Middle Bajocian Ammonites from the Cook Inlet Region Alaska

By RALPH W. IMLAY

JURASSIC AMMONITES FROM SOUTHERN ALASKA

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Description and illustrations of cephalopods of Middle Jurassic (middle Bajocian) age

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MIDDLE BAJOCIAN AMMONITES FROM THE COOK INLET REGION, ALASKA

By Ralph W. Imlay

ABSTRACT

Jurassic ammonites of middle Bajocian age occur in the Tuxedni Group along the northwest side of Cook Inlet and in the Tuxedni Formation in the eastern part of the Talkeetna Mountains, Alaska. Numerically the dominant families are the Otoitidae and Stephanoceratidae. The familes Phylloceratidae, Sonninidae, Oppelidae, and Perisphinctidae together compose only about one-third of the total specimens.

The Tuxedni Group has not furnished any ammonite genera that characterize the European zone of *Sonninia sowerbyi* at the base of the middle Bajocian. It has, however, furnished ammonites that characterize the next higher zones of *Otoites sauzei* and *Stephanoceras humphriesianum.*

The *Otoites sauzei* zone northwest of Cook Inlet is represented by an association of the genera *Sonninia, S.* (*Papilliceras*), *Witchellia, Bradfordia, Otoites, Emileia, Stephanoceras, S.* (*Skirroceras*), *Stemmatoceras*, and *Parabigotites*. These ammonites occur throughout most of the Red Glacier Formation and some occur in the overlying Gaikema Sandstone of the Tuxedni Group. The presence of *Normannites* in the upper third of the Red Glacier Formation suggests that this part correlates with only the upper part of the *Otoites sauzei* zone.

The *Otoites sauzei* zone is also well represented throughout most of the Tuxedni Formation in the Talkeetna Mountains by the same association of ammonite genera and by many of the species that occur in the Red Glacier Formation northwest of Cook Inlet. With these in the Talkeetna Mountains occurs the ammonite *Labyrinthoceras*, which is typical of the *Otoites sauzei* zone in Europe.

The *Stephanoceras humphriesianum* zone in the Cook Inlet region is represented by an association of the genera *Normannites, Chondroceras, Teloceras, Stephanoceras, Stemmatoceras,* and *Zemistephanus*. These range through most of the Fitz Creek Siltstone and the lower fourth of the overlying Cynthia Falls Sandstone. In addition *Chondroceras*, a genus not known above the middle Bajocian, ranges through the lower two-thirds of the Cynthia Falls Sandstone. The presence of a few specimens of *Sonninia* in the lower three-fourths of the Fitz Creek Siltstone suggests that this part of the member is not younger than the lower part of the *Stephanoceras humphriesianum* zone.

The middle Bajocian ammonites in the Tuxedni Group have closer affinities generically and specifically with those of the same age in other parts of the Pacific coast from Alaska to California than with middle Bajocian ammonites in the western interior of Canada and of the United States. The Alaska ammonites also show affinities on a generic level with ammonites that are common in beds of middle Bajocian age in other continents except for the presence in Alaska of the genera *Zemistephanus* and *Parabigotites* and the absence to date of certain other genera, such as *Dorsetensia.*

New species described herein include *Holcophylloceras costisparsum* Imlay, *Sonninia tuxedniensis* Imlay, *Witchellia adnata* Imlay, *W.*? *aquilonia* Imlay, *Oppelia stantoni* Imlay, *Bradfordia costidensa* Imlay, *B.*? *caribouensis* Imlay, *Otoites*? *filicostatus* Imlay, *Emileia constricta* Imlay, *Labyrinthoceras glabrum* Imlay, *Normannites kialagvikensis* Imlay, *N. variabilis* Imlay, *Stephenoceras obesum* Imlay, *S. nelchinanum* Imlay, *S.* (*Skirroceras*) *juhlei* Imlay, *S.* (*Skirroceras*) *kirschneri* Imlay, *Stemmatoceras ursinum* Imlay, and *Leptosphinctes evolutus* Imlay.

INTRODUCTION

The ammonites described herein have been studied partly as an aid to field geologists in dating the beds of middle Bajocian age in the Cook Inlet region, Alaska, partly to determine the sequence of faunas in the Middle Jurassic beds, partly as biological documentation of the genera and species present, and partly to establish biologic and stratigraphic standards of reference. As a consequence, fragmentary or distorted ammonites from other areas may now be compared readily with well-preserved ammonites and age determinations can be made with greater confidence. Such can be very important in areas of poor exposures, of partly metamorphosed rocks, or of complicated structures, such as exist at many places in the Pacific coast States.

The fossils from the middle Bajocian rocks of the Cook Inlet region, Alaska, were collected by A. A. Baker in 1921; Andrew Brown in 1904; R. L. Detterman in 1957 and 1958; L. F. Fay in 1954; C. N. Fenner in 1919; Arthur Grantz in 1950–1952, 1955, 1957; J. K. Hartsock in 1949–1951; R. D. Hoare in 1952; R. W. Imlay in 1948 and 1952; Herbert Insley in 1920; Werner Juhle in 1952; L. B. Kellum in 1944; C. E. Kirschner in 1946; Adolph Knopf in 1906; G. C. Martin in 1904 and 1913; J. B. Mertie in 1913; D. J. Miller in 1948 and 1949; F. H. Moffit in 1920 and 1921; E. R. Orwig in 1957; R. M. Overbeck in 1913; T. W. Stanton in 1904; and Helmuth Wedow, Jr. in 1944.

Most of these geologists have furnished stratigraphic and geographic information concerning some of the fossils. Thanks are due particularly, however, to Arthur Grantz and R. L. Detterman for preparing locality maps (figs. 1–4) and descriptions based on the most recent topographic surveys and for furnishing and then checking all the stratigraphic information presented herein.

BIOLOGIC ANALYSIS

The Alaskan Jurassic ammonites of middle Bajocian age described herein number about 740 specimens. Their distribution by families, subfamilies, genera, and subgenera is shown in table 1. The table shows that the Otoitidae and the Stephanoceratidae are the dominant families, composing nearly two-thirds of the specimens. The families Phylloceratidae, Sonniniidae, Oppeliidae, and Perisphinctidae are much less common and together compose about one-third of the specimens. The Lytoceratidae, Strigoceratidae, and Haploceratidae are of minor importance.

TABLE 1.—*Ammonite genera and subgenera in beds of middle Bajocian age in the Cook Inlet region, Alaska, showing biologic relationships and relative numbers available for study*

Family	Subfamily	Genus or subgenus	Number of specimens
Phylloceratidae	Phylloceratinae	*Phylloceras*	1
		Macrophylloceras	24
	Calliphylloceratinae	*Holcophylloceras*	33
Lytoceratidae	Lytoceratinae	*Lytoceras*	10
Sonniniidae		*Sonninia*	20
		Sonninia?	12
		Sonninia (Papilliceras).	12
		Witchellia	10
		Witchellia?	13
Strigoceratidae		*Strigoceras*	2
Haploceratidae		*Lissoceras*	9
Oppeliidae	Oppeliinae	*Oppelia*	11
		Bradfordia	36
		Bradfordia?	4
Otoitidae	Otoitinae	*Otoites*	4
		Otoites?	2
		Emileia	12
		Emileia?	2
	Sphaeroceratinae	*Labyrinthoceras*	13
		Chondroceras	120
Stephanoceratidae		*Normannites*	105
		Stephanoceras	13
		Stephanoceras (Skirroceras).	50
		Stemmatoceras	12
		Stemmatoceras?	2
		Teloceras	30
		Zemiitephanus	105
		Zemistephanus?	2
Perisphinctidae	Leptosphinctinae	*Parasbigotites*	69
		Leptosphinctes	2

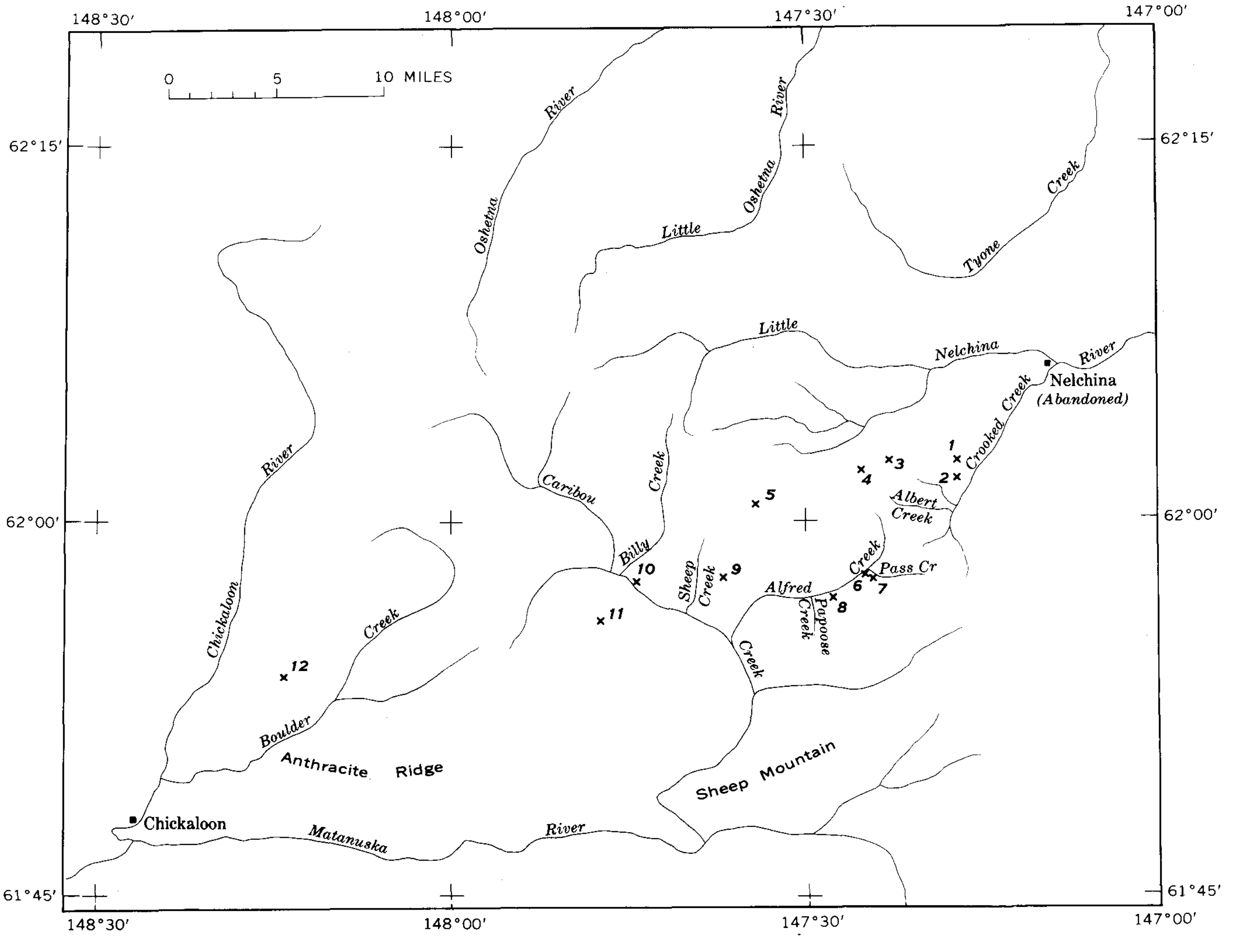

FIGURE 1.—Index map showing occurrences of middle Bajocian fossils in the Talkeetna Mountains, Alaska. (Numbers on maps refer to those given in tables 11 and 12.)

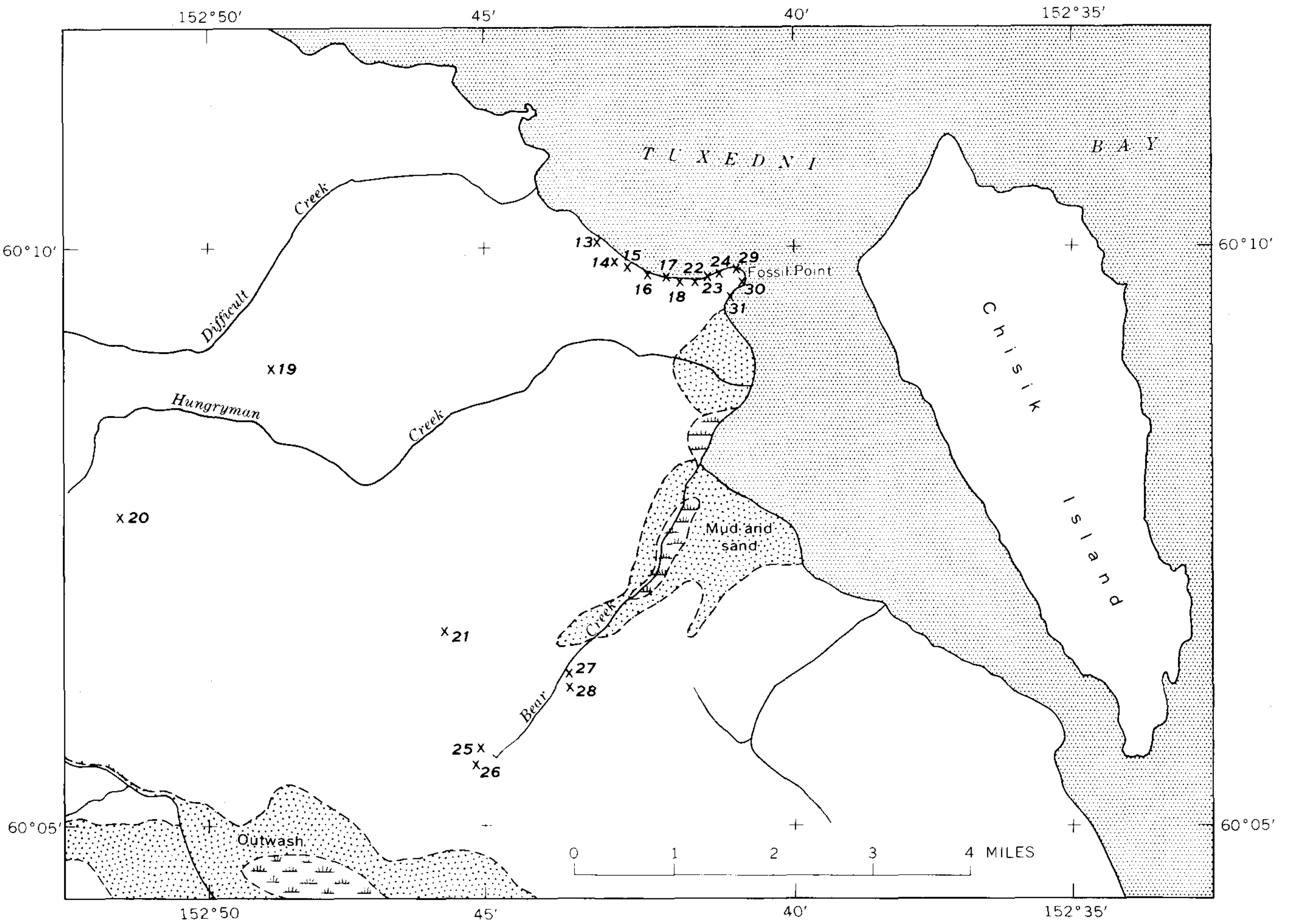

FIGURE 2.—Index map showing occurrences of middle Bajocian fossils in the Tuxedni Bay area, Alaska. (Numbers on maps refer to those given in tables 11 and 13.)

The genus *Zemistephanus* is assigned herein to the Stephanoceratidae rather than to the Otoitidae (Arkell and others, 1957, p. L289) because it greatly resembles *Teloceras* in shape, coiling, ribbing, in the presence of a simple aperture, and in having a broad deep first lateral saddle that is much larger than the second lateral saddle. It differs from *Teloceras* mainly by bearing tubercles nearer the umbilicus and by its adult body whorl becoming serpenticone as a result of umbilical enlargement and whorl contraction. It differs from *Pseudotoites* by having a much wider first lateral saddle, a simple instead of a collared aperture, a more coronate form, more prominent umbilical tubercles, and stronger ribbing on its inner whorls.

The ammonite *Normannites* presents a special problem taxonomically. It is used in a broad sense by Arkell and others (1957, p. L289) to include species showing considerable diversity in form, ribbing, and tuberculation. It is used in a narrow sense by Westermann (1954, p. 124–332; 1956b, p. 250, 251; 1958, p. 451) as one of five genera under the subfamily Normannitinae. He further divides his restricted *Normannites* into four subgenera and divides another of the five genera, *Masckeites*, into two subgenera. Evidently the genus *Normannites* as defined by Arkell includes all the ammonites that Westermann places under the Normannitinae.

