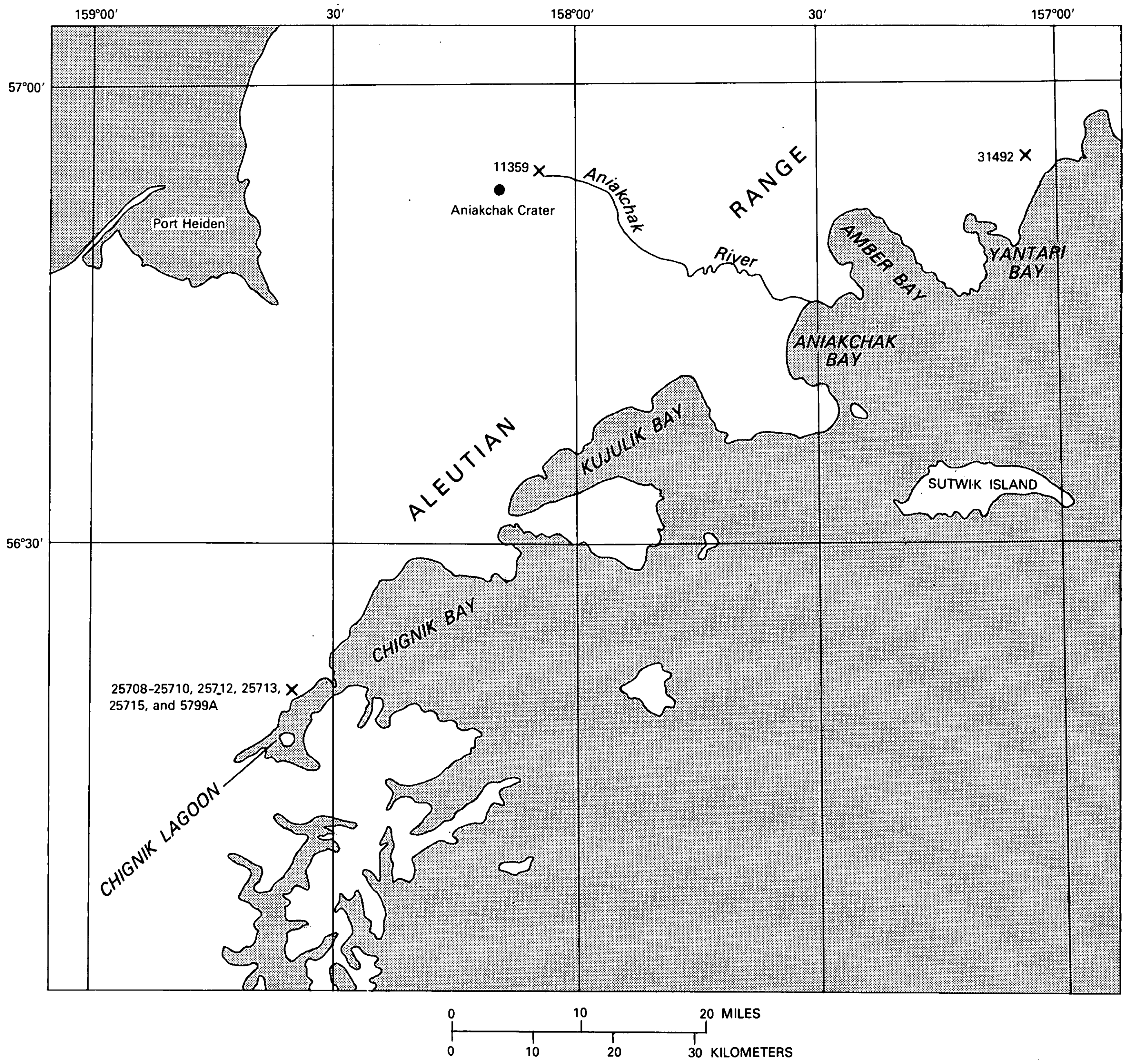

FIGURE 10.—Upper Jurassic ammonite localities north of Chignik Lagoon, Chignik (B-2) Quadrangle, and north of Amber Bay in the Sutwik (D-4) Quadrangle, Alaska Peninsula. Numbers on map refer to listing in tables 6 and 7.

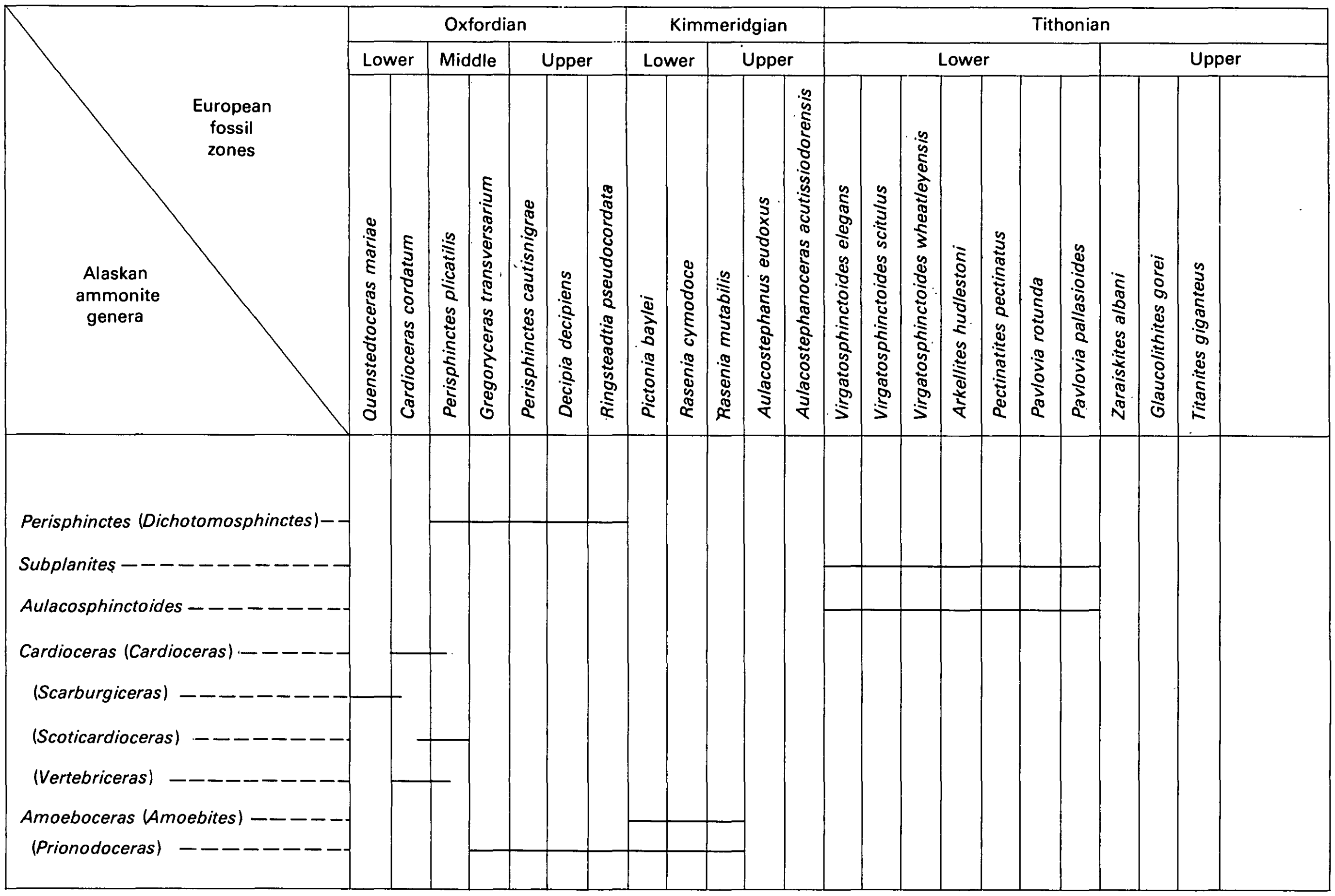

FIGURE 11.—European ranges of Late Jurassic ammonite genera and subgenera present in Alaska.

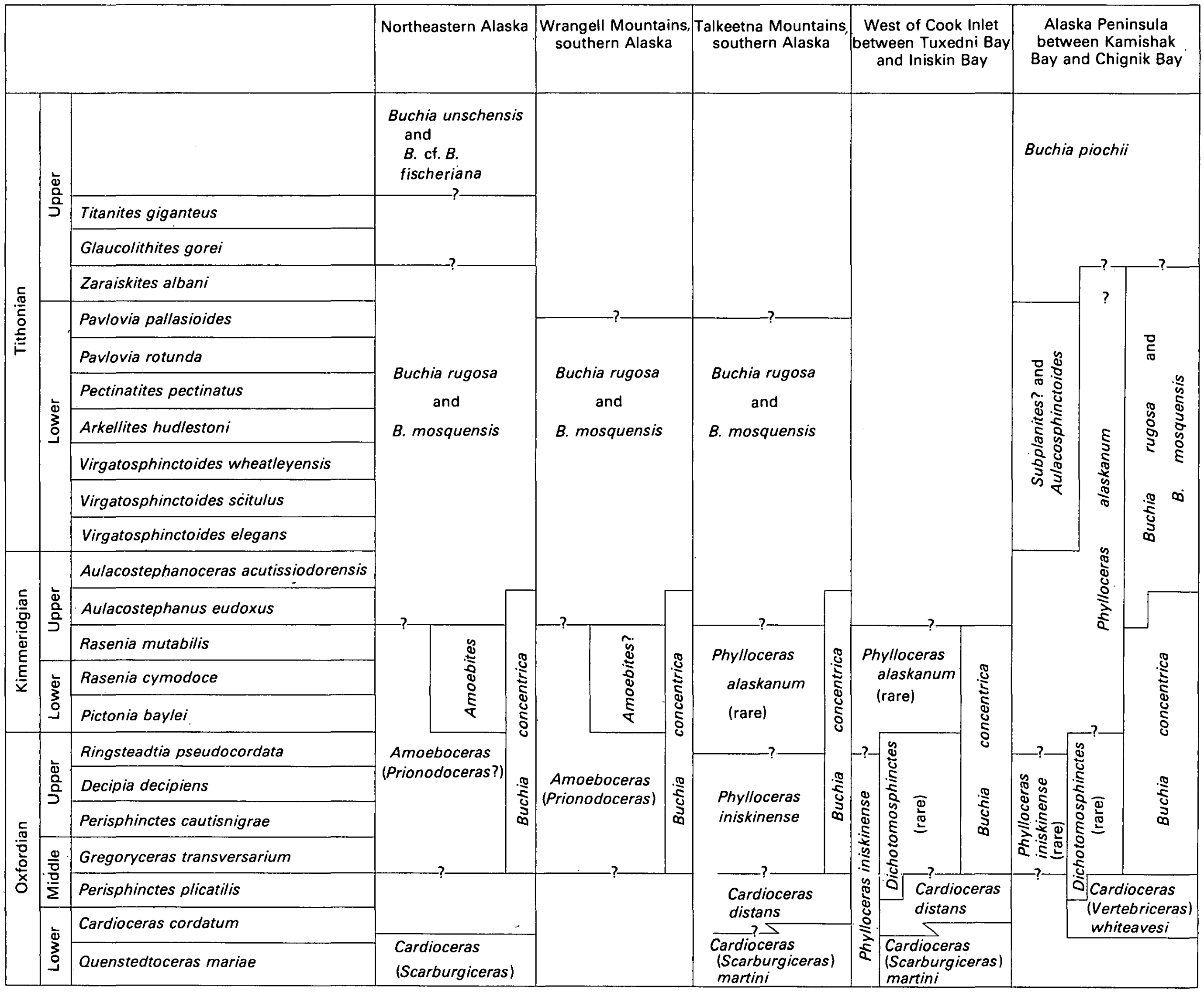

FIGURE 12.—Correlation of Late Jurassic ammonite faunas in Alaska.

This study is based mainly on fossil collections and stratigraphic information obtained during the last 70 years by many geologists of the U.S. Geological Survey, as listed by Imlay and Detterman (1973, p. 8, 9). It also includes fossil collections and data obtained by British Petroleum (Alaska), Inc., in 1964 in northern Alaska, by Continental Oil Co. in 1967 near Kamishak Bay at the south end of Cook Inlet, and by the Richfield Oil Co. in 1962 on the east shore of Puale Bay in the Alaska Peninsula. Biostratigraphic data for northern Alaska were furnished mainly in publications by Detterman and others (1975); for the Wrangell Mountains, by MacKevett (1969, 1970, 1971); for the Talkeetna Mountains, by Grantz (1960a, b); for the west side of Cook Inlet, by Detterman and Hartsock (1966); and for the Alaska Peninsula, by Capps (1923), Knappen (1929), Martin (1926), Keller and Reiser (1959), Smith (1925), Smith and Baker (1924), and, in particular, the comprehensive study by Burk (1965).

The described specimens are deposited in the type collections of the U.S. National Museum and are labeled "USNM."

BIOLOGIC ANALYSIS

Alaskan ammonites of Lake Jurassic age (Oxfordian to Tithonian) that are discussed herein number 233 specimens. Their distribution by family, subfamily, genus, and subgenus is shown in table 1. Among the families, the Cardioceratidae constitutes about 63 percent, the Phylloceratidae about 28 percent, the Lytoceratidae 7 percent, and the Perisphinctidae 2 percent. The characteristics of the genera and subgenera of Cardioceratidae have been discussed in detail by Arkell (1935–1948). The other genera and subgenera listed from Alaska have been described adequately by Arkell and others (1957).

TABLE 1.—*Ammonite genera and subgenera of Late Jurassic age in Alaska*

Family	Subfamily	Genus and subgenus	Number of specimens
Phylloceratidae	Phylloceratinae	*Phylloceras*	56
		Partschiceras	8
	Calliphylloceratinae	*Holcophylloceras*	2
Lytoceratidae	Lytoceratinae	*Lytoceras*	16
Perisphinctidae	Perisphinctinae	*Perisphinctes* (*Dichotomosphinctes*)	3
	Virgatosphinctinae	*Subplanites*?	1
		Aulacosphinctoides	1
Cardioceratidae	Cardioceratinae	*Cardioceras*	32
		(*Scarburgiceras*)	82
		(*Scoticardioceras*)	4
		(*Vertebriceras*)	1
		Amoeboceras (*Amoebites*)	1
		(*Amoebites*?)	1
		(*Prionodoceras*)	2
		(*Prionodoceras*?)	23
		Amoeboceras?	2

TABLE 2.—*Stratigraphic positions of ammonite occurrences above base of members of the Naknek Formation on south shore of Chinitna Bay, west of Cook Inlet*

	South shore of Chinitna Bay													
	lower sandstone member											Snug Harbor Siltstone Member		
Stratigraphic position above base of members in feet (meters).	50–100 (15–30)	200–250 (60–75)	200–250 (60–75)	200–250 (60–75)	200–250 (60–75)	200–250 (60–75)	200–250 (60–75)	200–250 (60–75)	450 (136)	450 (136)	800 (242)	600 (181)	600 (181)	600 (181)
USGS Mesozoic localities	21350a	11002	11013	11015	11016	11017	11018	21782	21351	21784	21783	21352	21785	21786
Buchia concentrica (Sowerby)	--	--	--	--	--	--	--	--	--	×	--	--	--	--
sp	--	--	--	--	--	--	--	--	--	--	--	×	--	--
Phylloceras cf. *P. alaskanum* Imlay, n. sp	--	--	--	--	--	--	×	--	--	--	--	--	--	--
iniskinense Imlay, n. sp	×	--	--	--	--	×	--	×	--	--	×	×	--	×
sp	--	--	--	--	--	--	--	--	--	--	--	--	×	--
Cardioceras (*Cardioceras*) *distans* (Whitfield)	--	×	×	--	--	×	--	--	×	--	--	--	--	--
hyatti Reeside	--	--	--	×	--	--	--	--	--	--	--	--	--	--
cf. *C.* (*C.*) *lilloetense* Reeside	--	×	--	--	--	×	--	--	×	--	--	--	--	--
(*Scarburgiceras*) *martini* Reeside	×	--	--	--	×	×	--	×	×	×	--	--	--	--
(*Scoticardioceras*) *alaskense* Reeside	--	--	--	×	--	--	--	--	×	--	--	--	--	--
cf. *C.* (*S.*) *stella* Arkell	--	--	--	--	--	--	--	--	×	--	--	--	--	--

BIOSTRATIGRAPHIC SUMMARY

NORTHEASTERN ALASKA

In northeastern Alaska east of the Sagavanirktok River, the Upper Jurassic part of the Kingak Shale ranges in thickness from a featheredge to at least 1,800 feet (545 m), is locally absent, and consists mostly of black clay shale interbedded with siltstone and some clay ironstone concretions (Imlay and Detterman, 1973, p. 5–16, figs. 6–9, 11*A*, 11*B*, 12, 14; Detterman and others, 1975, p. 18–20, 44, fig. 7).

On Ignek Mesa and nearby Fire Creek (table 4), the Kingak Shale has furnished *Cardioceras* (*Scarburgiceras*) of early Oxfordian Age. That subgenus on Ignek Mesa occurs 80 feet (24 m) below beds of Early Cretaceous (Valanginian) age and 135 feet (41 m) above the ammonite *Arcticoceras* of late Bathonian Age (Detterman and others, 1975, p. 18, 44; Imlay, 1976, p. 5).

TABLE 3.—*Stratigraphic positions of ammonite occurrences above base of members of the Naknek Formation at Oil Bay and Iniskin Bay, west of Cook Inlet*

	Oil Bay										Iniskin Bay	
	lower sandstone member									Snug Harbor Siltstone Member		
Stratigraphic position above base of members in feet (meters).	50 (15)	98 (30)	150 (45)	253 (77)	525 (159)	595 (180)	660 (200)	660 (200)	660 (200)	10 (3)	200–225 (61–68)	650–680 (197–206)
USGS Mesozoic localities	22418	3043	22426	3044	3045	3046	11056	10988	11055	20723	22450	22449
Buchia concentrica (Sowerby)	--	--	--	--	--	--	--	--	--	×	×	--
sp	--	--	--	--	--	--	--	--	--	--	--	×
Phylloceras iniskinense Imlay, n. sp	--	--	--	--	--	--	×	--	--	--	×	--
Lytoceras sp	×	×	--	--	--	--	--	--	--	×	--	--
Perisphinctes (*Dichotomosphinctes*) cf. *P.* (*D.*) *muhlbachi* Hyatt	--	--	--	--	--	--	--	--	--	--	--	×
Cardioceras (*Cardioceras*) *distans* (Whitfield)	--	--	--	--	×	--	×	--	--	×	--	--
(*C.?*) *spiniferum* Reeside	--	--	--	--	--	×	--	--	--	--	--	--
(*Scarburgiceras*) *martini* Reeside	×	--	×	×	--	--	--	×	×	--	--	--

TABLE 4.—*Geographic distribution of ammonite of late Jurassic age in northeastern Alaska and in the Wrangell Mountains*

[Numbers 1–5 are keyed to locality numbers in fig. 1; higher numbers are USGS Mesozoic locality numbers]

Genus and species	Northeastern Alaska										Wrangell Mountains						
	Kingak Shale (upper part)										Root Glacier Formation						
	1					2			3	4	5						
	21028	22598	24014	29882	24013	21027	29135	29136	29856	29137	14495	14496	14497	28577	28578	28579	28700
Buchia concentrica (Sowerby)	×	×	×	×	×	--	×	×	--	--	×	×	--	×	--	--	--
mosquensis (von Buch)	--	--	--	--	--	--	--	--	--	--	×	×	--	--	--	--	×
rugosa (Fischer)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	×	--
Phylloceras sp	--	--	--	--	--	×	--	--	--	--	--	--	--	--	--	--	--
Partschiceras sp. A	--	--	--	--	×	--	--	--	--	--	--	--	--	--	--	×	--
Cardioceras (*Scarburgiceras*) *dettermani* Imlay, n. sp	--	--	--	--	--	--	--	--	×	×	--	--	--	--	--	--	--
Amoeboceras (*Amoebites*) sp	--	--	×	--	--	--	--	--	--	--	--	--	--	--	--	--	--
(*Amoebites?*) sp	--	--	--	--	--	--	--	--	--	--	--	--	--	×	--	--	--
(*Prionodoceras*) sp. A	--	--	--	--	--	--	--	--	--	--	×	×	--	--	×	--	×
sp. B	--	--	--	--	--	--	--	--	--	--	--	×	×	--	--	--	--
(*P.?*) cf. *A.* (*P.?*) *prorsum* Spath	×	×	--	--	--	--	×	--	--	--	--	--	--	--	--	--	--
A.? sp. A	--	--	--	×	--	--	--	--	--	--	--	--	--	--	--	--	--
sp. B	--	--	--	--	--	--	--	×	--	--	--	--	--	--	--	--	--

In the Canning River area, the Kingak Shale has furnished the late Oxfordian to Kimmeridgian ammonite *Amoeboceras* (*Prionodoceras*) and *A.* (*Amoebites*) in association with the bivalve *Buchia concentrica* (Sowerby). Such mollusks were collected from about 1,040 feet (315 m) of shale exposed on the west side of the river opposite the mouth of Cache Creek (Imlay, 1976, p. 4). The lowermost occurrence (USGS Mesozoic loc. 29135) is about 600 feet (182 m) above beds containing the late middle Bathonian ammonite *Arctocephalites.* The uppermost occurrence (USGS Mesozoic loc. 29136) is about 1,040 feet (315 m) below a fault contact with beds of Bajocian Age.

