Late Bajocian Ammonites From Southern Alaska

GEOLOGICAL SURVEY PROFESSIONAL PAPER 1189

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By RALPH W. IMLAY

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In Alaska, upper Bajocian beds have been found only in the south. They have been dated by ammonites as early late Bajocian. Apparently, southern Alaska was not connected with the rest of Alaska during late Bajocian times

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LATE BAJOCIAN AMMONITES FROM SOUTHERN ALASKA

By Ralph W. Imlay

ABSTRACT

Early late Bajocian ammonites have been found in southern Alaska in the Talkeetna Mountains, on the west side of Cook Inlet between Tuxedni Bay and Iniskin Bay, and in the lower Kuskokwim-Bristol Bay area northeast of Tagiak Bay. This dating is based mostly on the association of *Normannites*, *Stephanoceras*, and *Stemmatoceras*, which are unknown or rare above beds of that age, with *Cadomites* and *Leptosphinctes*, which occur rarely just below beds of that age but range much higher. The dating is also based on the presence of a fragmentary ammonite that in lateral view resembles *Spiroceras*, a genus not known in beds older than early late Bajocian.

Such an association of ammonites occurs west of Cook Inlet in the Twist Creek Siltstone, which rests conformably on the Cynthia Falls Sandstone of late middle Bajocian age and is overlain with marked unconformity by the Bowser Formation of early to late Bathonian Age. Such an association of ammonites is also found in the Talkeetna Mountains in unnamed beds that are nearly identical lithologically with the Twist Creek Siltstone, that rest conformably on beds of late middle Bajocian Age, and that are overlain with probable unconformity by beds of early Bathonian Age. The presence of such an unconformity is suggested by the fact that beds of early late Bajocian Age have been found only in two areas in the Talkeetna Mountains, that still younger Bajocian beds have not been found anywhere in southern Alaska, and that still younger lower Bathonian beds are fairly widespread in the Talkeetna Mountains as well as west of Cook Inlet.

Most of the ammonite genera and subgenera present in the Twist Creek Siltstone and in equivalent beds in southern Alaska are characteristic of the Tethyan Realm. The exceptions include *Megasphaeroceras* and the subgenus *Oppelia* (*Liroxyites*). Of these, *Megasphaeroceras* constitutes 42 percent of the ammonite specimens collected and occurs elsewhere as far south as eastern Oregon and the western interior region of the United States. *Liroxyites* constitutes 27 percent of the ammonite specimens collected and has been found elsewhere only in northern Alaska in beds of middle Bathonian Age. Failure to find any ammonites of late middle Bajocian to middle late Bajocian Age in arctic Canada and in northern Alaska suggests that those areas were undergoing erosion at that time and that all ammonites of early late Bajocian Age found in southern Alaska entered from the Pacific Ocean. *Megasphaeroceras* definitely and *Liroxyites* probably were derived from the nearby Pacific Realm rather than from the Tethyan Realm, judging by their rather limited geographic distribution as compared with the other genera present. The fact that some of those ammonites are identical with species found in eastern Oregon and along the Idaho-Wyoming border suggests that the Bajocian beds now exposed in southern Alaska may have originally been deposited much farther south. Such a possibility is supported by paleomagnetic data.

INTRODUCTION

The late Bajocian ammonites in southern Alaska, some of which were described by the writer in 1962, are redescribed herein on the basis of additional collections from the Talkeetna Mountains and the Iniskin Peninsula west of Cook Inlet and one small collection from the Kuskokwim area in southwestern Alaska. Restudy of these ammonites permits more precise dating in terms of the standard Bajocian zones of western Europe and the evaluation of their geographic origin.

This study is based on biostratigraphic data compiled by Detterman and Hartsock in 1966 (p. 34, 35) for the Twist Creek Siltstone west of Cook Inlet and obtained by R. L. Detterman and the writer in 1972 and 1974 from equivalent beds in the Boulder Creek area of the Talkeetna Mountains. In addition, the writer took part in field studies west of Cook Inlet with D. J. Miller in 1948 and in the Talkeetna Mountains with Arthur Grantz in 1952. Most of the geologists who have collected ammonites of late Bajocian age in southern Alaska have been listed previously (Imlay, 1962, p. A1). All are listed herein in table 3 under locality descriptions. Many thanks are due to these geologists for collecting the fossils and for furnishing locality and stratigraphic data.

This study includes well-preserved ammonites from two localities in the Twist Creek Siltstone on the Iniskin Peninsula. These ammonites are part of a much larger collection from 28 localities made partly or entirely by Carleton Beal in 1937, and possibly during adjoining years, from beds of Bajocian Age on the peninsula. Most of the fossils do not have written labels, but all specimens bear an inked five-digit number, which ranges from 28952 to 30143 according to the locality and which presumably represents a numbering system at some museum, university, or oil company. In addition, 19 of the 28 localities are represented by two-digit field labels that are preceded by the letter "B" and that are written on paper as well as inked on the specimens.

I believe that the fossils from these two localities were collected by Carleton Beal because 1) the letter "B" precedes the 19 two-digit field labels ranging from B24 to B52; 2) Beal was associated with a company that drilled the first well on the peninsula in 1936–1938 (Detterman and Hartsock, 1966, p. 72, 73); and 3) one of his field labels was written as follows: "29515 (B24). About ¼ mile upstream from 29513. Fossil Creek, Iniskin District. Alaska Peninsula. Field no. 24. Carleton Beal. Coll. 1937".

BIOLOGIC ANALYSIS

Southern Alaskan Jurassic ammonites of late Bajocian Age that are discussed or described herein number 254 specimens, of which 154 specimens have been described previously (Imlay, 1962). Their distribution by genera, subgenera, subfamilies, and families is shown on table 1. The table shows that the Sphaeroceratidae comprises about 42½ percent, the Oppeliidae, 27 percent, the Stephanoceratidae, 11½ percent, the Phylloceratidae, 10 percent, and the remaining families, 9 percent of the total number of specimens. The most common ammonite genera are *Megasphaeroceras*, *Liroxyites*, and *Normannites*. These genera constitute about 76 percent of the total number of specimens.

STRATIGRAPHIC SUMMARY

TALKEETNA MOUNTAINS

Beds lithologically and faunally nearly identical with those in the Twist Creek Siltstone west of Cook Inlet have been found in the Talkeetna Mountains in two areas (figs. 1–3 and tables 2 and 3). One area is near the head of Sheep Creek in the northwestern part of the Anchorage (D–2) quadrangle. The other is 24 to 26 km farther west along the northwest side of Boulder Creek in the Anchorage (D–3) and (D–4) quadrangles. The occurrence near Sheep Creek is based on a single collection (USGS Mesozoic loc. 24821) obtained near the top of the Tuxedni Group. The ocurrence northwest of Boulder Creek is based on several exposures and on nine fossil collections.

Beds exposed on the ridge in the NW cor. SE ¼ sec. 26, T. 27 N., R. 7 E. in the Anchorage (D–3) quadrangle consist of orange-gray siltstone that contains limestone concretions and the ammonite *Megasphaeroceras* and that is at least 9 m thick. Above is a covered interval that represents a thickness of 21 m. Above that is 21 m of graywacke that contains *Cranocephalites costidensus* Imlay of probable earliest Bathonian Age. Above that is 61.5 m of gray to brown siltstone that contains the Bathonian ammonites *Cranocephalites*, *Cadomites*, and *Cobbanites*. Below the 9 m of orange-gray siltstone is 21 m of brown and gray siltstone that has not

TABLE 1.—*Ammonite genera and subgenera from beds of late Bajocian Age in southern Alaska, showing biological relationships and relative numbers available for study*

Family	Subfamily	Genus or subgenus	Number of specimens
Phylloceratidae	Phylloceratinae	*Macrophylloceras*	13
	Calliphylloceratinae	*Calliphylloceras*	13
Lytoceratidae	Lytoceratinae	*Lytoceras*	1
Spiroceratidae		*Spiroceras?*	1
Haploceratidae		*Lissoceras*	11
Oppeliidae	Oppeliinae	*Liroxyites*	68
Stephanoceratidae		*Normannites*	20
		Stephanoceras	1
		Stemmatoceras	7
		Cadomites	1
Sphaeroceratidae		*Megasphaeroceras*	106
		Sphaeroceras	2
Perisphinctidae	Leptosphinctinae	*Leptosphinctes*	8
		L. (*Prorsisphinctes?*)	2

Figure 1.—Principal occurrences of upper Bajocian (Jurassic) marine rocks in southern Alaska. 1, Eastern part of the Talkeetna Mountains; 2, Tuxedni Bay area; 3, northern part of the Iniskin Peninsula area; 4, lower Kuskokwim-Bristol Bay area.

furnished any ammonites. Below the brown and gray siltstone is 23 m of similar siltstone that contains the ammonite *Chondroceras* of late middle Bajocian Age. Evidently the beds characterized by *Megasphaeroceras* could be as much as 51 m thick and are probably considerably thicker than 9 m.

Similar orange to gray siltstone that contains many fossiliferous limestone concretions and is at least 40 m thick is well exposed on another ridge 2 to 3 km to the southwest in the SE ¼ sec. 34, T. 22 N., R. 7 E., and in the NE ¼ sec. 3, T. 21 N. R. 7 E., in the Anchorage (D–4) quadrangle. Still other exposures are found in a slumped area between that ridge and the tributary of Boulder Creek in the NW cor. sec. 2, T. 21 N., R. 7 E In addition, just east of the slumped area and west of that tributary are some well-exposed beds of late Bajocian Age that do not appear to be slumped and that are at least 15 m thick as those beds are about 300 m lower in altitude than beds of the same age on the

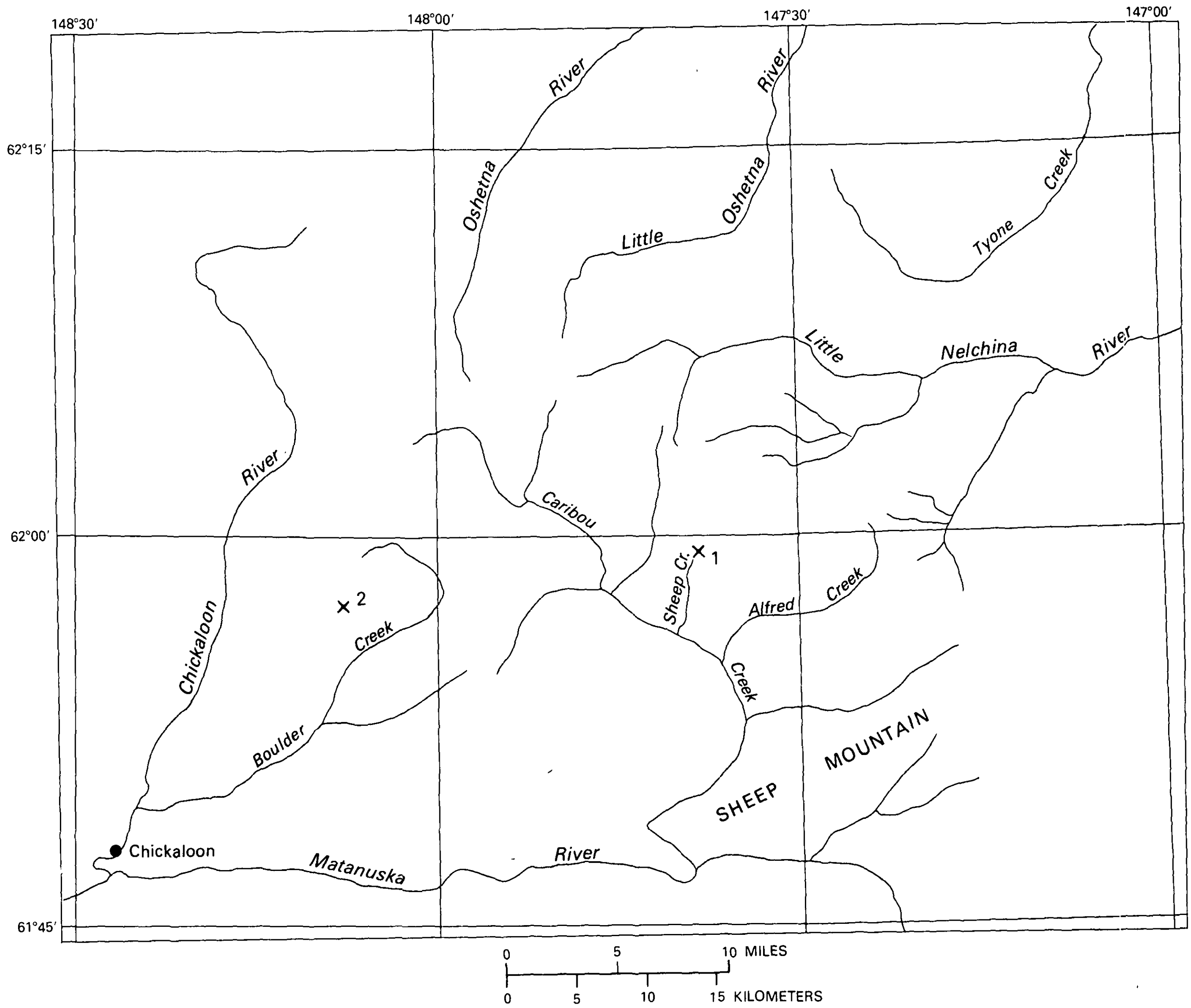

FIGURE 2.—Major areas in which late Bajocian ammonites occur in the Talkeetna Mountains. Numbers on map refer to listing in tables 2 and 3.

ridge, as they also dip eastward fairly steeply, and as they are nearly 1 km farther east, they could be an eastern extension of the beds on the ridge.