Arkell assumed apparently that the differences in form and sculpture of the ammonites in question merely reflect a highly variable rapidly developing population, such as has been demonstrated for the Triassic genus *Tropites* (Silberling, 1959, p. 42–44), the Jurassic genus *Ermoceras* (Arkell, 1952a, p. 272–277), the Cretaceous genera *Neogastroplites* (Reeside and Cobban, 1960, p. 51–54), and *Barroisiceras* (Basse, 1947, p. 97–178). In contrast, Westermann assumed that the differences are of considerable taxonomic significance and that the ammonites in question can be readily divided into distinct genera and subgenera. Both assumptions have precedents. Many paleontologists, including Arkell, who have studied a highly variable but closely related short-lived group of ammonites have decided that for

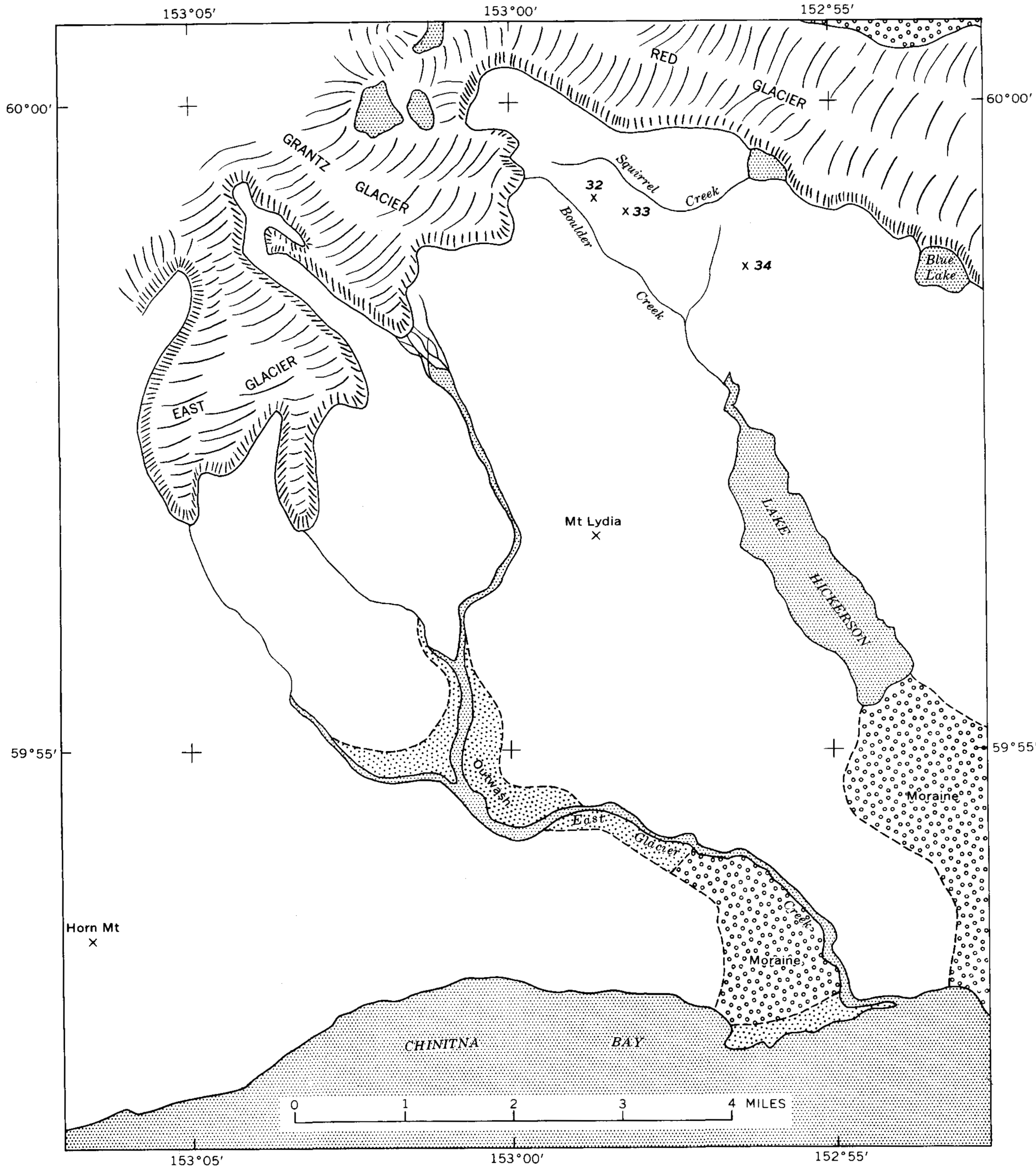

FIGURE 3.—Index map showing occurrences of middle Bajocian fossils north of Chinitna Bay, Alaska. (Numbers on maps refer to those given in tables 11 and 13.)

practical purposes of systematic description such a group should be divided into genera, or at least subgenera (Spath, 1928, p. 166; Arkell, 1952a, p. 272, 273). Others have decided that such distinctions serve no practical systematic purpose (Reeside and Cobban, 1960, p. 52) that cannot be handled adequately under descriptions of species, subspecies, and varieties.

The family position of *Normannites*, or of the Normannitinae of Westermann, is likewise in dispute. According to Arkell (1952b, p. 76; 1954, p. 568) *Normannites* appears to be closely related to *Otoites* and should be assigned, therefore, to the Otoitidae. According to Westermann (1954, p. 247; 1956b, p. 249; 1958, p. 451), however, some species of *Normannites* and *Itinsaites* of his Normannitinae greatly resemble *Stephanoceras* and *Stemmatoceras* of the Stephanoceratidae and are difficult to distinguish from them except by the presence of lateral lappets and a slightly less intricate suture line. As lateral lappets occur on *Polyplectites*, which both Arkell and Westermann assign to the Stephanoceratidae, as well as on *Otoites* of the Otoitidae, their presence on *Normannites* does not determine its family relationship.

Certain ammonites from beds of late Bajocian age in Alaska may have a bearing on the taxonomic position of *Normannites*. These ammonites were described by Imlay (1961, p. 471, 472) under the generic name *Dettermanites* and were assigned to the Stephanoceratidae on the basis of ribbing and sutural pattern. They show many resemblances to several genera including

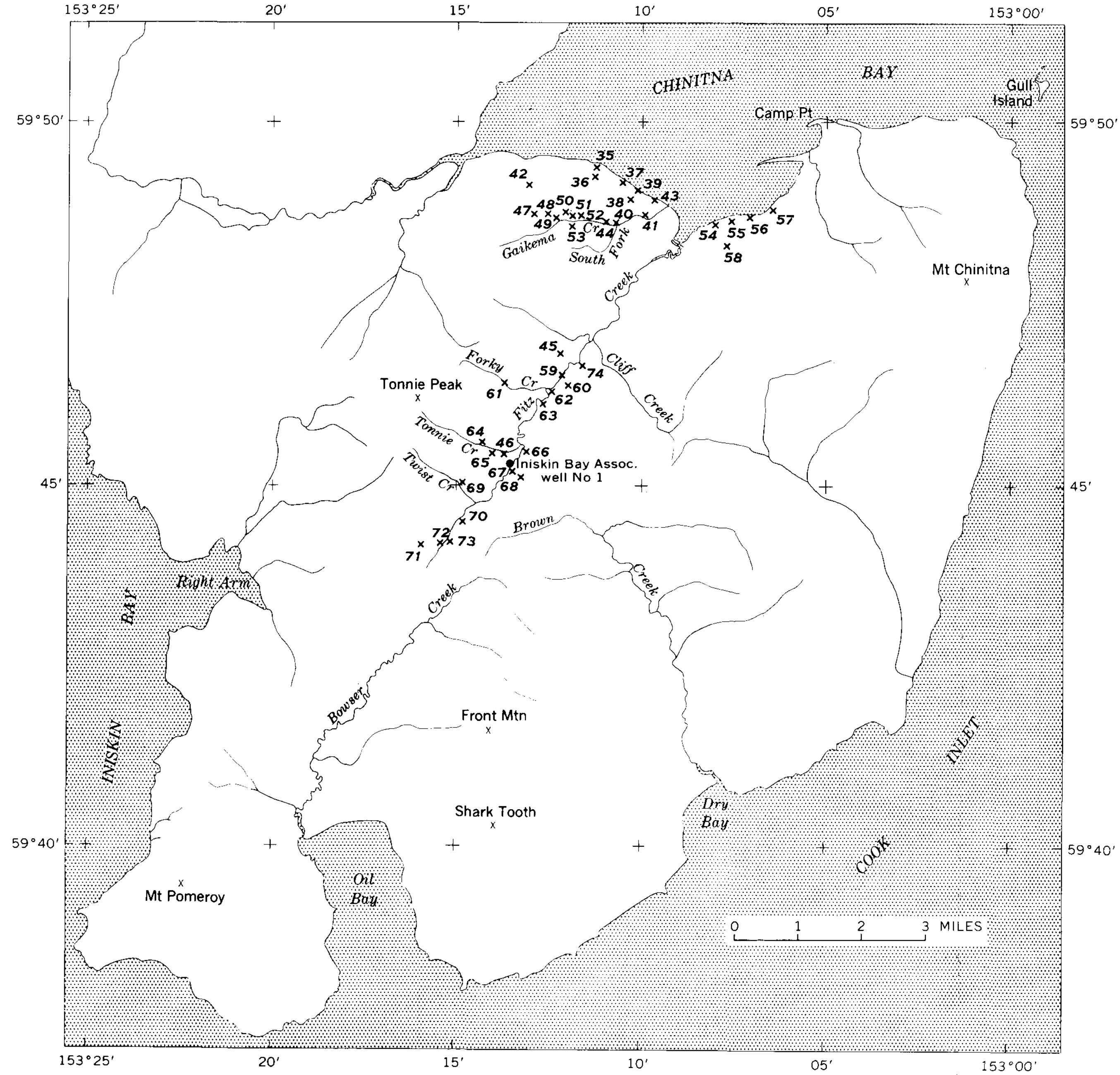

FIGURE 4.—Index map showing occurrences of middle Bajocian fossils on the Iniskin Peninsula, Alaska. (Numbers on maps refer to those given in tables 11 and 13.)

Stephanoceras, *Polyplectites*, and *Normannites*. They differ from typical species of *Normannites* by having more secondary ribs that are much weaker relative to the primary ribs and by the first lateral lobe being shorter relative to the ventral lobe. They greatly resemble, however, other species that Westermann (1954, p. 246–290, pls. 22–27) includes in *Itinsaites* McLearn and that Arkell and others (1957, p. L289) include in *Normannites*, differing from those species mainly by attaining a somewhat larger size. Evidently they are closely related if not congeneric with *Normannites* and should be placed in the same family.

In summation, *Normannites* as defined by Arkell and others (1957, p. L289) shows considerable diversity of form and sculpture. This diversity has been used by Westermann as justification for raising *Normannites* to subfamily rank and for dividing it into many genera and subgenera. Taxonomically *Normannites* appears to be related both to the Otoitidae and to the Stephanoceratidae and might with equal logic be placed in either family.

STRATIGRAPHIC SUMMARY

TUXEDNI GROUP ALONG NORTHWEST SIDE OF COOK INLET

Many of the ammonites of middle Bajocian age described herein were obtained from the lower four formations of the Tuxedni Group exposed along the northwest side of Cook Inlet between Tuxedni Bay and the Iniskin Peninsula. These formations, arranged from youngest to oldest, and their thicknesses are shown in table 2. This table, based on data supplied by R. L. Detterman between 1958 and 1961, not only shows the variations in thicknesses of the formations but in conjunction with tables 3–7 is useful in determining the relative stratigraphic positions of the fossil collections and the ranges of the species described herein (table 8). Table 2 does not include the two highest formations of the Tuxedni Group which contain faunas of late Bajocian (Imlay, 1962b), of probable Bathonian (Imlay, 1962a) and of early Callovian ages (Imlay, 1962a, p. C2–C3, table 2).

TABLE 2.—*Thickness, in feet of, the lower four formations of the Tuxedni Group along the northwest side of Cook Inlet, Alaska*

Formation	Tuxedni Bay-Bear Creek area	Lake Hickerson-Red Glacier area	Chinitna Bay area	Upper Fitz Creek area
Cynthia Falls Sandstone	765	660	645	600
Fitz Creek Siltstone	640	825	1,280	1,090
Gaikema Sandstone	600	880	850	500
Red Glacier Formation	1,980	4,540	1,530+ Incomplete owing to faulting.	Subsurface, 8,000–8,200 outcrop, 300+.

RED GLACIER FORMATION

The Red Glacier Formation near Tuxedni Bay is nearly 2,000 feet thick and consists of alternate units of massive to thin-bedded gray, greenish-gray, or grayish-green sandy siltstone and silty sandstone. Thin beds of pebble conglomerate occur locally. Most units contain fossiliferous concretions of limestone or of calcareous sandstone. The upper 790 feet is well exposed along the south shore of Tuxedni Bay west of Fossil Point. The remainder of the formation is mostly covered along the shore but is poorly exposed along Hungryman Creek and Difficult Creek from half a mile to several miles from Tuxedni Bay. The highest unit as exposed along the shore consists of sandy siltstone that is in fault contact with the upper part of the Fitz Creek Siltstone. The lowest unit of the Red Glacier Formation, as exposed near Difficult Creek and Hungryman Creek, consists mostly of light brown arkosic sandstone about 300 feet thick that rests on lava beds at the top of the Talkeetna Formation.

The upper 500 feet of the formation exposed along the south shore of Tuxedni Bay has furnished many ammonites (table 4) of middle Bajocian age including in particular *Sonninia*, *Papilliceras*, *Strigoceras*, *Lissoceras*, *Otoites*, *Emileia*, *Normannites*, *Stephanoceras*, *Skirroceras*, and *Stemmatoceras*. Farther west along the shore some beds from 700 to 730 feet below the top of the formation have furnished the ammonite *Parabigotites crassicostatus* Imlay in association with *Sonninia* and *Stephanoceras*. The middle part has not furnished any fossils, probably owing mainly to poor exposure and difficult access. The lower part has furnished ammonites of early Bajocian age, including *Tmetoceras* and *Erycites* (table 3, fig. 5) and, also, ammonites of middle Bajocian age including *Stephanoceras* and *Emileia*. The middle Bajocian ammonites were obtained from

TABLE 3.—*Early Bajocian ammonites from the lower part of the Red Glacier Formation along the northwest side of Cook Inlet, Alaska*

Mesozoic locality	Fossils	Position in feet below top of formation	Position in feet above base of formation
21244, Iniskin Bay Assoc. 1 at a depth of 6,339–6,359 ft. on the Iniskin Peninsula.	*Erycites* sp.	5,495–5,515	About 2,200–2,300
24335, 4.2 miles N. 5° W. of Blue Lake, Red Glacier Area, north of Chinitna Bay.	*Tmetoceras regleyi* Dumortier.	3,400–3,600	900–1,100
21233, 2.26 miles N. 77° W. of Fossil Point on Tuxedni Bay.	*Tmetoceras* sp. *Erycites*? sp.	About 1,500	380–480
21234, float from same place as 21233.	*Tmetoceras* sp. *Erycites* sp. *Pseudolioceras*? sp.	About 1,500	380–480
22718, 3.4 miles N. 85° W. of Fossil Point on Tuxedni Bay.	*Erycites*? sp.	About 1,800	150–200

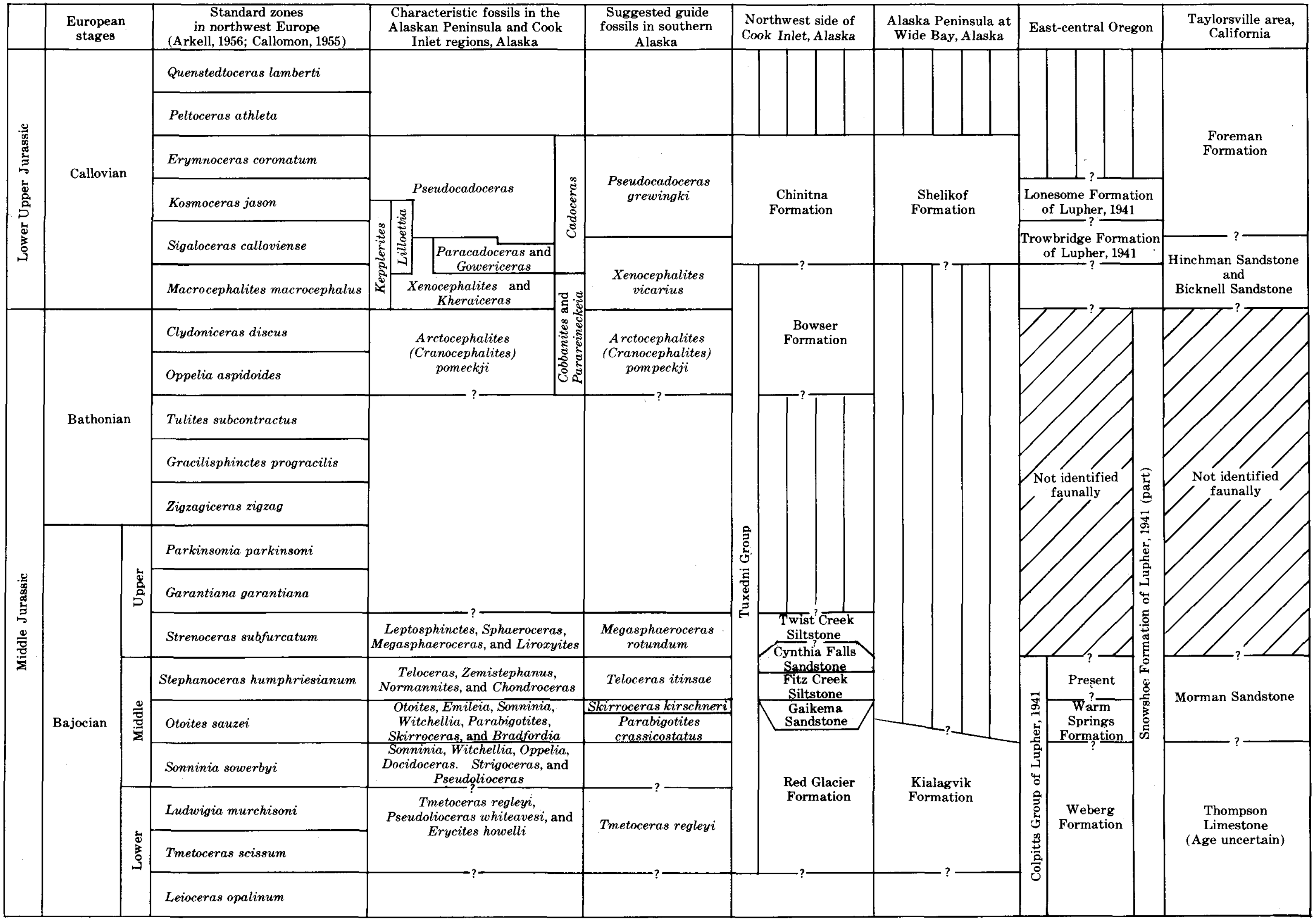

FIGURE 5.—Correlation of some Middle and Upper Jurassic formations and faunas in the Cook Inlet region, Alaska.