Other specimens of *Amoeboceras* and *Buchia concentrica* were collected from the upper 50 feet (15 m) of the Kingak Shale exposed on the west side of the Canning River about 9 miles (14.4 km) north of Cache Creek and 2.5 miles (4 km) south of Black Island at USGS Mesozoic locs. 24013, 24014, 21028, 22598, and 29882. No evidence has yet been found of the presence of *Buchia rugosa* (Fischer) in northeastern Alaska east of the east fork of the Shaviovik River, which is about 10 miles (16 km) west of the Canning River, except at Joe Creek near the Canadian border (Detterman and others, 1975, p. 44).

WRANGELL MOUNTAINS

The Root Glacier Formation (Upper Jurassic) has been described by MacKevett (1969, p. A45–A49; 1970; 1971, p. 17, 18) and mentioned briefly by Imlay and Detterman (1973, p. 8, 11). It ranges in thickness from a featheredge to about 3,800 feet (1,151 m), rests disconformably on beds of Pliensbachian to Bathonian Age, is overlain unconformably by beds of Early Cretaceous age, and consists

TABLE 5.—*Geographic distribution of ammonites of Late Jurassic*

[Numbers 6–10 are keyed to locality numbers in fig. 1;

Genus and species	Talkeetna Mountains										
	Naknek Formation										
	6										
	24156	24162	24165	24166	24167	24168	24175	24834	24837	24841	8575
Buchia concentrica (Sowerby)	X	--	X	--	X	--	X	--	--	--	--
Phylloceras alaskanum Imlay, n. sp	X	--	--	--	--	--	--	--	--	--	--
cf. *P. alaskanum* Imlay, n. sp	--	--	--	--	--	--	--	--	--	--	--
iniskinense Imlay, n. sp	--	X	X	--	X	--	--	--	--	--	--
sp	--	--	--	--	--	--	--	--	--	X	X
Holcophylloceras cf. *H. mesolcum* (Dietrich)	--	--	X	--	--	--	--	X	--	--	--
Partschiceras sp. A	--	--	--	--	--	--	--	--	--	--	--
Lytoceras sp	--	--	--	X	--	--	X	--	--	--	--
Perisphinctes (*Dichotomosphinctes*) cf. *P.* (*D.*) *muhlbachi* Hyatt	--	--	--	--	--	--	--	--	--	--	--
Cardioceras (*Cardioceras*) *distans* (Whitfield)	--	--	X	X	--	X	--	--	X	X	--
hyatti Reeside	--	--	--	--	--	--	--	--	--	--	--
lilloetense Reeside	--	--	--	--	--	--	--	--	--	X	--
cf. *C.* (*C.*) *lilloetense* Reeside	--	--	--	--	--	--	--	--	--	--	--
(*C.*?) *spiniferum* Reeside	--	--	--	--	--	--	--	--	--	--	--
(*Scarburgiceras*) *martini* Reeside	--	--	X	X	--	X	--	--	X	X	X
dettermani Imlay, n. sp	--	--	--	--	--	--	--	--	--	--	--
(*Scoticardioceras*) *alaskense* Reeside	--	--	--	--	--	--	--	--	--	--	--
cf. *C.* (*S.*) *stella* Arkell	--	--	--	--	--	--	--	--	--	--	--
sp	--	--	--	--	--	--	--	--	--	--	--

mostly of mudstone and siltstone but includes some shale, graywacke, arenite, conglomerate, and limestone. It has yielded ammonites only in the McCarthy (C–5) Quadrangle.

The exact stratigraphic positions of most of these ammonite fossil localities (table 4) in relation to the base of the Root Glacier Formation is not determinable because of faulting and folding. Nonetheless, Mesozoic loc. 28577 is about 250 feet (76 m) above the base; Mesozoic locs. 14495, 14496, 14497, and 28578 are probably 1,000 to 2,000 feet (303 to 606 m) above the base; and Mesozoic loc. 28579 is about 1,500 feet (454 m) above the base.

Within the McCarthy (C–5) Quadrangle, the lowermost part of the Root Glacier Formation is dated as late Kimmeridgian by the association of *Amoeboceras* (*Amoebites*?) with *Buchia concentrica* (Sowerby) at USGS Mesozoic loc. 28577. A slightly younger late Kimmeridgian Age is shown by the association of *Amoeboceras* (*Prionodoceras*) with *Buchia mosquensis* (von Buch) and (or) *B. concentrica* (Sowerby) at the other listed localities, which are estimated to be 1,000–2,000 feet (303–606 m) above the base of the formation. In addition, *Buchia rugosa* (Fischer) been found with the ammonite *Partschiceras* about 1,500 feet (455 m) above

TABLE 6.—*Geographic distribution of ammonites of Late Jurassic age in the Alaska Peninsula*

[Numbers 11–21 are keyed to locality numbers in fig. 1; higher numbers are USGS Mesozoic locality numbers]

Genus and species	Naknek Formation																		Staniukovich Formation (lower part)	Naknek Formation								
	Kamishak Bay					Mt. Katmai area							Mt. Peulik-Puale Bay area						Sutwik Island (D–4) Quadrangle	Aniakchak Crater Gates	Chignik Bay						
	11					12	13		14	15	16		17	18					19	20	21						
	3096	25832	25833	29253	29899	26003	29254	29255	10249	12077	3124	3128	3136	10795	10796	10798	10817	11345	31492	11359	25708	25709	25710	5799a	25712	25713	25715
Buchia concentrica (Sowerby)	--	--	--	--	X	--	--	--	--	--	--	--	X	X	--	--	X	X	------	------	X	--	X	--	--	X	X
rugosa (Fischer)	--	X	X	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	------	------	--	--	--	--	--	--	--
mosquensis (von Buch)	--	X	X	X	--	--	X	--	--	--	--	--	--	--	--	--	--	X	------	------	--	--	--	--	--	--	--
Phylloceras alaskanum Imlay, n. sp	--	X	X	--	X	X	--	--	X	X	X	--	--	X	X	--	X	X	------	------	X	X	X	X	X	X	X
iniskinense Imlay. n. sp	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--	------	------	--	--	--	--	--	--	--
cf. *P. knoxvillense* Stanton	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	------	--	--	--	--	--	--	--
Partschiceras sp. A	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	------	------	--	--	--	--	--	--	--
sp. B	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	------	X	--	--	--	--	--	--	--
Lytoceras sp	X	--	X	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--	------	------	--	--	--	--	--	--	--
Cardioceras (*Vertebriceras*) *whiteavesi* Reeside	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	------	------	--	--	--	--	--	--	--
Perisphinctes (*Dichotomisphinctes*) cf. *P.* (*D.*) *muhlbachi* (Hyatt)	--	--	--	--	X	--	--	--	--	--	--	--	--	--	X	--	--	--	------	------	--	--	--	--	--	--	--
Aulacosphinctoides sp	--	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	------	------	--	--	--	--	--	--	--
Subplanites? sp	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	--	------	------	--	--	--	--	--	--	--

age in the Talkeetna Mountains and west of Cook Inlet

higher numbers are USGS Mesozoic locality numbers]

West side of Cook Inlet																													
Naknek Formation—Continued																													
7	8														9														10
22701	11002	11013	11015	11016	11017	11018	21350	21351	21352	21782	21783	21784	21785	21786	3041	3043	3044	3045	3046	10988	11050a	11055	11056	20723	22418	22426	22449	22450	30764
--	--	--	--	--	--	--	--	--	X	--	--	X	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	X	--
--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	X	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	X	--	X	--	X	X	X	--	--	X	--	--	--	--	--	--	--	--	X	--	--	--	--	X	--
--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X
--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--	X	X	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--
--	X	X	--	--	X	--	--	X	--	--	--	--	--	--	--	--	--	X	--	--	--	--	X	X	--	--	--	--	--
--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
--	X	--	--	--	X	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	--
X	--	--	--	X	X	--	X	X	--	X	--	X	--	--	X	--	X	--	--	X	--	X	--	--	X	X	--	--	--
--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--	--
--	--	--	X	--	--	--	--	X	--	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
X	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

the base of the formation (USGS Mesozoic loc. 28579). Still younger beds of latest Kimmeridgian to early Tithonian Age are indicated by the presence of *Buchia rugosa* (Fischer) without ammonites at many localities that appear to be higher stratigraphically than those containing *Amoeboceras*. Such localities are indicated on the geologic map of the McCarthy (C–5) Quadrangle (MacKevett, 1970) by the numbers 65, 66, 69, 71, 72, 77, 81, and 84.

The occurrences of *Buchia mosquensis* with *Amoeboceras* needs checking in the field because *B. mosquensis* has the same time range as *B. rugosa* and neither has been found elsewhere in association with *Amoeboceras*. Both occur directly above or in younger beds than *Amoeboceras* and are associated basally with the highest occurrence of *B. concentrica*. As most of the fossil collections from the Root Glacier Formation were made on fairly steep slopes, the specimens of *Buchia mosquensis* collected with *Amoeboceras* may actually be float washed down from higher beds.

TALKEETNA MOUNTAINS

The Upper Jurassic in the Talkeetna Mountains is best exposed along the Little Nelchina River and its tributaries in the Talkeetna Mountains (A–1) and (A–2) Quadrangles. It is reported to be at least 2,000 feet (606m) thick and to consist of two units. The lower unit is considerably thicker than the upper unit, consists mostly of gray siltstone and shale that contain limestone concretions, locally includes cobble and boulder conglomerate at its base, as well as at higher levels, and locally in its upper part includes a lenticular unit consisting of sandstone, siltstone, and some coquinoid beds. The upper unit rests conformably on the lower unit, consists of sandstone and siltstone that are interbedded with shelly and glauconitic beds, and is overlain unconformably by beds of Valanginian Age (Grantz, 1960a, b).

An early to early middle Oxfordian Age for the basal and most of the lower third of the main siltstone and shale unit is demonstrated by the presence of *Cardioceras* (table 5) at many localities (USGS Mesozoic locs. 24165, 24166, 24168, 24837). A slightly younger age for part of the lower third is indicated by the presence of *Buchia concentrica* (Sowerby) at several localities. The middle and upper thirds of the main siltstone and shale unit are definitely dated as late middle to late Oxfordian by the presence of *Buchia concentrica* (Sowerby) in place in the middle third (USGS Mesozoic loc. 24175) and *Phylloceras iniskinense* Imlay, n. sp., near the top of the unit (USGS Mesozoic loc. 24162). The association of *Phylloceras alaskanum* Imlay, n. sp., with *Buchia concentrica* (Sowerby) at USGS Mesozoic loc. 24156 favors a Kimmeridgian Age younger than the beds containing *Phylloceras iniskinense* Imlay, n. sp., in association with *B. concentrica*.

TUXEDNI BAY-INISKIN BAY AREA

The Naknek Formation exposed on the west side of Cook Inlet between Tuxedni Bay and Iniskin Bay has been described in detail by Detterman and Hartsock (1966, p. 47–55) and was divided by them into four members. The Chisik Conglomerate Member at the base is found on Chisik Island and on the north side of Iniskin Bay, attains a maximum thickness of 560 feet (170 m), and is unfossiliferous. The overlying unnamed lower sandstone member interfingers with the Chisik, attains a thickness of 860 feet (261 m), contains an assemblage of bivalves, ammonites, belemnites, gastropods, and echinoids, and is characterized by the ammonite *Cardioceras*. The next higher Snug Harbor Siltstone Member ranges from 720 to 860 feet (218 to 261 m) in thickness, consists mostly of dark siltstone, contains an assemblage of bivalves, ammonites, and belemnites, and is characterized by *Phylloceras iniskinense* Imlay, n. sp., in association with *Buchia concentrica* (Sowerby). The Pomeroy Arkose Member at the top of the Naknek Formation ranges in thickness from 800 to 3,300 feet (242 to 1,000 m) and contains many siltstone beds, of which some bear the bivalve *Buchia concentrica* (Sowerby).

The unnamed lower sandstone member of the Naknek Formation exposed between Tuxedni Bay and Iniskin Bay west of Cook Inlet is characterized faunally by the presence of the ammonites *Cardioceras* and *Phylloceras* (tables 2, 3). *Cardioceras* (*Scarburgiceras*) *martini* Reeside occurs throughout the lower 450 feet (136 m) of the member on the south side of Chinitna Bay and the lower 660 feet (200 m) on the north side of Iniskin Bay. *C.* (*C.*) *distans* (Whitfield) occurs 200–400 feet (60–121 m) above the base of the member at Chinitna Bay and 525–660 feet (159–200 m) above the base at Oil Bay. *C.* (*Scoticardioceras*) *alaskense* Reeside and *C.* cf. *C. lilloetense* Reeside have ranges similar to that of *C. distans* but are less common. *Phylloceras iniskinense* Imlay, n. sp., ranges throughout the member and is associated with *Cardioceras* at three localities. In addition, the bivalve *Buchia concentrica* (Sowerby) was collected with *Cardioceras martini* 450 feet (136 m) above the base of the member at Oil Bay at USGS Mesozoic loc. 21784.

This association of *Buchia* with *Cardioceras* needs checking in the field because outside southern Alaska, the two taxa have never been found associated in the same bed, and the next higher occurrence of *Buchia* on the Iniskin Peninsula is in the overlying Snug Harbor Siltstone Member, about 410 feet (124 m) higher. Therefore, the specimen of *Buchia concentrica* in question may have been washed down from higher beds exposed in nearby cliffs.

The Snug Harbor Siltstone Member exposed on the Iniskin Peninsula west of Cook Inlet is characterized faunally by the presence of *Phylloceras*, *Perisphinctes* (*Dichotomosphinctes*), and *Cardioceras* (tables 2, 3). Of these, *Phylloceras iniskinense* Imlay, n. sp., occurs about 600 feet (181 m) above the base of the member at Chinitna Bay and 200–225 feet (61–68 m) above the base at Iniskin Bay. *Perisphinctes* (*Dichotomosphinctes*) is found 675 feet (205 m) above the base and 40 feet (12 m) below the top of the member at Iniskin Bay. *Cardioceras distans* (Whitfield) occurs at the very base of the member on the west shore of Oil Bay just above sandstone beds in which *Cardioceras* is common at USGS Mesozoic locs. 10988 and 11055. In addition, the bivalve *Buchia concentrica* (Sowerby) is found throughout the member but is most common in its upper 250 feet (76 m).

The next higher Pomeroy Arkose Member of the Naknek Formation contains *Buchia concentrica* at various levels in its lower part and *B.* cf. *B. concentrica* about 113 feet (34 m) below its top.

ALASKA PENINSULA

Upper Jurassic beds on the Alaska Peninsula are fairly continuous as far south as the Port Moller area and are divided into two formations. Their characteristics in local areas have been described by many geologists (Atwood, 1911, p. 33–38; Capps, 1923, p. 101–103; Keller and Reiser, 1959, p. 269–273; Mather, 1925, p. 168–171; Paige, 1906, p. 101–108; Smith, 1925, p. 198–201; Smith and Baker, 1924, p. 178–184; Knappen, 1929, p. 182–189). Their overall characteristics throughout the peninsula have been summarized by Martin (1926, p. 203–218), described in more detail on the basis of field studies by Burk (1965, p. 29–44, figs. 7–9), and briefly depicted by Imlay and Detterman (1973, p. 8, 9, fig. 11A).

The Naknek Formation on the peninsula comprises the lower part of the Upper Jurassic beds, ranges in thickness from 2,500 to 10,000 feet (758 to 3,030 m), and consists mostly of arkosic sandstone, dark siltstone, and conglomerate. From Kamishak Bay southward, the Naknek consists of three major units. At the base is a conglomerate that is overlain and intertongues laterally with interbedded arkosic sandstone and siltstone. Those beds are overlain conformably by a thick mass of dark siltstone interbedded with some fine-grained sandstone and locally with conglomerate. From Chignik Bay to Port Moller, the Naknek Formation consists of all these lithologic units, but most exposures represent the upper siltstone.

The Naknek Formation on the Alaska Peninsula is characterized faunally (table 6) by the ammonite

Phylloceras alaskanum Imlay, n. sp., in association with the bivalve *Buchia concentrica* (Sowerby) or with *Buchia mosquensis* (von Buch) and *B. rugosa* (Fischer). *P. alaskanum* also occurs at one locality with the ammonite *Aulacosphinctoides* and at two localities with the ammonite *Perisphinctes* (*Dichotomosphinctes*). It has not been found in association with *Cardioceras* or with *Phylloceras iniskinense* Imlay, n. sp., both of which are represented by single specimens on the peninsula.

The presence of these ammonites (fig. 12), as discussed in the sections on Ages and Correlations, shows that the Naknek Formation on the peninsula ranges in age from early Oxfordian to early Tithonian but that the basal part of the formation at most places is younger than Oxfordian. For example, in the Katmai area, *Buchia rugosa* and *B. mosquensis* of latest Kimmeridgian to early Tithonian Age occur in siltstone overlying 80 feet (24 m) of marine conglomerate at the base of the Naknek Formation, which is about 10,000 feet (3,030 m) thick (Keller and Reiser, 1959, p. 271, 272). These basal beds should be younger than most of the fossiliferous beds near Mt. Peulik that contain *Cardioceras* of early to early middle Oxfordian Age, *Dichotomosphinctes* of late middle to late Oxfordian Age, and an association of *Phylloceras alaskanum* with *Buchia concentrica*, which should be of early to middle Kimmeridgian Age. The basal beds could be of the same age as the beds near Mt. Peulik that have furnished *Phylloceras alaskanum* in association with *Buchia concentrica* (USGS Mesozoic loc. 11343).

The Staniukovich Formation constitutes the upper part of the Upper Jurassic beds from Wide Bay southward to the Port Moller area, attains a maximum thickness of about 2,000 feet (606 m), consists of siltstone and fine- to medium-grained sandstone, and intertongues basally with the Naknek Formation. It differs from the Naknek Formation by being uniform lithologically and by weathering tan to yellowish brown. It contains an abundance of *Buchia piochii* (Gabb) of late Tithonian Age, locally contains *B. mosquensis* and *B. rugosa* of late Kimmeridgian to early Tithonian Age, and in its upper part contains *B. crassicollis* of Valanginian Age (Burk, 1965, p. 35, 42–44, 219).

AGES AND CORRELATIONS

Upper Jurassic beds of Oxfordian to Tithonian Age in Alaska are dated (figs. 11, 12) partly by the succession of species of the bivalve *Buchia* and partly by the sucession of genera and subgenera of ammonites (Imlay and Detterman, 1973, p. 10–13, 19, 21). The genus *Buchia* in Alaska occurs throughout the Upper Jurassic beds entirely or almost entirely above those containing *Cardioceras* of early to early middle Oxfordian Age and comprises six species that represent three distinct *Buchia* zones. These zones, from bottom to top, are characterized by (1) *Buchia concentrica* (Sowerby), (2) *B. mosquensis* (von Buch) and *B. rugosa* (Fischer), and (3) *B. piochii* (Gabb), *B. fischeriana* (d'Orbigny), and *B. unschensis* (Pavlow).

This *Buchia* succession is similar to that found in western Canada, East Greenland, parts of northern Eurasia, the Pacific Coast region of North America as far south as Baja California, and in part even in north-central Mexico (Imlay 1955, 1959, 1965, 1980; Imlay and Jones, 1970; Jones, Bailey, and Imlay, 1969; Frebold, 1964). This similarity, coupled with the age evidence furnished by associated ammonites, permits fairly accurate correlations with some of the standard ammonite zones of northwest Europe through northern Canada (Frebold and Tipper, 1970, p. 13–17; Jeletzky, 1966) and East Greenland (Donovan, 1957, p. 136–142) and with the ammonite zones of the Mediterranean region through California and Mexico.

Late Jurassic ammonites in Alaska are fairly common in beds of Oxfordian to early late Kimmeridgian Age. They are much less common in younger beds that contain *Buchia mosquensis* (von Buch) of late Kimmeridgian to early Tithonian Age. They are rare in the uppermost Jurassic beds that contain *B. piochii* (Gabb) and *B.* cf. *B. fischeriana* (d'Orbigny) of late Tithonian Age.

EARLY TO EARLY MIDDLE OXFORDIAN

Early to early middle Oxfordian ammonites belonging to *Cardioceras* and its subgenera have been found in northern Alaska only in Ignek Valley (Imlay and Detterman, 1973, p. 25). In southern Alaska, such taxa have been found mainly in the Talkeetna Mountains and west of Cook Inlet between Tuxedni Bay and Iniskin Bay, but they are represented also on the Alaska Peninsula by one specimen found 5 miles (8 km) southeast of Mt. Peulik and 16 miles (26 km) north-northwest of the northeastern end of Wide Bay.

The earliest Oxfordian is represented by the subgenus *Cardioceras* (*Scarburgiceras*) in the Ignek Valley in northern Alaska, in the Talkeetna Mountains in southern Alaska, and west of Cook Inlet between Tuxedni Bay and Iniskin Bay. That subgenus in Europe is common in the *Quenstedtoceras mariae* zone and is rare in the lower third of the next higher *Cardioceras cordatum* zone. Typical species in Alaska include *C.* (*S.*) *martini* Reeside and *C.* (*S.*) *dettermani* Imlay.