The thickness of about 40 m for the upper Bajocian beds exposed on the ridge west of the tributary is only 11 m less than the maximum possible thickness for the beds exposed on the ridge east of the same tributary in sec. 26. T. 22 N., R. 7 E. Nonetheless, both Robert L. Detterman and the writer, who examined the lithologic units of late Bajocian Age on both ridges, consider that the unit on the ridge west of the tributary is probably at least 100 m and may be as much as 150 m thick.

Such possible differences in thicknesses of the upper Bajocian beds in the two ridges in the Boulder Creek area of the Talkeetna Mountains could be explained by folding, faulting, slumping, or erosion. The differences, however, are most readily explained by erosion in latest Bajocian time, like that which took place west of Cook Inlet (Detterman and Hartsock (1966, p. 35)). Erosion during that time in the area of the Talkeetna Mountains is supported by two facts: (1) upper Bajocian beds have been found there to date only in two places; and (2) these beds are dated by the ammonites present as not younger than early late Bajocian.

WEST SIDE OF COOK INLET

The Twist Creek Siltstone was defined by Detterman (1963, p. C33; Detterman and Hartsock, 1966,

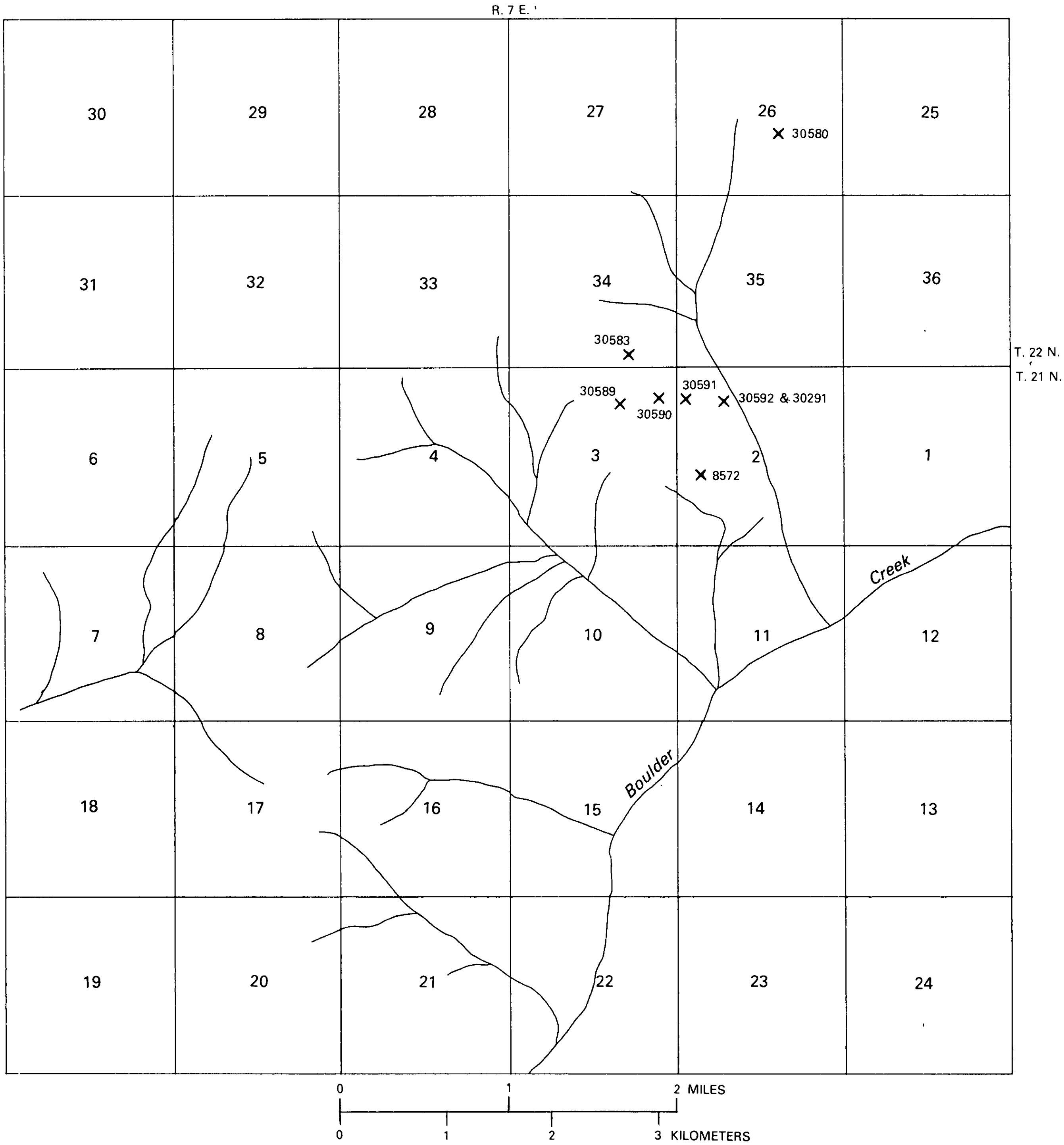

FIGURE 3.—Upper Bajocian ammonite localities in the Boulder Creek area of the Talkeetna Mountains. Numbers on map refer to listing in tables 2 and 3.

p. 35, fig. 2, tables 1 and 2) for a sequence of beds that was previously included in the lower part of the Bowser Member of the Tuxedni Formation (Kirschner and Minard, 1948; Imlay, 1953, table 5; 1962, p. A2). That sequence was considered by Detterman to be a separate formation because it consists mostly of a distinctive, soft, dark-gray thin-bedded to massive siltstone that weathers brownish-gray, contains many fossiliferous limestone concretions and many thin beds of volcanic ash, is overlain unconformably by the Bowser Formation, and is underlain conformably by thick-bedded to massive graywacke and conglomerate composing the Cynthia Falls Sandstone. On the Iniskin Peninsula, the Twist Creek Siltstone thins southward from 128 m to a featheredge. On the peninsula between Chinitna Bay and Tuxedni Bay, it thins northward from 125 to 91 m (Detterman and Hartsock, 1966, p. 35).

The Twist Creek Siltstone on those two peninsulas (figs. 4 and 5) was dated as early late Bajocian by Imlay (1962, p. A-6) on the basis of its ammonite faunule and its conformable position above two formations that contain ammonites of late middle Bajocian Age (Imlay, 1964, p. B7, B14).

LOWER KUSKOKWIM-BRISTOL BAY AREA

The late Bajocian ammonite *Leptosphinctes* was collected about 54 km north-northeast of the head of Togiak Bay (fig. 6) from beds consisting of argillite and thin bands of fine-grained tuff. This occurrence is within a sequence consisting of "massive coarse-grained volcanic conglomerate at least 152 meters thick overlying fine and medium-grained tuffs at least 30 meters thick" (J. M. Hoare, written commun., March 1979).

These beds are considered to be in the younger part of the Gemuk Group and are probably at least 305 m thick, but reliable estimates of their thickness cannot be made because of tight folding and much faulting (Hoare, 1961, p. 599).

AGE AND CORRELATION

The Twist Creek Siltstone on the west side of Cook Inlet and the lithologically and faunally equivalent beds in the Talkeetna Mountains were dated by Imlay (1962, p. A2, A3) as early late Bajocian (*Strenoceras subfurcatum* zone) on the basis of the

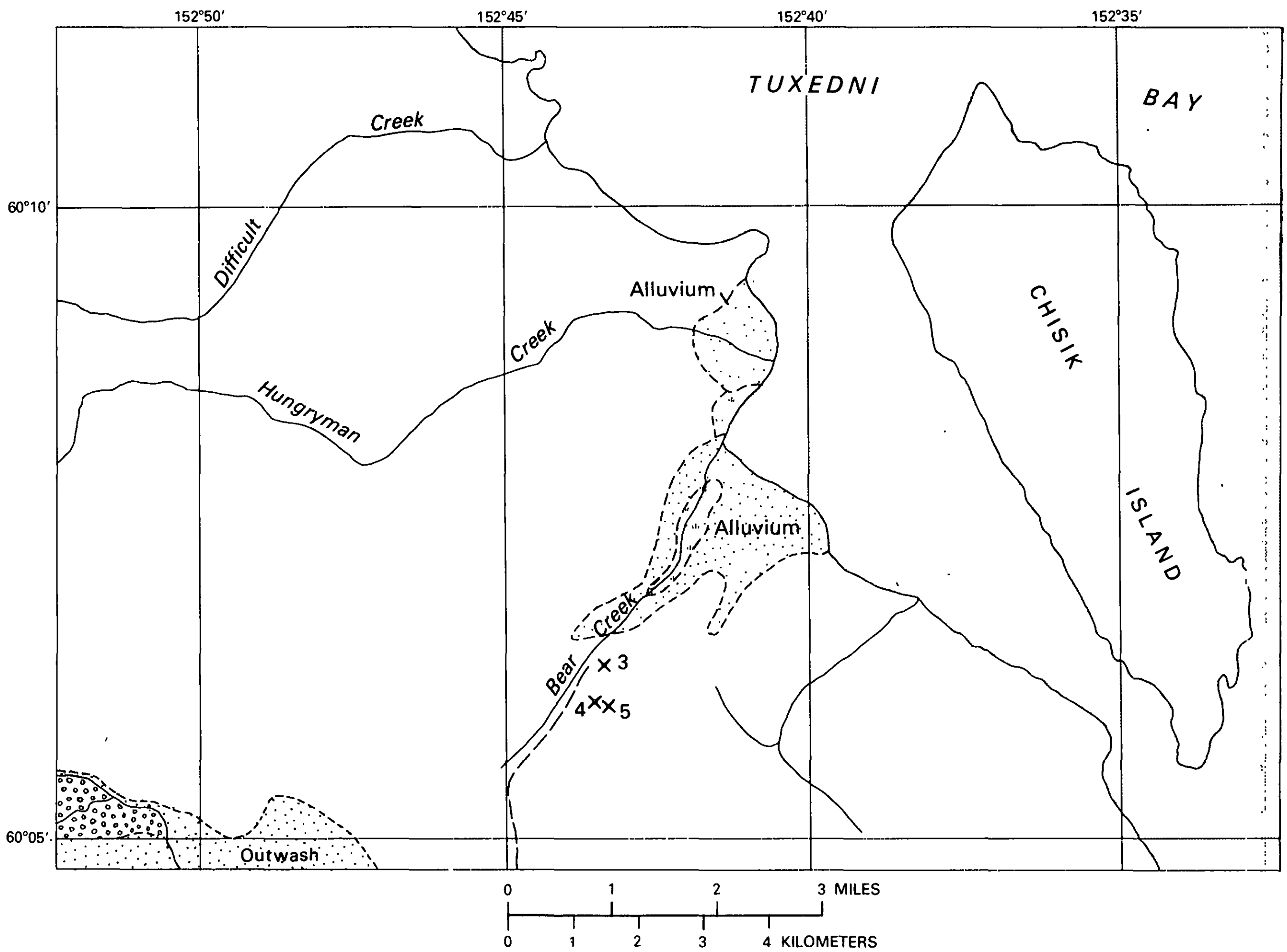

FIGURE 4.—Upper Bajocian ammonite localities in the Tuxedni Bay area, west of Cook Inlet. Numbers on map refer to listing in tables 2 and 3.