2 to 4 miles south of the early Bajocian ammonites and farther below the top of the formation. This situation, according to R. L. Detterman (written communication of July 17, 1962), is a result of rapid southward thickening of the Red Glacier Formation by the addition of beds at its top.

The Red Glacier Formation in the Hickerson Lake-Red Glacier area appears to be about 4,500 feet thick, but according to R. L. Detterman (written communication, 1960) it is cut by a thrust fault of unknown displacement about 1,200 feet above its base. The upper 2,930 feet is similar lithologically to the formation as exposed near Tuxedni Bay. Below this occurs about a thousand feet of soft black silty shale and siltstone. Below follows 200 feet of arkosic sandstone, 200 feet of shale and some sandstone, and then 200 feet of arkosic sandstone that rests on the Talkeetna Formation. The exposures are rather poor, are difficult of access, and have furnished few fossils. About 300 feet below the top was obtained *Parabigotites crassicostatus* Imlay, *Witchellia*? sp., and *Sonninia* sp. juv. (Mesozoic loc. 22529) of middle Bajocian age. About 1,300–1,400 feet below the top was obtained *Parabigotites* sp. undet. (Mesozoic loc. 22695). From 900 to 1,100 feet above the base was obtained *Tmetoceras* sp. of early Bajocian age.

The Red Glacier Formation exposed along the south shore of Chinitna Bay is only about 1,530 feet thick but its lower part is cut by a thrust fault having several thousand feet of displacement. Its upper 600 feet consists of olive to brown massive siltstone. Below follow units of gray to brown thin-bedded to massive sandstone alternating with units of gray sandy siltstone. The sequence is fairly fossiliferous and in its upper 1,200 feet has furnished ammonites belonging to the genera *Sonninia*, *Witchellia*, *Emileia*, *Normannites*, *Stemmatoceras*, and *Parabigotites* (table 4). Most of the species are identical with those that occur in the upper 730 feet of the Red Glacier Formation along the south shore of Tuxedni Bay.

Only the upper 300 feet of the Red Glacier Formation is exposed in the upper part of Fitz Creek near Tonnie Creek, but deep drilling has revealed that the formation in the subsurface is about 8,000 feet thick. The early Bajocian ammonite *Erycites* associated with the pelecypod *Inoceramus* cf *I. lucifer* Eichwald was obtained from a core of the Iniskin Bay Association No. 1 well at the depths of 6,339–6,359 feet, which is from 2,200 to 2,300 feet above the base of the Red Glacier Formation.

In addition to ammonites, the Red Glacier Formation has furnished some belemnites and many pelecypods. The pelecypod genera include *Inoceramus*, *Pleuromya*, *Pinna*, *Astarte*, *Trigonia*, *Camptonectes*, *Meleagrinella*, *Isocyrina*?, *Goniomya*, *Pholadomya*, *Protocardia*, *Parallelodon*, *Isognomon*, and *Thracia*. *Inoceramus lucifer* Eichwald and *Pleuromya dalli* (White) are fairly common species.

GAIKEMA SANDSTONE

The Gaikema Sandstone of the Tuxedni Group near Tuxedni Bay, as mapped by R. L. Detterman, is about 600 feet thick and consists mostly of massive to medium-bedded coarse- to fine-grained gray to greenish-gray sandstone that locally forms cliffs. Some beds are pebbly in its lower half and some beds are fossiliferous. It is absent on the south shore of Tuxedni Bay owing to faulting but is fairly well exposed away from the shore between Bear Creek and Hungryman Creek. At one place (Mesozoic loc. 22723) the lower 150 feet of the formation has furnished the ammonites *Sonninia* (*Papilliceras*), *Emileia*, and *Lissoceras* (table 5).

The Gaikema Sandstone near Lake Hickerson consists of units of medium- to thin-bedded fine- to medium-grained brown to gray sandstone and massive gray siltstone about 880 feet thick. It contains some fossiliferous layers that have furnished such pelecypods as *Meleagrinella*, *Trigonia*, *Plagiostoma*, *Inoceramus*, and *Isognomon*.

The Gaikema Sandstone on the south shore of Chinitna Bay is well exposed, about 850 feet thick, and consists mostly of medium- to thin bedded medium-grained gray to greenish-gray sandstone but contains interbeds of siltstone and of conglomerate. It has furnished a few ammonites (table 5) belonging to *Witchellia*?, *Bradfordia*?, *Stephanoceras*, and *Macrophylloceras*. Pelecypods are much more common than ammonites and belong mostly to the genera *Inoceramus*, *Meleagrinella*, *Trigonia*, and *Pleuromya*. All the specimens of *Inoceramus* that can be specifically identified belong to *I. lucifer* Eichwald.

The Gaikema Sandstone exposed on Fitz Creek is about 500 feet thick, is similar lithologically to the same formation on the south shore of Chinitna Bay, and likewise contains the same pelecypod faunule. The only ammonites found include *Bradfordia*? *caribouensis* Imlay, n. sp. and *Lytoceras*.

FITZ CREEK SILTSTONE

The Fitz Creek Siltstone of the Tuxedni Group near Tuxedni Bay, as mapped by R. L. Detterman, is about 640 feet thick. The upper 150 feet, well exposed on Fossil Point, consists mostly of dark-gray massive siltstone that is interbedded with some thin beds of gray sandstone and sandy limestone and with minor amounts of grit and conglomerate. The remainder of the formation is absent on Fossil Point owing to faulting. It is exposed, however, at the head of Bear Creek and along the divide between Bear Creek and Hungryman Creek where it consists mostly of brownish-gray massive siltstone that contains some sandy beds. The upper 150 feet has furnished many ammonites (tables 6, 8) including in particular *Sonninia*, *Lissoceras*, *Oppelia*, *Chondroceras*, *Normannites*, *Stephanoceras*, *Stemmatoceras*, *Teloceras*, and *Zemistephanus*. The lower part of the formation has furnished few ammonites and these include *Sonninia*, *Oppelia*, and *Stephanoceras* (Mesozoic locs. 22706, 22721, and 22722).

The Fitz Creek Siltstone in the Lake Hickerson-Red Glacier area is about 825 feet thick, consists of gray massive siltstone that weathers brown and contains a few interbeds of arkosic sandstone and some small sandy limestone concretions. The ammonite *Normannites variabilis* Imlay, n. sp., has been obtained from about the middle of the formation.

The Fitz Creek Siltstone near the south shore of Chinitna Bay and along Gaikema Creek is about 1,280 feet thick and consists of gray to gray-green sandy siltstone interbedded with gray silty sandstone. One conglomeratic sandstone unit occurs near the middle. A fairly large molluscan fauna, dominated by ammonites, has been obtained from all parts of the formation except the lower 200 feet. These include the same genera and species of ammonites as occur in the Fitz Creek Siltstone near Tuxedni Bay but most of the species in common between the two areas have been found relatively much lower in the formation near Chinitna Bay than near Tuxedni Bay.

The Fitz Creek Siltstone in the upper part of Fitz Creek is only partly exposed, is about 1,090 feet thick, and consists dominantly of gray sandy siltstone. It contains the same molluscan assemblage as characterizes the formation elsewhere, but, as near Chinitna Bay, the common species of ammonites occur relatively lower within the formation than near Tuxedni Bay.

In general the Fitz Creek Siltstone may be recognized by its stratigraphic position between two more resistant sandstone formations. It may also be distinguished rather easily from the underlying formations by the presence of the ammonites *Teloceras*, *Normannites*, *Zemistephanus*, and *Chondroceras* and by an abundance of the pelecypod *Inoceramus ambiguus* Eichwald, which species contrasts markedly with *I. lucifer* Eichwald in the underlying formations.

CYNTHIA FALLS SANDSTONE

The Cynthia Falls Sandstone of the Tuxedni Group gradually decreases in thickness southwestward from about 765 feet near Tuxedni Bay to 600 feet on the Iniskin Peninsula. Near Tuxedni Bay the lower 115 feet of the formation is well exposed on Fossil Point and the remainder of the formation is under the waters of Tuxedni Channel. The part exposed on Fossil Point consists mostly of gray to greenish-gray medium- to thick-bedded sandstone but includes a little gray siltstone. This part is easily accessible and has yielded most of the fossils that have been found in the Cynthia Falls Sandstone (table 7). These include many of the same species of the ammonites *Chondroceras*, *Normannites*, and *Zemistephanus* as occur in the underlying Fitz Creek Siltstone but in addition include *Chondroceras allani* (McLearn) and *Lissoceras bakeri* Imlay. On Bear Creek the exposures are rather poor and have not furnished many fossils. *Chondroceras defonti* (McLearn), however, has been found about 500 feet above the base of the formation (Mesozoic loc. 22707).

The Cynthia Falls Sandstone near Lake Hickerson and Red Glacier consists mostly of olive-gray to dark green medium- to thick-bedded sandstone and graywacke. Some pebbles occur in its lower part. The upper part has furnished a few belemnites and pelecypods.

The Cynthia Falls Sandstone on the south side of Chinitna Bay contains much coarse-grained material and has not furnished any fossils. The upper 200 feet consist of coarse conglomerate, the lower 220 feet of massive sandstone containing conglomerate interbeds, and the middle part of sandy siltstone and sandstone.

The Cynthia Falls Sandstone in the upper part of Fitz Creek consists mostly of massive gray-green sandstone. The ammonite *Chondroceras defonti* (McLearn) was obtained from the lower 150 feet of the formation (Mesozoic loc. 21771) and fragments suggestive of *Chondroceras* (Mesozoic loc. 20004) were obtained about 400 feet above the base of the formation.

Between Tuxedni Bay and the upper part of Fitz Creek, the massive sandstone or conglomerate forming the upper part of the Cynthia Falls Sandstone is overlain abruptly but apparently conformably by massive dark gray siltstone, sandy siltstone, and claystone. The lower contact of the Cynthia Falls with the underlying Fitz Creek Siltstone is also fairly abrupt in most sections.

TUXEDNI FORMATION IN THE TALKEETNA MOUNTAINS

The Tuxedni Formation in the Nelchina area of the Talkeetna Mountains is rather variable in thickness and in lithologic character (written communication from Arthur Grantz, Sept. 1, 1961). Its thickness ranges from 0 to at least 1,200 feet but locally may be greater. At most places the lower 700–1,200 feet of the formation consists of greenish-gray predominantly fine- to medium-grained sandstone. The upper part of the formation ranges in thickness from 0 to 500 feet and consists of greenish to olive-gray thin- to medium-bedded siltstone interbedded with sandstone and locally with soft shale. The relative amount of silty material varies from place to place. In some places the entire formation is mostly sandstone. In other places the formation contains much siltstone throughout. The formation as a whole is characterized by the presence of sandy limestone concretions that weather reddish-gray, and locally it contains pebbly beds and shelly or coquinoid beds.

The Tuxedni Formation, as mapped by Arthur Grantz, rests unconformably on the Talkeetna Formation of Early Jurassic age and is overlain unconformably either by the Chinitna Formation of Callovian age, or by slightly older beds containing the ammonite *Arctocephalites* (*Cranocephalites*).

The lower sandstone part of the Tuxedni Formation in the Talkeetna Mountains has furnished a few mollusks. *Inoceramus lucifer* Eichwald occurs throughout. *Erycites howelli* (White) (Mesozoic loc. 24235) and *Pleydellia*? cf. *P. digna* (Buckman) (Mesozoic loc. 24149) were obtained from float which probably originated within about a hundred feet of the base, considering that they were found at places where only the basal part of the Tuxedni Formation is exposed. An immature ammonite probably representing *Emileia* or *Docidoceras* (Mesozoic loc. 25946) was obtained about 200–300 feet above the base. *Witchellia* sp. and *Sonninia*? n. sp. undet. were found (Mesozoic loc. 26723) in the upper half of the sandstone (table 12).

The upper silty part of the Tuxedni Formation has furnished many pelecypods and cephalopods but also some gastropods, brachiopods, and one crinoid. The exact stratigraphic position of most of the fossil collections within the silty part has not been determined. These include Mesozoic localities 8584, 8585, 24120, 24215, 24220, 25345, 25346, 25942 and probably 3696, 3697 and 8567. One specimen of *Stephanoceras* (*Skirroceras*) (Mesozoic loc. 24134), however, was found at the very base of the silty part of the formation, and one large collection of mollusks (Mesozoic loc. 24113) was obtained from 50 to 250 feet above the base of the silty part. (See list in table 12.) Most of these collections contain some ammonites identical with species in the upper part of the Red Glacier Formation on the northwest side of Cook Inlet. One collection (Mesozoic loc. 8584), however, from the upper silty part of the Tuxedni Formation contains *Inoceramus ambiguus* Eichwald, which occurs in the Cook Inlet area above the Red Glacier Formation. Also, another collection (Mesozoic loc. 24821) contains ammonites, including *Megasphaeroceras*, that in the Cook Inlet area occur in beds directly overlying the Cynthia Falls Sandstone.

In the Nelchina area of the Talkeetna Mountains, erosion of the upper silty beds before deposition of the *Cranocephalites*-bearing beds, or of the Chinitna Formation, is apparently responsible for the variable thickness of the Tuxedni Formation and for the absence at most places of any beds younger than the Red Glacier Formation of the Cook Inlet area (written communication from Arthur Grantz, Sept. 1, 1961).

The above remarks concerning thicknesses, lithologic features, and uncomformable relations may not apply in the Boulder Creek area of the Talkeetna Mountains which has not been studied in recent years. In that area one collection (Mesozoic loc. 8567) contains species of *Normannites* and *Chondroceras* identical with species in the Fitz Creek Siltstone, and another collection (Mesozoic loc. 8572) contains ammonites identical with species in beds directly overlying the Cynthia Falls Sandstone northwest of Cook Inlet.

AGES OF THE FAUNAS

AGES OF THE TUXEDNI GROUP NORTHWEST OF COOK INLET

RED GLACIER FORMATION

The Red Glacier Formation has yielded ammonites of early Bajocian age from its lower part (table 3) and of early middle Bajocian age from its lower, middle, and upper parts (tables 4, 8, 9).

The early Bajocian ammonites from the Red Glacier Formation (table 3) are poorly preserved, but the presence of the genera *Tmetoceras* and *Erycites* clearly date the beds (Arkell, 1956, p. 34; Arkell and others, 1957, p. L267). Associated with the ammonites are such pelecypods as *Inoceramus* cf. *I. lucifer* Eichwald, *Meleagrinella*, *Oxytoma*, and *Pleuromya*. Both on the Iniskin Peninsula and in the Lake Hickerson-Red Glacier area the Red Glacier Formation includes considerable thicknesses of strata below the occurrences of early Bajocian ammonites and conceivably such strata could be older than Bajocian.