The next younger beds of early to early middle Oxfordian Age in Alaska are characterized by *Cardioceras* sensu strictu and its subgenus *Scoticardioceras*. Of them, *Cardioceras* sensu strictu in Europe ranges through the *Cardioceras cordatum* zone and the lower part of the next younger *Perisphinctes plicatilis* zone. *Scoticardioceras* ranges through the upper third of the *Cardioceras cordatum* zone and all of the *Perisphinctes plicatilis* zone (fig. 12). The overlap of the ranges of these taxa is apparently reflected in Alaska by the association of *Cardioceras* sensu strictu with *Cardioceras* (*Scarburgiceras*) *martini* Reeside at three localities west of Cook Inlet (USGS Mesozoic locs. 3041 float, 11017, 21351) and at five localities in the Talkeetna Mountains (USGS Mesozoic locs. 24165, 24166, 24168, 24837, 24841).

All beds west of Cook Inlet and in the Talkeetna Mountains that contain many specimens of *Cardioceras* also contain specimens of *Phylloceras iniskinense* Imlay, n. sp., at many localities. That species, however, ranges higher into beds containing abundant *Buchia concentrica* (Sowerby), apparently occurs throughout all of the Oxfordian beds, and has never been found associated with *Phylloceras alaskanum* Imlay, n. sp.

Cardioceras has also been collected with *Buchia concentrica* (Sowerby) in the Talkeetna Mountains at USGS Mesozoic loc. 24165, whose stratigraphic position is unknown. On the Iniskin Peninsula, those taxa are associated at USGS Mesozoic loc. 21784, which is about 450 feet (136 m) above the base of the unnamed lower sandstone member of the Naknek Formation, and at USGS Mesozoic loc. 20723, which is in the basal part of the overlying Snug Harbor Siltstone Member.

As *Cardioceras* has never been reported in association with *Buchia concentrica* elsewhere in the world, their association at these three localities means that the fossils were collected from different stratigraphic levels, or that the taxa have slightly different ranges in Alaska from those reported elsewhere, or that some specimens are float-derived from nearly cliffs.

LATE MIDDLE OXFORDIAN TO EARLY LATE KIMMERIDGIAN

Directly overlying the *Cardioceras*-bearing beds in northeastern Alaska and in the Wrangell Mountains are beds characterized by *Amoeboceras* (*Prionodoceras*) and *A.* (*Amoebites*) in association with the bivalve *Buchia concentrica* (Sowerby) or locally in the Wrangell Mountains, in association with both *B. concentrica* and *B. mosquensis* (von Buch). These fossils in association are good evidence of an age ranging from middle Oxfordian to early late Kimmeridgian.

Directly overlying the *Cardioceras*-bearing beds in the Talkeetna Mountains are beds characterized by *Phylloceras iniskinense* Imlay, n. sp., in association with the bivalve *Buchia concentrica* (Sowerby). Still higher beds contain *Buchia concentrica* (Sowerby) associated with *Phylloceras alaskanum* Imlay, n. sp. These beds, on the basis of their stratigraphic position above *Cardioceras* and the presence of *Buchia concentrica*, must likewise be of middle Oxfordian to early late Kimmeridgian Age.

On the Iniskin Peninsula west of Cook Inlet, the Snug Harbor Siltstone Member above the *Cardioceras*-bearing beds is dated as late middle Oxfordian to late Oxfordian by its stratigraphic position, by the presence of *Buchia concentrica* (Sowerby) and *Dichotomosphinctes*, and by the absence of *Buchia mosquensis* (von Buch) and *B. rugosa* (Fischer). Similarly, the overlying Pomeroy Arkose Member is dated as probably early Kimmeridgian on the basis of stratigraphic position and the presence of *B. concentrica*.

On the Alaska Peninsula, the ammonite sequence directly overlying or slightly younger than the *Cardioceras*-bearing beds is characterized by the same two species of *Phylloceras* that occur in the Talkeetna Mountains and in the Iniskin Peninsula west of Cook Inlet. It also contains the same species of *Perisphinctes* (*Dichotomosphinctes*) (USGS Mesozoic locs. 10796 and 29899) that is found in the Iniskin Peninsula. The sequence differs mainly by having only one occurrence of *Phylloceras iniskinense* Imlay, n. sp., by having many occurrences of *P. alaskanum* Imlay, n. sp., and by the fact that *Dichotomosphinctes* at USGS Mesozoic loc. 10796 is associated with *Phylloceras alaskanum* instead of with *P. iniskinense*. In addition, in the peninsula, *Buchia concentrica* (Sowerby) is common in the lower part of the range of *Phylloceras alaskanum* and is associated with *Dichotomosphinctes* at USGS Mesozoic loc. 29899.

Of the ammonites listed, *Amoeboceras* and its subgenus *Prionodoceras* are boreal in origin and in northwest Europe range from the *Gregoryceras transversarium* zone to the *Rasenia mutabilis* zone inclusive (that is, upper middle Oxfordian to lower upper Kimmeridgian). *Amoebites* ranges from the

Pictonia bayleyi zone to the *Rasenia mutabilis* zone. The subgenus *P.* (*Dichotomosphinctes*) is characteristic of the Mediterranean region, is also common in Cuba and the Gulf of Mexico region, and ranges through the middle and upper Oxfordian. It has also been found in the upper Oxfordian of California associated with *Buchia concentrica* (Imlay, 1961, D13, D14, D18). *Phylloceras alaskanum* Imlay, n. sp., judging by associated genera of ammonites, by associated species of *Buchia,* and by stratigraphic occurrences, ranges from the upper Kimmeridgian into the lower part of the upper Tithonian. (For further details concerning the ranges of *Prionodoceras, Amoeboceras,* and *Dichotomosphinctes* (fig. 11), see Enay, Tintant, and Cariou, 1971, p. 635, 661; Cariou, Enay, and Tintant, 1971; and Callomon, 1964, p. 286–288.)

LATEST KIMMERIDGIAN AND EARLY TITHONIAN

Beds characterized by *Buchia rugosa* (Fischer) and *B. mosquensis* (von Buch) are widespread in northern, southeastern, southern, and southwestern Alaska and on the Alaska Peninsula but are absent on the west side of Cook Inlet between Tuxedni Bay and Iniskin Bay (Imlay and Detterman, 1973, p. 10–13, 26, 27).

These species on the basis of available collections have been found rarely with ammonites except in the Alaska Peninsula and in the Wrangell Mountains. Such ammonites in the Alaska Peninsula include many specimens of *Phylloceras alaskanum* Imlay, n. sp., at many localities, one specimen of *Aulacosphinctoides,* and the larger outer whorl of an ammonite herein assigned questionably to *Suplanites.*

The beds in Alaska that contain *Buchia mosquensis* and *B. rugosa* in association are dated as latest Kimmeridgian to early Tithonian by their stratigraphic position above *Amoeboceras* (*Amoebites*) of early to early middle Kimmeridgian Age and below *Buchia piochii* (Gabb), which species is associated with ammonites of late Tithonian Age in California (Imlay, 1961, D5, D8; Imlay and Jones, 1970, p. B11, B12) and in Arctic Canada (Jeletzky, 1965, 1966). This dating of *B. mosquensis* and *B. rugosa* (USGS Mesozoic loc. 29254) is substantiated by the presence of *Aulacosphinctoides,* a Mediterranean genus of early Tithonian Age, which elsewhere in North America has been found only in Mexico (Imlay, 1939, p. 22, 27–30, 38, 39, tables 7 and 10; Burckhardt, 1906, p. 147–149; 1930, p. 68–71). This dating is also substantiated by the presence in the Alaska Peninsula of a fairly large ammonite that has virgatomous ribbing as in the subfamily Virgatosphinctinae. Within that subfamily, this ammonite shows some resemblance to *Subplanites,* a genus of early Tithonian Age, which in North America has been found in Mexico (Burckhardt, 1906, p. 112, pl. 32, fig. 1; Imlay, 1943, p. 533, pl. 91, fig. 1) and in Cuba (Judoley and Bermudez, 1968, p. 5, 23, 109, pl. 64, fig. 1, pl. 67, fig. 1, and pl. 68). This dating is substantiated by the known ranges of *Buchia mosquensis* and *B. rugosa* in Eurasia (Spath, 1936, p. 166, 167) and elsewhere in North America (Imlay, 1955, p. 74, 75, 85).

Thus, the highest occurrences of *Buchia mosquensis* (Von Buch) in Alaska could be of early late Tithonian Age on the basis of the occurrence of that species in Mexico in beds containing *Kossmatia* and *Durangites* (Burckhardt, 1912, p. 206, 221, 236), which are correlated with the European zone of *Zaraiskites albani.* Likewise, in Milne Land, East Greenland, *Buchia mosquensis* occurs with *B. rugosa* (Fischer) in the upper part of the Glauconitic Series (Spath, 1936, p. 156, 157, 162–167, pl. 2, figs. 1a–g, 2a, b) associated with such ammonites as *Pavlovia* and *Dorsoplanites* of latest early Tithonian Age and *Glaucolithites* of early late Tithonian Age (Arkell, 1956, p. 524; Donovan, 1957, p. 140–142). These genera are definitely characteristic of the middle Volgian of the Russia Platform. Evidently, both species of *Buchia* first appeared in late Kimmeridgian time. *B. mosquensis* survived until early late Tithonian time, and *B. rugosa* survived at least during all of early Tithonian time. The latest survival time of either species in Alaska needs confirmation based on associated ammonites or other age-diagnostic fossils.

LATE TITHONIAN

The uppermost Jurassic beds in Alaska are characterized by *Buchia piochii* (Gabb), *B. fischeriana* (d'Orbigny), and *B. unschensis* (Pavlow). *B.* cf. *B. fisheriana* occurs on the middle fork of the Okpikruak River in north-central Alaska. *B. unschensis* occurs on Kemik Creek near the Shaviovik River in northeastern Alaska as well as about 100 miles (160 km) farther east on Joe Creek near the Canadian border (Imlay and Detterman, 1973, p. 27). *B. fischeriana* occurs on Joe Creek in northeastern Alaska (Detterman and others, 1975, p. 20), as well as in the Nabesna area in the southeastern part of the main body of Alaska (Imlay and Detterman, 1973, p. 27). *B. piochii* occurs in the southern part of the Alaska Peninsula nearly as far north as Wide Bay. These species of *Buchia* in Alaska have not been found with ammonites except for one occurrence of a poorly preserved *Phylloceras* on the Alaska Peninsula a little north of Amber Bay. That ammonite is herein compared with *P. knoxvillensis* Stanton.

Outside Alaska, in arctic Canada, *B. piochii* ranges throughout most of the beds assigned to the upper Tithonian, *B. fischeriana* (d'Orbigny) ranges through the upper half of the range of *B. piochii,* and *B. unschensis* ranges through the upper two-thirds of the range of *B. fischeriana* (Jeletzky, 1965, figs. 1, 2; 1966, p. 25–43), in association with the ammonite *Craspedites* of latest Tithonian Age. In British Columbia, *B. fischeriana* is recorded directly above *B. piochii* (Frebold and Tipper, 1970, table 1 on p. 17; Jeletzky, 1965, fig. 2). In California, *B. fischeriana* is recorded from the upper part of the range of *B. piochii,* and both are overlain by uppermost Tithonian beds containing *B.* cf. *B. okensis* (Imlay and Jones, 1970).

On the basis of these fossil records in arctic Canada, British Columbia, and California, the latest Tithonian is represented at least locally in north-central and northeastern Alaska, in the eastern part of the Alaska Range in eastern Alaska, and in the southern part of the Alaska Peninsula. In some places, however, the Upper Jurassic beds are overlain unconformably by beds of Valanginian Age. For example, in the Talkeetna Mountains, beds of Valanginian Age rest unconformably on beds containing *Buchia mosquensis* and *B. rugosa.*

AMMONITE FAUNAL SETTING

The Late Jurassic ammonite genera in Alaska are of diverse geographic origin. Ammonites characteristic of the Boreal Realm include *Cardioceras* and *Amoeboceras* and their subgenera. Ammonites characteristic of the Tethyan and Pacific Realms include *Perisphinctes* (*Dichotomosphinctes*), *Subplanites*?, *Aulacosphinctoides, Phylloceras,* and *Lytoceras.* All these taxa except *Cardioceras* are associated with the bivalve *Buchia,* a genus that thrived on hard bottoms in shallow waters (Imlay, 1959, p. 156) and is particularly common in the Boreal Realm.

Of these ammonites, the genus *Cardioceras* of early to early middle Oxfordian Age is common west of Cook Inlet and in the Talkeetna Mountains but is represented elsewhere in Alaska by only one specimen from the Mt. Peulik area on the Alaska Peninsula and by a few specimens from northern Alaska. It has been found with *Phylloceras iniskinense* Imlay, n. sp., only in the Talkeetna Mountains and west of Cook Inlet. Apparently *Cardioceras* in the Cook Inlet region lived in a shallow to fairly shallow sea, as shown by its occurrence in thin-bedded sandstone and siltstone in association with many bivalves, some echinoids, and some belemnites. Its association with *Phylloceras iniskinense* in the western part of southern Alaska shows that it lived in a sea that was connected with or bordered the Pacific Ocean.

The next younger beds in Alaska are characterized by *Buchia concentrica* (Sowerby) in association with the ammonite *Amoeboceras* in northeastern Alaska and in the Wrangell Mountains but in association with certain species of *Phylloceras* from the Talkeetna Mountains southward to Chignik Bay on the Alaska Peninsula. The age of these two ammonite faunules, as discussed herein in detail, is based on their stratigraphic position, on their association with *Buchia concentrica,* and on the presence of the ammonite *Perisphinctes* (*Dichotomosphinctes*) of middle to late Oxfordian Age both in the upper part of the range of *Phylloceras iniskinense* Imlay, n. sp., and near the base of the range of *Phylloceras alaskanum* Imlay, n. sp.

Evidently two fairly different ammonite faunules existed in Alaska from late middle Oxfordian to early late Kimmeridgian time. The faunule characterized by *Amoeboceras* came into Alaska from the north and is of boreal origin. The faunule characterized by certain species of *Phylloceras* came into Alaska from the Pacific Ocean but includes *Dichotomosphinctes,* which is common in both the Tethyan and Pacific Realms.

The next younger beds in Alaska are characterized by the presence of *Buchia rugosa* and *B. mosquensis* but have furnished few ammonites, except on Alaska Peninsula where *Phylloceras alaskanum* and *Lytoceras* are fairly common, *Subplanites?* and *Aulacosphinctoides* of Tethyan affinities are represented by single specimens, and many genera of bivalves are present. In contrast, equivalent beds elsewhere in Alaska contain a scant bivalve fauna other than the genus *Buchia* and very few ammonites. For example, in northeastern Alaska, only one ammonite, a specimen of *Phylloceras* (Imlay, 1955, p. 87, pl. 10, fig. 20), has been found with *Buchia rugosa* (USGS Mesozoic loc. 21027). In the Wrangell Mountains only one ammonite, herein described as *Partschiceras* sp. A. (pl. 6, figs. 2–7), has been found with *B. rugosa* (USGS Mesozoic loc. 28579). Evidently the marine environment throughout most of Alaska was unfavorable for ammonites during latest Kimmeridgian and early Tithonian time but remained favorable in the area of the Alaska Peninsula. Presumably, the seas throughout most of Alaska were becoming too muddy or too shallow, and sedimentation was too rapid for ammonites and most bivalves other than *Buchia* to thrive.

These conditions persisted and spread during late Tithonian time throughout most of Alaska. Such is indicated by the fact that only one ammonite (*Cardioceras* (*Vertebriceras*) *whiteavesi Reeside*) of that age is present in the U.S. Geological Survey fossil collections, and that ammonite (pl. 7, figs. 4–6) was obtained a little north of Amber Bay near the middle of the Alaska Peninsula. Evidently the late Tithonian seas in Alaska gradually became more restricted, shallower, and less favorable environmentally for ammonites, even though the bivalve *Buchia* continued to flourish.

GEOGRAPHIC DISTRIBUTION

The geographic occurrences of the Late Jurassic ammonites described herein are shown in figures 1–10 and tables 2–6. Detailed descriptions of the occurrences are given in table 7.

TABLE 7.—*Description of Upper Jurassic ammonite localities in Alaska*

Locality No. (fig. 1)	USGS Mesozoic loc. No.	Collector's field No.	Collector, year of collection, description of locality, stratigraphic assignment, and age
1	21028	47AGr239	George Gryc, 1947. West bank of Canning River, 4 km south of Black Island, lat 69°30′45″ N., long 146°18′45″ W., SE. cor. sec. 19, T. 2 N., R. 24 E., Mt. Michelson Quadrangle. Black shale with limestone interbeds near top of Kingak Shale. Late Oxfordian to early Kimmeridgian.
1	22598	50AGr31	George Gryc, R. W. Imlay, and A. N. Kover, 1950. West bank of Canning River at same place as USGS Mesozoic loc. 21028. Kingak Shale about 61 m below top. Late Oxfordian to early Kimmeridgian.
1	24014	52AMo50	R. H. Morris, 1952. Cutbank on west side of Canning River, lat 69°32′ N., long 146°18′ W., near boundary of secs. 19 and 20, T. 2 N., R. 24 E., Mt. Michelson Quadrangle. Kingak Shale about 15 m below top. Late Oxfordian to early Kimmeridgian.
1	29882	70ADt231A	R. L. Detterman, 1970. West bank of Canning River, 5.4 km S. 10° W. of mouth of Ignek Creek, lat 69°30′45″ N., long 146°19′30″ W., Mt. Michelson Quadrangle. Shale containing clay ironstone concretions about 15 m below top of Kingak Shale. Late Oxfordian to early Kimmeridgian.
1	24013	52AMo48	R. H. Morris, 1952. Cutbank on west side of Canning River, lat 69°30′45″ N., long 146°18′45″ W., Mt. Michelson Quadrangle. Black fissile shale containing limestone concretions about 15 m below top of Kingak Shale. Late Oxfordian to early Kimmeridgian.
2	21027	47AGr8	George Gryc, 1947. East Fork of Shaviovik River about 16 km west of mouth of Cache Creek at Canning River, lat 69°22′ N., long 146°32′ W., Mt. Michelson Quadrangle. Black shale containing limestone concretions and beds of ironstone and some limestone. Kingak Shale, isolated outcrop. Latest Kimmeridgian or early Tithonian.
2	29135	Ag 882	British Petroleum Alaska (Inc.), 1964. Canning River near Shublik Island and about 1.6 km west of mouth of Cache Creek, lat 69°24′ N., long 146°10′ W., SE. cor. T. 1 N., R. 24 T., Mt. Michelson Quadrangle, Kingak Shale. Late Oxfordian to early Kimmeridgian.
2	29136	Ag 887	British Petroleum Alaska (Inc.) 1964. At same place as USGS Mesozoic loc. 29135. Kingak Shale. Late Oxfordian to early Kimmeridgian.
3	29856	69ADt40	R. L. Detterman, 1969. Ignek Mesa in Ignek Valley, 11 km S. 75° E. of Katakturuk Canyon, lat 69°33′30″ N., long 145°20′ W., east-central part of sec. 6, T. 2 N., R. 28 E., Mt. Michelson Quadrangle. Fossils from concentrations in black silty clay shale of Kingak Shale about 24 m below top. Early Oxfordian.
4	29137	AG 26	British Petroleum Alaska (Inc.), 1964. About 0.5 km south of Fire Creek in NW. cor. NE¼ sec. 13, T. 2 N., R. 28 E., Mt. Michelson Quadrangle, Kingak Shale. Early Oxfordian.
5	14495	28AMF32	F. H. Moffit, 1928. 0.8 km east of McCarthy Creek on mountain slope south of second tributary north of Dimond Creek, sec. 31, T. 3 S., R. 15 E., McCarthy (C–5) Quadrangle, Wrangell Mountains, southern Alaska. Root Glacier Formation. Dark-gray shale, probably 305–610 m above base of formation. Late Kimmeridgian.
5	14496	28AMF33	Do.