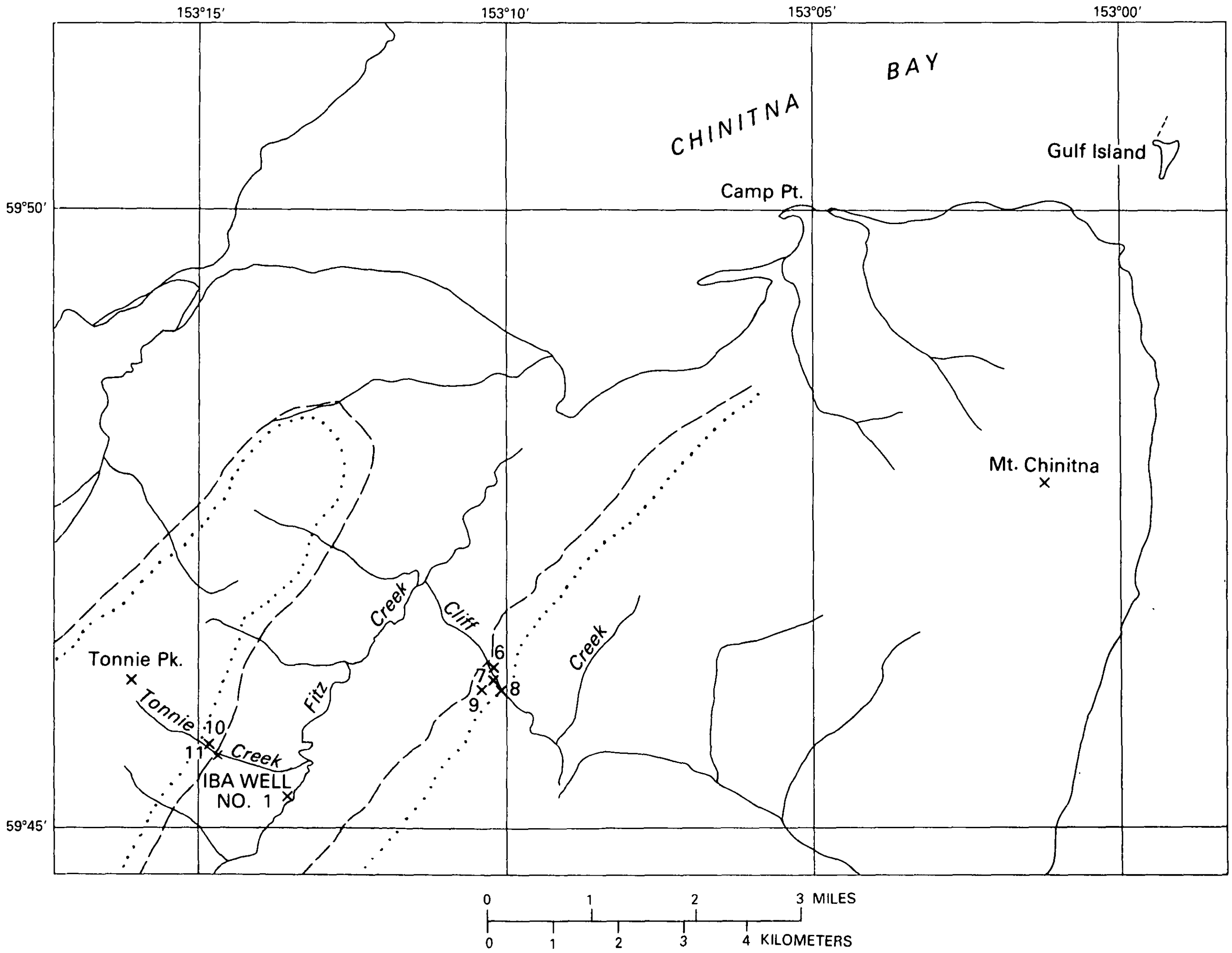

FIGURE 5.—Upper Bajocian ammonite localities in the northern part of the Iniskin Peninsula, west of Cook Inlet. Numbers on map refer to listing in tables 2 and 3. Top of Twist Creek Siltstone is indicated by dotted lines; its base is indicated by dashed lines.

association of the ammonites *Sphaeroceras*, *Spiroceras*?, and *Leptosphinctes*. That dating is herein upheld by the presence within the same beds of *Normannites*, *Stemmatoceras*, and *Stephanoceras*, which are rare or unknown elsewhere in the world later than early late Bajocian (see fig. 7) ; by the presence of *Cadomites*, which in Europe ranges from the highest part of the middle Bajocian through the Bathonian (Arkell, 1952, p. 70; Kopik, 1974, p. 9) ; and by the absence of *Chondroceras*, which is common nearly worldwide in the *Stephanoceras humphriesianum* zone of the middle Bajocian (Imlay, 1973, p. 19) but is unknown in beds of late Bajocian Age.

The only evidence to date that the Twist Creek Siltstone and equivalent beds in Alaska could be at least in part as old as latest middle Bajocian consists of the presence of *Cadomites* and *Leptosphinctes*, which in southeast France occur as low stratigraphically as the uppermost middle Bajocian (*Teloceras blagdeni* subzone of *Stephanoceras humphriesianum* zone) (Pavia, 1971, p. 83, 100, 101, tables 2 and 3). Similarly, *Leptosphinctes* has also been found in the Boulder Creek area of the Talkeetna Mountains (Imlay, 1964, p. B18, B54, B55, pl. 28, figs. 4–6) associated with species of *Stemmatoceras*, *Chondroceras* (abundant), and *Normannites* (U.S. Geol. Survey Mesozoic loc. 8572) that are identical with species that occur west of Cook Inlet in the Fitz Creek Siltstone and in the Cynthia Falls Sandstone of middle Bajocian Age but that do not occur in the overlying Twist Creek Siltstone. This occurrence of *Leptosphinctes* with many specimens of

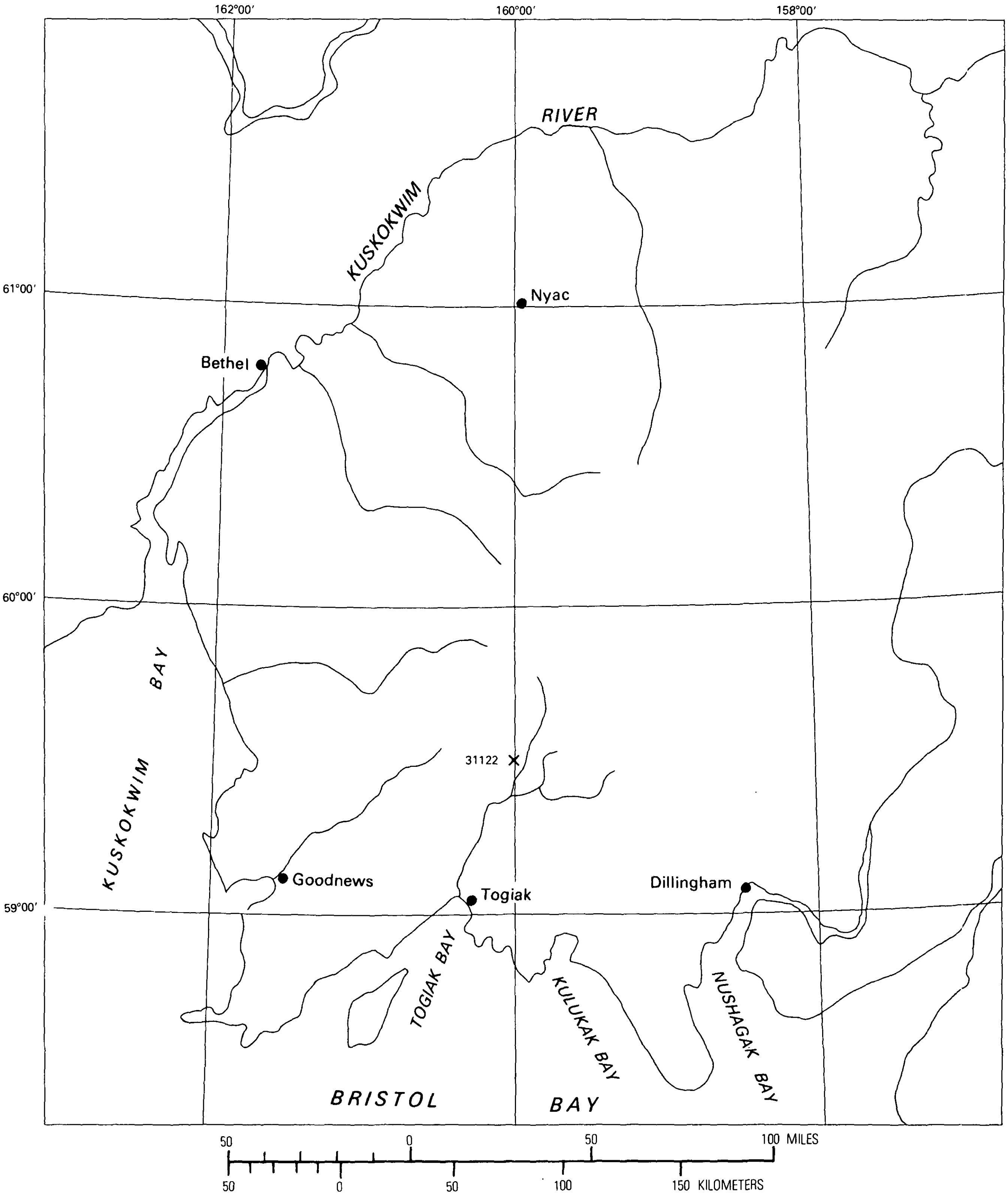

FIGURE 6.—Approximate occurrence of an upper Bajocian ammonite locality in the lower Kuskokwim-Bristol Bay area in southwestern Alaska. Number on map refers to listing on tables 2 and 3.

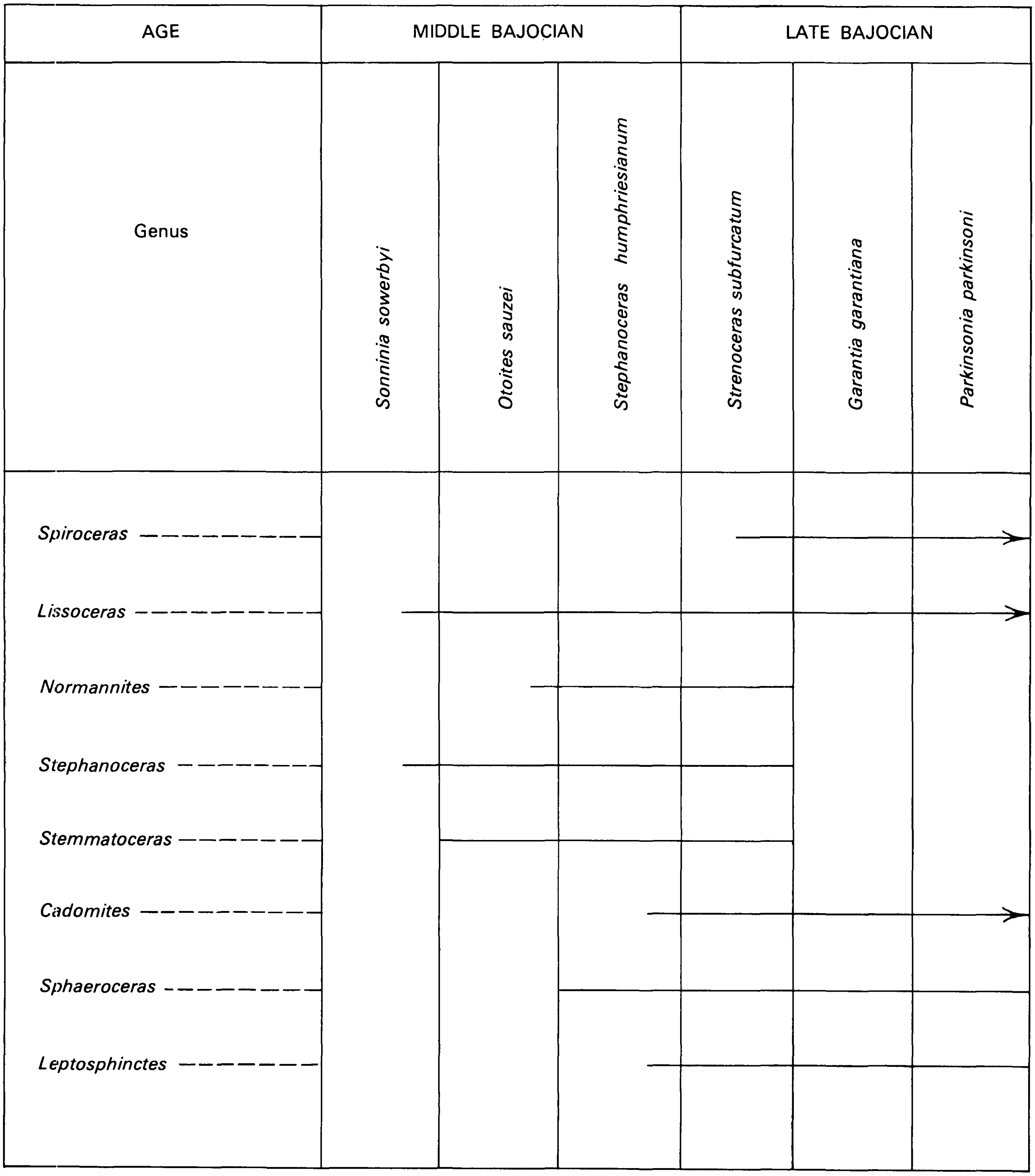

FIGURE 7.—Diagram showing European ranges of certain ammonite genera present in beds of late Bajocian Age in southern Alaska.

TABLE 2.—*Geographic distribution of late Bajocian*

[Numbers 1 and 2 are keyed to locality numbers in figs. 2 and 3. Numbers 3–11 are keyed to locality numbers in figs. 4 and places as the localities listed under those individual numbers. Higher numbers are USGS Mesozoic locality numbers.]