The early middle Bajocian ammonites from the Red Glacier Formation (table 4) have been found mainly in its upper part. This includes the upper 200 feet of the formation on the south shore of Chinitna Bay, the upper 1,400 feet in the Lake Hickerson-Red Glacier area, and the upper 730–800 feet on the south shore of Tuxedni Bay. In addition, some ammonites of the same age have been found in the lower part of the formation near Tuxedni Bay. These include *Emileia* cf. *E. constricta* Imlay, n. sp. (Mesozoic loc. 24334), found 1,700–1,800 feet below the top of the formation and *Stephanoceras* (*Skirroceras*) *juhlei* Imlay, n. sp. (Mesozoic loc. 24333). found 1,800–1,900 feet below the top of the formation.

These collections are of age significance because *Stephanoceras* and *Emileia* in Europe (table 10) are not known below the middle part of the European zone of *Sonninia sowerbyi* (Arkell, 1952b, p. 74–76) and the serpenticone subgenus *Skirroceras* is not known below the zone of *Otoites sauzei*. The presence of such genera low in the Red Glacier Formation near Tuxedni Bay

TABLE 4.—*Middle Bajocian ammonites in the Red Glacier Formation along the northwest side of Cook Inlet, Alaska*

[Fossils at locs. 3004, 3007, 3010, 20017, 21263 and 21268 were obtained as float]

Fossils	Position in feet below top of Red Glacier formation			USGS Mesozoic fossil localities		
	Tuxedni Bay area	Lake Hickerson area	Chinitna Bay, south shore	Tuxedni Bay area	Lake Hickerson area	Chinitna Bay, south shore
Macrophylloceras sp. undet. A	215			21265		
Holcophylloceras costisparsum Imlay, n. sp.	170			21267		
sp. juv.	450–700?			3007, 3010		
Lytoceras cf. *L. eudisianum* d'Orbigny			300–850			19958, 19966
Sonninia tuxedniensis Imlay, n. sp.	100–230			21266, 21268		
cf. *S. tuxedniensis* Imlay, n. sp.	500			3009		
(*Papilliceras*) cf. *S.* (*P.*) *arenata* (Quenstedt)	480–515		630	21262, 21263		19964
? n. sp. undet.			1200			21293
? sp. juv.	170–700?			3008–3010, 21267		
Witchellia adnata Imlay, n. sp.	700?		725–800	3010		19956
sp.			350–360			21296
? sp.	250–700?	300	250–360	3004, 3010	22529	19957, 21296
Strigoceras sp.	100–230?			21268		
Lissoceras cf. *L. semicostulatum* Buckman	100–230?			21268		
sp.	480–515?			21263		
Otoites cf. *O. contractus* (Sowerby)	500			3009		
? *filicostatus* Imlay, n. sp.	700?		45	3010		19951
Emileia constricta Imlay, n. sp.	480–500, 515?			3009, 21262, 21263, 21268		
cf. *E. constricta* Imlay, n. sp.	1700–1800		350–1200	24334		19959, 21293
Chondroceras cf. *C. defonti* (McLearn)	480–515?		800–900?	21263		20017
Normannites kialagvikensis Imlay, n. sp.	500–515, 700?			3010, 21261		
cf. *N. kialagvikensis* Imlay, n. sp.			350–360			21296
cf. *N.* (*Itinsaites*) *crickmayi* (McLearn)	95			21269		
Stephanoceras cf. *S. nodosum* (Quenstedt)	95			21269		
(*Skirroceras*) *kirschneri* Imlay, n. sp.	50–250		800–900?	3013, 21264, 21267, 21268		20017
(*S.*) *juhlei* Imlay, n. sp.	1800–1900			24333		
sp.	700?		850	3010		19966
Stemmatoceras n. sp. undet	480–515?		350–360	21263		21296
sp.			320–850			19966, 21295
cf. *S. triptolemus* (Morris and Lycett)	500–515			21261		
Parabigotites crassicostatus Imlay	700–730?	300	850	3010	22529	19966
sp.		1300–1400	350–360		22695	21296
? sp.	700?		100–150	3010		21766

shows that most of the formation at that place is of middle Bajocian age not older than the European zone of *Otoites sauzei*.

The ammonites from the upper part of the Red Glacier Formation that are most significant in determining its age include the following:

Stephanoceras (*Skirroceras*) *kirschneri* Imlay, n. sp.
Stemmatoceras n. sp. undet.
Normannites, kialagvikensis Imlay, n. sp.
Otoites? *filicostatus* Imlay, n. sp.
cf. *O. contractus* (Sowerby)
Emileia constricta Imlay, n. sp.
Sonninia tuxedniensis Imlay, n. sp.
(*Papilliceras*) cf. *S. arenata* (Quenstedt)
Witchellia adnata Imlay, n. sp.
Lissoceras cf. *L. semicostulatum* Buckman
Parabigotites crassicostatus Imlay

Of these, *Sonninia tuxedniensis* Imlay, n. sp., and *Lissoceras* cf. *L. semicostulatum* have been found only in the upper 230 feet of the Red Glacier Formation on the south shore of Tuxedni Bay. *Parabigotites crassicostatus* Imlay has found from 730 to 800 feet below the top of the Formation at Tuxedni Bay (Martin, 1926, p. 143, unit 37 of section), 300 feet below the top of the formation near Red Glacier, and 850 feet below the top on the south shore of Chinitna Bay. Fragments of *Parabigotites* have also been found near Red Glacier from 1,300 to 1,400 feet below the top of the formation and on the south shore of Chinitna Bay about 350 feet below the top of the formation. These figures suggest that *Parabigotites* does not range to the top of the formation.

In addition to the ammonites listed, *Normannites* cf. *N. crickmayi* (McLearn) was obtained in place 95 feet below the top of the formation on Tuxedni Bay (Mesozoic loc. 21269). *Strigoceras* (Mesozoic loc.

21268) and *Chondroceras* (Mesozoic locs. 21263, 20017) were obtained as float only and, therefore, may have been derived from the Fitz Creek Siltstone. *Sonninia*? n. sp. undet. was obtained 1,200 feet below the top of the Red Glacier Formation associated with *Emileia*.

The ammonite fauna from the upper part of the Red Glacier Formation is correlated with part of the European zone of *Otoites sauzei* because of the association of certain genera and subgenera. *Papilliceras*, *Otoites*, and *Emileia* are not known above the *Otoites sauzei* zone; *Normannites* and *Chondroceras* are not known below the upper part of that zone; *Skirroceras* and *Stemmatoceras* are not known below that zone, and *Otoites* reached its climax in that zone, although present in the upper part of the older *Sonninia sowerbyi* zone (table 10). The presence of *Normannites* from 95 to about 700 feet below the top of the Red Glacier Formation at Tuxedni Bay indicates that the upper part of the formation correlates with only the upper part of the *Otoites sauzei* zone.

In summation, the Red Glacier Formation in its lower part contains ammonites of early Bajocian age, and in its lower, middle, and upper parts contains ammonites of middle Bajocian age correlating with the European zone of *Otoites sauzei*. The highest part probably correlates with the upper part of that zone. Near Tuxedni Bay some ammonites belonging to that zone were obtained within a few hundred feet of the base of the formation.

Interestingly, no ammonites indicative of the European zone of *Sonninia sowerbyi* have yet been found in the Red Glacier Formation, although that zone is well represented in the Kialagvik Formation on the Alaskan Peninsula by such ammonites as *Docidoceras*, *Pseudotoites*?, and *Witchellia* associated with strongly spinose *Sonninia*. These occur directly above beds containing *Tmetoceras*, *Erycites*, and *Pseudolioceras* (Imlay, 1952, p. 978).

GAIKEMA SANDSTONE

The presence of *Sonninia* (*Papilliceras*) and *Emileia* in the lower fourth of the Gaikema Sandstone (tables 5, 9) of the Tuxedni Group in the Tuxedni Bay area shows that that part of the formation is not younger than the zone of *Otoites sauzei*. On the Iniskin Peninsula the formation has furnished the ammonites *Bradfordia*?, *Witchellia*?, and *Stephanoceras* which suggest a middle Bajocian age. However, one of the species, *Bradfordia*? *caribouensis* Imlay, n. sp., occurs elsewhere in the Talkeetna Mountains (Mesozoic loc. 3696) with *Witchellia* and *Skirroceras*, which in association (table 10) indicate a correlation with the *Otoites sauzei* zone.

FITZ CREEK SILTSTONE

The Fitz Creek Siltstone has furnished a fairly large ammonite fauna (tables 6, 9) of middle Bajocian age as

TABLE 5.—*Middle Bajocian ammonites in the Gaikema Sandstone along the northwest side of Cook Inlet, Alaska*

Fossils	Position in feet above base of Gaikema Sandstone		USGS Mesozoic fossil localities	
	Tuxedni Bay area	Chinitna Bay and Fitz Creek	Tuxedni Bay area	Chinitna Bay and Fitz Creek
Macrophylloceras sp. undet. B		At base		10980
Lytoceras cf. *L. eudisianum* d'Orbigny		300–400		27115
Sonninia (*Papilliceras*) cf. *S.* (*P.*) *arenata* (Quenstedt)	Lower 150		22723	
Witchellia? sp		180–650		19961, 26600
Lissoceras sp	Lower 150		22723	
Bradfordia? *caribouensis* Imlay, n. sp		50–100		26601
Emileia constricta Imlay, n. sp	Lower 150		22723	
Stephanoceras sp		120		19989

shown by the association of such genera and subgenera as *Sonninia*, *Strigoceras*, *Lissoceras*, *Oppelia*, *Chondroceras*, *Normannites*, *Stephanoceras*, *Skirroceras*, *Stemmatoceras*, and *Teloceras*. Considering the reported ranges of these ammonites in Europe (table 10), the formation should be equivalent to the European zone of *Stephanoceras humphriesianum*. This is shown particularly by the presence of *Teloceras*, which is not known below that zone, in association with *Chondroceras*, *Skirroceras*, and *Stemmatoceras*, which are not known above that zone. It is also indicated by an abundance of *Normannites* which attained its greatest development in that zone.

This age determination for the Fitz Creek Siltstone is in line with the fossil evidence obtained from the underlying members. Certain qualifications, however, need to be made. First, *Teloceras* has not been found in the basal 200 feet of the formation on the Iniskin Peninsula or in the basal two-thirds of the formation near Tuxedni Bay. Hence, the basal part of the formation could be as old as the zone of *Otoites sauzei*. Second, *Sonninia* in Europe has been recorded rarely above the zone of *Otoites sauzei* (Gillet, 1937, p. 11: Dorn, 1935, p. 48, 120; Oechsle, 1958, p. 75, 124), and therefore its presence in the Fitz Creek Siltstone may conflict with the age evidence furnished by the other ammonite genera.

Actually *Sonninia* has been found at only three places in the Fitz Creek Siltstone, is represented by only four specimens, and one of the records may not be valid. One occurrence of *Sonninia* from near the top of the siltstone on the south shore of Tuxedni Bay at Mesozoic locality 3000 is questioned because the genus has not been found there during recent collecting and the single specimen of *Sonninia* from Mesozoic locality 3000 has a different matrix than the associated fossils. A second occurrence of *Sonninia* consists of one small fragment, comparable to the small septate whorls of *S. tuxedniensis* Imlay, n. sp., found near the base of the formation (Mesozoic loc. 22706)

TABLE 6.—*Middle Bajocian ammonites in the Fitz Creek Siltstone along the northwest side of Cook Inlet, Alaska*

[Fossils at locs. 2999, 20020–20022, 20756, 21272 and 21274 were obtained as float]

	Position in feet below top of Fitz Creek Siltstone				USGS Mesozoic fossil localities			
	Tuxedni Bay area	Lake Hickerson area	Chinitna Bay, south shore	Fitz Creek, upper part	Tuxedni Bay area	Lake Hickerson area	Chinitna Bay, south shore	Fitz Creek, upper part
Macrophylloceras sp. undet. A	100				10515			
sp. undet. B	150?		Near top	640–690	2999		22533	26597
Holcophylloceras costisparsum Imlay, n. sp.	150				2999, 3000			
cf. *H. costisparsum* Imlay, n. sp.				650				19997, 20002
sp. juv.			Near top				19932	
Sonninia tuxedniensis Imlay, n. sp.	150				2999, 3000			
cf. *S. tuxedniensis* Imlay, n. sp.	Near top		180–230		22706		26596	
Strigoceras cf. *S. languidum* Buckman				640–690				27105
Lissoceras sp.	100–150				2999, 3000, 21271			
Oppelia stantoni Imlay, n. sp.	150–490				3000, 22721			
Chondroceras defonti (McLearn)	35–150		?	490–690	2997, 2999, 3000, 10245, 10516, 21270, 21271, 21275, 21276		20022	21769, 26597
cf. *C. defonti* (McLearn)	25			690–800	2996			19940, 21767, 22441
allani (McLearn)			120–320	50–790			19981, 19984, 20025	20000, 21768, 21317
cf. *C. allani* (McLearn)	35			540–690	21276			20002, 21306, 27105
sp.			Near top—1,080	Near top—790			19974, 26599, 22533, 26594	19081, 19933, 21303, 21306, 22440, 22441, 22534, 27108, 27109
Normannites sp.	100			Near top—800	2998, 21274			21767, 22552
(*Itinsaites*) *crickmayi* (McLearn)	75–150		800–930	690–840	2997, 2999, 3000, 21270, 21271, 21275, 27056		19977, 19978	19997, 21305
cf. (*I.*) *crickmayi* (McLearn)			Near top—1,080				19974, 21302, 26599	
(*I.*) *itinsae* (McLearn)	75–150		980–1,080	690	2997, 2999		26599	19997
cf. (*I.*) *itinsae* (McLearn)	100				21271			
(*I.*) *variabilis* Imlay, n. sp.		Near middle		50–790		22528		11023, 11024, 11027–29, 19940, 19941, 20002, 21303, 21316, 21768, 22440
cf. (*I.*) *variabilis* Imlay, n. sp.				300–790				20000, 21306, 22439
Stephanoceras sp.	340–390		380–480	940–990	22722		21292	27111
(*Skirroceras*) *kirschneri* Imlay, n. sp.	75–150?		980–1,080		2999, 21274, 20756		26599	
? sp.			160				19981	
Stemmatoceras cf. *S. palliseri* (McLearn)	150				21270			
ursinum Imlay, n. sp.	40–140				21281, 22705			
sp. juv.	Upper 150		160		10245		19981	
Teloceras itinsae (McLearn)	75–150		920–1,080	440–840	2998, 2999, 3000, 21270, 21275		19973, 19975, 27110	21304, 21305, 27107, 27109
aff. *T. itinsae* (McLearn)	Upper 150			640–680	26953			26598
Zemistephanus richardsoni (Whiteaves)	100–150		Near top—1,080	640–840	2998, 2999, 3000, 10245, 10515, 10520, 21270, 21271, 21274		19978, 20020, 21772, 22533, 26599	19997, 21304, 21305, 26598, 27108
cf. *Z. richardsoni* (Whiteaves)			Near top	800			20021, 21302	21767
carlottensis (Whiteaves)	75–100				2998, 2999, 3000, 21275			
? sp.			Near top—840				19974, 26595	

about 2½ miles from Tuxedni Bay. A third occurrence consists of two septate specimens, similar to *S. tuxedniensis* Imlay, n. sp., found in the upper fifth of the formation, above occurrences of *Teloceras*, on the south shore of Chinitna Bay (Mesozoic loc. 26596). This last occurrence may correspond to one of the scarce occurrences of the genus in the lower part of the European zone of *Stephanoceras humphriesianum*.

The known stratigraphic distribution of the ammonite species within the Fitz Creek Siltstone is shown in table 8. It appears from that table that the species of *Chondroceras*, *Normannites*, *Teloceras*, and *Zemistephanus*, which numerically compose the bulk of the fauna occur near the top of the formation at Tuxedni Bay and near the middle of the formation on the Iniskin Peninsula. This relationship may be real, or it may reflect the accessibility of good exposures. Thus at Tuxedni Bay the upper 150 feet of the formation is well exposed along the shore, whereas the remainder of the formation is relatively poorly exposed and at a considerable distance from the shore. As a consequence many collections have been made from the upper 150 feet and only two collections from the lower three-fourths of the formation. Clearly the stratigraphic distribution of species within the entire Fitz Creek Siltstone near Tuxedni Bay is not known.

One species, *Normannites variabilis* Imlay, n. sp., from the Fitz Creek Siltstone, may be of stratigraphic importance because it has not been found in the many collections from the upper part of the formation on Tuxedni Bay, and it has not been found with the other species of *Normannites*. Also, on Fitz Creek it occurs in greatest abundance near the middle of the formation, whereas the other species of *Normannites* have been found there in greatest abundance below the middle of the formation. Its most common associates are *Chondroceras allani* (McLearn) and *C.* cf. *C. allani* (McLearn), which species likewise have not been found with the other species of *Normannites* and occur most commonly higher in the formation. However, these stratigraphic ranges may be more apparent than real and need checking by additional collecting.