TABLE 7.—*Description of Upper Jurassic ammonite localities in Alaska*—Continued

Locality No. (fig. 1)	USGS Mesozoic loc. No.	Collector's field No.	Collector, year of collection, description of locality, stratigraphic assignment, and age
5	14497	28AMF34	F. H. Moffitt, 1928. East side of McCarthy Creek at edge of west glacier, probably in SW¼ sec. 13 T. 3 S., R. 14 E., McCarthy (C–5) Quadrangle, Wrangell Mountains, southern Alaska. Root Glacier Formation. Probably same stratigraphic data as Mesozoic loc. 14495. Late Oxfordian to early late Kimmeridgian.
5	28577	61ABC27	M. C. Blake, 1961. On ridge just south of a rock glacier in SE¼ SE¼ sec. 14, T. 3 S., R. 15 E., lat 61°36′15″ N., long 142°37′10″ W., McCarthy (C–5) Quadrangle, Wrangell Mountains, southern Alaska. Root Glacier Formation, about 76 m above the top of the Nizina Mountain Formation. Early Kimmeridgian.
5	28578	61ABC36	M. C. Blake, 1961. Same data as USGS Mesozoic loc. 14495.
5	28579	61–17	D. L. Jones, 1961. About 2.4 km east of McCarthy Creek and 0.8 km north of Lubbe Creek in NE¼ NW¼ sec. 5, T. 4 S., R. 15 E. McCarthy Creek (C–5) Quadrangle, Wrangell Mountains, southern Alaska. Root Glacier Formation, about 457 m above contact with Nizina Mountain Formation. Late Kimmeridgian to early Tithonian.
5	28700	62 AMK51	E. M. Mackevett, Jr., 1962. West of Nizina River and northeast of West Fork in SE¼ SE¼ sec. 19. T. 3 S., R. 16 E., McCarthy (C–5) Quadrangle. Wrangell Mountains, southern Alaska. Root Glacier Formation. Dark-gray sandstone and a few limy beds less than 305 m above contact with Nizina Mountain Formation. Late Kimmeridgian.
6	24156	52AGz116	Arthur Grantz, R. D. Hoare, and R. W. Imlay, 1952. Lat 62°10.0′ N., long 147°22.0′ W., Talkeetna Mountains (A–1) Quadrangle, southern Alaska. Lower(?) third of main siltstone and shale member of Naknek Formation. Early Oxfordian.
6	24162	52AGz136	Arthur Grantz, R. D. Hoare, and R. W. Imlay, 1952. Lat 62°06.3′ N., long 147°36.7′ W., Talkeetna Mountains (A–2) Quadrangle, southern Alaska. Near top of main siltstone and shale member of Naknek Formation. Kimmeridgian to early Tithonian.
6	24165	52AGz146	Arthur Grantz, R. D. Hoare, and R. W. Imlay. Lat 62°09.4′ N., long 147°35.8′ W., south side of Little Nelchina River, Talkeetna Mountains (A–2) Quadrangle, southern Alaska. Lower third of main siltstone and shale member of Naknek Formation. Early Oxfordian.
6	24166	52AGz147	Arthur Grantz, R. D. Hoare, and R. W. Imlay, 1952. Lat 62°07.5′ N., long 147°35.0′ W., on north side of Little Nelchina River, Talkeetna Mountains (A–2) Quadrangle, southern Alaska. Lower third of main siltstone and shale member of Naknek Formation. Early Oxfordian.
6	24167	52AGz149	Arthur Grantz, R. D. Hoare, and R. W. Imlay, 1952. Lat. 62°09.4′ N., long 147°38.6′ W., on north side of Little Nelchina River, Talkeetna Mountains (A–2) Quadrangle, southern Alaska. Lower third of main siltstone and shale member of Naknek Formation. Late middle to late Oxfordian.
6	24168	52AGz163	Arthur Grantz, R. D. Hoare, and R. W. Imlay, 1952. 62°08.5′ N., 147°44.3′ W., Talkeetna Mountains (A–2) Quadrangle, southern Alaska. Near base of main siltstone and shale member of Naknek Formation. Early Oxfordian.
6	24175	52AHr39	R. D. Hoare, 1952. Lat. 62°07.49′ N., long 147°44.7′ W., Talkeetna Mountains (A–2) Quadrangle, southern Alaska. Middle third of main siltstone and shale member of Naknek Formation. *Buchia concentrica* (Sowerby) found in place. Ammonites occur as float derived from higher beds. Late Oxfordian to early Kimmeridgian.
6	24834	53AGz261	Arthur Grantz and L. F. Fay, 1953. Lat 62°07.7′ N., long 147°41.9′ W., Talkeetna Mountains (A–2) Quadrangle, southern Alaska. Float from lower third of main siltstone and shale member of Naknek Formation. Late middle to late Oxfordian.

TABLE 7.—*Description of Upper Jurassic ammonite localities in Alaska*—Continued

Locality No. (fig. 1)	USGS Mesozoic loc. No.	Collector's field No.	Collector, year of collection, description of locality, stratigraphic assignment, and age
6	24837	53AGz272	Arthur Grantz and L. F. Fay, 1953. Lat 67°07.25′ N., long 147°32.7′ W., Talkeetna Mountains (A–2) Quadrangle, southern Alaska. Lower third of main siltstone and shale member of Naknek Formation. Early Oxfordian.
6	24841	53AFy17	L. F. Fay, 1953. Lat 62°06.7′ N., long 147°43.5′ W. and also at a point 46 m farther west, Talkeetna Mountains (A–2) Quadrangle, southern Alaska. Lower third of main siltstone and shale member of Naknek Formation. Early Oxfordian.
6	8575	Martin 24	G. C. Martin, 1913. From concretions on talus across the stream from the lowest outcrop on the creek entering Boulder Creek from the northwest 9 km upstream from mouth of East Boulder Creek, Anchorage (D–3) Quadrangle, Naknek Formation. Early Oxfordian.
7	22701	51AGz123	Arthur Grantz, 1951. South side of Red Glacier, 0.3 km above present terminus, near center of west half of sec. 36, T. 2 S., R. 21 W., Seldovia (D–8) Quadrangle. On Peninsula between Tuxedni Bay and Chinitna Bay west of Cook Inlet. Naknek Formation, unnamed lower sandstone member 30.5–53 m above base. Early Oxfordian.
8	11002	AFf11	A. A. Baker, 1921. Chinitna Bay area, south shore, a little east of Sea Otter Point in NW¼ sec. 14, T. 4 S., R. 22 W., Iliamna (D–1) Quadrangle. Naknek Formation, unnamed lower sandstone member, 61–76 m above base. Early Oxfordian.
8	11013	ABF21	Do.
8	11015	ABf22	Do.
8	11016	ABf23	Do.
8	11017	ABf24	Do.
8	11018	ABf25	Do.
8	21350	48AI24	R. W. Imlay, 1948. Near head of first stream entering Chinitna Bay east of Park Creek. Center of SE¼ sec. 22, T. 4 S., R. 22 W., Iliamna (D–1) Quadrangle. Naknek Formation, unnamed lower sandstone member, 15–31 m above base. Early Oxfordian.
8	21351	48AI27	R. W. Imlay, 1948. Eight km N. 71° E. of dock at mouth of Fitz Creek and slightly southeast of Mesozoic loc. 11002. Naknek Formation, unnamed lower sandstone member, 137 m above base. Early Oxfordian.
8	21352	48AI85	R. W. Imlay, 1948. South shore of Chinitna Bay, 8 km N. 74° E. of dock at mouth of Fitz Creek, and 0.8 km southeast of Mesozoic loc. 21350 in east-central part of same section. Naknek Formation, Snug Harbor Siltstone Member, 183 m above base. Late middle to late Oxfordian.
8	21782	49AGz15	Arthur Grantz, 1949. South shore of Chinitna Bay, 1.3–1.4 km west of Gull Island at same place as Mesozoic loc. 11002. Naknek Formation, unnamed lower sandstone member, 61–76 m above base. Early Oxfordian.
8	21783	49AGz35	Arthur Grantz, 1949. South shore of Chinitna Bay, 1 km west of Gull Island and 0.3 km southwest of Mesozoic loc. 21351. Naknek Formation, unnamed lower sandstone member, 244 m above base. Early Oxfordian.
8	21784	49AGz36	Arthur Grantz, 1949. South shore of Chinitna Bay, 1.3 km west of Gull Island at same general location as Mesozoic loc. 21351. Naknek Formation, unnamed lower sandstone member, 168 m above base. Early Oxfordian.
8	21785	49AGz37	Arthur Grantz, 1949. South shore of Chinitna Bay at same place as Mesozoic loc. 21352. Naknek Formation, Snug Harbor Siltstone Member, 183 m above base. Late middle to late Oxfordian.
8	21786	49AGz45	Arthur Grantz, 1949. South shore of Chinitna Bay, 1 km west of Gull Island, a little southeast of Mesozoic loc. 21783 in the same section, Iliamna (D–1) Quadrangle. Naknek Formation, Snug Harbor Siltstone Member, 183 m above base. Oxfordian.
9	3041	934a	T. W. Stanton, 1904. East shore of Oil Bay near a large waterfall, SE¼ sec. 12, T. 6 S., R. 24 W., Iliamna (C–1) Quadrangle, west of Cook Inlet, southern Alaska. Naknek Formation, float from higher beds exposed in cliffs. Kimmeridgian.

TABLE 7.—*Description of Upper Jurassic ammonite localities in Alaska*—Continued

Locality No. (fig. 1)	USGS Mesozoic loc. No.	Collector's field No.	Collector, year of collection, description of locality, stratigraphic assignment, and age
9	3043	934c	T. W. Stanton, 1904. East shore of Oil Bay, west-central margin of sec. 18, T. 6 S., R. 23 W., Iliamna (C–1) Quadrangle, west of Cook Inlet, southern Alaska. Naknek Formation, unnamed lower sandstone member, 4.6 m above base of bed no. 8 and 30 m above base of member drawn at base of bed no. 14 (Martin, 1926, p. 173). Oxfordian.
9	3044	934d	T. W. Stanton. 1904. Slightly south of Mesozoic locality 3043 and 62 m above base of unnamed lower sandstone member of the Naknek Formation. Early Oxfordian.
9	3045	934e	T. W. Stanton, 1904. Slightly south of Mesozoic locality 3044. Naknek Formation, unnamed lower sandstone member, 24 m above base of bed no. 7 and 160 m above base of member. Late early Oxfordian.
9	3046	934f	T. W. Stanton, 1904. Slightly south of Mesozoic locality 3044. Naknek Formation, 46 m above base of bed no. 7 and 181 m above base of unnamed lower sandstone member (Martin, 1926, p. 173). Early Oxfordian.
9	10988		F. H. Moffit, 1921. West shore of Oil Bay about 0.8 km from head on point near center of SE¼ sec. 14, T. 6 S., R. 24 W., Iliamna (C–1) Quadrangle, west of Cook Inlet, southern Alaska. Naknek Formation, at top of unnamed lower sandstone member. Early Oxfordian.
9	11050a	ABF 61	A. A. Baker, 1921. Probably at head of Edelman Creek in east-central part of sec. 32, T. 5 S., R. 23 W., Iliamna (C–1) Quadrangle, west of Cook Inlet, southern Alaska. Naknek Formation, talus from below Chinitna-Naknek contact. Early Oxfordian.
9	11055	ABF66, 67	A. A. Baker, 1921. West shore of Oil Bay at second point down bay from gravel spit near mouth of Bowser Creek, near center of SE¼ sec. 14, T. 6 S., R. 24 W., Iliamna (C–1) Quadrangle, west of Cook Inlet, southern Alaska. Naknek Formation, at top of unnamed lower sandstone member, but possibly reworked. Early Oxfordian.
9	11056	ABF69	A. A. Baker, 1921. East shore of Oil Bay, N. 61° E., from Mt. Pomeroy, a little south of Mesozoic loc. 3046, in SW¼ sec. 18, T. 6 S., R. 23 W., Iliamna (C–1) Quadrangle, west of Cook Inlet, southern Alaska. Naknek Formation, near top of unnamed lower sandstone member. Early Oxfordian.
9	20723	46AKr102	C. E. Kirschner, 1946. East shore of Oil Bay at about same place as USGS Mesozoic locality 11056. Naknek Formation, near base of Snug Harbor Siltstone Member. Oxfordian.
9	22418	50AHa21	R. D. Hoare and J. K. Hartsock, 1950. West shore of Oil Bay, NE cor. SE¼ SE¼ sec. 14, T. 6 S., R. 24 W., Iliamna (C–1) Quadrangle, west of Cook Inlet, southern Alaska. Naknek Formation, about 15 m above base of unnamed lower sandstone member. Early Oxfordian.
9	22426	50AHa21a	R. D. Hoare and J. K. Hartsock, 1950. West shore of Oil Bay, about 213 m south of USGS Mesozoic loc. 22418 and 427 m south of first major point down bay from gravel spit near mouth of Bowser Creek. SE corner SE¼ sec. 14, T. 6 S., R. 24 W., Iliamna (C–1) Quadrangle, west of Cook Inlet. Naknek Formation, 48 m above base of unnamed lower sandstone member. Early Oxfordian.
9	22449	50AGz12	Arthur Grantz, 1950. East shore of Iniskin Bay northeast of Scott Island on southwest tip of Iniskin Peninsula, NE¼ sec. 19, T. 6 S., R. 24 W., Iliamna (C–2) Quadrangle west of Cook Inlet, southern Alaska. Naknek Formation, 198–206 m above base and 12 m below top of Snug Harbor Siltstone Member. Late Oxfordian.
9	22450	AGz16	Arthur Grantz, 1950. East shore of Iniskin Bay in NE cor. NE¼ sec. 19, T. 6 S., R. 24 W., about 0.3 km north of Mesozoic loc. 22449 in Iliamna (C–2) Quadrangle. Naknek Formation, 61–69 m above base of Snug Harbor Siltstone Member. Late middle to late Oxfordian.
10	30764	74ADt9	R. L. Detterman, 1974. On peninsula between Ursus Cove and Bruin Bay 91 m north of mouth of Sunday Creek, northwest of Augustine Island, Iliamna (B–2) Quadrangle, west of Cook Inlet, southern Alaska. Naknek Formation, upper part.

TABLE 7.—*Description of Upper Jurassic ammonite localities in Alaska*—Continued

Locality No. (fig. 1)	USGS Mesozoic loc. No.	Collector's field No.	Collector, year of collection, description of locality, stratigraphic assignment, and age
11	3096	940a	T. W. Stanton and G. C. Martin, 1904. South side of Kamishak Bay on west bank of Douglas River about 1.6 km above its mouth, Iliamna (A–3) Quadrangle, at head of Alaska Peninsula. Naknek Formation.
11	25832	CEK776	C. E. Kirschner, 1955. South side of Kamishak Bay on west end of Douglas Island, Iliamna (A–3) Quadrangle, at head of Alaska Peninsula. Naknek Formation. Early Tithonian.
11	25833	CEK787	C. E. Kirschner, 1955. South side of Kamishak Bay near mouth of Douglas River, coordinates 19.8–0.9 on the Iliamna (A–3) Quadrangle, at head of Alaska Peninsula, Naknek Formation. Early Tithonian.
11	29253	65AP363	Marvin Mangus, 1965. South side of Kamishak Bay about 1.6 km from beach and 19.5 km S. 67° E. of VABM McNeil, Iliamna (A–3) Quadrangle, at head of Alaska Peninsula. Naknek Formation. Early Tithonian.
11	29899	14828.2	Continental Oil Company, 1967. South side of Kamishak Bay on east tip of westernmost island that is 1.6 km N. 40° E. of mouth of Douglas River, Iliamna (A–3) Quadrangle, at head of Alaska Peninsula. Naknek Formation. Kimmeridgian.
12	26003	CEK 800	C. E. Kirschner, 1955. On ridge east of the Kamishak River, coordinates 16.0–13.3. Mt. Katmai Quadrangle on Alaska Peninsula. Naknek Formation. Kimmeridgian or early Tithonian.
13	29254	65AP 375	Marvin Mangus, 1965. From small island 1.1 km S. 18° E. of abandoned site of Kaguyak in the Shelikof Strait, Afognak Quadrangle, on Alaska Peninsula. Naknek Formation. Early Tithonian.
13	29255	65AP376	Marvin Mangus, 1965. From same island as USGS Mesozoic loc. 29254. Naknek Formation. Early Tithonian.
14	10249	F	C. N. Fenner, 1919. From sandstone in place and in loose slabs on shore south of Iliuk Arm of Naknek Lake near Savanoski camp (abandoned), Mt. Katmai Quadrangle, on Alaska Peninsula. Naknek Formation. Kimmeridgian or early Tithonian.
15	12077	4	W. R. Smith, 1923. East side of Kejulik Pass below Gas Creek, Mt. Katmai Quadrangle, on Alaska Peninsula. Naknek Formation. Kimmeridgian or early Tithonian.
16	3124	3	Lawrence Martin, 1904. West side of Katmai Bay, 0.8 km north of camp on west side of Shelikof Strait, Mt. Katmai Quadrangle, on Alaska Peninsula. Naknek Formation. Late Oxfordian to early Tithonian.
16	3128	5a	Lawrence Martin, 1904. On north shore of Katmai Bay, 1.6 km north of camp on west side of Shelikof Strait, Mt. Katmai Quadrangle, on Alaska Peninsula. Naknek Formation.
17	3136	12	Lawrence Martin, 1904. From 0.8 km up creek entering marshes at head of Puale Bay, Karluk (D–5) Quadrangle, on Alaska Peninsula. Naknek Formation. Late middle Oxfordian or Kimmeridgian.
18	10795	1–82	S. R. Capps, 1921. 1.6 km west of shore of Becharof Lake, and 4.8 km southeast of Mt. Lee, Ugashik (C–1) Quadrangle, on Alaska Peninsula. Naknek Formation, about 305 m above its base. Lower Kimmeridgian.
18	10796	1–83	S. R. Capps, 1921. 1.6 km southeast of Mesozoic loc. 10795, Ugashik (C–1) Quadrangle, on Alaska Peninsula. Naknek Formation, about 305 m above its base. Kimmeridgian or early Tithonian.
18	10798	1–89	S. R. Capps, 1921. Eight km south of Mt. Peulik, Ugashik (C–2) Quadrangle, on Alaska Peninsula. Naknek Formation. Early to early middle Oxfordian.
18	10817	1–122	S. R. Capps, 1921. Southeast shore of Becharof Lake between extreme south end of lake and the fishing village, Ugashik (C–1) Quadrangle, on Alaska Peninsula. Naknek Formation. Kimmeridgian.
18	11345	7	W. R. Smith, 1922. Creek across divide (south of) Ugashik Creek, Ugashik (C–1) Quadrangle, on Alaska Peninsula. Naknek Formation. Latest Kimmeridgian.

TABLE 7.—*Description of Upper Jurassic ammonite localities in Alaska*—Continued

Locality No. (fig. 1)	USGS Mesozoic loc. No.	Collector's field No.	Collector, year of collection, description of locality, stratigraphic assignment, and age
19	31492	78ACe34	Jim Case and Tom Ovenshine, 1978. On hill 154 m high about 3.2 km northwest of ocean in SE cor. sec. 3, T. 38 S., R. 49, Sutwik Island (D–4) Quadrangle, on Alaska Peninsula. Staniukovich Formation. Late Tithonian.
20	11359	33	W. R. Smith, 1922. Gates of Crater Aniakchak at head of Aniakchak River. West-central part of sec. 8, T. 38 S., R. 55 W., Chignik (D–1) Quadrangle, on Alaska Peninsula. Naknek Formation.
21	25708	55–AKe–12	A. S. Keller, 1955. Beach on north side of Chignik Lagoon. East-central part of sec. 33, T. 44 S., R. 59 W., Chignik (B–2) Quadrangle, on Alaska Peninsula. From green slabby calcareous siltstone and thin beds of limestone near top of upper 30.5 m of exposed Naknek Formation. Kimmeridgian.
21	25709	55–AKe–13	A. S. Keller, 1955. Same place as USGS Mesozoic loc. 25708 but from near middle of upper 30.5 m of exposed Naknek Formation. Kimmeridgian.
21	25710	55–AKe–14	A. S. Keller, 1955. Same place as USGS Mesozoic loc. 25708 but from near base of upper 30.5 m of exposed Naknek Formation. Kimmeridgian.
21	25712	55–AKe–16a	A. S. Keller, 1955. Beach on north side of Chignik Lagoon. About 0.5 km west of USGS Mesozoic loc. 25708 in north-central part of SE¼ sec. 33, T. 44 S., R. 59 W., Chignik (B–2) Quadrangle, on Alaska Peninsula. Naknek Formation. Kimmeridgian or early Tithonian.
21	25713	55–AKe–17	A. S. Keller, 1955. Same place as USGS Mesozoic loc. 25712 but from 15 m of gray-green slabby siltstone containing calcareous concretions and thin beds of limestone from 14–27 m above lowermost part of the Naknek Formation. Kimmeridgian.
21	25715	55–AKe–19	A. S. Keller, 1955. Same place as USGS Mesozoic loc. 25712 but from 50–63 m above lowermost exposures. Kimmeridgian.
21	5799a	58A	W. W. Atwood, 1908. Opposite Alaska Packers cannery on north side of Chignik Lagoon. Naknek Formation. Kimmeridgian or early Tithonian.

SYSTEMATIC DESCRIPTIONS

Family PHYLLOCERATIDAE Zittel, 1884

Subfamily PHYLLOCERATINAE Zittel, 1884

Genus PHYLLOCERAS, Suess, 1884

Phylloceras alaskanum Imlay, n. sp.

Plates 1 and 2

This species is represented in northern Alaska by 34 specimens. It has a discoidal compressed form, highly elliptical whorls, which are widest a little below the middle of the flanks, and a very narrow umbilicus. Its body chamber is not preserved.

Its ornamentation consists of fine, gently flexuous ribs, which become a little stronger ventrally, and conspicuous radial folds. These folds are weak near the umbilicus, become fairly strong near the middle of the flanks, and then fade out adorally as they pass into three to five fine ribs. These fine ribs, as exposed on the upper third of the flanks, outnumber the radial folds 7 to 10 times. Both ribs and folds curve forward on the lower third of the flanks, recurve on the middle of the flanks, curve forward on the upper third of the flanks, and then arch forward slightly on the venter. All ribs are separated by somewhat wider interspaces.