Genus and species	Talkeetna Mountains								
	Sheep Creek area	Boulder Creek area							
		Unnamed beds equivalent to Twist Creek Siltstone							
	1	2							
	24821	8572	30291	30580	30583	30589	30590	30591	30592
Phylloceras (*Macrophylloceras*) *grossicostatum* Imlay	×					×			
(*M.*) cf. *P.* (*M.*) *grossicostatum* Imlay									
Calliphylloceras freibrocki Imlay									
sp	×								
Lytoceras sp									
Spiroceras? sp									
Lissoceras bakeri Imlay									
Oppelia (*Liroxyites*) *kellumi* Imlay					×	×			
Normannites vigorosus (Imlay)	×	×				×			
boulderensis Imlay, n. sp						×			
Stephanoceras cf. *S. caamanoi McLearn*									
Stemmatoceras cf. *S. arcicostatum* Imlay	×					×			
sp								×	
Cadomites magnus Imlay, n. sp							×		
Megasphaeroceras rotundum Imlay	×		×	×		×			×
cf. *M. rotundum* Imlay									
sp									
Sphaeroceras talkeetnanum Imlay		×							
Leptosphinctes cliffensis Imlay									
cf. *L. leptus* Buckman									
(*Prorsisphinctes*?) *delicatus* Imlay									
(*P.*?) sp									
L.? sp									

Chondroceras at Mesozoic loc. 8572 contrasts with the absence of *Chondroceras* in the Twist Creek Siltstone; it shows that the lowest part of the range of *Leptosphinctes* in Alaska is the same as it is in France and definitely favors an early late Bajocian Age assignment for the Twist Creek Siltstone and equivalent beds in Alaska.

Similar early late Bajocian ammonites have been found elsewhere in North America in east-central Oregon near Seneca and Huntington and in the western interior region in southeastern Idaho and adjoining parts of Wyoming and Utah. In east-central Oregon, the ammonite faunule of that age is nearly the same as the faunule in the Twist Creek Siltstone in southern Alaska (Imlay, 1973, p. 28–31); the faunule in east-central Oregon differs by containing more specimens of *Spiroceras* and by the presence of the genus *Lupherites*. In the western interior region, the upper part of the Sliderock Member of the Twin Creek Limestone has furnished a much less varied ammonite faunule, consisting only of *Spiroceras*, *Megasphaeroceras*, *Stemmatoceras*, and *Stephanoceras* (Imlay, 1967, p. 26–29, 59). Nonetheless, the species of those genera are identical with or very similar to species in eastern Oregon and in Alaska.

Elsewhere in North America, the early late Bajocian is possibly represented in the Smithers area of British Columbia by specimens that have been assigned questionably to *Megasphaeroceras* by Frebold and Tipper (1973, p. 1130, pl. 3, figs. 2, 3). Likewise, the early late Bajocian is represented near Mixtepec, Oaxaca, in south-central Mexico by *Leptosphinctes* (Burckhardt, 1927, p. 27, pl. 10, figs. 11, 12) and *Parastrenoceras* (Burckhardt, 1927, p. 90, pl. 16, figs. 10, 11, 16; Ochoterena F., 1963, p. 1–15, pls. 1–4).

ammonites in southern Alaska by areas and localities

5 and in table 3. The columns numbered 6–11 represent two ammonite collections that are probably from some of the same

West side of Cook Inlet																	Lower Kuskokwim-Bristol Bay area
Tuxedni Bay area			Iniskin Peninsula														
Twist Creek Siltstone																	Gemuk Group (upper area)
3	4	5	6			7				8	9	10	11		6–11		12
21282	22709	22710	11034	19934	21314	11036	19943	21313	21315	26593	11035	20001	21318	27099	31713	31714	31122
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----	----	----	----	----	×	----	----	----	----	----	----	----	----	----	----	----	----

AMMONITE FAUNAL SETTING

The early late Bajocian ammonite genera found in southern Alaska are mostly of Tethyan origin. They are distinguished, however, from assemblages of the same age in southern Eurasia by the absence of any genus of the Parkinsoniidae and by the presence of *Megasphaeroceras* and *Oppelia* (*Liroxyites*). *Megasphaeroceras* has been found elsewhere in eastern Oregon (Imlay, 1973, p. 8, 54, 82, pl. 40, figs. 4–7) and in the western interior of the United States (Imlay, 1967, p. 96, pl. 14, figs. 1–6, 9–16, pl. 16, figs. 1–4) and is possibly represented at Tensas Creek in the Smithers area of central British Columbia (Frebold and Tipper, 1973, p. 1113, 1127, 1128, pl. 3, figs. 2, 3). The subgenus *Liroxyites* has been found elsewhere in northern Alaska associated with ammonites of middle Bathonian age (Imlay, 1976, p. 14, pl. 1, fig. 15). The fact that no ammonites of early late Bajocian Age have been found in arctic Alaska or in arctic Canada is good evidence that the ammonites of that age found in southern Alaska entered from the Pacific Ocean. Furthermore, such ammonites apparently lived considerably south of their present site in southern Alaska, as indicated by their close resemblances to species in Oregon and in the western region and by paleomagnetic data (Stone and Packer, 1979, p. 558–560, fig. 6).

GEOGRAPHIC DISTRIBUTION

Figure 1 shows the principal areas in southern Alaska in which late Bajocian ammonites have been found. Figure 2 shows the major areas in which such ammonites have been found in the Talkeetna Mountains, and figure 3 is a detailed index map of late

Bajocian ammonite occurrences in the Boulder Creek area of those mountains. Figures 4 and 5 are fairly detailed index maps of late Bajocian ammonite occurrences west of Cook Inlet. A single ammonite occurrence of that age in the lower Kuskokwim-Bristol Bay region is shown in figure 6. The geographic occurrences of the late Bajocian ammonite genera and species by areas and localities are shown herein in table 2. Detailed descriptions of those localities are given in table 3.

TABLE 3.—*Description of upper Bajocian ammonite localities in southern Alaska*

Locality No. (figs. 2–6)	USGS Mesozoic loc. No.	Collector's field No.	Collector, year of collection, description of locality, and stratigraphic assignment
1	24821	53AGz144	Arthur Grantz and L. F. Fay, 1953. Talkeetna Mountains near head of Sheep Creek, lat 61° 59′ 17″ N., long 147°38′35″ W., Anchorage (D–2) quadrangle. Tuxedni Group, near top in beds equivalent to the Twist Creek Siltstone.
2	8572	13Am21	G. C. Martin, 1913. Talkeetna Mountains at altitude of 4,200 ft (1,280 m) on ridge west of creek that enters main Boulder Creek from north, 3 miles (4.8 km) above its junction with the East Fork. Probably from west-central part of sec. 2, T. 21 N., R. 17 E., Anchorage (D–4) quadrangle. Tuxedni Group in beds equivalent to the Twist Creek Siltstone west of Cook Inlet.
2	30291	72ADf17	Don Hartman and R. W. Imlay, 1972. Talkeetna Mountains, on west side of a tributary of Boulder Creek, at same place as USGS Mesozoic loc. 30592. Tuxedni Group, from beds equivalent to the Twist Creek Siltstone west of Cook Inlet.
2	30580	74AI8	R. W. Imlay and Jordan Pflaker, 1974. Talkeetna Mountains. From 9 m of reddish-brown siltstone about 21 m below beds of Bathonian Age and 21 m above beds of late middle Bajocian Age. The reddish-brown siltstone occurs at the west base of a bluff and at the east end of a fairly flat area and is underlain by 44 m of brown to gray siltstone. NW ¼ sec. 26, T. 22 N., R. 7 E., Anchorage (D–3) quadrangle. Tuxedni Group in beds equivalent to the Twist Creek Siltstone west of Cook Inlet.
2	30583	74ADt 97	R. L. Detterman, 1974. Talkeetna Mountains. From brown-weathering siltstone and shale containing limestone concretions. On ridge 2.22 miles (3.52 km) N. 83° E. of VABM Suicide at altitude of 4,460 ft (1,341 m), SW ¼ SE ¼ sec. 34, T. 22 N., R. 7 E., Anchorage (D–4) quadrangle. Tuxedni Group, 30–46 m below beds at USGS Mesozoic loc. 30589 in beds equivalent to the Twist Creek Siltstone west of Cook Inlet.
2	30589	74ADt106	R. L. Detterman and R. W. Imlay, 1974. Talkeetna Mountains. From siltstone and gray limestone containing limestone concretions. On ridge top 0.35 mile (0.56 km) south of USGS Mesozoic loc. 30583 at altitude of 4,510 ft (1,356 m), NW ¼ NE ¼ sec. 3, T. 21 N., R. 7 E., Anchorage (D–4) quadrangle. Tuxedni Group, in beds equivalent to the Twist Creek Siltstone west of Cook Inlet.
2	30590	74ADT 107	R. L. Detterman and R. W. Imlay, 1974. Talkeetna Mountains, on east slope of ridge about midway between USGS Mesozoic locs. 30589 and 30591 at altitude of 4,000 ft (1,219 m), NE ¼ NE ¼ sec. 3, T. 21 N., R. 7 E., Anchorage D–4) quadrangle. Tuxedni Group, float from beds equivalent to the Twist Creek Siltstone west of Cook Inlet.
2	30591	74ADt108	R. L. Detterman and R. W. Imlay, 1974. Talkeetna Mountains. Brown-weathering siltstone containing limestone concretions. Downslope 0.2 mile (0.32 km) from USGS Mesozoic loc. 30590 at altitude of 3,670 ft (1,119 m), NW

TABLE 3.—*Description of upper Bajocian ammonite localities in southern Alaska*—Continued

Locality No. (figs. 2–6)	USGS Mesozoic loc. No.	Collector's field No.	Collector, year of collection, description of locality, and stratigraphic assignment
			cor. sec. 2, T. 21 N., R. 7 E., Anchorage (D–4) quadrangle. Tuxedni Group, float from beds equivalent to the Twist Creek Siltstone west of Cook Inlet.
2	30592	74ADt109	R. L. Detterman and R. W. Imlay, 1974. Talkeetna Mountains. Brown to gray siltstone containing limestone concretions. Downslope 0.2 mile (0.32 km) N. 85° E. from USGS Mesozoic loc. 30591 at altitude of 3,440 ft (1,036 m). NW ¼ NW ¼ sec. 2, T. 21 N., R. 7 E., Anchorage (D–4) quadrangle. Tuxedni Group, from beds equivalent to the Twist Creek Siltstone west of Cook Inlet.
3	21282	48AI81	R. W. Imlay and D. J. Miller, 1948. Tuxedni Bay area, on tributary entering Bear Creek from the southeast, 4.75 miles (7.6 km) S. 22° W. of Fossil Point. Twist Creek Siltstone, 300 ft (91 m) above base.
4	22709	51AGz140	Arthur Grantz, 1951. Tuxedni Bay area, about 0.3 mile (0.5 km) above mouth of tributary entering Bear Creek from southeast at a point 2.53 miles (4 km) from Tuxedni channel. Twist Creek Siltstone, about 100 ft (30.5 m) above base.
5	22710	51AGz141	Arthur Grantz, 1951. Tuxedni Bay area, about 0.5 mile (0.8 km) above mouth of same tributary described under Mesozoic loc. 22709. Twist Creek Siltstone, about 260 ft (79.6 m) above base.
6	11034	21ABF–42	A. A. Baker, 1921. Iniskin Peninsula, on right fork of Cliff Creek about 2,700 ft (823 m) above junction with left fork and 2.46 miles (4 km) S. 15° W. of mouth of Fitz Creek. Twist Creek Siltstone, about 100 ft (30.5 m) above base.
6	19934	44AWWF–3	Helmuth Wedow, Jr., 1944. Iniskin Peninsula, small tributary on right side of Cliff Creek about 5,100 ft (1,554 m) above junction with Fitz Creek and 2.42 miles (3.9 km) S. 14° W. of mouth of Fitz Creek. Twist Creek Siltstone, about 85 ft (26 m) above base.
6	21314	48AI30	R. W. Imlay and D. J. Miller, 1948. Iniskin Peninsula, on Cliff Creek 3.66 miles (5.8 km) N. 87° E. of Tonnie Peak. Same location as USGS Mesozoic locs. 11034 and 19934. Twist Creek Siltstone, 10–100 ft (3–30 m) above base.
7	11036	21ABF–43	A. A. Baker, 1921. Iniskin Peninsula, on right fork of Cliff Creek about 8,000 ft (2,438 m) above junction with Fitz Creek and 2.58 miles (4 km) S. 15° W. of mouth of Fitz Creek. Twist Creek Siltstone, 125–175 ft. (38–53 m) above base.
7	19943	44AWWF–12	Helmuth Wedow, Jr., 1944. Iniskin Peninsula, on Cliff Creek about 200 ft (67 m) downstream from a prominent cascade, 1¼ miles (2 km) above junction with Fitz Creek and 3.35 miles (5.3 km) east of Tonnie Peak. Twist Creek Siltstone, 125–175 ft (38–53 m) above base.
7	21313	48AI29	R. W. Imlay and D. J. Miller, 1948. Iniskin Peninsula, on Cliff Creek just below a cascade. Same location and stratigraphic position as USGS Mesozoic locs. 11036 and 19943.
7	21315	48AI31	R. W. Imlay and D. J. Miller, 1948. Iniskin Peninsula, on Cliff Creek near USGS Mesozoic locs. 21313 and 19943. Twist Creek Siltstone, float from lower 175 ft (53 m).
8	26593	57ADt5	R. L. Detterman, 1957. Iniskin Peninsula, on Cliff Creek near USGS Mesozoic loc. 21313, lat 59°49′20″ N., long 153°11′00″ W. Twist Creek Siltstone, 200 ft (61 m) above base.
9	11035	21ABF–44	A. A. Baker, 1921. Iniskin Peninsula, on right fork of right fork of Cliff Creek about 9,000 ft (2,743 m) above junction with Fitz Creek and 2.68 miles (4.2 km) S. 16° W. of mouth of Fitz Creek. Twist Creek Siltstone, lower part.