Another species that may be of stratigraphic significance is *Zemistephanus carlottensis* (Whiteaves) which has been found in Alaska only on the south shore of Tuxedni Bay in the upper 150 feet of the Fitz Creek Siltstone and in the basal 115 feet of the overlying Cynthia Falls Sandstone.

In summation, ammonite evidence indicates correlation of the upper three-fourths of the Fitz Creek Siltstone with the European zone of *Stephanoceras humphriesianum*. This correlation is also favored by the stratigraphic position of the Fitz Creek Siltstone above the Red Glacier Formation whose upper part may reasonably be correlated with the upper part of the *Otoites sauzei* zone. The lower one-fourth of the Fitz Creek Siltstone has furnished few ammonites and could be as old as the *Otoites sauzei* zone.

CYNTHIA FALLS SANDSTONE

The Cynthia Falls Sandstone has furnished a few ammonites of which most are from the lower 115 feet of the formation on the south shore of Tuxedni Bay (table 7). The genera and most of the species are

TABLE 7.—*Middle Bajocian ammonites in the Cynthia Falls Sandstone along the northwest side of Cook Inlet, Alaska*

Fossils	Position in feet above base of Cynthia Falls Sandstone		USGS Mesozoic fossil localities	
	Tuxedni Bay area	Fitz Creek, upper part	Tuxedni Bay area	Fitz Creek, upper part
Lissoceras bakeri Imlay	60–115	----------	10512	
sp	60–115	----------	10512	
Chondroceras defonti (McLearn)	1–500	Lower 150	2994, 10514, 10515, 10519, 22707	21771
allani (McLearn)	60–115	----------	10511	
cf. *C. oblatum* (Whiteaves)	47–115	----------	2993, 2995, 10511	
sp	60–115	----------	10512	
Normannites sp	Near base	----------	10523	
(Itinsaites) crickmayi (McLearn)	1–115	----------	10513, 10519	
cf. *N. (I.) crickmayi* (McLearn)	60–115	----------	10512	
Stephanoceras sp	47–50	----------	2995	
sp	60–80	----------	21280	
Zemistephanus carlottensis (Whiteaves)	60–115	----------	10513	

identical with those in the underlying Fitz Creek Siltstone and presumably are of nearly the same age. The presence of *Chondroceras* about 500 feet above the base of the formation on Bear Creek, about 2½ miles from Tuxedni Bay, shows that at least two-thirds of the formation at that place is not younger than middle Bajocian. Similarly on the Iniskin Peninsula the lower two-thirds of the formation has furnished *Chondroceras* or fragments suggestive of that genus. Correlation of the Cynthia Falls Sandstone with some part of the European zone of *Stephanoceras humphriesianum* is indicated by its stratigraphic position above beds containing *Teloceras*, which is characteristic of that zone, and by the presence of *Chondroceras*, which is not known above that zone.

AGES OF THE TUXEDNI FORMATION IN THE TALKEETNA MOUNTAINS

The Tuxedni Formation in the Nelchina area of the Talkeetna Mountains contains ammonites (table 12) of early, middle, and late Bajocian age. The early Bajocian age is based on the presence of *Erycites howelli* (White) (Mesozoic loc. 24235) from probably the lower 100 feet of the formation. This age assignment is supported by an ammonite resembling *Pleydellia digna* Buckman (1904, fig. 129 on p. CXLII) from the same stratigraphic position at a nearby locality (Mesozoic loc. 24149). The species *Erycites howelli* (White) has been found elsewhere in Alaska in the lower part of the Red Glacier Formation northwest of Cook Inlet and in the lower part of the Kialagvik Formation on the Alaskan Peninsula associated with the ammonite *Tmetoceras*. The lower 200–300 feet of the Tuxedni Formation in the Talkeetna Mountains has furnished one small ammonite that resembles the inner whorls of *Emileia* or *Docidoceras* (Mesozoic loc. 25946) and is suggestive of a middle rather than an early Bajocian age. The upper half of the sandstone that forms the lower 700–1,200 feet of the Tuxedni Formation has furnished ammonites of definite middle Bajocian age, including *Witchellia* (Mesozoic loc. 25945) and *Sonninia*? n. sp. undet. (Mesozoic loc. 26723). The last mentioned species has been found elsewhere on the Iniskin Peninsula associated with *Emileia* (Mesozoic loc. 21293) 1,200 feet below the top of the Red Glacier Formation.

Most of the fossil collections from the upper silty part of the Tuxedni Formation in the Nelchina area of the Talkeetna Mountains contain the same ammonite genera and subgenera (see table 12) and some of the same ammonite species as occur in the upper part of the Red Glacier Formation (table 4) and in the Gaikema Sandstone (table 5) along the northwest side of Cook Inlet. The presence of such ammonites permits a correlation with the European zone of *Otoites sauzei* as discussed above. The evidence is even stronger, however, for the silty part of the Tuxedni Formation

TABLE 8.—*Stratigraphic distribution of middle Bajocian ammonite species within the formations of the Tuxedni Group along the northwest side of Cook Inlet, Alaska*

	Fitz Creek area			South side Chinitna Bay and Gaikema Creek				Lake Hickerson and Red Glacier area			Tuxedni Bay area			
	Gaikema Sandstone	Fitz Creek Siltstone	Cynthia Falls Sandstone	Red Glacier Formation	Gaikema Sandstone	Fitz Creek Siltstone	Cynthia Falls Sandstone	Red Glacier Formation	Gaikema Sandstone	Fitz Creek Siltstone	Red Glacier Formation	Gaikema Sandstone	Fitz Creek Siltstone	Cynthia Falls Sandstone
Macrophylloceras n. sp. undet. A													—	
cf. n. sp. undet. A											—			
sp.undet. B		—			—								—	
Holcophylloceras costisparsum Imlay, n. sp		—									—		—	
cf. *H. costisparsum* Imlay, n. sp		—												
sp. juv						—					—			
Lytoceras cf. *L. eudisianum* d'Orbigny	—			—										
Sonninia tuxedniensis Imlay, n. sp											—			
cf. *S. tuxedniensis* Imlay, n. sp						—					—		—	
(Papilliceras) cf. S. *(P.) arenata* (Quenstedt)											—	—		
? n. sp. undet				—										
? sp. juv								—			—			
Witchellia adnata Imlay, n. sp				—							—			
sp				—										
? sp				—	—			—			—			
Strigoceras cf. *S. languidum* Buckman		—												
sp. juv											—			
Lissoceras bakeri Imlay														—
cf. *L. semicostulatum* Buckman											—			
sp											—	—	—	—
Oppelia stantoni Imlay, n. sp													—	
Bradfordia? caribouensis Imlay, n. sp	—													
Otoites cf. *O. contractus* (Sowerby)											—			
? *filicostatus* Imlay, n. sp											—			
Emileia constricta Imlay, n. sp											—	—		
cf. *E. constricta* Imlay, n. sp				—							—			
Chondroceras defonti (McLearn)		—	—										—	—
cf. *C. defonti* (McLearn)		—											—	
allani (McLearn)		—				—								—
cf. *C. allani* (McLearn)		—											—	
cf. *C. oblatum* (Whiteaves)														—
sp		—				—								—
Normannites kialagvikensis Imlay, n. sp											—			
cf. *N. kialagvikensis* Imlay, n. sp				—										
sp		—											—	—
(Itinsaites) crickmayi (McLearn)		—				—							—	—
cf. *(I.) crickmayi* (McLearn)		—				—					—			—
(I.) itinsae (McLearn)		—				—							—	
cf. *(I.) itinsae* (McLearn)													—	
(I.) variabilis Imlay, n. sp		—								—				
cf. *(I.) variabilis* Imlay, n. sp		—												
Stephanoceras cf. *S. nodosum* (Quenstedt)											—			
sp		—			—	—							—	—
(Skirroceras) kirschneri Imlay, n. sp						—					—			
(S.) juhlei Imlay, n. sp											—			
Stemmatoceras n. sp. undet				—							—			
sp				—										
cf. *S. palliseri* (McLearn)													—	
ursinum Imlay, n. sp													—	
cf. *S. triptolemus* (Morris and Lycett)											—			
sp. juv													—	
? sp											—			
Teloceras itinsae (McLearn)		—				—							—	
aff. *T. itinsae* (McLearn)						—							—	
Zemistephanus richardsoni (Whiteaves)		—				—							—	
cf. *Z. richardsoni* (Whiteaves)		—												
carlottensis (Whiteaves)													—	—
? sp		—				—								
Parabigotites crassicostatus Imlay				—			—							
sp				—			—							
? sp				—							—			

TABLE 9.—*Stratigraphic distribution of certain Bajocian ammonite genera and subgenera within the Tuxedni Group along the northwest side of Cook Inlet, Alaska*

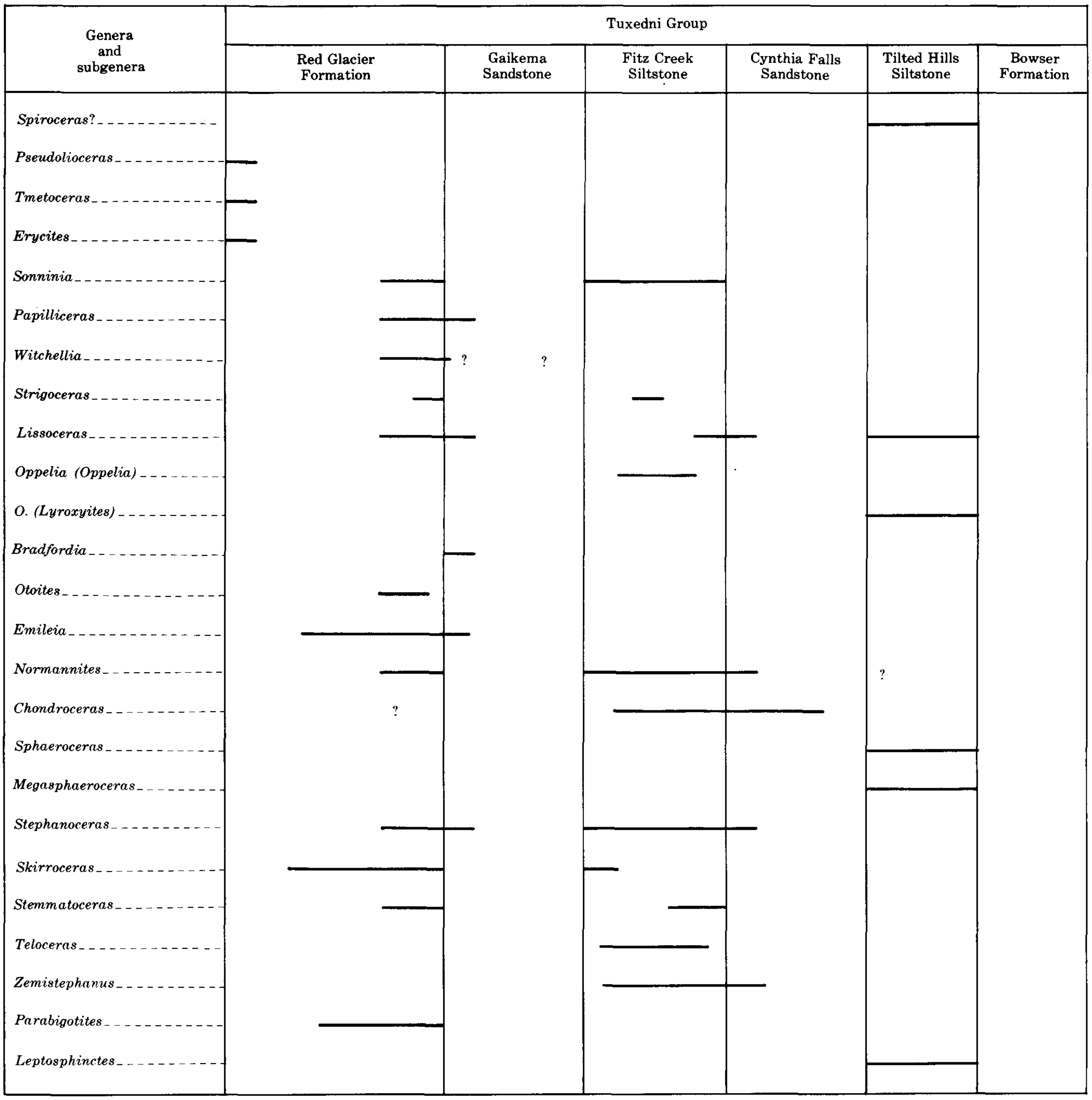

TABLE 10.—*European ranges of certain Bajocian ammonites present in the Tuxedni Group in the Cook Inlet region, Alaska*

	Toarcian				Bajocian									Bathonian				
Genera or subgenera	*Dactylioceras tenuicostatum*	*Harpoceras falcifer*	*Hildoceras bifrons*	*Lytoceras jurense*	*Lioceras opalinum*	*Tmetoceras scissum*	*Ludwigia murchisonae*	*Sonninia sowerbyi*	*Otoites sauzei*	*Stephanoceras humphriesianum*	*Strenoceras subfurcatum*	*Garantiana garantiana*	*Parkinsonia parkinsoni*	*Zigzagiceras zigzag*	*Gracilisphinctes progracilis*	*Tulites subcontractus*	*Oppelia aspidoides*	*Clydoniceras discus*
Spiroceras											—	—	—	—	—	—	—	—
Pseudolioceras			—	—	—													
Tmetoceras					—	—	—											
Erycites					—	—	—											
Sonninia							(—)	—	—	(—)								
Papilliceras								—	—									
Witchellia								—	—	(—)								
Strigoceras								—	—	—	—	—	—					
Lissoceras								(—)	—	—	—	—	—	—				
Oppelia (Oppelia)									—	—	—	—	—					
Bradfordia								—	—									
Otoites								(—)	—									
Emileia								(—)	—									
Normannites									(—)	—	—							
Labryinthoceras									—									
Chondroceras									(—)	—								
Sphaeroceras										—	—	—	—					
Stephanoceras								(—)	—	—	—							
Skirroceras									—	—								
Stemmatoceras									—	—								
Teloceras										—	—	—						
Leptosphinctes										?	—	—	—					

in the Talkeetna Mountains because of the presence of *Labyrinthoceras* at two localities.

Locally the Tuxedni Formation in the Nelchina area of the Talkeetna Mountains has yielded fossils that are of slightly younger age. One collection (Mesozoic loc. 24821) contains ammonites of late Bajocian age (Imlay, 1962, p. A–6). Another collection (Mesozoic loc. 8584) contains *Inoceramus ambiguus* Eichwald, which in the Cook Inlet area is not known below the Fitz Creek Siltstone. With these exceptions the Tuxedni Formation in the Nelchina area correlates very well on the basis of ammonites with the Red Glacier Formation and the overlying Gaikema Sandstone northwest of Cook Inlet. This correlation is also confirmed by the presence of *Inoceramus lucifer* Eichwald at many localities throughout most of the Tuxedni Formation in the Talkeetna Mountains. This species elsewhere in southern Alaska ranges throughout the Kialagvik Formation on the Alaska Peninsula and throughout the Red Glacier Formation and the Gaikema Sandstone northwest of Cook Inlet. Its oldest occurrence in these areas, as well as in northern Alaska (Imlay, 1955, p. 86), is with *Tmetoceras* or *Erycites* of early Bajocian age. The presence of this species in the basal beds of the Tuxedni Formation in the Talkeetna Mountains is good evidence, therefore, that the basal beds are not older than Bajocian.

The Tuxedni Formation in the Boulder Creek area of the Talkeetna Mountains has yielded only two fossil collections. One (Mesozoic loc. 8572) contains an ammonite of late Bajocian age (Imlay, 1962b, p. 6). The other (Mesozoic loc. 8567) contains *Normannites variabilis* Imlay, n. sp. and *Chondroceras allani* (McLearn), which species in the Cook Inlet area occur together in the middle and upper parts of the Fitz Creek Siltstone. With these in the Boulder Creek area occurs the ammonite *Leptosphinctes*, which in Europe is characteristic of the late Bajocian. It is not known, however, whether the fossils from Mesozoic locality 8567 were collected from a few feet of beds or from a much greater thickness. Even if they were collected from a single bed, a correlation with the European zone of *Stephanoceras humphriesianum* is favored by the presence of *Chondroceras* and *Normannites*. In addition, the presence of *Inoceramus ambiguus* Eichwald shows that the beds containing the fossils are younger than the Gaikema Sandstone on Cook Inlet, which sandstone is correlated with the upper part of the *Otoites sauzei* zone.