Most of the specimens cannot be measured accurately because of lateral crushing. The holotype at a diameter of 74 mm, has a whorl height of 42 mm, a whorl thickness of 22 mm, and an umbilical width of 7 mm. A somewhat larger specimen (pl. 2, figs. 2, 3) at a whorl height of 52 mm, has a whorl thickness of 29 mm. These measurements indicate that the whorls are nearly twice as high as they are thick.

The suture line is similar to that of *P. appenninicum* Canavari in Burckhardt (1906, pl. 28, fig. 4).

This species in shape and in fineness of ribbing resembles *Phylloceras knoxvillense* Stanton (1896, p. 72, pl. 14, figs. 1–3; Imlay and Jones, 1970, p. B28, pl. 2, figs. 4–11) but differs by lacking pronounced constrictions on its internal mold and by having much stronger radial folds. Its ribbing appears to be identical with that on *Phylloceras apenninicum* Canavari in Burckhardt (1906, p. 106, 153, 182, pl. 28, figs. 1–5) from lower Tithonian beds in north-central Mexico. It differs, however, by having a smaller umbilicus and a higher more compressed whorl section. Its radial folds are much stronger and extend higher on its flanks than do those on *P. subplicatius* Burckhardt (1906, p. 40, pl. 8, figs. 1–6) from the Kimmeridgian *Idoceras*-bearing beds at San Pedro del Gallo in northern Mexico. Its radial folds appear to be somewhat stronger and much more flexuous than are those on the type specimen of *P. plicatum* Neumayr (1871, p. 313, pl. 12, figs. 7a, b, pl. 13, fig. 2) from the Oxfordian of Europe.

Phylloceras alaskanum Imlay, n. sp., is associated with *Buchia concentrica* (Sowerby) at USGS Mesozoic locs. 10795, 10817, 25708, 25710, 25713, 25715, 29899, and 24156. It is associated with *Buchia mosquensis* (Von Buch) at USGS Mesozoic locs. 11345, 25832, and 25833 and with *B. rugosa* (Fischer) at Mesozoic loc. 25832, 25833.

Type.—Holotype, USNM 256879; paratypes, USNM 256875–256878.

Occurrences.—Naknek Formation in Talkeetna Mountains at USGS Mesozoic loc. 24156; and on Alaska Peninsula at Mesozoic locs. 3124, 5799A, 10249, 10795, 10796, 10817, 11345, 12077, 24156, 25708–25710, 25712, 25713, 25715, 25832, 25833, 26003, and 29899.

Phylloceras cf. P. alaskanum Imlay

Two fragmentary ammonites differ from *Phylloceras alaskanum* Imlay, n. sp., in that their ribs are less flexuous on their flanks. They differ from *P. iniskinense* Imlay, n. sp., by having stronger radial folds. Their general appearance is similar to that of *P. plicatum* Neumayr (1871, p. 313, pl. 12, figs. 7a, b, pl. 13, fig. 2) from the Oxfordian of Europe.

Occurrences.—Naknek Formation, unnamed lower sandstone member, on south shore of Chinitna Bay at USGS Mesozoic loc. 11018; float at base of cliff near a large waterfall on east shore of Oil Bay at Mesozoic loc. 3041.

Phylloceras iniskinense Imlay, n. sp.

Plate 3, figures 1–9

This species is represented in southern Alaska by 17 septate specimens that are similar in size and shape to *Phylloceras alaskanum* n. sp. Its ribs are very fine, gently flexuous, and become a little stronger ventrally. Faint radial folds occur only on the lower parts of the flanks on some whorls but are absent or inconspicuous on most whorls.

The holotype, at a diameter of 87 mm, has a whorl height of 50 mm, a whorl thickness of 24 mm, and an umbilical width of 6 mm.

The suture line is not well preserved.

This species differs from *P. alaskanum* Imlay, n. sp., by having finer radial ribbing and inconspicuous radial folds. It differs from *P. knoxvillense* Stanton (1896, p. 72, pl. 14, figs. 1–3; Imlay and Jones, 1970, p. B28, pl. 8, figs. 4–11) from northern California and Oregon by lacking constrictions on its internal molds. It differs from *P. glennense* Anderson (1945, p. 976, pl. 11, figs. 1, 2; Imlay and Jones 1970, p. B28, pl. 1, figs. 9, 10) from California by having weaker radial folds, a little finer ribbing, and a smaller umbilicus. It differs from *P.* aff. *P. consanguineum* Gemmellaro in Burckhardt (1906, p. 71, pl. 18, figs. 8–11) by having a higher whorl section and weaker radial folds.

P. iniskinense Imlay, n. sp., apparently occurs at a different stratigraphic position than does *P. alaskanum* Imlay, n. sp., as indicated by their nonassociation. A lower stratigraphic position for *I. iniskinense* is indicated by its association with *Buchia concentrica* (Sowerby) at USGS Mesozoic locs. 22450, 24165, or 24167 but not with *B. rugosa* (Fischer) or *B. mosquensis* (von Buch), whereas *P. alaskanum* occurs with all three species of *Buchia.*

Types.—Holotype, USNM 256880; paratypes USNM 256881–256884.

Occurrences.—Naknek Formation in the Talkeetna Mountains at USGS Mesozoic locs. 24162, 24165, and 24167; west side of Cook Inlet at Mesozoic locs. 11017, 11056, 21350, 21352, 21782, 21783, 21786, and 22450; Alaska Peninsula at Mesozoic loc. 3124.

Phylloceras cf. P. knoxvillense Stanton

Plate 4, figure 10

This genus is represented in the Staniukovich Formation on the Alaska Peninsula by a single large internal mold that is crushed laterally, is mostly septate, and bears ribbing identical with that on *P. knoxvillense* Stanton (1896, p. 72, pl. 14, figs. 1–3; Anderson, 1945, p. 976, pl. 11, fig. 5; Imlay and Jones, 1970, p. B28, pl. 2, figs. 4–11).

Its surface bears very fine, closely spaced, gently flexuous ribs that become a little coarser ventrally. On the venter of the nonseptate part of the shell, the ribs became considerably wider than the interspaces. The suture line is imperfectly preserved on the venter because of the crushing, but it definitely has a triphyllic second lateral saddle.

Figured specimen.—USNM 256936.

Occurrence.—Staniukovich Formation on the Alaska Peninsula at USGS Mesozoic loc. 31492.

Phylloceras sp.

Plate 4, figs. 9–11

One specimen is highly involute. Its whorl section is subovate and is widest a little below the middle of the flanks. Its surface, wherever the shell is preserved, bears very fine riblets or lirae that are faint near the umbilicus but become slightly stronger ventrally. These lirae curve forward strongly on the lower third of the flanks, recurve a little near the middle of the flanks, and then cross the venter transversely.

The specimen at a diameter of 72 mm, has a whorl height of 44 mm, and a whorl thickness of 30 mm.

It differs from *Phylloceras*? *contrarium* Imlay and Jones (1970, p. B28, pl. 1, figs. 1–8) mainly by having a subovate instead of a subelliptical whorl section and by the fact that its ribs cross the venter transversely.

Figured specimen.—USNM 256885 .

Occurrence.—Naknek Formation in Talkeetna Mountains at USGS Mesozoic loc. 24841 and on the south shore of Chinitna Bay at Mesozoic loc. 21785, and in northeastern Alaska at Mesozoic loc. 21027. The same species is probably represented by five faintly striate much smaller specimens from the Talkeetna Mountains at Mesozoic loc. 8575.

Genus PARTSCHICERAS Fucini, 1923

Partschiceras sp. A

Plate 6, figures 2–7

One species, represented by three specimens, is similar to *P.* (*P*) *subobtusiforme Pompeckj* (Imlay, 1953, p. 73, pl. 35, figs. 1–3, 8) from the Chinitna Formation west of Cook Inlet, Alaska, but differs by having slightly stronger and sparser ribbing on the upper part of its flanks. It is associated with *Buchia concentrica* (Sowerby) at USGS Mesozoic loc. 3136.

Figured specimen.—USNM 256886–256888.

Occurrences.—Naknek Formation on the Alaska Peninsula at USGS Mesozoic loc. 3136; Naknek Formation, northwest of Augustine Island on west side of Cook Inlet between Ursus Cove and Bruin Bay at Mesozoic loc. 30764; Root Glacier Formation in the Wrangell Mountains at Mesozoic locality 28579; possibly represented in the Kingak shale by one immature specimen from west bank of Canning River in northern Alaska at Mesozoic loc. 24013 (see Imlay, 1955, p. 86, pl. 10, figs. 18, 19).

Partschiceras sp. B

Plate 4, figures 1–8

This species, represented by four crushed specimens, has smooth inner whorls, but during growth, it develops coarse, widely spaced, radial trending ribs on the venter and upper parts of the flanks.

Figured specimens.—USNM 256889–256892 .

Occurrences.—Naknek Formation on Alaska Peninsula at USGS Mesozoic locs. 11359 and 29253.

Subfamily CALLIPHYLLOCERATINAE Spath, 1927

Genus HOLCOPHYLLOCERAS Spath, 1927

Holocophylloceras cf. H. mesolcum (Dietrich)

Plate 5, figures 1–3

This species is represented by two septate specimens, of which the smaller is compressd laterally and the larger is much worn on one side. It has a discoidal compressed form. Whorls are elliptical and are widest at about the top of the lower third of the flanks. The umbilicus is fairly narrow and has a low vertical wall that rounds rather abruptly into the flanks.

Ornamentation consists mostly of acutely sigmoid to tongue-shaped constrictions on both the test and the internal mold and partly of weak radial ribs on the upper parts of the flanks wherever the shell is preserved. The smaller specimen has nine constrictions; the incomplete larger specimen has seven constrictions on an inner whorl and eight constrictions on the incomplete outer whorl.

The suture line is imperfectly preserved.

The inner whorl of the larger specimen, at a diameter of 93 mm, has a height of 49 mm and a thickness of 30 mm. The outer whorl, at a diameter of about 190 mm, has a height of 108 mm and an estimated thickness of 70 mm.

This species in shape, constrictions, and fine ventral ribbing greatly resembles *Holcophylloceras mesolcum* Dietrich (1925, p. 8, pl. 1, figs. 4, 5; Spath, 1930, p. 24, pl. 1, figs. 2a–d; Collignon, 1959, pl. 96, fig. 366) from near Mombasa in Kenya, east Africa.

Figured specimens.—USNM 256893 and 256894.

Occurrences.—Naknek Formation in the Talkeetna Mountains at USGS Mesozoic locs. 24165 and 24834.

Family LYTOCERATIDAE Neumayr, 1875

Subfamily LYTOCERATINAE Neumayr, 1875

Genus LYTOCERAS Suess, 1865

Lytoceras sp.

Plate 6, figures 1, 8–10

Sixteen fragmentary specimens of *Lytoceras* have been collected at nine localities in southern Alaska. Some have crinkled riblets, and some have more closely spaced riblets than others. Those that are not crushed have round whorls. Their preservation is not sufficient to permit recognition of species.

Figured specimens.—USNM 256895–256898.

Occurrences—Naknek Formation west of Cook Inlet at USGS Mesozoic locs. 3043, 20723, and 22418; in the Talkeetna Mountains at Mesozoic locs. 24166 and 24175; and in the Alaska Peninsula at Mesozoic locs. 3090, 3128, and 25833.

Family PERISPHINCTIDAE Steinmann, 1890

Subfamily PERISPHINCTINAE Steinmann, 1890

Genus PERISPHINCTES Waagen, 1869

Subgenus DICHOTOMOSPHINCTES Buckman, 1926

Perisphinctes (Dichotomosphinctes) cf. P. (D.) muhlbachi Hyatt

Plate 7, figures 7–12

Perisphinctes (*Dichotomosphinctes*) cf. *P.* (*D.*) *muhlbachi* Hyatt. Imlay 1961, U.S. Geological Survey Professional Paper 374–D, p. D24, pl. 4, fig. 6.

The subgenus *Dichotomosphinctes* is represented by three specimens from southern Alaska. The two largest specimens were collected on the Alaska Peninsula in association with *Buchia concentrica* (Sowerby). The smallest specimen was collected on the west end of Cook Inlet in association with *Buchia* sp.

These specimens are characterized by evolute coiling, by moderately spaced, high narrow ribs, and by deep constrictions. The ribs incline forward gently on the flanks, most of them bifurcate high on the flanks, and all cross the venter transversely. Some pairs of secondary ribs are separated by single ribs that arise freely along the zone of furcation.

The dimensions of the largest specimen are not determinable because of lateral crushing. The next smaller specimen has also been crushed laterally but has a whorl section that is slightly wider than high. On the smallest specimen at one place, the whorl height is 23 mm and the whorl thickness is 28 mm.

These specimens are nearly identical in shape and ornamentation with *P.* (*D*) *muhlbachi* Hyatt (Crickmay, 1933, p. 57, pl. 18, figs. 1, 2) from California and with *P.* (*D.*) *durangensis* Burckhardt (1912, p. 16, pl. 3, figs. 1, 2, pl. 4, fig. 6) from north-central Mexico.

Figured specimens.—USNM 130789, 256899, and 256900.

Occurrence.—Naknek Formation on the Alaska Peninsula at USGS Mesozoic locs. 10796 and 29899 and on the Iniskin Peninsula west of Cook Inlet at USGS Mesozoic loc. 22449.

Subfamily VIRGATOSPHINCTINAE Spath, 1923

Genus SUBPLANITES Spath, 1925

Subplanites? sp.

Plate 8, figure 15

One fragment of a large ammonite has many strong, widely spaced, forwardly inclined ribs that branch at two levels (virgatotomous) on the middle part of the flank. Constrictions are not present.

The presence of virgatotomous ribs suggests that the specimen belongs to the subfamily Virgatosphinctinae (Arkell and others, 1957, p. L328) and probably represents part of the outer whorl of *Subplanites* or *Pachysphinctes*. An assignment to *Subplanites* is favored by the fact that most of the ribs are virgatotomous, whereas most of the ribs of *Pachysphinctes* are biplicate.

Figured specimen.—USNM 256901.

Occurrence.—Naknek Formation on the Alaska Peninsula at USGS Mesozoic loc. 29255.

Genus AULOCOSPHINCTOIDES Spath, 1923

Aulacosphinctoides sp.

Plate 7, figures 1–3

The genus *Aulacosphinctoides* is represented by one laterally crushed specimen on which some shelly material is preserved. Its whorls are fairly evolute and rounded. The outermost preserved whorl embraces about half of the preceding whorl and bears fairly sharp biplicate ribs. These ribs curve backward on the umbilical wall, curve forward on the lower part of the flanks, curve backward on the upper part of the flanks, and then cross the venter transversely. The next smaller whorl bears similar biplicate ribs, which are exposed at one place (pl. 7, fig. 3) where the outer whorl has been deformed by crushing. Constrictions are not evident on the outer whorl. One constriction may be present on the next inner whorl.

This specimen in lateral view resembles *A. infundibulum* (Uhlig) (1910, p. 371, pl. 72, figs. 1a–e, 2a, and 4 a, b) in coiling and in having fairly sharp, strongly curved, biplicate ribbing. The much narrower appearance of its venter is due at least in part to crushing.

Figured specimen.—USNM 256902.

Occurrence.—Naknek Formation on the Alaska Peninsula at USGS Mesozoic loc. 29254 in association with *Buchia mosquensis* (von Buch) and *B. rugosa* (Fisher).

Family CARDIOCERATIDAE Siemiradzki, 1891

Subfamily CARDIOCERATINAE Siemiradzki, 1891

Genus CARDIOCERAS Neumayr and Uhlig, 1881

Cardioceras (Cardioceras) distans (Whitfield)

Plate 8, figures 1–14

Ammonites cordiformis var. *distans* Whitfield, 1880, U.S. Geographical and Geological Survey of the Rocky Mountain Region, p. 380, 381, pl. 6, fig. 25.

C. distans (Whitfield). Neumayr, 1883, K. Akademie der Wissenschaften, Wien, Mathematisch-Naturwissenschaftliche Klasse, Denkschriften, v. 47, p. 302.

C. distans (Whitfield) Reeside, 1919, U.S. Geological Survey Professional Paper 118, p. 24, pl. 15, figs. 18–21, pl. 16, figs. 1–6.

C. distans (Whitfield) var. *depressum* Reeside, 1919, U.S. Geological Survey Professional Paper 118, p. 24, pl. 15, figs. 22–24, pl. 16, figs. 7–11.

This species is represented in Alaska by 20 specimens. It is characterized by a subquadrate whorl section that is as high or nearly as high as wide; by a moderately wide umbilicus; by sharp, prominent, widely spaced primary ribs that become stronger ventrally; by sharp but less prominent secondary ribs, most of which arise in pairs from the primary ribs near the middle of the flanks, but some arise freely higher on the flanks, and all curve strongly forward on the venter; and by a coarsely nodose pinched keel on the venter.

Types.—Paratypes, USNM 32335, 32336, 32338; hyptotypes, 256903–256907.

Occurrences.—Naknek Formation on the Iniskin Peninsula west of Cook Inlet at USGS Mesozoic locs. 3045, 11002, 11013, 11017, 11056, 20723, and 21351; in the Talkeetna Mountains at Mesozoic locs. 24165, 24166, 24168, 24837, and 24841.

Cardioceras (Cardioceras) hyatti Reeside

Plate 9, figure 6

Cardioceras hyatti Reeside, n. sp., 1919, U.S. Geological Survey Professional Paper 118, p. 26, pl. 15, figs. 1–4.

C. (*Anacardioceras*) *hyatti* Reeside. Maire, 1938 Société Géologique de France Mémoires, new series, v. 15, no. 2/3 (Mémoire 34), p. 75, pl. 13, fig. 2.

This species in Alaska is represented by a single specimen that attains a larger size than the holotype but has identical ribbing, except near its adoral end, where the ribs branch a little lower on the flanks. The species is characterized by its compressed form and by regular ribs that are only slightly stronger on the lower part of the flanks than on the upper.

Types.—Holotype ,USNM 32326; hypotype, USNM 256908.

Occurrence.—Naknek Formation west of Cook Inlet at USGS Mesozoic loc. 11015.

Cardioceras (Cardioceras) lilloetense Reeside

Plate 9, figures 1–5

Cardioceras lilloetense Reeside 1919, U.S. Geological Survey Professional Paper 118, p. 27, pl. 17, figs. 20–23.

C. (*Cardioceras*) *lilloetense* Reeside. Maire, 1938, Société Géologique de France Mémoires, new series, v. 15, no. 2/3 (Mémoire 34), p. 96, pl. 13, figs. 10, 10a.

This species is represented in Alaska by one specimen that is crushed laterally. The outer whorl of the holotype has a subquadrate whorl section that is higher than wide; flattened flanks; a weakly shouldered venter; a moderately wide umbilicus; and sharp radial-trending, widely spaced primary ribs that terminate near the middle of the flank in weak tubercles, from which arise pairs of weaker ribs. One or two additional secondary ribs arise between the forked ribs. The secondary ribs outnumber the primary ribs nearly four to one, all bend forward on the venter, many fork again near the keel, and all pass into crenulations on the venter. The outer whorl of the smaller specimen has slightly finer ribbing than that on the holotype at a comparable size.

Types.—Holotype, USNM 32347; hypotype USNM 256909.

Occurrences.—Naknek Formation in Talkeetna Mountains at USGS Mesozoic loc. 24841. The holotype was collected from the head of Big Creek in the Chilcotin River area, near Lilloet, British Columbia.

Cardioceras (Cardioceras) cf. C. (C.) lilloetense Reeside

Plate 9, figures 7–21

Nine laterally crushed ammonites differ from *C.* (*C.*) *lilloetense* Reeside by having shorter primary ribs, fewer and stronger secondary ribs, and a rounded instead of a weakly shouldered venter. Their general appearance is similar to that of *C.* (*C.*) *persecans* (S. Buckman), as illustrated by Arkell (1946, p. 315, pl. 68, figs. 10–12, pl. 69, figs. 5, 6), but they differ by having a narrower umbilicus.

Figured specimens.—USNM 256910–256917.

Occurrence.—Naknek Formation west of Cook Inlet at USGS Mesozoic locs. 11002, 11017, and 21351.

Cardioceras (Cardioceras?) spiniferum Reeside

Plate 11, figures 8, 9

Cardioceras spiniferum Reeside, n. sp., 1919, U.S. Geological Survey Professional Paper 118, p. 30, 31, pl. 18, fig. 4, pl. 19, figs. 1–3.

This species to date is represented only by the holotype, on which are exposed part of a septate whorl and an adjoining nonseptate whorl but none of the inner whorls. These whorls show that the shell is compressed, the umbilicus is fairly narrow, and the venter terminates in a high sharp keel that is not bordered by furrows. The septate whorl bears strong sharp primary ribs that become stronger ventrally and that terminate in laterally compressed tubercles at or a little above the middle of the flanks. From these tubercles arise two or three weak secondary ribs that arch forward on the upper part of the flanks. In addition, two to three similarly weak forwardly arched ribs arise freely near the middle of the flanks between the tubercles. All secondary ribs appear to pass into striae on the keel.