TABLE 3.—*Description of upper Bajocian ammonite localities in southern Alaska*—Continued

Locality No. (figs. 2–6)	USGS Mesozoic loc. No.	Collector's field No.	Collector, year of collection, description of locality, and stratigraphic assignment
10	20001	44AWWF-68	Helmuth Wedow, Jr., and L. B. Kellum, 1944. Iniskin Peninsula, on northeast side of Tonnie Creek about 200 ft (61 m) downstream from top of a cascade, which is 0.9 mile (1.4 km) S. 48° E. of Tonnie Peak. Twist Creek Siltstone, about 100 ft (30.5 m) above base.
11	21318	48AI35	R. W. Imlay and D. J. Miller, 1948. Iniskin Peninsula, on Tonnie Creek 1 to 1.05 miles (1.6 km) S. 51° E. of Tonnie Peak. Same location as USGS Mesozoic loc. 27099. Twist Creek Siltstone, 50–125 ft (15–38 m) above base.
11	27099	58ADt2	R. L. Detterman, 1958. Iniskin Peninsula, on Tonnie Creek 0.81 mile N. 55° W. of Iniskin Bay Association No. 1 well. Lat 59°45'30"N., long. 153°15'05"W. Same location as USGS Mesozoic loc. 21318. Twist Creek Siltstone, 75–100 ft ((23–30 m) above base.
6–11	31713	B37 (29471 on specimen)	Carleton Beal, 1937. Iniskin Peninsula. Probably in Cliff Creek at or near USGS Mesozoic loc. 21314 (No. 6 on fig. 5), judging by the large number of ammonite genera present. Probably in NW ¼ SE ¼ sec. 3, T. 5 S., R. 23 W., Iliamna (D–1) quadrangle. Twist Creek Siltstone, probably in lower 100 ft (30 m).
6–11	31714	No field number (29466 on specimen)	Carleton Beal?, 1937? Iniskin Peninsula. Probably on Tonnie Creek at or near USGS Mesozoic loc. 20001 (No. 10 on fig. 5), judging by the small number and the kind of ammonite genera present. Probably in SW ¼ NE ¼ NE ¼ sec. 7, T. 5 S., R. 23 W., Iliamna (D–1) quadrangle. Twist Creek Siltstone.
12	31122	GC3-1116	W. L. Coonrad and J. M. Hoare, 1975. Lower Kuskokwin-Bristol Bay region. From north-facing scree slope consisting of argillite and thin bands of fine-grained tuff. At altitude of about 1,400 ft (427 m) in SE cor. NW ¼ sec. 3, T. 8 S., R. 63 W., lat 59°30'51" N., long 159°59'36" W., Goodnews (C–3) quadrangle, Gemuk Group, upper part.

SYSTEMATIC DESCRIPTIONS

Family PHYLLOCERATIDAE Zittel, 1884
Subfamily PHYLLOCERATINAE Zittel, 1884
Genus PHYLLOCERAS Suess, 1865
Subgenus MACROPHYLLOCERAS Spath, 1927

Phylloceras (Macrophylloceras) grossicostatum Imlay

Plate 1, figures 1–3

Phylloceras (*Macrophylloceras*) *grossicostatum* Imlay, n. sp., 1953, U.S. Geological Survey Professional Paper 249–B, p. 74, pl. 25, figs. 11–13, 15, 16.

Macrophylloceras cf. *M. grossicostatum* Imlay, 1962, U.S. Geological Survey Professional Paper 418–A, A5, pl. 5, figs. 6, 7.

Phylloceras (*Macrophylloceras*) *grossicostatum* Imlay, 1980, U.S. Geological Survey Professional Paper 1091, p. 16, pl. 1, figs. 12, 13.

This species originally was based on six specimens from the lower part of the Chinitna Formation west of Cook Inlet (Imlay, 1953, p. 74), but more recently it was collected from the underlying Bowser Formation and Twist Creek Siltstone in the same area and from equivalent beds in the Talkeetna Mountains. To date, 13 septate specimens have been collected from the Bowser Formation and equivalent beds and 14 specimens from the Twist Creek Siltstone and equivalent beds. These collections show that the innermost whorls are smooth and that very fine riblets and striae appear at a diameter of about 26 mm. These riblets pass into striae near the umbilicus, become stronger ventrally and adorally, and persist to diameters of 60–70 mm. In addition, at a diameter of about 30 mm, some broad, low, gently flexuous ribs appear on the upper two-thirds of the flanks but tend to fade out on the venter at diameters less than 60 mm. Adorally, these broad ribs become prominent or fairly prominent within about one-fourth of a whorl, or at diameters of 60–70 mm, and become separated by broad flat interspaces. The coarseness of these ribs varies somewhat from one specimen to another and is intermediate on the holotype.

Types.—Holotype, USNM 108014; paratypes, USNM 10815–10817; hypotypes, USNM 273501–273503.

Occurrences.—Twist Creek Siltstone west of Cook Inlet at USGS Mesozoic loc. 11035, 21313, 21314, 31713 and 31714. Equivalent unnamed beds in the Talkeetna Mountains at USGS Mesozoic locs. 24821 and 30589.

Subfamily CALLIPHYLLOCERATINAE, Spath, 1929
Genus CALLIPHYLLOCERAS Spath, 1927

Calliphylloceras freibrocki (Imlay)

Plate 1, figures 4–7

Phylloceras (*Calliphylloceras*) *freibrocki* Imlay n. sp., 1953, U.S. Geological Survey Professional Paper 249–B, p. 73, pl. 26, figs. 7–11.

Calliphylloceras freibrocki (Imlay), 1980, U.S. Geological Survey Professional Paper 1091, p. 16, pl. 1, figs. 7–9, 11.

This species is represented in the Twist Creek Siltstone by three specimens that closely resemble the type specimens from the Chinitna Formation in shape, in fineness of ribbing (lirae), and in the gently sigmoidal pattern of both ribs and constrictions on the flanks.

Types.—Holotype, USNM 108006; paratypes, USNM 108007, 108008; hypotypes, 273504, 273505.

Occurrence.—Twist Creek Siltstone west of Cook Inlet at USGS Mesozoic locs. 20001 and 31714.

Family HAPLOCERATIDAE Zittel, 1884
Genus LISSOCERAS Bayle, 1879

Lissoceras bakeri Imlay

Plate 2, figure 8

Lissoceras bakeri Imlay, 1962, U.S. Geological Survey Professional Paper 418–A, p. A6, pl. 1, figs. 1–6, 9–12.

The nearly complete adult specimen illustrated herein shows that the adult body chamber occupies nearly half a whorl and retracts a little from the outermost septate whorl. At a diameter of 135 mm, the whorl height is about 60 mm and the umbilical width is 30 mm.

Types.—Holotype, USNM 130886; paratypes, USNM 130887a, b, 130888, 130889a–c, 130890; hypotype, 273506.

Occurrence.—Twist Creek Siltstone west of Cook Inlet at USGS Mesozoic locs. 11034, 19934, 21282, 21314, 21315, 22709, 22710, and 31713.

Family OPPELIIDAE Bonarelli, 1894
Subfamily OPPELIINAE Bonarelli, 1894
Genus OPPELIA Waagen, 1869
Subgenus LIROXYITES Imlay, 1962

Oppelia (Liroxyites) kellumi Imlay

Plate 2, figures 1, 2, 6, 7

Oppelia (*Liroxyites*) *kellumi* Imlay, n. sp., 1961, Journal of Paleontology, v. 35, no. 3, p. 470, pl. 63, figs. 5, 7–9.

Oppelia (*Liroxyites*) *kellumi* Imlay, 1962, U.S. Geological Survey Professional Paper 418–A, p. A8, pl. 2, figs. 1–12.

This species, now represented by 68 specimens, is the second most abundant species in the upper Bajocian beds of southern Alaska. It is characterized by its discoidal shape, highly evolute coiling, sharp venter, broad falcoid ribs and falcoid striae that persist onto the body chamber, and by the presence of faint broad spiral bands. Its ornamentation varies considerably in strength from one specimen to another. Three specimens in which the ribs and bands are fairly conspicuous are illustrated herein.

Types.—Holotype, USNM 130886; paratypes, USNM 130887a, b, 130888, 130889a–c, 130890; hypotypes, USNM 273507–273509.

Occurrences.—Twist Creek Siltstone west of Cook Inlet at USGS Mesozoic locs. 11035, 11036, 19943, 20001, 21282, 21313, 21314, 21315, 21318, 27099, 31713 and 31714. Equivalent beds in the Talkeetna Mountains at USGS Mesozoic locs. 30583 and 30589.

Family STEPHANOCERATIDAE Neumayr, 1875
Genus NORMANNITES Munier-Chalmas, 1892

Normannites vigorosus (Imlay)

Plate 4, figures 1–4

Dettermanites vigorosus Imlay, n. sp., 1961, Journal of Paleontology, v. 35, no. 3, p. 472, pl. 64, figs. 1–3.

Dettermanites vigorosus Imlay, 1962, U.S. Geological Survey Professional Paper 418–A, p. A12, pl. 4, figs. 1–9.

This species is represented by 17 specimens. It differs from most species of *Normannites* by attaining a larger size, by having more secondary ribs per primary rib, and by the secondary ribs being much weaker than the primary ribs. Among the 17 specimens available, the strength of ribbing varies appreciably, but the number of secondary ribs per primary rib varies from three to four. Generally, two secondary ribs arise from tubercles near the middle of the flanks, and one or two secondary ribs arise freely between the tubercles.

Normannites vigorosus (Imlay) greatly resembles *N. formosus* Buckman (1920, pl. 151, figs. 1–3; Westermann, 1954, p. 259, pl. 22, fig. 4, pl. 23, figs. 1a–c; Imlay, 1973, p. 84, pl. 41, fig. 19) but differs by having stronger primary ribs and much weaker secondary ribs.

Type.—Holotype, USNM 130895; paratypes, USNM 130896, 130897a, b; hypotypes, USNM 273510, 273511.

Occurrences.—Twist Creek Siltstone on the Iniskin Peninsula at USGS Mesozoic locs. 11034–11036, 19934, 21314, 21318, and 31713. Equivalent beds in the Talkeetna Mountains at USGS Mesozoic locs. 8572, 24821, and 30589.

Normannites boulderensis Imlay, n. sp.

Plate 3, figures 2–8

This species is represented by three internal molds preserved in concretions. The whorls are coronate in section, much wider than high, and each embraces nearly half of the preceding whorl. The body chamber is incomplete but occupies three-fourths of a whorl and is not contracted from the preceding septate whorl. The umbilicus is moderately wide. Its wall is steeply inclined and rounds evenly into the flanks.

On septate whorls, the primary ribs are sharp, high, widely spaced, incline slightly forward, and terminate near the middle of the flanks in acute prominent tubercles. From these pass two, or rarely one, somewhat weaker secondary ribs that incline forward on the flanks and cross the venter transversely. A few ribs arise freely along the zone of tuberculation. All ribs gradually become stronger and sparser during growth. Adorally on the body chamber, the secondary ribs become even stronger than the primary ribs.

The holotype at a diameter of 95 mm has a whorl height of 30 mm and an umbilical width of 45 mm. The paratype at a diameter of 80 mm has a whorl height of 22 mm, a whorl thickness of 35 mm, and an umbilical width of 42 mm.

The suture line is similar to that on *Normannites vigorosus* (Imlay) (1962, p. A12, pl. 4, fig. 7) but differs by its ventral lobe being of about the same length as the first lateral lobe.

The three specimens herein assigned to *Normannites boulderensis* Imlay, n. sp., bear some resemblance to the coarsely ribbed variant of *N. vigorosus* with which they are associated. They differ by having much stronger and fewer secondary ribs that adorally on the body chamber become as strong or stronger than the primary ribs.

These three specimens bear more resemblance to *Normannites orbignyi* Buckman (1927, pl. 734, figs. 1–3; Westermann, 1954, p. 138, pl. 5, figs. 3, 4, pl. 6, fig. 1; Imlay, 1973, p. 82, pl. 41, figs. 9, 10, 18, 20) but differ by being less evolute, by bearing more prominent tubercles, and by the largest specimen attaining a much larger size.

Types.—Holotype, USNM 273512, paratypes 273513, 273514.

Occurrences.—Twist Creek Siltstone on the Iniskin Peninsula at USGS Mesozoic loc. 31713. Unnamed beds in the Talkeetna Mountains at USGS Mesozoic loc. 30589.