COMPARISONS WITH OTHER FAUNAS

ALASKAN PENINSULA

At Wide Bay the upper 200–400 feet of the Kialagvik Formation contains many of the same ammonites that occur in the upper part of the Red Glacier Formation southwest of Cook Inlet and in the upper silty part of the Tuxedni Formation in the Talkeetna Mountains. These ammonites may be listed as follows:

Phylloceras cf. *P. kunthi* Neumayr (Mesozoic loc. 19838)
Macrophylloceras n. sp. undet. (Mesozoic loc. 19795)
 cf. M. undulatum Imlay, n. sp. (Mesozoic locs. 19823, 21255)
Holcophylloceras costisparsum Imlay, n. sp. (Mesozoic locs. 12402, 19877)
Lytoceras sp. (Mesozoic loc. 21255)
Sonninia tuxedniensis Imlay, n. sp. (Mesozoic loc. 10809)
 (*Papilliceras*) cf. *S.* (*P.*) *arenata* (Quenstedt) (Mesozoic locs. 19840, 19852)
Witchellia? *aguilonia* Imlay, n. sp. (Mesozoic locs. 12402, 19742, 19773, 19858, 19876, 19877, 19923, 21258)
 cf. *W*? *aguilonia* Imlay, n. sp. (Mesozoic locs. 19822, 19823, 19825)
 sp. (Mesozoic loc. 21255)
Bradfordia costidensa Imlay, n. sp. (Mesozoic locs. 19786, 19823, 19838, 19798, 19850, 19742, 19884, 21257)
 cf. *B. costidensa* Imlay, n. sp. (Mesozoic locs. 19852, 19853, 21256)
 sp. (Mesozoic loc. 21255)
Otoites sp. (Mesozoic loc. 21257)
Normannites kialagvikensis Imlay, n. sp. (Mesozoic loc. 19773)
Stephanoceras sp. (Mesozoic locs. 19786, 21257)
Stemmatoceras sp. (Mesozoic locs. 19823, 19836)
Arkelloceras? sp. juv. (Mesozoic loc. 21255) (pl. 28, figs. 7–9)
Parabigotites crassicostatus Imlay (Mesozoic locs. 11349, 11352, 12402, 12404, 19773, 19796, 19800, 19811, 19824, 19926, 21258)
 cf. *P. crassicostatus* Imlay (Mesozoic locs. 19823, 21256)

The faunule listed above is correlated with the European zone of *Otoites sauzei* because of the association of such genera as *Bradfordia*, *Otoites*, *Stemmatoceras*, *Normannites*, *Sonninia*, and *Witchellia* (table 10). Of these, *Sonninia* and *Witchellia* are uncommon above the *Otoites sauzei* zone, *Bradfordia* and *Otoites* are unknown above that zone, *Stemmatoceras* and *Normannites* are unknown below that zone, and *Otoites* is characteristic of that zone although it occurs also in the upper part of the underlying zone of *Sonninia sowerbyi*.

Below this faunule on the southeast shore of Wide Bay another ammonite faunule of middle Bajocian age has been obtained from 225 to 500 feet below the top of the Kialagvik Formation. This older faunule is characterized by the genera *Sonninia*, *Witchellia*, *Docidoceras*, *Pseudotoites*?, and *Strigoceras*. Of these, only *Sonninia* has been recorded from beds older than the European zone of *Sonninia sowerbyi* (Arkell and others, 1957, p. L267); *Docidoceras* is characteristic of that zone. *Pseudotoites* has been recorded previously only from Australia (Arkell, 1954, p. 556, 572–577) and Argentina (Arkell, 1954, p. 592). In Australia it is associated with ammonites indicating a correlation with the zone of *Sonninia sowerbyi*. In Argentina the exact stratigraphic position of *Pseudotoites* has not been described, but it occurs in a sequence of beds containing ammonite genera that apparently represent both the *Sonninia sowerbyi* and *Otoites sauzei* zones.

QUEEN CHARLOTTE ISLANDS, BRITISH COLUMBIA

On Maude Island the lower beds of the Yakoun Formation contain ammonites identical specifically with those in the Fitz Creek Siltstone and in the Gaikema Sandstone northwest of Cook Inlet. On the southeast shore of Maude Island have been found species of *Stephanoceras* and *Chondroceras* (McLearn, 1929, p. 13–18; 1932, p. 54, 55) that Arkell (1956, p. 542) correlated with the European zone of *Stephanoceras humphriesianum*, presumably because of the presence of *Chondroceras*. On the northwest shore of Maude Island have been found species of *Zemistephanus*, *Normannites*, and *Teloceras* (McLearn, 1929, p. 18–27; 1932a, p. 51–52) that Arkell (1954, p. 587, 588; 1956, p. 542) correlated tentatively with the European zone of *Otoites sauzei*. This last correlation was based apparently on the absence of *Chondroceras;* on the fact that *Teloceras* was obtained as float and, therefore, is of little age value; on an identification of *Ammonites carlottensis* Whiteaves (1876, p. 38, pl. 6) with *Pseudotoites* instead of *Zemistephanus* (Arkell, 1954, p. 594); and on the presumption that *Zemistephanus* was obtained from older beds than the float specimen of *Teloceras* (Arkell, 1954, p. 596). However, the various species of *Chondroceras, Normannites, and Teloceras* that were obtained from these localities on Maude Island occur together in the Fitz Creek Siltstone in in Alaska and belong to a single faunule. The evidence, 'as presented herein, is decidedly in favor of correlating this faunule with only the zone of *Stephanoceras humphriesianum.*

CENTRAL BRITISH COLUMBIA

The presence of rocks of middle Bajocian age in central British Columbia is proved by occurrences of *Stephanoceras*, *Sonninia*, and *Witchellia* (McLearn, 1926; 1927, p. 65; Frebold, 1957a, p. 16 and fig. 4). The last two genera provide a broad correlation with the European zones of *Sonninia sowerbyi* and *Otoites sauzei*, but Arkell (1956, p. 542) favored a correlation with only the zone of *Sonninia sowerbyi*. The few species that have been described are not identical with any known from the Tuxedni Group in Alaska.

WESTERN INTERIOR OF CANADA

The middle part of the Fernie Group at many places in western Alberta and southeastern British Columbia has furnished middle Bajocian ammonites including the genera *Teloceras*, *Stemmatoceras*, *Stephanoceras*, *Zemistephanus*, *Normannites*, and *Chondroceras* (McLearn, 1927, p. 72; 1928, p. 21, 22; 1932b; Warren, 1947; Frebold, 1957a, p. 12–18, 47–53). These genera are the same as occur in the lower beds of the Yakoun Formation on the Queen Charlotte Islands and in the Fitz Creek Siltstone of the Cook Inlet region, Alaska, but the species appear to be different except for *Chondroceras allani* (McLearn), which is recorded herein from Alaska. On the basis of these ammonites the middle part of the Fernie Group has been correlated by Arkell (1956, p. 542) and Frebold (1957a, p. 13) with the European zone of *Stephanoceras humphriesianum* and *Otoites sauzei*. The evidence for correlation with the first named zone is particularly strong as shown by the association of *Teloceras*, *Normannites*, and *Chondroceras* and the absence of *Sonninia* and *Witchellia*, provided that these genera have the same stratigraphic ranges as in northwest Europe (table 10).

Below the beds characterized by *Teloceras* at one locality have been found coarsely ribbed specimens of *Sonninia* that are indicative of early middle Bajocian age (Frebold, 1957a, p. 13, 48, 49) by comparison with the European faunal succession. Its presence below the *Teloceras*-bearing beds corresponds with the stratigraphic positions of the two genera in Europe.

WESTERN INTERIOR OF THE UNITED STATES

Some ammonites of middle Bajocian age have been found in the northern part of the western interior region (Imlay, 1948, p. 13, 14, 19; 1952, p. 967, 968). They have been obtained from the middle part of the Gypsum Spring Formation in northwestern Wyoming (Imlay, 1956, p. 583), from the middle part of the Piper Formation in southern Montana (Imlay, 1956, p. 577), from the lower part of the Sawtooth Formation in western Montana (Imlay, 1948, p. 19) and from Members B and C of the Twin Creek Limestone in southeastern Idaho and westernmost Wyoming (Imlay, 1950, p. 39). The genera present include at least *Stemmatoceras*, *Zemistephanus*, *Stephanoceras*, *Chondroceras*, and *Normannites*. Most of the specimens are crushed and poorly preserved, but as far as their preservation permits comparisons they resemble the species of those genera from the middle part of the Fernie Group in western Alberta.

EAST-CENTRAL OREGON

In east-central Oregon, ammonites of middle Bajocian age have been found in the Weberg, Warm Springs, and Snowshoe Formations of Lupher (1941, p. 227, 248–252, 259, 260). The evidence furnished by the ammonites has been discussed by Lupher (1941, p. 253–255, 261–263) and Arkell (1954, p. 589, 590; 1956, p. 555). In recent years the writer has restudied the ammonites collected by Lupher as well as many ammonites collected by himself and by other geologists and can confirm that Luphers age determinations are mainly correct.

The basal beds of the Weberg Formation contain a constricted species of *Tmetoceras* that furnishes a correlation with the European zone of *Tmetoceras scissum*. The overlying beds have furnished *Tmetoceras, Praestrigites* and *Docidoceras*. These furnish a correlation with both the upper part of the lower Bajocian and with the basal part of the middle Bajocian considering that in Europe *Tmetoceras* ranges to the top of the *Graphoceras concavum* zone (Arkell, 1956, p. 34); *Praestrigites* ranges through the zones of *Graphoceras concavum* and *Sonninia sowerbyi* (Arkell, and others 1957, p. L271), and *Docidoceras* is characteristic of the lower part of the zone of *Sonninia sowerbyi* and is not known from older beds.

The highest part of the Weberg Formation has furnished many specimens of *Euhoploceras* and *Witchellia* and some specimens of *Docidoceras* and *Praestrigites*. These genera in association are excellent evidence for a correlation with the zone of *Sonninia sowerbyi* because in Europe *Witchellia* is unknown below that zone, *Praestrigites* is unknown above it, and *Euhoploceras* and *Docidoceras* are typical of its lower part.

The Warm Springs Formation overlies the Weberg Formation transitionally and apparently is only slightly younger. The presence of such ammonites as *Witchellia, Sonninia* (*Papilliceras*), *Euhoploceras*, and *Stemmatoceras*? shows that it is of middle Bajocian age.

The Snowshoe Formation in its lower 50 feet contains ammonites of late Toarcian age including such genera as *Haugia, Grammoceras, Catulloceras*? and *Harpoceras*. Directly above, throughout a stratigraphic thickness of about 150 feet, occurs *Tmetoceras* cf. *T. scissum* (Benecke) of early Bajocian age. Still higher in the lower and middle parts of the formation occur the ammonites *Witchellia, Sonninia, S.* (*Papilliceras*), and *Stephanoceras* (*Skirroceras*), which suggest correlations with both the zones of *Sonninia sowerbyi* and *Otoites sauzei*. At a few places in the Snowshoe Formation have been found an association of the ammonites *Normannites, Chondroceras, Teloceras,* and *Stephanoceras*. These appear to be identical specifically with ammonites in the Fitz Creek Siltstone in Alaska and are correlated similarly with the European zone of *Stephanoceras humphriesianum*.

NORTHERN CALIFORNIA

From the Mormon Sandstone in the Taylorsville area, California, have been obtained a few ammonites of middle Bajocian age (Crickmay, 1933, p. 898, 899, 909–913, pl. 27, figs. 6–11, pls. 28–31, pl. 32, fig. 1) including species of *Sonninia, S.* (*Papilliceras*), *Normannites*, and *Chondroceras*. These were referred by Crickmay to the early Middle Jurassic (1933, p. 899) and by Arkell (1954, p. 590; 1956, p. 555) with qualifications to the European zones of *Sonninia sowerbyi* and *Otoites sauzei*. In addition from the upper part of the formation Crickmay (1933, p. 898) obtained a small ammonite that he identified with *Teloceras* but did not describe. If this identification is correct the upper part of the Morman Sandstone may correspond with the zone of *Stephanoceras humphriesianum*. The published evidence for correlation of the Mormon Sandstone with this zone, or with the zone of *Sonninia sowerbyi* is not decisive, but a correlation of part of the formation with the *Otoites sauzei* zone is confirmed by the association at one place of the genera *Normannties, Chondroceras,* and *Sonninia* (*Papilliceras*). As noted by Lupher (1941, p. 262) some of the species of *Papilliceras* described by Crickmay from the Mormon Sandstone appear to be identical with species in the Snowshoe Formation of eastern Oregon.

SOUTHERN CALIFORNIA

A few fossils of middle Bajocian age have been obtained from a limestone lens in the Bedford Canyon Formation in the Santa Ana Mountains southeast of Corona, Calif. The exact locality is near the head of McBride Canyon in the NE. cor. sec. 31, T. 4 S., R. 6 W., Corona South quadrangle, Orange County. The fossils include the ammonites *Dorsetensia* sp. and *Teloceras*? sp. juv. and the pelecypods *Posidonia ornati* Quenstedt and *Inoceramus* cf. *I. hamadae* Hayami.

SOUTHERN MEXICO

Most of the ammonites from southern Mexico that Burckhardt (1927, p. 19–28, 92–94; 1930, p. 25, 26) considered to be of middle Bajocian age are considered by Arkell (1954, p. 590; 1956, p. 564, 565) to be of Bathonian age, or perhaps in part of late Bajocian age. He assigned *Stephanoceras undulatum* Burckhardt (1927, pl. 12, figs. 1–4), however, to *Normannites* which genus is typical of the upper part of middle Bajocian (table 10) although ranging into the lower part of the upper Bajocian. Except for this species of *Normannites*, which bears a little resemblance to *N. crickmayi* (McLearn), the Middle Jurassic ammonites from Mexico that Burckhardt described are unlike the middle Bajocian ammonites from Alaska and, judging from the preliminary studies of Erben (1956, p. 28, 29), are mostly of late Bajocian age.

SOUTH AMERICA

The presence of middle Bajocian ammonites in Argentina, Chile, Peru, and Bolivia has been discussed recently by Arkell (1954, p. 590–593; 1956, p. 585). Evidence for the European zone of *Stephanoceras humphriesianum* is meager and is based mainly on one specimen of *Stephanoceras* (Steinmann, 1881, p. 268, pl. 12, figs. 7, 7a). In contrast, evidence for the zones

Otoites sauzei and *Sonninia sowerbyi* is excellent. In the lower part of the Middle Jurassic sequence occur the genera *Eudmetoceras*, *Bradfordia*, and *Fontannesia* that Arkell (1954, p. 591) considered to represent the zone of *Sonninia sowerbyi*. In the overlying limestone occur the genera *Sonninia*, *S.* (*Papilliceras*), *Witchellia*, *Shirbuirnia*, *Otoites*, *Chondroceras*, *Emileia*, *Fontannesia*, *Eudmetoceras*, *Bradfordia*, and *Pseudotoites* that Arkell considered to represent both the *S. sowerbyi* and the *Otoites sauzei* zones. Of the genera listed, however, only *Chondroceras* is not known from beds older than the *Otoites sauzei* zone.

INDONESIA AND AUSTRALIA

Beds of Middle Bajocian age have been identified in eastern Indonesia, in New Guinea, and in western Australia. The zone of *Stephanoceras humphriesianum* is represented in eastern Indonesia by *Teloceras* and *Chondroceras* (Arkell, 1954, p. 583, 584; 1956, p. 440), in New Guinea by *Stephanoceras*, *Chondroceras*, and *Normannites* (Arkell, 1954, p. 583; 1956, p. 448), and is possibly represented in western Australia by specimens of *Stemmatoceras* (Arkell, 1954, p. 581–583). The zone of *Otoites sauzei* has not been identified anywhere in Indonesia or Australasia. The zone of *Sonninia sowerbyi* has been identified in western Australia (Arkell, 1954) by an association of the ammonites *Sonninia*, *Witchellia*, *Fontannesia*, *Otoites*, and *Pseudotoites*. An occurrence of the same zone in eastern Indonesia is indicated by the presence of *Pseudotoites* (Kruizinga, 1926, pl. 6, figs. 1, 2; pl. 12, fig. 3) according to Arkell (1954, p. 576, 584; 1956, p. 440). None of the described ammonites are closely similar specifically to the middle Bajocian ammonites of the Cook Inlet region, Alaska, although the species of *Teloceras* and *Stephanoceras* are compared by Arkell (1954, p. 583) with species from western Canada.

EUROPE

Many ammonite genera that in Europe are common in or characterize beds of middle Bajocian age are likewise common in the Cook Inlet region, Alaska, in the Tuxedni Group. In general, as discussed under the heading "Ages of the faunas," the association of ammonite genera and the stratigraphic succession of those genera are nearly the same in Alaska as in Europe. A possible exception is the genus *Sonninia* which at the top of its range in Alaska occurs with *Teloceras*, *Chondroceras*, and *Normannites*, an association typical of the zone of *Stephanoceras humphriesianum* in Europe. Even in Europe, however, *Sonninia* has been reported from the lower part of that zone (Dorn, 1935, p. 120; Gillet, 1937, p. 11). Another possible exception is *Leptosphinctes* which at one locality in Alaska (Mesozoic loc. 8367) is associated with ammonites such as *Normannites*, *Zemistephanus*, and *Chondroceras*, which indicate a middle rather than a late Bajocian age.