The nonseptate whorl is fairly smooth, but on its lower half, it bears weak, broad, widely spaced swellings, and throughout, it bears rather weak striae that trend nearly radially, except near the keel where they arch gently forward.

This species is assigned to *Cardioceras* rather than *Amoeboceras* on the basis of the absence of furrows bordering the keel. Its preservation, however, is not sufficient to make a subgeneric assignment.

Holotype.—USNM 32348.

Occurrence.—Naknek Formation on east side of Oil Bay on the Iniskin Peninsula west of Cook Inlet at USGS Mesozoic loc. 3046. This occurrence is 70 feet (21 m) higher than that of *Cardioceras distans* (Whitfield) at Mesozoic loc. 3045, 417 feet (126 m) higher than *C.* (*Scarburgiceras*) *martini* Reeside at Mesozoic loc. 3044, and 550 feet (167 m) below an occurrence of *Buchia concentrica* (Sowerby) (see Martin, 1926, p. 173).

Subgenus SCARBURGICERAS Buckman, 1924

Cardioceras (Scarburgiceras) dettermani Imlay, n. sp.

Plate 10, figures 1–11

This species is represented by 12 specimens. The smallest specimens (pl. 10, figs. 1–3, 7, 8), at diameters less than 25 mm, have a narrow umbilicus, a subovate whorl section that is a little higher than wide, a narrowly rounded venter, and fairly strong ribs that trend radially on the lower half of the flanks, bifurcate in part near the middle of the flanks, curve slightly forward on the upper half, and cross the venter without becoming nodose.

On a somewhat larger specimen (pl. 10, figs. 5, 6), the whorl section becomes higher, the venter becomes sharp and weakly nodose, the primary ribs bifurcate below the middle of the flanks, simple unforked ribs become common, all ribs arch strongly forward on the upper part of the flanks and on the venter, and some ribs bifurcate high on the venter. Striations occur in places on the flanks and on the venter.

On the largest specimens (pl. 10, figs. 9–11), forwardly arched striations become common, and the venter becomes nodose but apparently is not compressed at its base.

This species differs from immature specimens of *C.* (*S.*) *martini* Reeside by having a smaller umbilicus, coarser and sparser ribs that arch forward more strongly, a venter that does not become sharpened or keeled until a much larger size is attained, and striations at a smaller size. Its ribbing and the shape of its inner whorls resemble those features on *C.* (*S*) *scarburgensis* (Young and Bird) (Arkell, 1939, p. 156, pl. 10, figs. 1a, b; Arkell and others, 1957, p. L307, figs. 379, 2a, b). It differs, however, by having a smaller umbilicus and a narrowly rounded instead of a sharp venter. It likewise resembles *Lamberticeras lamberti* Sowerby (Arkell and others, 1957, p. L303, figs. 372, 1a, b) except for having a narrower umbilicus and finer ribbing and by developing ventral crenulations.

Types.—Holotype, USNM 256919; paratypes, USNM 256920–256925.

Occurrences.—Kingak Shale in Ignek Valley of northeastern Alaska at USGS Mesozoic locs. 29137 and 29856. Naknek Formation west of Cook Inlet in southern Alaska at Mesozoic loc. 11050a (float).

Cardioceras (Scarburgiceras) martini Reeside

Plate 10, figures 12–22

For synonymy, see Imlay, 1964, U.S. Geological Survey Professional Paper 483–D, p. D15.

This species is represented in Alaska by about 70 specimens. It is characterized by its compressed form, a vertical umbilical wall on the larger septate specimens, flattened and high flanks, a pinched venter, and fine, sharp, rather closely spaced ribs, of which many bifurcate a little below the middle of the flanks. Other ribs remain single, a few trifurcate, and some arise freely near the middle of the flanks. The primary ribs arise low on the umbilical wall on small specimens, arise near the top of the wall on larger specimens, and trend slightly forward on the flanks. The secondary ribs curve strongly forward on the venter and are continuous with prominent serrations on the keel. The adoral half of the largest preserved whorl, which is entirely septate, is marked by an abrupt change from fairly strong ribbing to faint striations that likewise curve forward on the venter. The adapical ribbed half of the same whorl is marked near the keel by faint striae that incline forward more strongly than the ribs.

The immature forms of this species, including the holotype, greatly resemble *C.* (*S.*) *bukowski* Maire (1938, p. 64, pl. 7, fig. 8; Arkell, 1946 (Monograph), p. 305, text-figs. 105–2 and 108–1; Malinowski, 1963, p. 44, pl. 16, figs. 87–90). They differ by having a more compressed whorl section, somewhat weaker primary ribs that do not become swollen near the middle of the flanks, and some trifurcated ribs (Arkell, 1946 (Monograph), p. 306). The immature forms of *C.* (*S.*) *martini* have much weaker primary ribs than do some specimens from Wyoming that

Reeside (1919, pl. 8, figs. 4–7) assigned to *C.* (*S.*) *cordiforme* (Meek and Hayden) and Maire (1938, p. 61) assigned to a new species, *C. reesidei.*

Types.—Holotype, USNM 32317; hypotypes USNM 132360, 256926–256930.

Occurrences.—Naknek Formation, west of Cook Inlet at USGS Mesozoic locs. 3041, 3044, 10988, 11016, 11017, 11055, 21350a, 21351, 21782, 21784, 22418, 22426, 22701; Talkeetna Mountains and upper part of Matanuska Valley at Mesozoic locs. 8575, 24165, 24166, 24168, 24837, and 24841.

Subgenus SCOTICARDIOCERAS Buckman, 1925

Cardioceras (Scoticardioceras) alaskense Reeside

Plate 11, figures 1–6

Cardioceras alaskense Reeside, 1919, U.S. Geological Survey Professional Paper 118, p. 18, pl. 6, figs. 7–10.

This species, now represented in Alaska by four specimens, was originally described on the basis of a single septate fragment, whose outermost preserved whorl bears features characteristic of the subgenus *Scoticardioceras* (Arkell, 1956, p. 548). Such features include a very small umbilicus, a vertical umbilical wall, a laterally compressed trigonal-shaped whorl section, a tall serrated keel, and ribbing that fades out adorally within about two-fifths of a whorl. Such fading, starting near the umbilicus, is typical of the outer septate whorl of the subgenus (Arkell, 1941, p. LXXVI).

Several smaller whorls are partly exposed within the umbilicus of the holotype. The largest of these whorls is mostly covered but has a steep umbilical wall, a round umbilical edge, and sharp, widely spaced, radial-trending ribs. The next smaller whorl, as described by Reeside (1919, p. 18), is subovate, a little higher than wide, sharp ventered, and bears low ribs that bifurcate near the middle of the flanks, arch forward in the venter, and pass into crenulations on the keel.

The species is also represented by smaller septate specimens (pl. 11, figs. 1, 6) whose adoral parts are similiar in size, shape, and ribbing to the adapical part of the holotype. In contrast, the adapical parts of the smaller specimens bear sharp, widely spaced, radially trending primary ribs that become stronger ventrally and pass near the middle of the flanks into two or three weaker secondary ribs. One or two secondary ribs also arise freely near the middle of the flanks between the forked ribs. All secondary ribs arch strongly forward and become faint on the venter, some divide into two ribs, and all pass into crenulations on the keel.

The ribbing on the adapical end of these smaller specimens is similar to that on small specimens of *C.* (*S.*) *excavatum* (J. Sowerby) figured by Arkell (1941, pl. 49, figs. 3, 5). The ribbing on the adoral end of these specimens as well as on the holotype is similar to that on some larger specimens of *C.* (*A.*) *excavatum* (J. Sowerby) (Arkell, 1941, pl. 49, figs. 1a, b, pl. 50, fig. 9). *C.* (*S.*) *alaskense* Reeside differs mainly by having a smaller umbilicus and by losing its ribbing at an earlier growth stage.

Types.—Holotype, USNM 32306; hypotypes USNM 256931–256933.

Occurrences.—Naknek Formation on west side of Cook Inlet at USGS Mesozoic locs. 3041 (float), 11015, 21351, and 22426.

Cardioceras (Scoticardioceras) cf. C. (S.) stella Arkell

Plate 11, figures 7, 10

One laterally crushed, mostly septate specimen is nearly identical in appearance with *Cardioceras* (*Scoticardioceras*) *stella* Arkell (1947, p. 333, pl. 73, figs. 4a, b). It has a tall, coarsely serrated keel, prominent sharp ribbing, a narrow umbilicus, and a low vertical umbilical wall. Within the umbilicus are exposed parts of two inner whorls that bear sharp, widely spaced primary ribs. On the outer whorl, the primary ribs are short and terminate in sharp tubercles. On the adapical half of the outer whorl, these tubercles give rise to pairs of ribs that become a little stronger ventrally and are separated from other pairs by one, or in places by two intercalary ribs that begin near the middle of the flanks. On the adoral half of the outer whorl, the primary ribs fade out rather abruptly and the secondary ribs fade a little. On the venter of the outer whorl, all secondary ribs swing sharply forward, become very fine, and then pass into prominent serrations on the keel.

This specimen differs from the holotype of *C.* (*S.*) *stella* Arkell by having a slightly smaller umbilicus and by the fact that its ribs fade out at a smaller shell size. It could be within the range of variation of that species.

Figured specimen.—USNM 256934.

Occurrence.—Naknek Formation west of Cook Inlet at USGS Mesozoic loc. 21351.

Subgenus VERTEBRICERAS Buckman, 1920

Cardioceras (Vertebriceras) whiteavesi Reeside

Plate 7, figures 4–6

Cardioceras whiteavesi Reeside, 1919, U.S. Geological Survey Professional Paper 118, p. 33, pl. 17, figs. 1–4.

One uncrushed external mold from 5 miles (8 km) east-southeast of Mt. Peulik on the Alaska Peninsula differs from the holotype of *C. whiteavesi* Reeside only by being somewhat larger and by the adoral secondary ribs of each pair being indistinctly connected with the primary rib.

Hypotype.—USNM 256935.

Occurrence.—Naknek Formation on the Alaska Peninsula at USGS Mesozoic loc. 10798.

Genus AMOEBOCERAS Hyatt, 1900

Subgenus AMOEBITES Buckman, 1925

Amoeboceras (Amoebites) sp.

Plate 12, figure 1

Amoebites is represented by one small laterally crushed fragment of an inner whorl. The ribs on the flanks are sharp, fairly straight, and moderately spaced, incline slightly forward, and terminate ventrally in tubercles. The venter is poorly exposed but is marked along its midline by a serrated keel that appears to be bounded laterally by shallow narrow furrows. These features are similar to those on a small specimen of *A.* (*A.*) *dubium* (Hyatt) (Reeside, 1919, pl. 24, fig. 7) from California and on *A.* (*A.*) *rasenense* Spath (1935, p. 29, pl. 1, figs. 6a, b) from England.

Figured specimen.—USNM 256941.

Occurrence.—Kingak Shale in northern Alaska at USGS Mesozoic loc. 24014.

Amoeboceras (Amoebites?) sp.

Plate 12, figure 2

One external mold is characterized by a fairly narrow umbilicus and by moderately spaced ribs that are mostly simple, that incline forward gently on the flanks, and that terminate ventrally in small tubercles. One rib bifurcates a little above the middle of the flank. The venter is not exposed. The general appearance of the specimen is similar that of *A.* (*A.*) *irregulare* Spath (1935, p. 32, pl. 1, figs. 1a, b) from East Greenland.

Figured specimen.—USNM 256942.

Occurrence.—Root Glacier Formation in Wrangell Mountains at USGS Mesozoic loc. 28577 associated with *Buchia concentrica* (Sowerby).

Subgenus PRIONODOCERAS Buckman, 1920

Amoeboceras (Prionodoceras) sp. A

Plate 12, figures 3–12

Six Alaskan specimens have a fairly small umbilicus, a subquadrate whorl section that is as wide as high, and a fairly high moderately serrate keel that is bordered by narrow smooth furrows. Their ribs are sharp, bear fairly prominent lateral and ventral tubercles, incline gently forward on the flanks, curve strongly forward on the margin of the venter, and terminate at the ventral furrows. Most of the ribs are simple, but some bifurcate at the lateral tubercles, and some secondary ribs arise freely near the middle of the flank. There are two serrations on the venter for every rib that borders the ventral furrows.

This species has much sparser and coarser ribs and tubercles than the species herein compared with *A.* (*P.*) *prorsum* Spath. *A.* (*P.*) cf. *quadratoides* (Nikitin) of Sokolov (1912, pl. 2, figs. 7–9) has a more finely serrated keel and weaker lateral tubercles that are higher on the flanks.

The two smallest specimens resemble a small specimen from East Greenland that Spath (1935, p. 19, pl. 1, fig. 5) described as *Amoeboceras* (*Prionodoceras*) sp. juv., and that he suggested might be a young form of *A.* (*P.*) *transitorium* Spath (1935, p. 17, pl. 1, fig. 8). The four larger specimens, however, bear ribbing that is a little weaker than that in *A.* (*P.*) *transitorium.*

Amoeboceras (*Prionodoceras*) sp. A. is associated with *Buchia mosquensis* (von Buch) at USGS Mesozoic locs. 14495, 14496, and 28700. It is also associated with *Buchia concentrica* (Sowerby) at Mesozoic locs. 14495 and 14496.

Figured specimens.—USNM 256937, 256939, and 256943–256946.

Occurrence.—Root Glacier Formation in the Wrangell Mountains at USGS Mesozoic locs. 14495, 14496, 28578, and 28700.

Amoeboceras (Prionodoceras) sp. B

Plate 12, figures 13–15

Two specimens differ from *A.* (*P.*) sp. A in that their keel is more finely serrated and their ribs are finer, more closely spaced, and more nearly radial on the flanks. Compared with the specimens compared herein with *A.* (*P.*) *prorsum* Spath, their ribs are higher, denser, and straighter on the flanks but curve forward more strongly on the venter, and their lateral tubercles are stronger.

Figured specimens.—USNM 256938 and 256947.

Occurrence.—Root Glacier Formation in the Wrangell Mountains at USGS Mesozoic locs. 14496 and 14497.

Amoeboceras (Prinodoceras?) cf. A. (P.?) prorsum Spath

Plate 12, figures 16–18

Amoeboceras (*Prionodoceras*?) sp., Imlay 1955, U.S. Geological Professional Paper 274–D, p. 90, pl. 12, figs. 2–6.

A previous comparison of 20 small fragmentary ammonites from northern Alaska (Imlay, 1955, p. 91) with *A.* (*P.*?) *prorsum* Spath (1935, p. 24, pl. 5, figs. 4a, b) from East Greenland is supported by the discovery of several larger specimens that closely resemble the holotype from East Greenland. The

Alaskan specimens have a fairly narrow umbilicus, flattened flanks, and a fairly high finely crenulated keel that is bordered by narrow smooth furrows. The specimens bear sharp ribs that incline gently forward on the flanks, curve strongly forward on the ventral margin, and rarely bifurcate. Weak tubercles are present on most ribs near the middle of the flanks. Fairly sharp tubercles are present near the ventral ends of all ribs.

Figured specimens.—USNM 108772, 108773, 256948–256950.

Occurrences.—Kingak Shale in northern Alaska at USGS Mesozoic locs. 21028, 22598, and 29135 in association with *Buchia concentrica* (Sowerby).

Amoeboceras? sp. A.

Plate 12, figures 20, 21

One poorly preserved specimen from northern Alaska is characterized by fairly evolute coiling and by strong rather widely spaced ribs that swing forward on the upper part of the flanks and on the venter. Some of these ribs merge ventrally with a low serrated keel. Serrations outnumber the ribs about two to one.

The assignment to *Amoeboceras* is questioned because the serrated keel is not separated from the ribs by furrows. Otherwise, the specimen shows some resemblance to *Amoeboceras* (*Prionodoceras*) *transitorium* Spath (1935, p. 17, pl. 1, figs. 8a, b). An assignment to *Cardioceras* or any of its subgenera is questioned because the specimen was found near the top of the Kingak Shale associated with *Buchia concentrica* (Sowerby) and near occurrences of *Amoeboceras* at USGS Mesozoic locs. 21028 and 24014.

Figured specimen.—USNM 256940.

Occurrences.—Kingak Shale in northern Alaska at USGS Mesozoic loc. 29882, in association with *Buchia concentrica* (Sowerby).

Amoeboceras? sp. B.

Plate 12, figure 19

One laterally compressed specimen has fairly evolute coiling. The outermost preserved whorl has moderately spaced, moderately strong ribs that incline forward slightly on the flanks, arch forward on the venter, and bear weak tubercles on the middle and upper parts of the flanks. The next inner whorl has much stronger and more widely spaced ribs that bear fairly strong lateral tubercles. The venter has a serrated keel, which does not appear to be bordered by furrows but which is too poorly preserved for a definite generic determination.

Figured specimens.—USNM 256918 .

Occurrence.—Kingak Shale in northern Alaska at USGS Mesozoic loc. 29136, in association with *Buchia concentrica* (Sowerby).

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[Italic page numbers indicate major references]

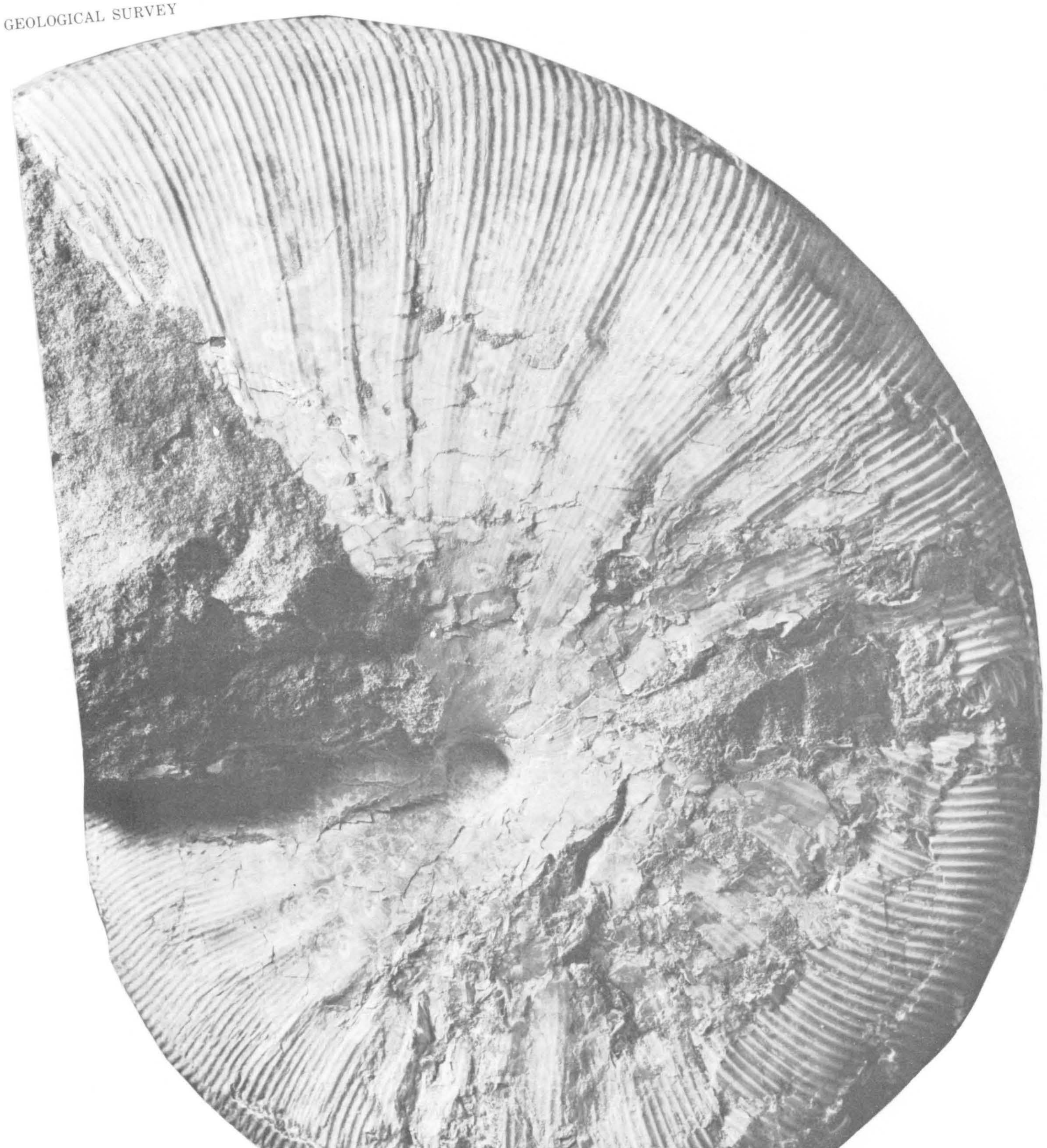
PLATES 1-12

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 1 and 3 are × 9/10; figure 2 is natural size]

FIGURES 1–3. *Phylloceras alaskanum* Imlay, n. sp. (p. 28).
1, 3. Holotype, USNM 256879, from USGS Mesozoic loc. 25832.
2. Paratype, USNM 256875, from USGS Mesozoic loc. 25832. See plate 2, figure 1, for lateral view.