Genus STEPHANOCERAS Waagen, 1869

Stephanoceras cf. S. caamanoi McLearn

Plate 3, figure 1

One small septate Alaskan ammonite bears ribs and tubercles that are similar in strength and density to those on the inner whorls of *Stephanoceras caamanoi* McLearn (1930, p. 5, pl. 2, fig. 2; 1932a, p. 55, pl. 2, fig. 2, pl. 3, fig. 7, pl. 4, fig. 8; Frebold, 1964, pl. 15, figs. 1a, b). This ammonite differs from *Stephanoceras* (*Skirroceras*) *kirschneri* Imlay (1964, p. B47, pl. 18, figs. 1–4, pl. 19; 1973, p. 87, pl. 30, fig. 13; pl. 42, figs. 1–10) at a comparable size by having fewer and finer primary ribs, much weaker tubercles, and fewer secondary ribs per primary rib.

Figured specimen.—USNM 273515.

Occurrences.—Twist Creek Siltstone at USGS Mesozoic loc. 31713.

Genus STEMMATOCERAS Mascke, 1907

Stemmatoceras cf. S. arcicostatum Imlay

Plate 5, figures 1–10

Six somewhat crushed septate specimens are characterized by fairly evolute coiling; by a depressed whorl section; by fairly strong, widely spaced primary ribs that curve slightly forward and terminate in acute tubercles a little above the middle of the flank; and by weak secondary ribs that arise from the primary ribs by threes and fours and then arch gently forward on the venter.

These specimens differ from *Stemmatoceras albertense* McLearn (1928, p. 20, pls. 5–7; Warren, 1947, p. 67, pl. 5, fig. 1; Frebold, 1957, p. 50, 51, pl. 21, figs. 2a, b, pl. 23, figs. 1a–c) by having finer and more numerous secondary ribs. The specimens show more resemblance to *S. arcicostatum* Imlay (1967, p. 90, pl. 8; figs. 1, 2; pl. 9, figs. 1–11) but apparently have a more depressed whorl section and sharper primary ribs.

Figured specimens.—USNM 273516–273521.

Occurrences.—Twist Creek Siltstone on Iniskin Peninsula, USGS Mesozoic loc. 31713. Equivalent unnamed beds in the Talkeetna Mountains at USGS Mesozoic locs. 24821 and 30589.

Stemmatoceras sp.

Plate 6, figures 1–5; plate 7, figure 2

One fairly large laterally compressed ammonite consists of parts of two septate whorls and half of a body whorl. The septate whorls bear strong primary ribs that incline gently forward and terminate in strong tubercles near the middle of the flanks. From these tubercles pass three or four rather weak secondary ribs that incline forward on the flanks but cross the venter nearly transversely. Other secondary ribs arise freely along the zone of tuberculation, resulting in nearly five secondary ribs for each primary rib.

On the body chamber, the primary ribs are low, very broad, become less distinct adorally, and terminate in acute tubercles near the middle of the flanks. The secondary ribs are very broad and low at the adapical end of the body chamber and become faint adorally within one-fourth of a whorl.

This ammonite differs from some ammonites described previously as *Stemmatoceras* n. sp. indet. (Imlay, 1964, p. B48, pl. 20, figs. 1–4) by having slightly weaker primary ribs and a higher whorl section. Its septate whorls greatly resemble those of the holotype of *S. palliseri* McLearn (1932b, p. 114, pl. 2, pl. 5, fig. 1). It likewise resembles the septate whorls of an Alaskan specimen that was compared with *S. palliseri* McLearn by Imlay (1964, p. B48, pl. 20, figs. 5, 6, pl. 21, figs. 2, 4), but this ammonite differs by having weak instead of strong ribbing on its body chamber.

Figured specimen.—USNM 273522.

Occurrence.—Unnamed beds in the Boulder Creek area of the Talkeetna Mountains at USGS Mesozoic loc. 30591.

Genus CADOMITES Munier-Chalmas, 1892

Cadomites magnus Imlay, n. sp.

Plate 4, figure 10; plate 7, figures 1, 3, 4

One fairly large specimen is septate except for the outermost one-fourth whorl, which is crushed ventrally. The outer two septate whorls are fairly well exposed, are depressed coronate in section, and become more depressed during growth.

On the next to outermost septate whorl, the primary ribs are moderate in height and spacing, become broader, lower, and more widely spaced adorally, curve gently forward on the umbilical wall, and terminate in weak nodes a little below the middle of the flanks. From these nodes pass three to four very fine, closely spaced secondary ribs. In addition, one or two very fine secondary ribs arise freely between the nodes.

Adorally on the outermost septate whorl, the primary ribs become much lower, broader, and more widely spaced, and the secondary ribs are replaced by densely spaced striations, or lirae.

On the preserved adapical part of the nonseptate whorl, the primary ribs are even lower and broader, and the upper parts of the flanks as well as the venter are smooth.

On the septate whorls at a diameter of 84 mm the whorl height is 33 mm and the whorl thickness is 44 mm. At a diameter of 132 mm, the whorl height is 44 mm and the whorl thickness is 62 mm.

The secondary ribs on the Alaskan specimen are comparable in fineness and density with the secondary ribs on *Cadomites exstinctus* (Quenstedt) (1887, p. 630, pl. 74, figs. 30, 32–34; Hahn, 1971, p. 110, pl. 9, figs. 10–13) and on some specimens that have been assigned to *Cadomites rectelobatus* (Hauer) by Sturani (1964, p. 22, pl. 2, figs. 6, 8). The Alaskan specimen differs, however, by its primary ribs becoming weaker, broader, and sparser during growth, by its secondary ribs becoming much finer on the outermost septate whorl, by the ventral part of the adapical fourth of the body chamber becoming smooth, and by attaining a much larger size.

The ribbing on the next to the outer septate whorl of the Alaskan specimen is also comparable in fineness with that on two ammonites that were illustrated under the new generic names *Polystephanus* and *Stegeostephanus* by Buckman (1922, pl. 311 and 312) but which were considered to be synonyms of *Cadomites deslongchampsi* (d'Orbigny) by Arkell (1952, p. 80). Nonetheless the lectotype of that species (Arkell, 1952, v. 3, p. 79, text-fig. 21) as well as a specimen assigned to that species by Hahn (1971, p. 111, pl. 9, fig. 16) differ from the Alaskan specimen by having coarser ribbing that persists onto the body chamber.

In summation, the Alaskan specimen bears fine ribbing as in *C. exstinctus* (Quenstedt) and on some specimens of *C. deslongchampsi* (d'Orbigny) and *C. rectelobatus* (Hauer). The Alaskan specimen differs by its secondary ribs becoming much finer on its outermost septate whorl, by its primary ribs becoming much broader and more widely spaced adorally, and by its venter becoming smooth on at least the adapical part of the body chamber.

Type.—Holotype, USNM 273523.

Occurrence.—Unnamed beds in the Talkeetna Mountains at USGS Mesozoic loc. 30590.

Family SPHAEROCERATIDAE Buckman, 1920
Genus MEGASPHAEROCERAS Imlay, 1961

Megasphaeroceras rotundum Imlay

Plate 4, figures 8, 11

Megasphaeroceras rotundum Imlay, n. sp., 1961, Journal of Paleontology, v. 35, no. 3, p. 471, pl. 63, figs. 1–4, 6.

Megasphaeroceras rotundum Imlay, 1962, U.S. Geological Survey Professional Paper 418-A, p. A10, pl. 3, figs. 1-4, 6.

This species, represented by 106 specimens in available collections, is the most common species in the upper Bajocian beds of southern Alaska. It is characterized by stout to moderately stout whorls, a depressed whorl section; a tiny umbilicus; sharp, forked gently flexuous, forwardly inclined ribs on the septate part of the shell, and much weaker and broader ribs and some striae on the body chamber. The ribbing is much weaker on the internal molds of the septate whorls than on the shell and becomes weak to indistinct on internal molds of the adult body chamber. The specimens illustrated herein bear more shelly material on their body chambers than do most specimens of the species and hence bear more distinct ribbing.

Types.—Holotype, USNM 130898; paratypes, USNM 130899a-d, 130900; hypotypes, USNM 273524 and 275775.

Occurrences.—Twist Creek Siltstone west of Cook Inlet at USGS Mesozoic locs. 11035, 11036, 19943, 21282, 21313-21315, 21318, 22709, 26593, 27099, 31713, and 31714. Equivalent unnamed beds in the Talkeetna Mountains at USGS Mesozoic locs. 24821, 30291, 30580, 30589, and 30592.

Genus SPHAEROCERAS Bayle, 1878

Sphaeroceras talkeetnanum Imlay

Plate 2, figures 3-5

Sphaeroceras talkeetnanum Imlay, 1962, U.S. Geological Survey Professional Paper 418-A, p. A11, pl. 5, figs. 1-4.

This species, originally based on a single specimen, is now represented by another specimen that differs only by being a little more globose.

Types.—Holotype, USNM 130902; hypotype, USNM 273525.

Occurrences.—Unnamed beds in the Talkeetna Mountains at USGS Mesozoic loc. 8572; Twist Creek Siltstone on the Iniskin Peninsula at USGS Mesozoic loc. 31713.

Family PERISPHINCTIDAE Steinmann, 1890
Subfamily LEPTOSPHINCTINAE Arkell, 1950
Genus LEPTOSPHINCTES Buckman, 1920

Leptosphinctes cf. L. leptus Buckman

Plate 4, figures 6, 7, 9

Six laterally crushed ammonite fragments bear sharp, moderately spaced primary ribs that incline slightly forward on the flanks. Most of the primary ribs divide at about three-fifths of the height of the flanks into pairs of slightly weaker ribs that trend forward only slightly. A few primary ribs remain simple, and some secondary ribs are indistinctly connected with the primary ribs. A constriction appears to be present near the adoral end of the largest fragment.

The rib pattern on these specimens is similar to that on *Leptosphinctes leptus* Buckman (1920, pl. 160) from England and to that on *L.* cf. *leptus* Buckman (Imlay, 1973, p. 91, pl. 47, fig. 25), from eastern Oregon.

Figured specimens.—USNM 273526.

Occurrence.—Unnamed beds in the lower Kuskokwim-Bristol Bay area of southwestern Alaska at USGS Mesozoic loc. 31122.

Subgenus PRORSISPHINCTES Buckman, 1921

Leptosphinctes (Prorsisphinctes?) sp.

Plate 4, figure 5

One specimen is characterized by high, sharp, widely spaced primary ribs that incline slightly forward on the flanks. They divide at about three-fifths of the height of the flanks into pairs of weaker secondary ribs that incline considerably forward.

The rib pattern is similar to that on the inner whorls of *L.* (*Prorsisphinctes*) *pseudomartinsi* (Siemiradzki) (Arkell and others, 1957, p. L314, fig. 395) from Europe and to that on the inner whorls of *L.* sp. from eastern Oregon (Imlay, 1973, p. 91, pl. 47, fig. 24). Its ribs are a little higher and sharper than those on *L. cliffensis* Imlay from the Iniskin Peninsula west of Cook Inlet (Imlay, 1962, p. A12, pl. 5, figs. 10, 11). Its ribbing is much stronger than that on *L.* (*Prorsisphinctes*?) *delicatus* Imlay (1962, p. A13, pl. 5, figs. 8, 9).

Figured specimens.—USNM 273527.

Occurrence.—Unnamed beds in the lower Kuskokwim-Bristol Bay area of southwestern Alaska at USGS Mesozoic loc. 31122.

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[Italic page numbers indicate descriptions and principal references]

PLATES 1-7

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Denver, Colorado 80225

PLATE 1

[All figures are natural size]

FIGURES 1–3. *Phylloceras (Macrophylloceras) grossicostatum* Imlay (p. 14).
1. Hypotype, USNM 273501, from USGS Mesozoic loc. 31713.
2. Hypotype of immature specimen, USNM 273503, from USGS Mesozoic loc. 24821.
3. Hypotype, USNM 273502, from USGS Mesozoic loc. 21314.

4–7. *Calliphylloceras freibrocki* (Imlay) (p. 15).
4. Hypotype, USNM 273505, from USGS Mesozoic loc. 31714.
5–7. Hypotype, USNM 273504, from USGS Mesozoic loc. 31714.