One difference between the middle Bajocian ammonite assemblages of Europe and Alaska is the presence in Alaska of the genera *Zemistephanus* and *Parabigotites*, which are as yet unknown in Europe. Similarly some genera found in Europe and Asia in beds of middle Bajocian age have not been found in Alaska. Their absence from Alaska may be due to collection failure and hence only apparent, or their absence may actually reflect provincial differences. This last possibility is suggested by the fact that not a single specimen of *Dorsetensia* has yet been found in Alaska, although the genus ranges through most of the middle Bajocian in Eurasia and Africa and is particularly common in the zone of *Stephanoceras humphriesianum* (Arkell, 1954, p. 559; 1952a, p. 295; 1956, p. 122–124, 264, 268, 278, 300, 325, 342, 413, 487).

Similarly on the specific level the middle Bajocian ammonites from the Cook Inlet region, Alaska, show many resemblances to those in beds of middle Bajocian age in Europe, as mentioned under the specific descriptions. For example, in the Fitz Creek Siltstone the species of *Teloceras*, *Stemmatoceras*, *Normannites*, and *Chondroceras* are similar to species in the European zone of *Stephanoceras humphriesianum*. The species of *Strigoceras* and *Sonninia*, however, resemble species in the *Otoites sauzei* zone. In the Red Glacier Formation most of the species resemble European species from the *Otoites sauzei* zone or the *Sonninia sowerbyi* zone. However, *Stephanoceras* cf. *S. nodosum* (Quenstedt) and *S.* (*Skirroceras*) *kirschneri* Imlay, n. sp. from near the top of the formation resemble species from the lower part of the *Stephanoceras humphriesianum* zone of Europe. These species of *Stephanoceras* are not good evidence for correlation with that zone because the Gaikema Sandstone, overlying the Red Glacier Formation contains the genera *Emileia* and *Bradfordia* which in Europe are not known above the *Otoites sauzei* zone.

Overall the middle Bajocian ammonites from the Cook Inlet region, Alaska, show many resemblances, both generically and specifically, to the middle Bajocian ammonites of Europe. There are differences, however, that suggest some provincial developments.

GEOGRAPHIC DISTRIBUTION

Detailed descriptions of the individual fossil localities are given in table 11. The occurrence of the fossils by area and locality are indicated in tables 12 and 13. The positions of the areas are shown in figures 1–4.

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TABLE 11.—*Localities at which fossils of middle Bajocian age have been collected in the Cook Inlet region, Alaska*

Locality No. on figs. 1–4	Geological Survey Mesozoic localities	Collector's field Nos.	Collector, year of collection, description of locality, and stratigraphic assignment
1	27577	----------------------	Western Gulf Oil Co., 1959. Talkeetna Mountains (A–1) quad., near Crooked Creek south of Nelchina, lat 62°02′00″ N., long 147°18′00″ W., Tuxedni Formation, lower part.
2	24113	52AGz85	Arthur Grantz, Richard Hoare, and R. W. Imlay, 1952. Talkeetna Mountains (A–1) quad. From a landslide scar 1.63 miles north of the mouth of Albert Creek. Tuxedni Formation, 50–250 ft above base.
3	25945	55AGz245a	Arthur Grantz, 1955. Talkeetna Mountains (A–1) quad., lat 62°02′28″ N., long 147°22′ 59″ W., Tuxedni Formation, upper half of lower sandstone.
4	26723	57AGz43N	Arthur Grantz, 1957. Talkeetna Mountains (A–1) quad., lat 62°02′00″ N., long 147°25′15″ W., Tuxedni Formation, upper half of lower sandstone.
5	25345	54AFy28	L. F. Fay, 1954. Talkeetna Mountains (A–2) quad., lat 62°00′46″ N., long 147°34′-02½″ W., Tuxedni Formation, upper siltstone.
5	25346	54AFy29	L. F. Fay, 1954. Talkeetna Mountains (A–2) quad., lat 62°00′41″ N., long 147°34′-16½″ W., Tuxedni Formation, upper siltstone.
6	24176	52AHr51	Richard Hoare, 1952. Anchorage (D–2) quad., Pass Creek, 0.35 mile above its mouth. Basal sandstone of the Tuxedni Formation, 100–200 ft above base.
7	25946	55AGz309	Arthur Grantz, 1955. Anchorage (D–2) quad., lat 61°57′47″ N., long 147°24′21″ W., Tuxedni Formation, 200–300 ft above base.
8	24215	52AGz182	Richard Hoare and Arthur Grantz, 1952. Anchorage (D–2) quad., Alfred Creek, 0.8 mile east of Papoose Creek. Tuxedni Formation, upper siltstone.
8	25942	55AGz163	Arthur Grantz, 1955. Anchorage (D–2) quad., lat 61°57′09″ N., long 147°27′56″ W., Tuxedni Formation, upper siltstone.
9	24134	52AGz275	Arthur Grantz, Richard Hoare, and R. W. Imlay, 1952. Anchorage (D–2) quad., 2.63 miles N. 52½ miles E. of mouth of Sheep Creek. Tuxedni Formation, base of upper siltstone.
10	8585	13AM36	G. C. Martin, 1913. Talkeetna Mountains. North bank of Caribou Creek 0.75 mile below Billy Creek. Tuxedni Formation, upper siltstone.
10	24120	52AGz198	Arthur Grantz, Richard Hoare, and R. W. Imlay, 1952. Anchorage (D–2) quad., Caribou Creek 0.62 mile east of Billy Creek. Tuxedni Formation, upper siltstone.
10	24220	52AGz215	Arthur Grantz, Richard Hoare, and R. W. Imlay, 1952. Anchorage (D–2) quad., north side of Caribou Creek 0.73 mile east of Billy Creek. Tuxedni Formation, upper siltstone.
11	3696	6AK88A	Adolph Knopf, 1906. Talkeetna Mountains. Tributary of Caribou Creek from the west, 0.25 mile above Billy Creek at altitude of 4,050 ft. Tuxedni Formation, probably upper siltstone.
11	3697	6AK88B	Adolph Knopf, 1906. Talkeetna Mountains. Boulder in stream bed at same location as Mesozoic loc. 3696.
12	8567	13AM16	G. C. Martin, R. M. Overbeck, and J. B. Mertie, Jr., 1913. Talkeetna Mountains. About 3.2 miles up second creek entering Boulder Creek from the north above the Canyon. This creek is north of extreme west end of Anthracite Ridge. Tuxedni Formation.
13	3010	917j	T. W. Stanton, 1904. Tuxedni Bay area, 1.4 miles west of Fossil Point. Red Glacier Formation. Float about 700 ft below top.
14	3009	917i	T. W. Stanton, 1904. Tuxedni Bay area, 1.24 miles west of Fossil Point. Red Glacier Formation, about 500 ft below top.
14	21261	48AI56	R. W. Imlay and D. J. Miller, 1948. Tuxedni Bay area, 1.26 miles N. 87° W. of Fossil Point. Red Glacier Formation. From silty sandstone 500–515 ft below top of formation in unit 34 of section measured by Stanton and Martin.
14	21262	48AI57	R. W. Imlay and D. J. Miller, 1948. Tuxedni Bay area, 1.25 miles N. 88° W. of Fossil Point. Red Glacier Formation. Massive gray siltstone 480–500 ft below top of formation in unit 33 of section measured by Stanton and Martin.
14	21263	48AI58	R. W. Imlay and D. J. Miller, 1948. Same geographical location as 21261. Red Glacier Formation. Float from 480 to 515 ft below top of formation.
15	3007	917g	T. W. Stanton, 1904. Tuxedni Bay area, 1.2 miles west of Fossil Point. Red Glacier Formation. Float about 450 ft below top of formation.
15	3008	917h	T. W. Stanton, 1904. Tuxedni Bay area, 1.22 miles west of Fossil Point. Red Glacier Formation, about 475 ft below top.
16	3004	917d	T. W. Stanton, 1904. Tuxedni Bay area, 0.96 mile west of Fossil Point. Red Glacier Formation. Float on beach 250–300 ft below top of formation.
17	21264	48AI59	R. W. Imlay and D. J. Miller, 1948. Tuxedni Bay area, 3,650 ft S. 80° W. of Fossil Point. Red Glacier Formation. Massive gray siltstone 250 ft below top of formation and from base of unit 23 of section by Stanton and Martin.
17	21265	48AI60	R. W. Imlay and D. J. Miller, 1948. Tuxedni Bay area, 3,500 ft S. 86° W. of Fossil Point. Red Glacier Formation, 215 ft below top in massive gray siltstone.
17	21266	48AI61	R. W. Imlay and D. J. Miller, 1948. Tuxedni Bay area, 3,250 ft S. 85° W. of Fossil Point. Red Glacier Formation, 200 ft below top in massive gray siltstone.
18	3013	917n	T. W. Stanton, 1904. Tuxedni Bay area, 1.0 mile west of Fossil Point. Red Glacier Formation, upper 50 ft.
18	21267	48AI62	R. W. Imlay and D. J. Miller, 1948. Tuxedni Bay area, 3,075 ft S. 84° W. of Fossil Point. Red Glacier Formation, 170 ft below top in massive gray siltstone.
18	21268	48AI63	R. W. Imlay and D. J. Miller, 1948. Tuxedni Bay area, 3,250–3,500 ft S., 85°–86° W. of Fossil Point. Red Glacier Formation. Float from 100 to 230 ft below top of formation.

TABLE 11.—*Localities at which fossils of middle Bajocian age have been collected in the Cook Inlet region Alaska*—Continued

Locality No. on figs. 1-4	Geological Survey Mesozoic localities	Collector's field Nos.	Collector, year of collection, description of locality, and stratigraphic assignment
18	21269	48AI63	R. W. Imlay and D. J. Miller, 1948. Tuxedni Bay area, 2,800 ft S. 86° W. of Fossil Point. Red Glacier Formation, about 95 ft below top in massive gray siltstone.
19	24333	52AJuN5	Werner Juhle, 1952. Tuxedni Bay area, on ridge top between Difficult Creek and Hungryman Creek 4.8 miles S. 79° W. of Fossil Point. Red Glacier Formation, 1,800–1,900 ft below top.
20	24334	52AJu-F15	Werner Juhle, 1952. Tuxedni Bay area, on a ridge south of the headwaters of Hungryman Creek, 5.5 miles S. 78° W. of the mouth of Hungryman Creek. Red Glacier Formation, 1,700–1,800 ft below top.
21	22723	51AHall	J. K. Hartsock, 1951. Tuxedni Bay area. Near Bear Creek about 3 miles S. 62° W. of mouth of Bear Creek. Gaikema Sandstone. From gray sandy shale in lower 150 ft.
22	2999	916e	T. W. Stanton, G. C. Martin, and Andrew Brown, 1904. Tuxedni Bay area, 2,500 ft west of Fossil Point. Fitz Creek Siltstone. Float from 100 to 150 ft below top.
22	3000	916f	T. W. Stanton, 1904. Tuxedni Bay area, 3,000 ft west of Fossil Point. Fitz Creek Siltstone 150 ft below top.
22	10245	B	C. N. Fenner, 1919. Tuxedni Bay area, south shore west of Fossil Point. Fitz Creek Siltstone.
22	10520	20-AM-10	F. H. Moffit, 1920. Tuxedni Bay area, 3,000 ft west of Fossil Point. Fitz Creek Siltstone, 150 ft below top.
22	20756	46AKr33	C. E. Kirschner, 1946. Tuxedni Bay area, south shore west of Fossil Point. Float from both Fitz Creek Siltstone and Cynthia Falls Sandstone.
22	21270	48AI65	R. W. Imlay and D. J. Miller, 1948. Tuxedni Bay area, 0.52 mile N. 87° W. of Fossil Point. Fitz Creek Siltstone. From silty sandstone 150 ft below top. Same as unit 19 of section by Stanton and Martin.
22	26953		E. R. Orwig, 1957. Tuxedni Bay area, west of Fossil Point. Fitz Creek Siltstone.
23	2997	916c	T. W. Stanton, G. C. Martin, and Andrew Brown, 1904. Tuxedni Bay area, 1,500 ft west of Fossil Point. Fitz Creek Siltstone, sandy limestone 75 ft below top.
23	2998	916d	T. W. Stanton, G. C. Martin, and Andrew Brown, 1904. Tuxedni Bay area, 2,000 ft west of Fossil Point. Fitz Creek Siltstone, siltstone and sandstone 100 ft below top.
23	10515	20AM-4	F. H. Moffit, 1920. Tuxedni Bay area, 0.32 mile west of Fossil Point. Fitz Creek Siltstone, 100 ft below top.
23	10516	20-AI-5	Herbert Insley, 1920. Tuxedni Bay area, 0.28 mile west of Fossil Point. Fitz Creek Siltstone, 75 ft below top.
23	21271	48AI66	R. W. Imlay and D. J. Miller, 1948. Tuxedni Bay area, 0.40 mile N. 87° W. of Fossil Point. Fitz Creek Siltstone, from silty sandstone, 100 ft below top. Same as unit 14 of section by Stanton and Martin.
23	21274	48AI73	R. W. Imlay and D. J. Miller, 1948. Tuxedni Bay area, 0.40 mile N. 87° W. of Fossil Point. Fitz Creek Siltstone, from silty sandstone, 100 ft below top.
23	21275	48AI74	R. W. Imlay and D. J. Miller, 1948. Tuxedni Bay area, 0.3 mile N. 87° W. of Fossil Point. Fitz Creek Siltstone, from silty sandstone, 75 ft below top.
24	2996	916b	T. W. Stanton, G. C. Martin, and Andrew Brown, 1904. Tuxedni Bay area, about 1,300 ft west of Fossil Point. Fitz Creek Siltstone, 25 ft below top.
24	21276	48AI75	R. W. Imlay and D. J. Miller, 1948. Tuxedni Bay area, 0.25 mile N. 87° W. of Fossil Point, Fitz Creek Siltstone, from silty sandstone, 25–60 ft below top. Same as unit 8 of section by Stanton and Martin.
25	22721	51AHa9	J. K. Hartsock, 1951. Tuxedni Bay area. On tributary of Bear Creek, 3.56 miles S. 38° W. of mouth of Bear Creek. Fitz Creek Siltstone, 150 ft above base.
26	22722	51AHa10	J. K. Hartsock, 1951. Tuxedni Bay area. Near Bear Creek, 3.75 miles S. 38° W. of mouth of Bear Creek. Fitz Creek Siltstone, 250–300 ft above base.
27	21281	48AI80	R. W. Imlay and D. J. Miller, 1948. Tuxedni Bay area. Same outcrop as loc. 22705. Fitz Creek Siltstone.
27	22705	51AGz136	Arthur Grantz, 1951. Tuxedni Bay area, on Bear Creek 2.36 miles from Tuxedni Channel. Fitz Creek Siltstone, 500–600 ft above base.
28	22706	51AGz137	Arthur Grantz, 1951. Tuxedni Bay area, 0.12 mile above mouth of tributary entering Bear Creek from southeast 2.53 miles from Tuxedni Channel. Fitz Creek Siltstone. Sandy siltstone 600–650 ft above base.
28	22707	51AGz138	Arthur Grantz, 1951. Tuxedni Bay area, 600 ft above mouth of a tributary entering Bear Creek from southeast 2.53 miles from Tuxedni Channel. Cynthia Falls Sandstone, 400–500 ft above base.
29	2995	916a	T. W. Stanton, G. C. Martin, and Andrew Brown, 1904. Tuxedni Bay area. At Fossil Point between Mesozoic locs. 2993 and 2994. Cynthia Falls Sandstone, about 47 ft above base.
29	10513	20-AI-2	Herbert Insley, 1920. Tuxedni Bay area, just west of extreme end of Fossil Point, Cynthia Falls Sandstone. From same unit as Mesozoic loc. 2993.
29	10514	20-AI3	F. H. Moffit and Herbert Insley, 1920. Tuxedni Bay area at same place as Mesozoic loc. 10523 but about 20 ft lower stratigraphically.
29	10519	20-AM-7, 8, 9	F. H. Moffit, 1920. Tuxedni Bay area, west of Fossil Point. Cynthia Falls Sandstone, from basal 39 ft.
29	10523	20AM-3	F. H. Moffit, 1920. Tuxedni Bay area, 200 ft west of the point on Fossil Point. Cynthia Falls Sandstone near base.
30	2993	914	T. W. Stanton, G. C. Martin, and Andrew Brown, 1904. Tuxedni Bay area at Fossil Point. Cynthia Falls Sandstone from 55 ft of shaly sandstone whose base is about 50 ft above base of formation.
30	10511	20-AI-1	Herbert Insley, 1920. Tuxedni Bay area, just southeast of end of Fossil Point, Cynthia Falls Sandstone.