1

2

3

PHYLLOCERAS

PLATE 2

[All figures are natural size]

FIGURES 1–6. *Phylloceras alaskanum* Imlay, n. sp. (p. 28).

1. Paratype, USNM 256875, from USGS Mesozoic loc. 25832. See plate 1, figure 3, for ventral view.

2, 3. Paratype, USNM 256877, from USGS Mesozoic loc. 24156.

4. Paratype, USNM 256876, from USGS Mesozoic loc. 10796.

5, 6. Paratype, USNM 256878, from USGS Mesozoic loc. 29899.

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PHYLLOCERAS

PLATE 3

[All figures are natural size]

FIGURES 1–9. *Phylloceras iniskinense* Imlay, n. sp. (p. 29).

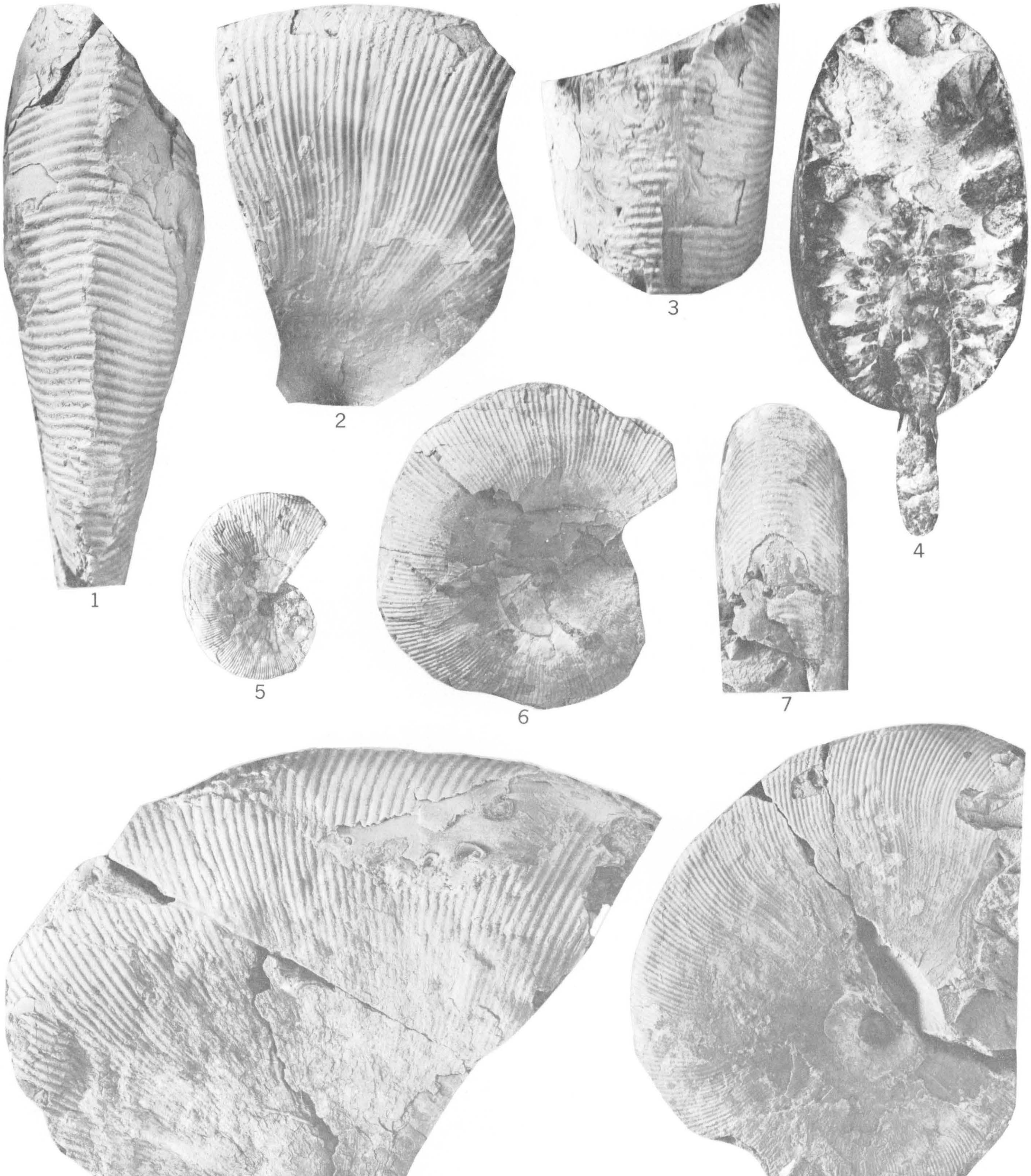
1, 8. Paratype, USNM 256884, from USGS Mesozoic loc. 21783.

2–4. Lateral, ventral and cross-sectional views of paratype, USNM 256883, from USGS Mesozoic loc. 11056.

5. Paratype, USNM 256881, from USGS Mesozoic loc. 21352.

6. Paratype, USNM 256882, from USGS Mesozoic loc. 21352.

7, 9. Holotype, USNM 256880, from USGS Mesozoic loc. 24162.



PHYLLOCERAS

PLATE 4

[Figures natural size unless otherwise indicated]

FIGURES 1–8. *Partschiceras* sp. *B*. (p. 30).

1, 2. Distorted specimen, USNM 256892, from USGS Mesozoic loc. 11359.

3, 4. Laterally compressed specimen, USNM 256889, from USGS Mesozoic loc. 29253.

5, 6. Specimen, USNM 256890, from USGS Mesozoic loc. 29253.

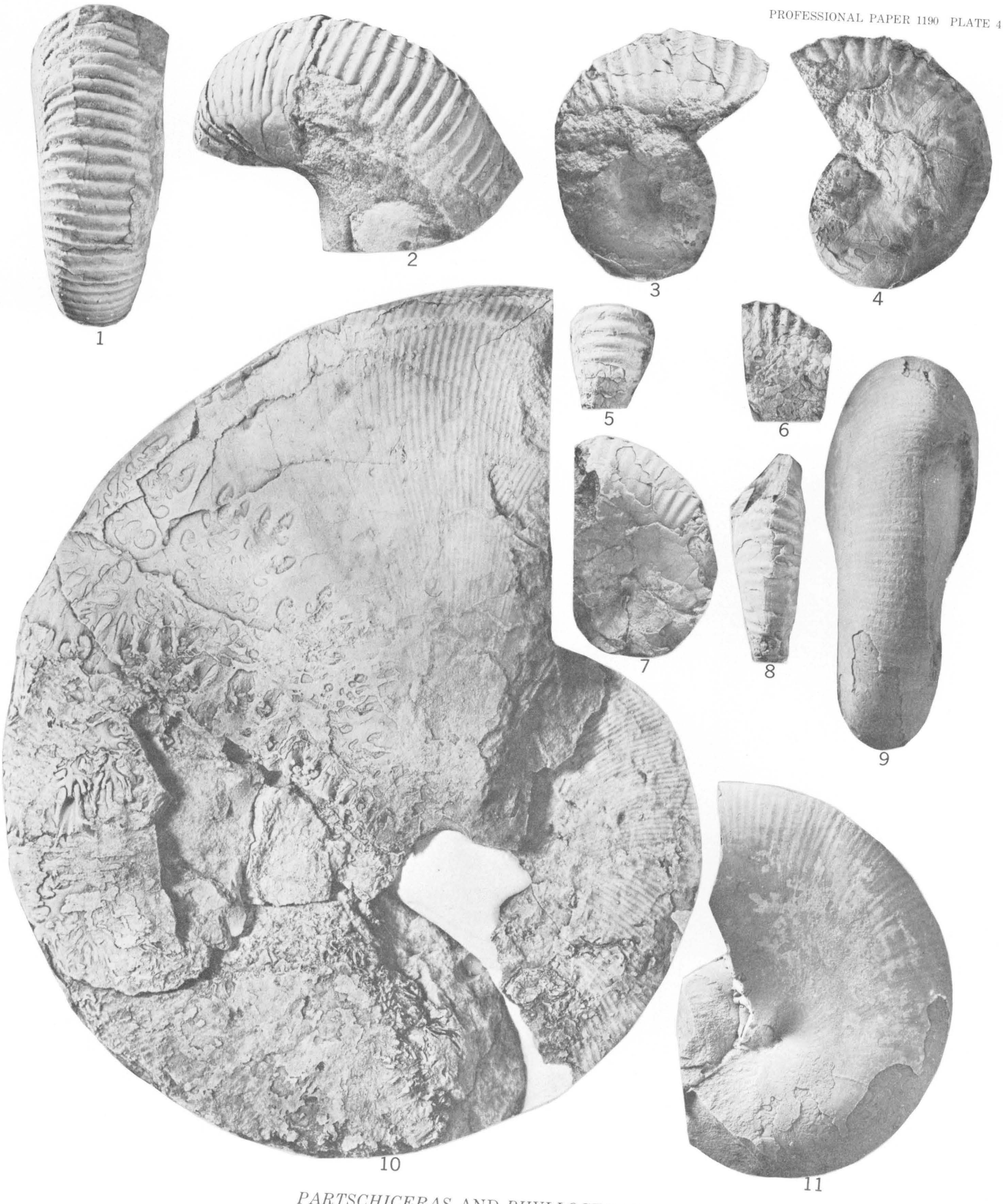
7, 8. Crushed specimen, USNM 256891, from USGS Mesozoic loc. 29253.

9, 11. *Phylloceras* sp. (p. 30).

Septate specimen, USNM 256885, from USGS Mesozoic loc. 24841.

10. *Phylloceras* cf. *P. knoxvillense* Stanton (p. 29).

Specimen, USNM 256936, from USGS Mesozoic loc. 31492 ($\times$ 9/10).



PARTSCHICERAS AND *PHYLLOCERAS*

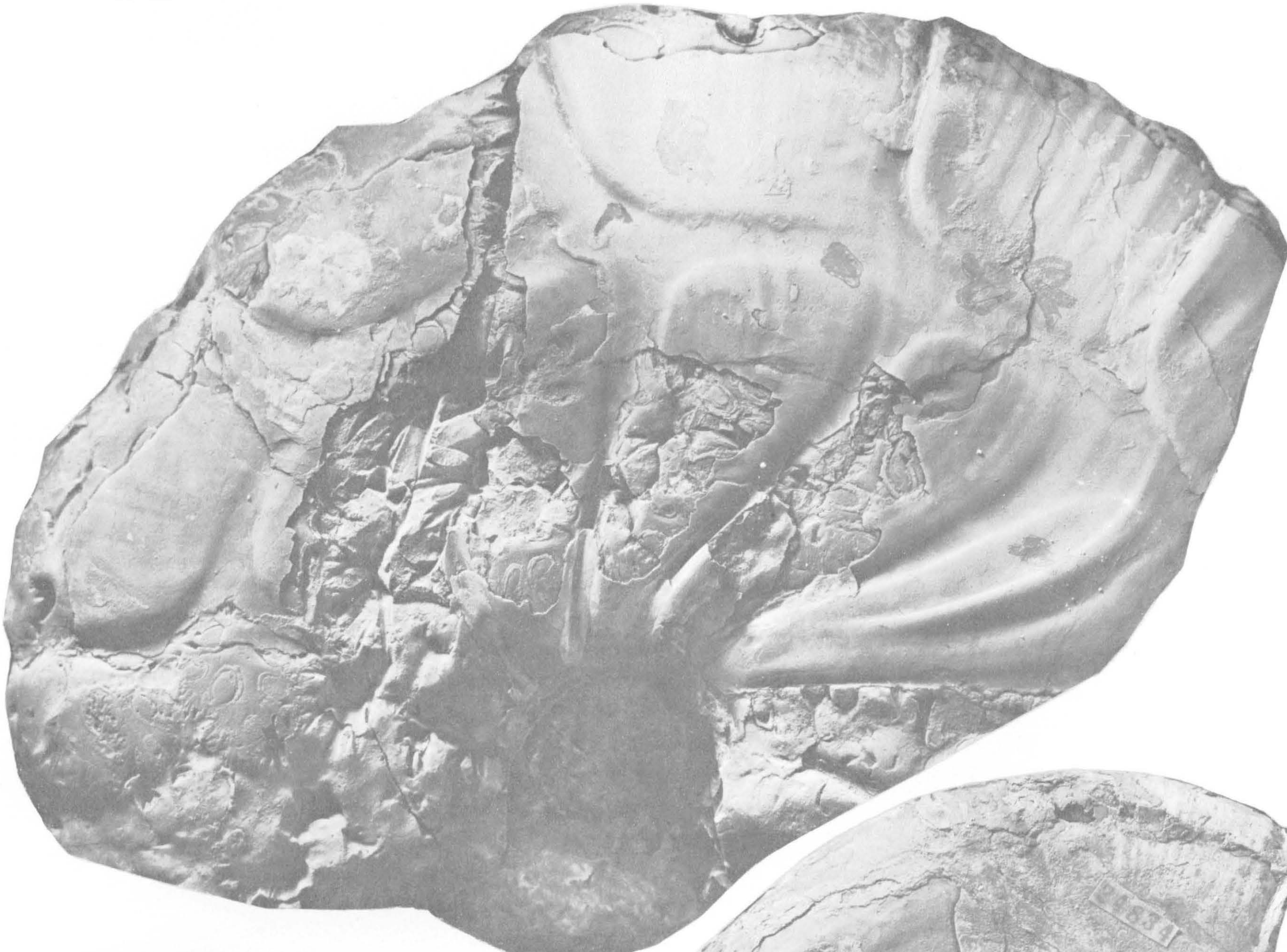
PLATE 5

[Figures 1, 2 are × 9/10; figure 3 is natural size]

FIGURES 1–3. *Holcophylloceras* cf. *H. mesolcum* (Dietrich) (p. 30).

1, 2. Two whorls of specimen, USNM 256893, from USGS Mesozoic loc. 24165. The smaller whorl shown in figure 2 is exposed on the much weathered side opposite that shown on figure 1.

3. Specimen, USNM 256894, from USGS Mesoizoic loc. 24834.



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HOLCOPHYLLOCERAS

PLATE 6

[All figures are natural size]

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1. Laterally crushed specimen, USNM 256897, from USGS Mesozoic loc. 24175.

8, 9. Specimen, USNM 256896, from USGS Mesozoic loc. 3090.

10. Specimen, USNM 256895, from USGS Mesozoic loc. 3043.

2–7. *Partschiceras* sp. A. (p. 30).

2, 3. Specimen, USNM 256887, from USGS Mesozoic loc. 3136.

4, 7. Specimen, USNM 256886, from USGS Mesozoic loc. 28579.

5, 6. Specimen, USNM 256888, from USGS Mesozoic loc. 30764.

LYTOCERAS AND *PARTSCHICERAS*

PLATE 7

[All figures are natural size]

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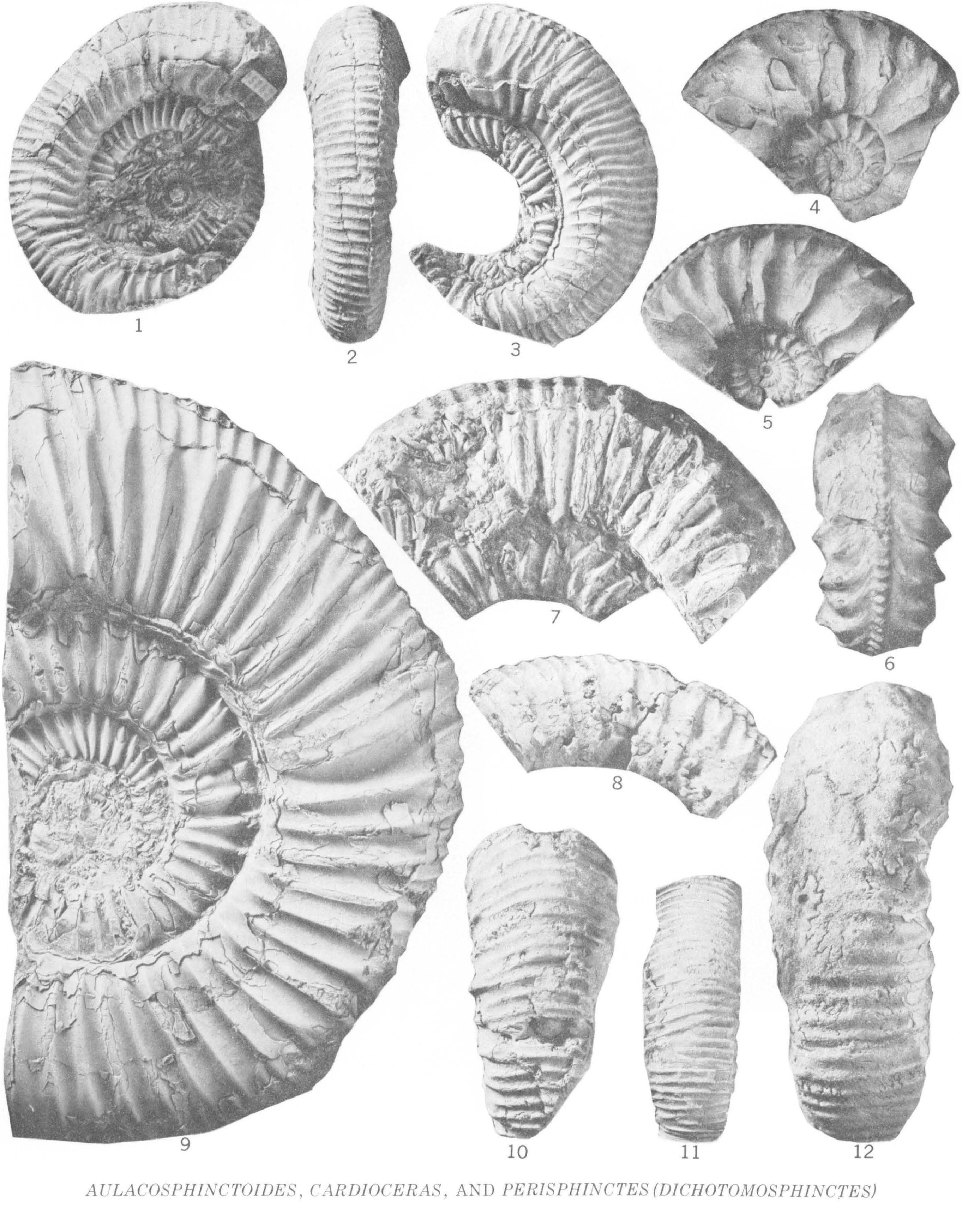
Views of rubber cast of external mold, hypotype, USNM 256935, from USGS Mesozoic loc. 10798.

7–12. *Perisphinctes* (*Dichotomosphinctes*) cf. *P.* (*D.*) *muhlbachi* Hyatt (p. 31).
7, 12. Specimen, USNM 256899, from USGS Mesozoic loc. 29899.
8, 10, 11. Specimen, USNM 256900, from USGS Mesozoic loc. 22449. Figure 11 is a ventral view of an inner whorl.
9. Specimen, USNM 130789, from USGS Mesozoic loc. 10796.