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MACROPHYLLOCERAS AND *CALLIPHYLLOCERAS*

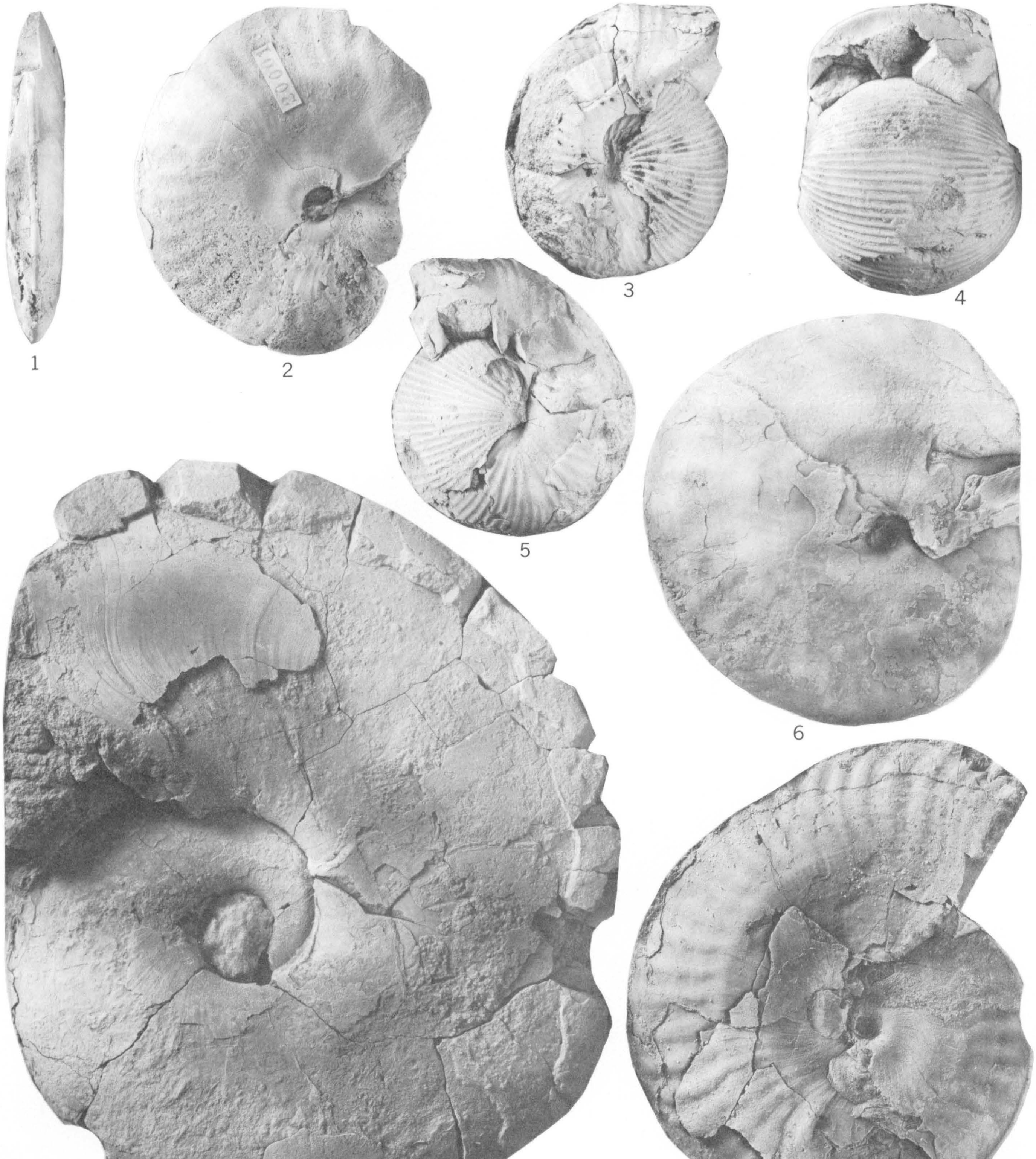
PLATE 2

[All figures are natural size]

FIGURES 1, 2, 6, 7. *Oppelia* (*Liroxyites*) *kellumi* Imlay (p. 15).
- 1, 2. Ventral and lateral views of hypotype, USNM 273509, from USGS Mesozoic loc. 20001.
- 6. Hypotype, USNM 273508, from USGS Mesozoic loc. 20001.
- 7. Hypotype, USNM 273507, from USGS Mesozoic loc. 31713. Shows broad falcoid ribs, falcoid striae, and faint spiral bands and striae.

3–5. *Sphaeroceras talkeetnanum* Imlay (p. 18).
Lateral and ventral views of hypotype, USNM 273525, from USGS Mesozoic loc. 31713.

8. *Lissoceras bakeri* Imlay (p. 15).
Adult specimen showing complete body chamber. Hypotype, USNM 273506, from USGS Mesozoic loc. 31713.



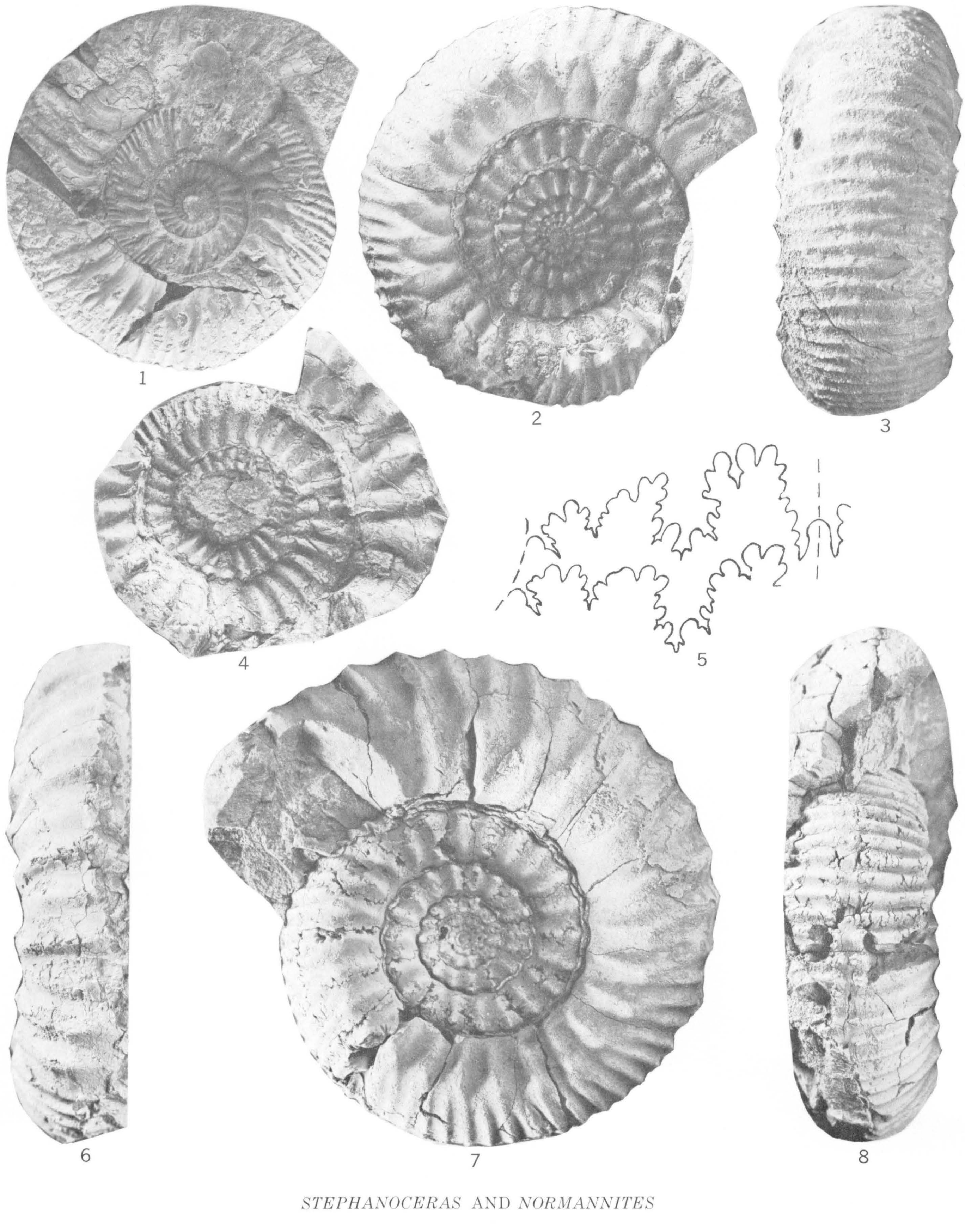
LIROXYITES, *SPHAEROCERAS*, AND *LISSOCERAS*

PLATE 3

[All figures are natural size]

FIGURE 1. *Stephanoceras* cf. S. *caamanoi* McLearn (p. 16).
Figure specimen, USNM 273515, from USGS Mesozoic loc. 31713.

2–8. *Normannites boulderensis* Imlay, n. sp. (p. 16).
2, 3. Lateral and ventral views of paratype, USNM 273513, from USGS Mesozoic loc. 30589.
4. Lateral view of paratype, USNM 273514, at USGS Mesozoic loc. 30589. Shows characteristic ribbing on a septate whorl.
5–8. Suture line and ventral, lateral, and apertural views of holotype, USNM 273512, from USGS Mesozoic loc. 31713.



STEPHANOCERAS AND *NORMANNITES*

PLATE 4

[All figures are natural size]

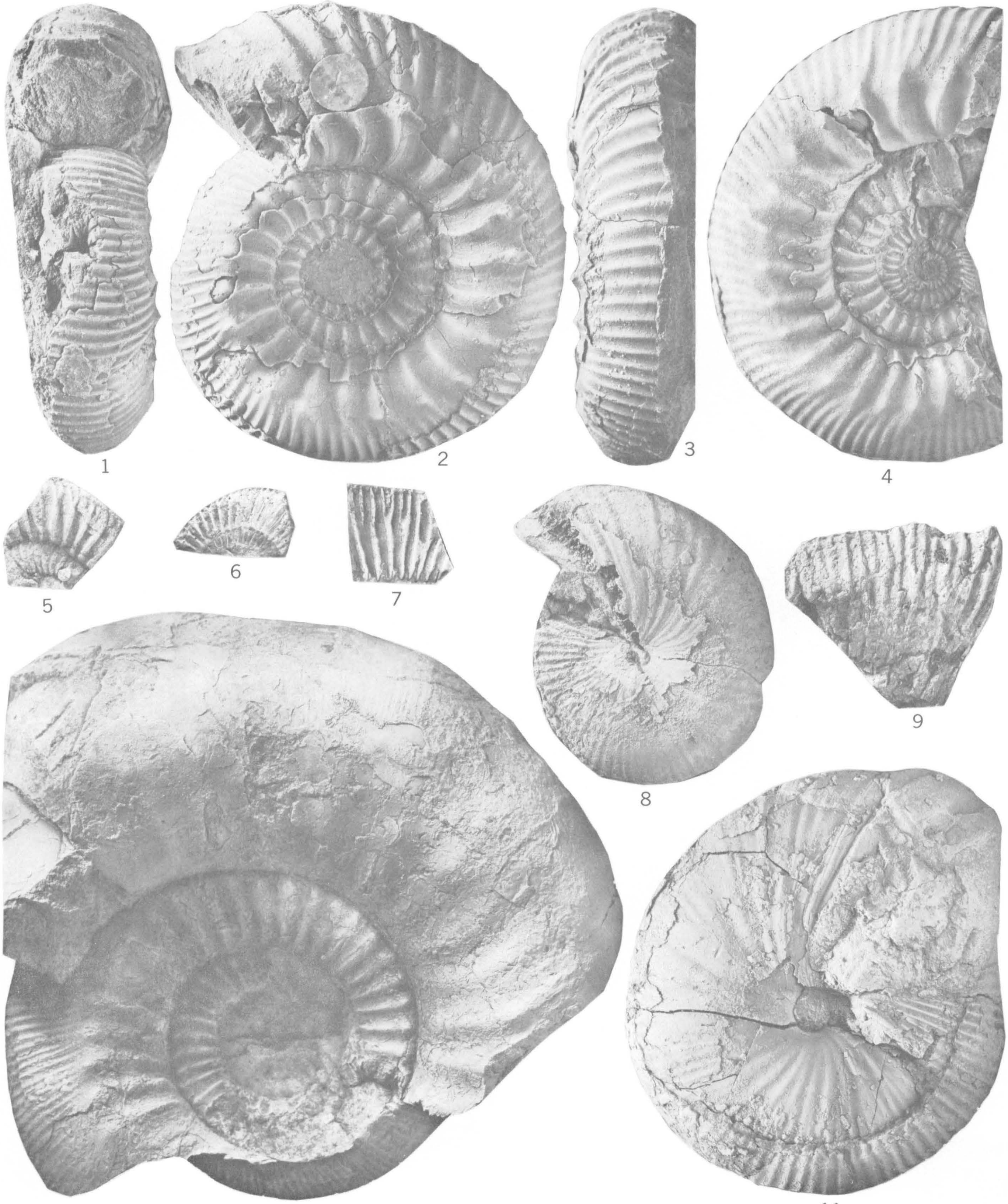
FIGURES 1–4. *Normannites vigorosus* (Imlay) (p. 15).
1–3. Apertural, lateral, and ventral views of hypotype, USNM 273511, from USGS Mesozoic loc. 11036.
4. Hypotype, USNM 273510, from USGS Mesozoic loc. 19934.

5. *Leptosphinctes* (*Prorsisphinctes*?) sp. (p. 18).
Figured specimen, USNM 273527, from USGS Mesozoic loc. 31122.

6, 7, 9. *Leptosphinctes* cf. *L. leptus* Buckman (p. 18).
Laterally crushed fragments, USNM 273526, from USGS Mesozoic loc. 31122.

8, 11. *Megasphaeroceras rotundum* Imlay (p. 17).
8. Small septate hypotype, USNM 275775, from USGS Mesozoic loc. 30291.
11. Hypotype, USNM 273524, from USGS Mesozoic loc. 11035. Shows distinct ribbing on adult body chamber.

10. *Cadomites magnus* Imlay n. sp. (p. 17).
Holotype, USNM 273523, from USGS Mesozoic loc. 30590. Shows about 80 mm of body chamber.



NORMANNITES, LEPTOSPHINCTES, MEGASPHAEROCERAS, AND *CADOMITES*

PLATE 5

[All figures are natural size]

FIGURES 1–10. *Stemmatoceras* cf. S. *arcicostatum* Imlay (p. 16).

1, 2. Ventral and lateral views of septate whorls, USNM 273519, from USGS Mesozoic loc. 24821.

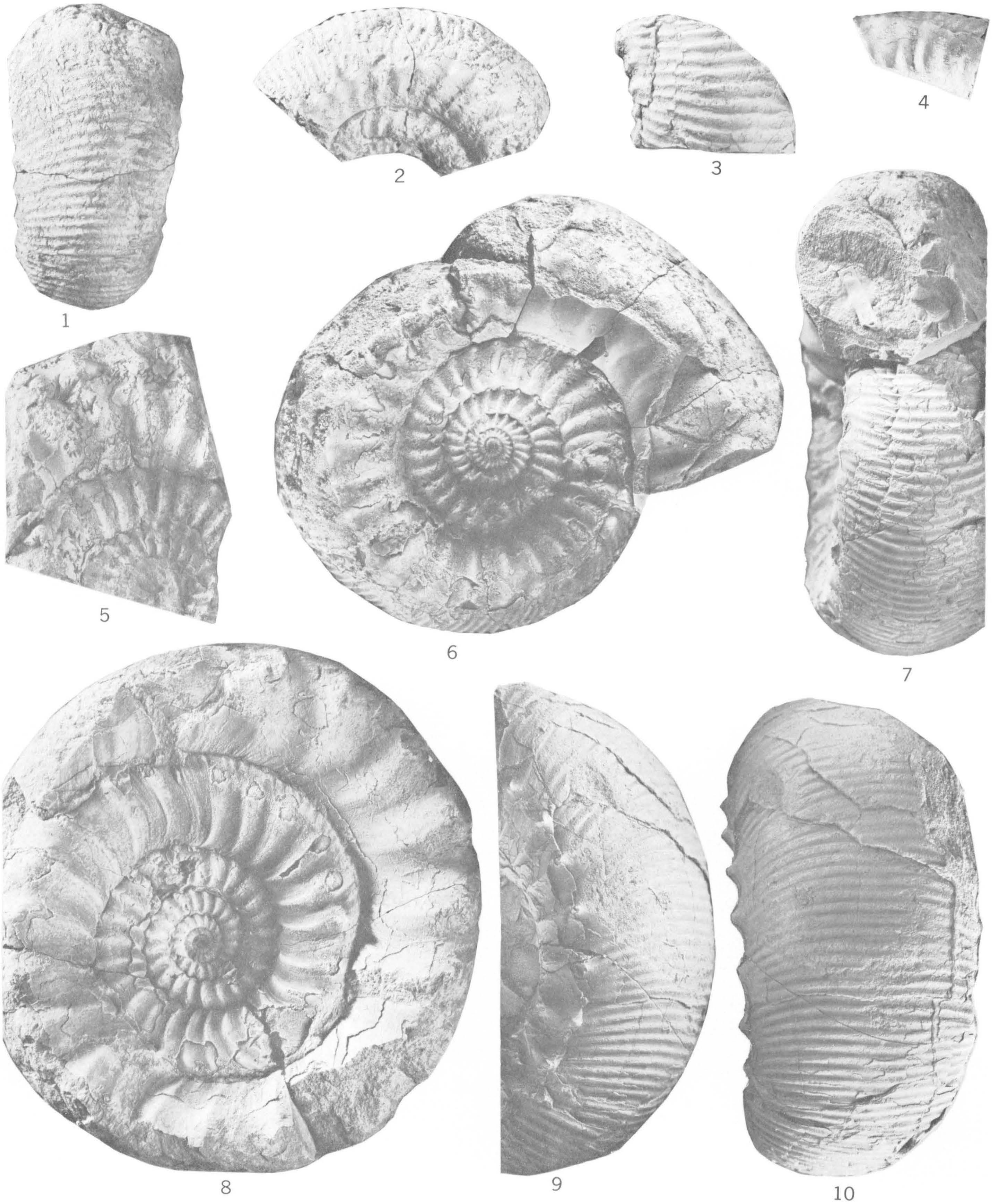
3, 4. Ventral and lateral views of a fragment of a septate whorl, USNM 273520, from USGS Mesozoic loc. 30589.

5. Lateral view of some septate whorls, USNM 273518, from USGS Mesozoic loc. 30589.

6, 7. Lateral and apertural views of a specimen on which the adoral one-third of the outermost whorl is nonseptate, USNM 273517, from USGS Mesozoic loc. 30589.

8. Lateral view of a worn specimen, USNM 273516, from USGS Mesozoic loc. 31713.

9, 10. Lateral and ventral views of a ventrally crushed fragment, USNM 273521, from USGS Mesozoic loc. 30589.



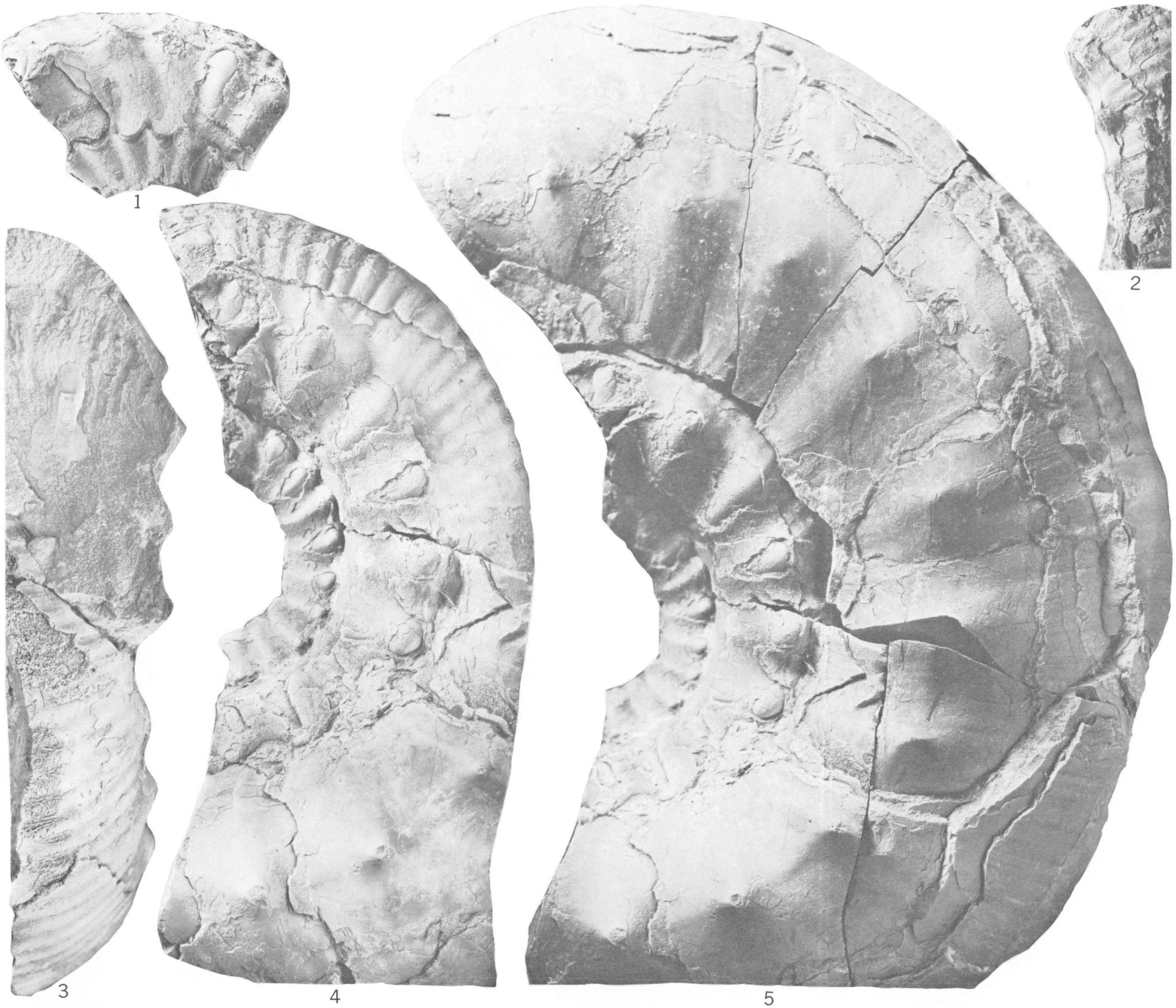
STEMMATOCERAS

PLATE 6

[All figures are natural size]

FIGURES 1–5. *Stemmatoceras* sp. (p. 16).

1, 2. Lateral and ventral views of a fragment belonging to the same innermost whorl shown in figures 4 and 5.
3, 4. Ventral and lateral views of the two septate inner whorls shown in figure 5 plus a small part of the body chamber.
5. Lateral view of body chamber and of two septate whorls of hypotype, USNM 273522, from USGS Mesozoic loc. 30591.



STEMMATOCERAS

PLATE 7

[All figures are natural size]

FIGURES 1, 3, 4. *Cadomites magnus* Imlay, n. sp. (p. 17).
Ventral, apertural, and lateral views of holotype, USNM 273523, from USGS Mesozoic loc. 30590. Note that the incomplete body chamber, represented by one-fourth of a whorl, becomes smooth adorally except for low, broad, widely spaced ribs on the lower parts of the flanks. These ribs become faint adorally. Compare with view on pl. 4, fig. 10.

2. *Stemmatoceras* sp. (p. 16).
Ventral view of adapical part of body chamber of specimen shown on plate 6. Note low to faint ribs.

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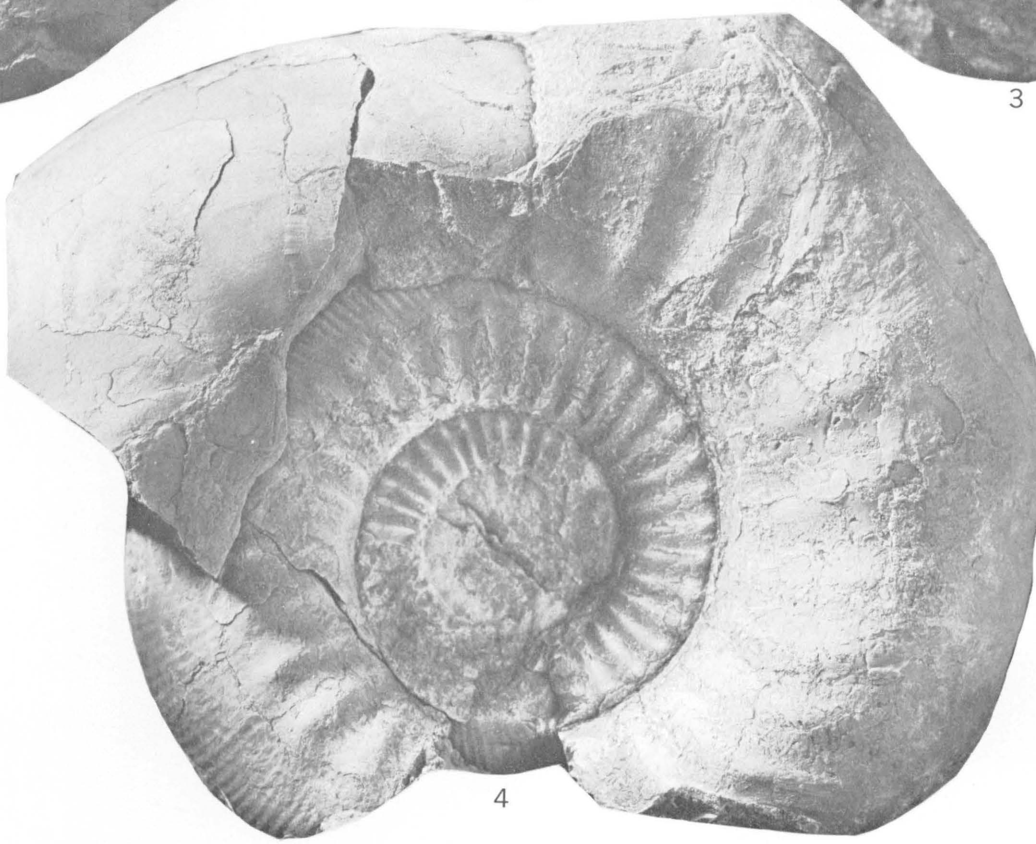

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CADOMITES AND *STEMMATOCERAS*

Imlay—LATE BAJOCIAN AMMONITES FROM SOUTHERN ALASKA—Geological Survey Professional Paper 1189