AULACOSPHINCTOIDES, *CARDIOCERAS*, AND *PERISPHINCTES* (*DICHOTOMOSPHINCTES*)

PLATE 8

[All figures are natural size]

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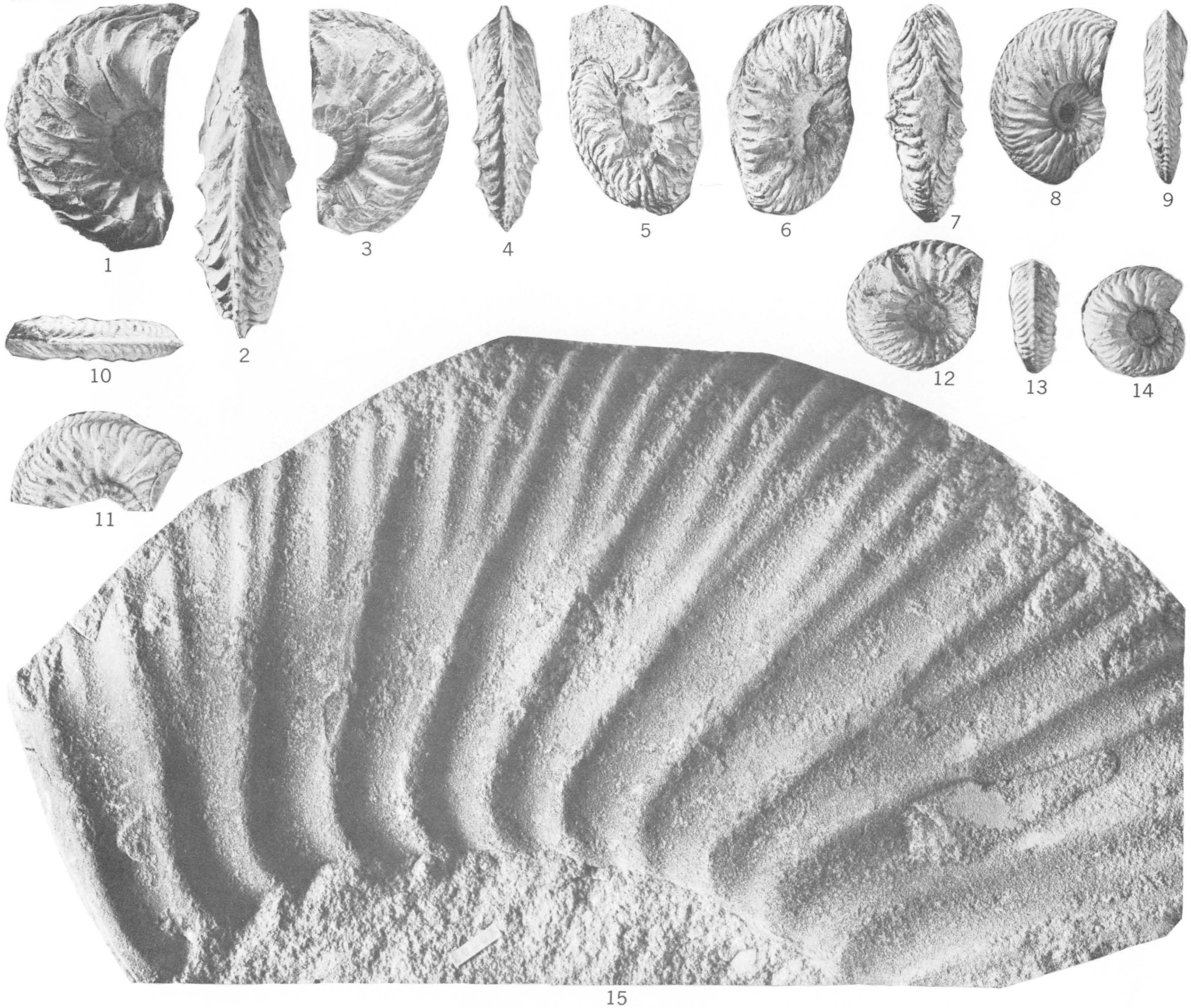
3, 4. Hypotype, USNM 256903, from USGS Mesozoic loc. 3045.
5–7. Hypotype, USNM 256904, from USGS Mesozoic loc. 21351.
8, 9. Hypotype, USNM 256905, from USGS Mesozoic loc. 11013.
10, 11. Hypotype, USNM 256906, from USGS Mesozoic loc. 11002.
12. Paratype, USNM 32335, from USGS Mesozoic loc. 3045.
13, 14. Paratype, USNM 32338, from USGS Mesozoic loc. 3045.

15. *Subplanites*? sp. (p. 31).

Lateral view of specimen, USNM 256901, from USGS Mesozoic loc. 29255.



CARDIOCERAS AND *SUBPLANITES*?

PLATE 9

[All figures are natural size]

FIGURES 1–5. *Cardioceras* (*Cardioceras*) *lilloetense* Reeside (p. 32).

1–3. Lateral and ventral views of holotype, USNM 32347, from near Lilloet, British Columbia.

4, 5. Hypotype, USNM 256909, from USGS Mesozoic loc. 24841.

6. *Cardioceras* (*Cardioceras*) *hyatti* Reeside (p. 32).

Hypotype, USNM 256908, from USGS Mesozoic loc. 11015.

7–21. *Cardioceras* (*Cardioceras*) cf. *C.* (*C.*) *lilloetense* Reeside (p. 32).

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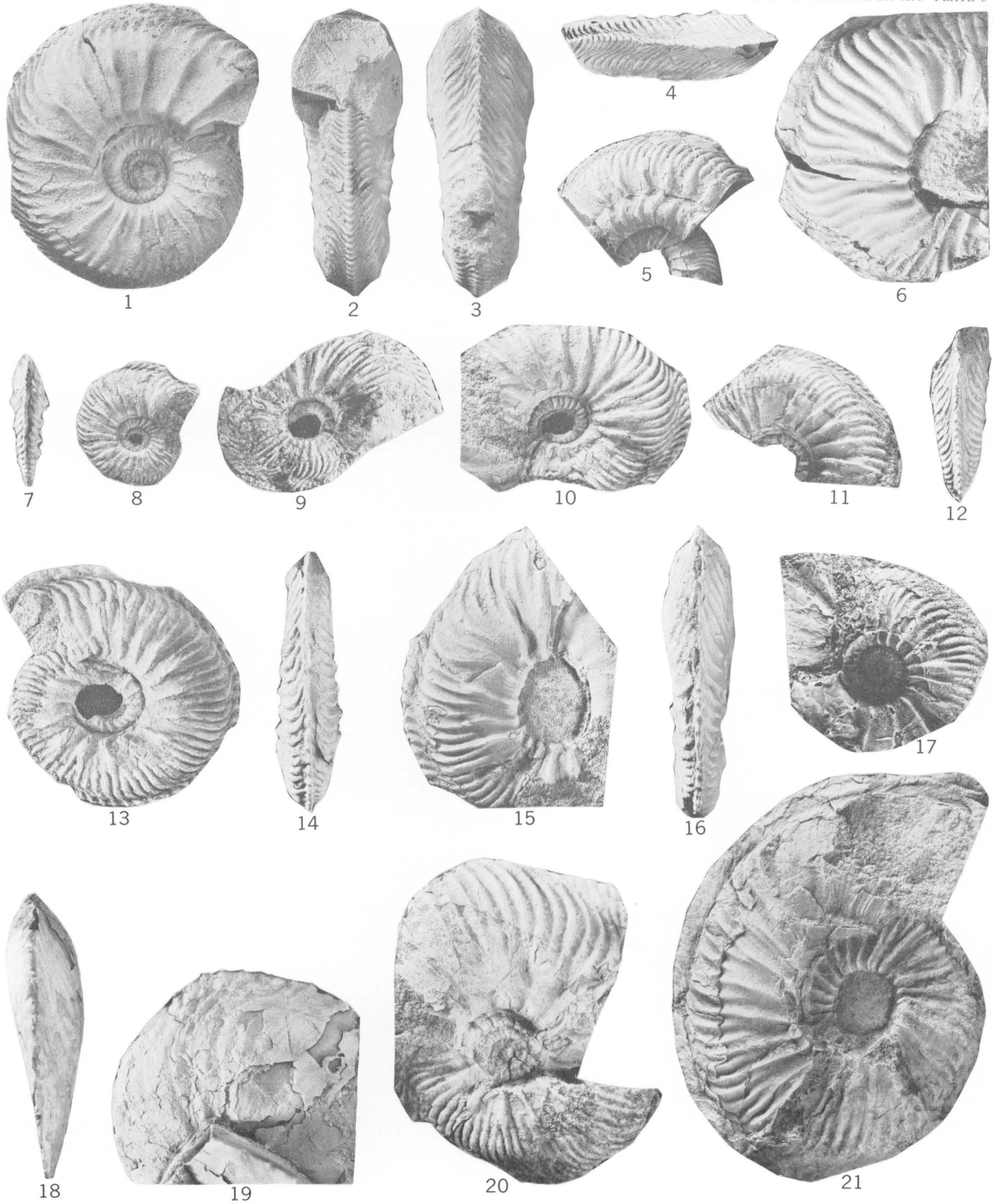
13, 14. Specimen, USNM 256914, from USGS Mesozoic loc. 21351.

15, 16. Specimen, USNM 256912, from USGS Mesozoic loc. 21351.

17–19. Specimen, USNM 256913, from USGS Mesozoic loc. 21351. Figure 17 is a rubber cast of an external mold preserved on opposite side of specimen shown in figure 19.

20. Specimen, USNM 256910, from USGS Mesozoic loc. 11002.

21. Specimen, USNM 256911, from USGS Mesozoic loc. 21351.



CARDIOCERAS

PLATE 10

[Figures natural size unless otherwise indicated]

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4. Paratype, USNM 256920, from USGS Mesozoic loc. 29137.
5, 6. Holotype, USNM 256919, from USGS Mesozoic loc. 11050a.
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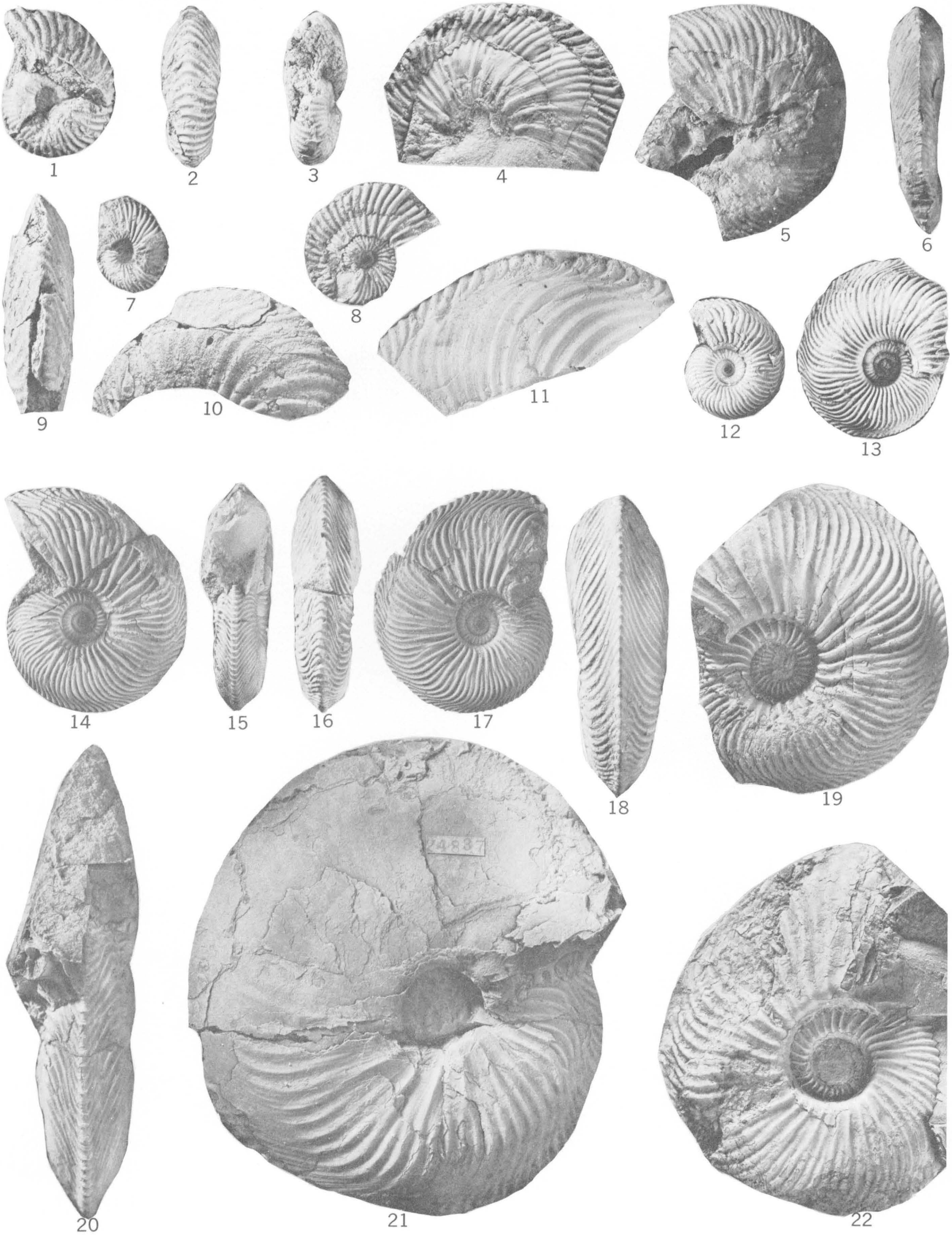
13. Hypotype, USNM 256929, from USGS Mesozoic loc. 8575.
14–17. Holotype, USNM 32317, from USGS Mesozoic loc. 8575.
18, 19. Hypotype, USNM 256928, from USGS Mesozoic loc. 21784.
20, 21. Hypotype, USNM 256926, from USGS Mesozoic loc. 24837.
22. Hypotype, USNM 256927, from USGS Mesozoic loc. 24837.



CARDIOCERAS

PLATE 11

[All figures are natural size]

FIGURES 1–6. *Cardioceras* (*Scoticardioceras*) *alaskense* Reeside (p. 34).
- 1, 2. Hypotype, USNM 256931, from USGS Mesozoic loc. 21351.
- 3, 4. Holotype, USNM 32306, from USGS Mesozoic loc. 3041.
- 5. Hypotype, USNM 256933, from USGS Mesozoic loc. 22426.
- 6. Hypotype, USNM 256932, from USGS Mesozoic loc. 11015.

7, 10. *Cardioceras* (*Scoticardioceras*) cf. *C.* (*S.*) *stella* Arkell (p. 34).
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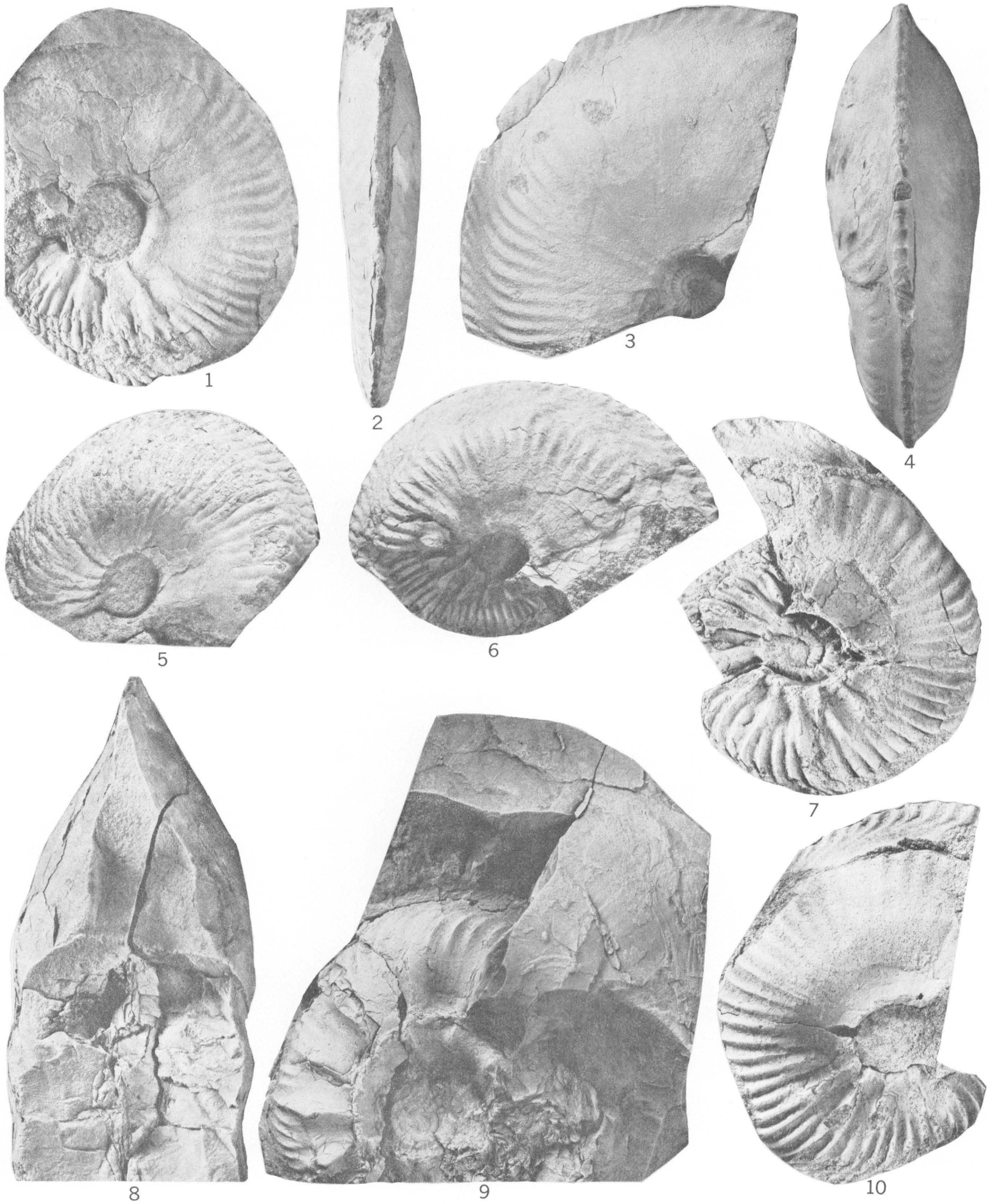
8, 9. *Cardioceras* (*Cardioceras*?) *spiniferum* Reeside (p. 32).
Holotype, USNM 32348, from USGS Mesozoic loc. 3046.



CARDIOCERAS

PLATE 12

[All figures are natural size]

FIGURE 1. *Amoeboceras* (*Amoebites*) sp. (p. 35).
Specimen, USNM 256941, from USGS Mesozoic loc. 24014.

2. *Amoeboceras* (*Amoebites*?) sp. (p. 35).
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3–12. *Amoeboceras* (*Prinonodoceras*) sp. A. (p. 35).
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5, 6. Specimen, USNM 256944, from USGS Mesozoic loc. 14495.
7. Specimen, USNM 256939, from USGS Mesozoic loc. 28700.
8, 9. Specimen, USNM 256946, from USGS Mesozoic loc. 14495.
10, 11. Specimen, USNM 256943, from USGS Mesozoic loc. 14495.
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20, 21. *Amoeboceras*? sp. A. (p. 36).
Specimen, USNM 256940 from USGS Mesozoic loc. 29882.

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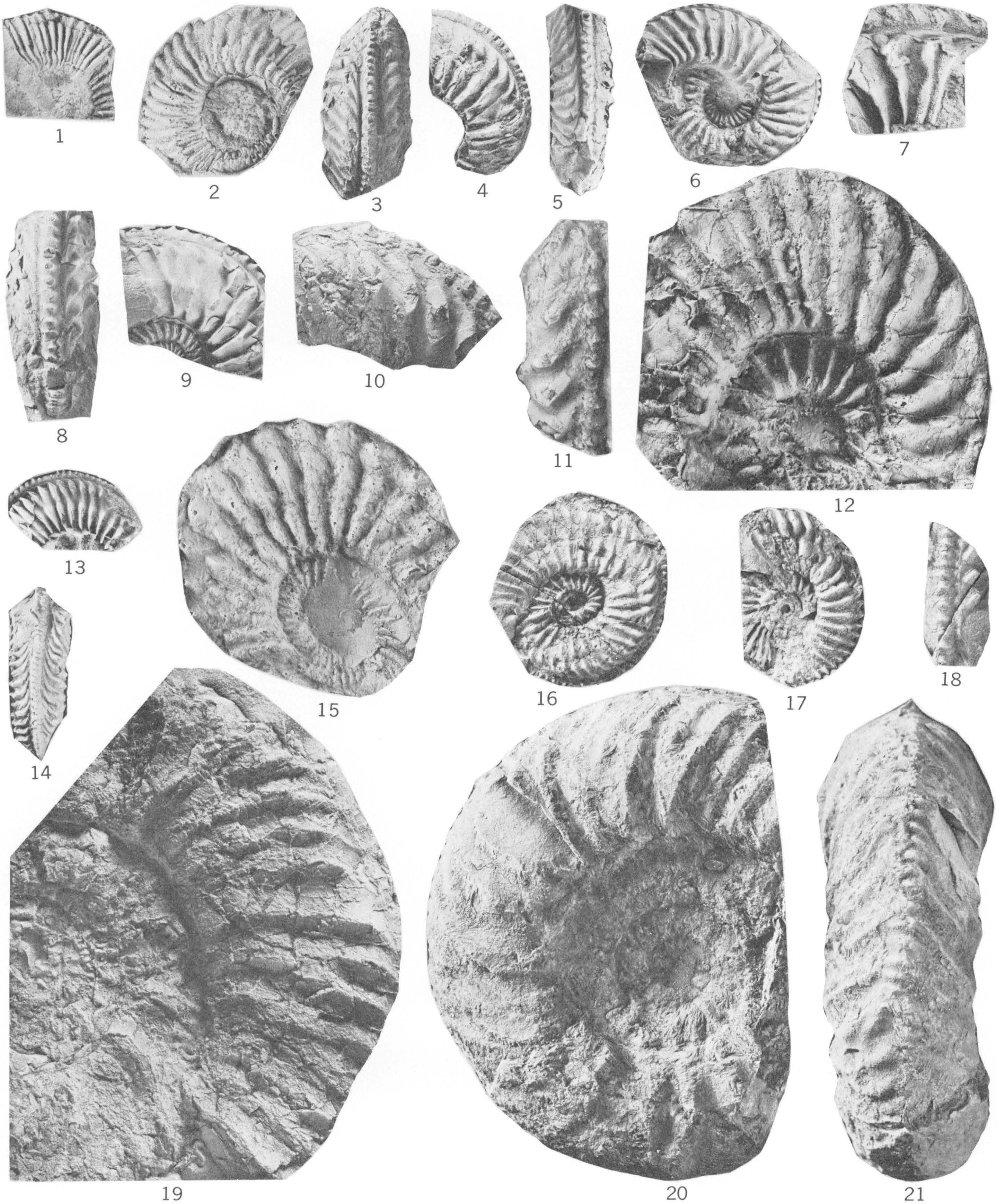

AMOEBOCERAS AND *AMOEBOCERAS*?