TABLE 11.—*Localities at which fossils of middle Bajocian age have been collected in the Cook Inlet region, Alaska*—Continued

Locality No. on figs. 1–4	Geological Survey Mesozoic localities	Collector's field Nos.	Collector, year of collection, description of locality, and stratigraphic assignment
30	10512	20–AM–1	F. H. Moffit, 1920. Tuxedni Bay area. South side of Fossil Point. Cynthia Falls Sandstone. From same unit as Mesozoic loc. 2993.
30	21280	48AI 79	R. W. Imlay and D. J. Miller, 1948. Tuxedni Bay area, 900 ft south of Fossil Point. Cynthia Falls Sandstone. Sandstone and siltstone in lower 20 ft of unit 1 of section measured by Martin (1926, p. 142.)
31	2994	915	T. W. Stanton, G. C. Martin, and Andrew Brown, 1904. Tuxedni Bay area, about half a mile south of Mesozoic loc. 2993 and probably at about same stratigraphic position.
32	22695	51AGz–97	Arthur Grantz, 1951. Lake Hickerson area, 2.5 miles N. 30° W. of Lake Hickerson and approximately 1.3 miles S. 80° W. of the junction of Squirrel Creek and the ice margin of Red Glacier. Red Glacier Formation, about 1,300–1,400 ft below top in brownish-gray siltstone.
33	22529	50AGz 82	Arthur Grantz, 1950. Lake Hickerson area, 5.3 miles S. 55° E. of peak of Mount Iliamna, Red Glacier Formation, about 300 ft below top.
34	22528	50AGz 83	Arthur Grantz, 1950. Lake Hickerson area, 6.0 miles S. 55° E. of peak of Mount Iliamna. Fitz Creek Siltstone near middle.
35	21766	49AGz–2	D. J. Miller, 1949. Iniskin Peninsula. South shore of Chinitna Bay in gully 1.66 miles N. 53° W. of Fitz Creek. Red Glacier Formation, 100–150 ft below top. In massive green siltstone.
36	21295	48AI–6	R. W. Imlay, 1948. Iniskin Peninsula. South shore of Chinitna Bay in gulch 1.62 miles N. 55° W. of dock at mouth of Fitz Creek. Red Glacier Formation, 320–330 ft stratigraphically below top in gray siltstone.
36	21296	48AI–7	R. W. Imlay, 1948. Iniskin Peninsula. South shore of Chinitna Bay in gulch 1.62 miles N. 54° W. of dock at mouth of Fitz Creek. Red Glacier Formation, 350–360 ft stratigraphically below its top in gray siltstone.
37	19956	F–24	Helmuth Wedow, Jr., and L. B. Kellum, 1944. Iniskin Peninsula. Cliffs on south shore of Chinitna Bay 1.15 miles N. 44° W. of mouth of Fitz Creek. Red Glacier Formation, 725–800 ft below top.
37	21293	48AMr–143	D. J. Miller, 1948. Iniskin Peninsula. Gulch draining into Chinitna Bay from south, 1.20 miles N. 42° W. of dock at mouth of Fitz Creek. Red Glacier Formation, about 1,200 ft below top. From concretions in siltstone about 100 ft below a sandstone unit.
38	19957	F–25	Helmuth Wedow, Jr., and L. B. Kellum, 1944. Iniskin Peninsula. South shore of Chinitna Bay, about 360 ft up the second left tributary gully of small stream that flows almost on axis of the Gaikema Creek anticline (Kirschner and Minard, 1948), about 1000 ft above mouth of stream at Chinitna Bay and about 1.02 miles N. 48° W. of the mouth of Fitz Creek. Red Glacier Formation from 250–300 ft below top in shaly sandstone.
38	19958	F–26	Helmuth Wedow, Jr., and L. B. Kellum, 1944. Iniskin Peninsula. South shore of Chinitna Bay about 100 ft up the same tributary gully as Mesozoic loc. 19957 and 1.0 mile N. 50° W. of mouth of Fitz Creek. Red Glacier Formation from 300–350 ft below top in shaly sandstone containing concretions 6 in. in diameter.
38	19959	F–27	Helmuth Wedow, Jr., and L. B. Kellum, 1944. Iniskin Peninsula, 3 ft below Mesozoic loc. 19958. Red Glacier Formation. Consolidated sandstone.
39	19964	F–32	Helmuth Wedow, Jr., and L. B. Kellum, 1944. Iniskin Peninsula. South shore of Chinitna Bay in small gully 2,600 ft west of mouth of Gaikema Creek and 0.90 mile N. 39° W. of mouth of Fitz Creek. Red Glacier Formation, 630 ft below top. Thin bedded brown to gray shaly sandstone.
40	19966	F–34	Helmuth Wedow, Jr., and L. B. Kellum, 1944. Iniskin Peninsula. North side of Gaikema Creek about 400 ft upstream from mouth of South Fork of Gaikema Creek or 1.0 mile N. 80° W. of the mouth of Fitz Creek. Red Glacier Formation, 850 ft below top. Shaly sandstone interbedded with sandy shale.
40	20017	F–84	L. B. Kellum and Helmuth Wedow, Jr., 1944. Iniskin Peninsula. Float from streambed about 100 ft upstream from confluence of Gaikema Creek and the South Fork of Gaikema Creek and 1.0 mile N. 80° W. from mouth of Fitz Creek. Red Glacier Formation. Float obtained about 800–900 ft below top.
41	19951	F–20	Helmuth Wedow, Jr., and L. B. Kellum, 1944. Iniskin Peninsula. Gaikema Creek about 1,200 ft upstream and 1.18 miles N. 82° W. of mouth of Fitz Creek. Red Glacier Formation, about 45 ft below top. Silty limestone with partings of sandy shale.
42	27115	58ADt 44	R. L. Detterman, 1958. Iniskin Peninsula. South shore of Chinitna Bay, 2.36 miles N. 74° W. of mouth of Fitz Creek. Gaikema Sandstone. Float obtained from 300 to 400 ft above base of member. Olive-gray to dark-yellow sandstone and siltstone.
43	10980	F–3	F. H. Moffit, 1921. Iniskin Peninsula. South shore of Chinitna Bay, 0.78 mile N. 33° W. of mouth of Fitz Creek. Gaikema Sandstone at base.
43	19961	F–29	Helmuth Wedow, Jr., and L. B. Kellum, 1944. Iniskin Peninsula. Sea cliffs on south shore of Chinitna Bay, 1,600 ft west of the mouth of Gaikema Creek and 0.7 mile N. 35° W. of the mouth of Fitz Creek. Gaikema Sandstone, 180 ft above base. Fine-grained evenly bedded sandstone just below a coarse conglomerate.
44	26600	57ADt 11	R. L. Detterman, 1957. Iniskin Peninsula. On Gaikema Creek 1.1 miles N. 80° W. of mouth of Fitz Creek. Gaikema Sandstone 600–650 ft above base. Green sandstone and conglomerate.
45	26601	57ADt 6	R. L. Detterman, 1957. Iniskin Peninsula. Roadcut along Fitz Creek, 3,000 ft S. 70° W. of mouth of Cliff Creek. Gaikema Sandstone, 50–100 ft above base. Soft chocolate brown coquinoid sandstone.

TABLE 11.—*Localities at which fossils of middle Bajocian age have been collected in the Cook Inlet region, Alaska*—Continued

Locality No. on figs. 1–4	Geological Survey Mesozoic localities	Collector's field Nos.	Collector, year of collection, description of locality, and stratigraphic assignment
46	19989	F–56	Helmuth Wedow, Jr., and L. B. Kellum, 1944. Iniskin Peninsula. Southwest side of Tonnie Creek about 700 ft upstream from the trail crossing at the mouth of the canyon and 1.47 miles S. 60° E. from Tonnie Peak. Gaikema Sandstone, 120 ft above base. Firmly consolidated sandstone 25 ft below a 2½-ft thick boulder conglomerate bed.
47	19984	F–51	Helmuth Wedow, Jr., and L. B. Kellum, 1944. Iniskin Peninsula. North side of Gaikema Creek about 200 ft downstream from the falls and 2.1 miles N. 85° W. of the mouth of Fitz Creek. Fitz Creek Siltstone, 120 ft below top. Greenish-gray sandy shale and numerous small concretions.
48	19981	F–47	Helmuth Wedow, Jr., and L. B. Kellum, 1944. Iniskin Peninsula. Small gully on south side of Gaikema Creek about 800 ft upstream from the crest of lower falls and 1.85 miles N. 84° W. of the mouth of Fitz Creek. About 125 ft above stream level. Fitz Creek Siltstone, 160 ft below top.
48	20025	44AWWF–49	Helmuth Wedow, Jr., and L. B. Kellum, 1944. Iniskin Peninsula. In Gaikema Creek about 400 ft downstream from twin falls, which are about 2¼ miles upstream from the mouth of Gaikema Creek on the south shore of Chinitna Bay and 2.02 miles N. 85° W. of the mouth of Fitz Creek. Fitz Creek Siltstone 320 ft below top. Gray sandy shale containing a few thin layers of soft greenish gray medium-grained sandstone and some lenticular calcareous sandstone concretions.
49	26599	57ADt 12	R. L. Detterman, 1957. Iniskin Peninsula. On Gaikema Creek, 1.72 miles N. 81° W. of mouth of Fitz Creek. Fitz Creek Siltstone, 200–300 ft above base. Sandstone and conglomerate interbedded in siltstone.
49	27110	58ADt 12	R. L. Detterman, 1958. Iniskin Peninsula. Gaikema Creek, 1.72 miles N. 81° W. of mouth of Fitz Creek. Same as Mesozoic loc. 26599. Fitz Creek Siltstone, 200–300 ft above base. Sandstone and siltstone containing conglomerate interbeds.
50	20020	F–87	Helmuth Wedow, Jr., and L. B. Kellum, 1944. Iniskin Peninsula. Float from streambed of Gaikema Creek about 3,300 ft upstream from the mouth of South Fork and 1.61 miles N. 82½° W. of the mouth of Fitz Creek. Fitz Creek Siltstone.
50	20021	F–88	Helmuth Wedow, Jr., and L. B. Kellum, 1944. Iniskin Peninsula. Float on northeast side of Gaikema Creek about 3,300 ft upstream from the mouth of South Fork and 1.6 miles N. 82° W. of the mouth of Fitz Creek. Fitz Creek Siltstone.
51	19975	F–42	Helmuth Wedow, Jr., 1944. Iniskin Peninsula. North side of Gaikema Creek about 3,200 ft upstream from the mouth of South Fork and 1.60 miles N. 82° W. from the mouth of Fitz Creek at stream level. Fitz Creek Siltstone, 360 ft above base. Sandy shale containing wood fragments.
51	19977	F–44	Helmuth Wedow, Jr., and L. B. Kellum, 1944. Iniskin Peninsula. North side of Gaikema Creek about 3,400 ft upstream from the mouth of South Fork and 1.60 miles N. 82° W. of the mouth of Fitz Creek. Fitz Creek Siltstone, 480 ft above base sandstone.
51	21305	48AI 28	R. W. Imlay, 1948. Iniskin Peninsula. Gaikema Creek, 1.63 miles N. 81° W. of mouth of Fitz Creek. Fitz Creek Siltstone, 250–300 ft above base.
52	19973	F–40	Helmuth Wedow, 1944. Iniskin Peninsula. North side of Gaikema Creek about 2,800 ft upstream from the mouth of South Fork and 1.54 miles N. 81° W. of mouth of Fitz Creek at an altitude of 180 ft above stream level. Fitz Creek Siltstone, 320 ft above base. Sandy shale, light gray to rusty yellow and limestone stringers.
52	19974	F–41	Helmuth Wedow, 1944. Iniskin Peninsula. North side of Gaikema Creek about 3,000 ft upstream from the mouth of South Fork, 1.58 miles N. 81½° W. of the mouth of Fitz Creek and about 100 ft above the streambed. Fitz Creek Siltstone, 440 ft above base. Shaly sandstone.
53	19978	F–45	Helmuth Wedow, Jr., and L. B. Kellum, 1944. Iniskin Peninsula. South side of Gaikema Creek about 3,300 ft upstream from the mouth of South Fork and 1.68 miles N. 83° W. from the mouth of Fitz Creek. Fitz Creek Siltstone, 410 ft above base. Gray to grayish green shaly sandstone interbedded with sandy shale, which weathers rusty yellow brown.
53	20022	F–89	Helmuth Wedow, Jr., and L. B. Kellum, 1944. Iniskin Peninsula. Float on southwest side of Gaikema Creek in small gully about 50 ft upstream from USGS Mesozoic loc. 19978 and about 1.7 miles N. 83° W. of the mouth of Fitz Creek. Probably from Fitz Creek Siltstone.
54	19933	44AWW 2a	Helmuth Wedow, 1944. Iniskin Peninsula. South shore of Chinitna Bay, about 0.9 mile N. 66° E. of the mouth of Fitz Creek. Fitz Creek Siltstone just below top and above loc. 19932.
54	21772	49AGz1	D. J. Miller, 1949. Iniskin Peninsula. South shore of Chinitna Bay. Float in gully 0.9 mile northeast of Fitz Creek. Fitz Creek Siltstone near top.
54	22533	49AHa3	J. K. Hartsock, 1949. Iniskin Peninsula. South shore of Chinitna Bay, 0.92 mile N. 67° E. of mouth of Fitz Creek. Fitz Creek Siltstone near top.
54	22552	29AHa1	J. K. Hartsock, 1949. Iniskin Peninsula. South shore of Chinitna Bay near axis of Fitz Creek anticline (Kirschner and Minard, 1948) 1.00 mile N. 68° E. of mouth of Fitz Creek. Fitz Creek Siltstone near top.
55	21302	48AHa9	J. K. Hartsock, 1948. Iniskin Peninsula. South shore of Chinitna Bay, 1.2 miles N. 72° E. of mouth of Fitz Creek on bluffs above beach. Fitz Creek Siltstone, near top.
56	21292	48AHa8	R. W. Imlay, D. J. Miller, and J. K. Hartsock, 1948. Iniskin Peninsula. South shore of Chinitna Bay, 1.4 miles N. 74° E. of mouth of Fitz Creek, Fitz Creek Siltstone. Gray siltstone.

TABLE 11.—*Localities at which fossils of middle Bajocian age have been collected in the Cook Inlet region, Alaska*—Continued

Locality No. on figs. 1-4	Geological Survey Mesozoic localities	Collector's field Nos.	Collector, year of collection, description of locality, and stratigraphic assignment
56	26596	57ADt-10	R. L. Detterman, 1957. Iniskin Peninsula. South shore of Chinitna Bay at axis of Fitz Creek anticline, 1.3 miles N. 73° E. of mouth of Fitz Creek. Fitz Creek Siltstone, 1,050-1,100 ft above base.
57	26594	57ADt-8	R. L. Detterman, 1957. Iniskin Peninsula. South shore of Chinitna Bay near mouth of Park Creek, 2.12 miles N. 65° E. of mouth of Fitz Creek along road. Fitz Creek Siltstone, upper 150 ft. Green sandstone lenses and concretions in siltstone.
57	26595	57ADt-9	R. L. Detterman, 1957. Iniskin Peninsula. South shore of Chinitna Bay, 1.8 miles N. 71° E. of mouth of Fitz Creek. Fitz Creek Siltstone, near top. Bluish-gray siltstone containing sandstone interbeds and calcareous concretions.
58	19932	44WW 2	Helmuth Wedow, 1944. Iniskin Peninsula. South shore of Chinitna Bay, about 1.2 miles N. 69° E. of the mouth of Fitz Creek, Fitz Creek Siltstone, just below the top.
59	10981	F-4	F. H. Moffit, 1921. Iniskin Peninsula. East side Fitz Creek, 2.24 miles N. 82° E. of Tonnie Peak. Fitz Creek Siltstone, 300-400 ft above base. Concretions in siltstone.
59	11023	ABF-30	A. A. Baker, 1921. Iniskin Peninsula. Same as loc. 10981.
59	11024	ABF-31	A. A. Baker, 1921. Iniskin Peninsula. Same as loc. 10981.
59	11027	ABF-34	A. A. Baker, 1921. Iniskin Peninsula. Same as loc. 10981.
59	11028	ABF-35	A. A. Baker, 1921. Iniskin Peninsula. Same as loc. 10981.
59	11029	ABF-36	A. A. Baker, 1921. Iniskin Peninsula. Same as loc. 10981.
59	19940	44AW 9	Helmuth Wedow, 1944. Iniskin Peninsula. Right side of Fitz Creek about 900 ft downstream from the mouth of Forky Creek and 2.16 miles N. 86° E. of Tonnie Peak. Fitz Creek Siltstone, 300-400 ft above base.
59	21317	48AI 34	R. W. Imlay, 1948. Iniskin Peninsula. East side of Fitz Creek 2.12 miles N. 86° E. of Tonnie Peak. Fitz Creek Siltstone, 300-400 ft above base. Same location as loc. 10981.
59	22441	50AHa41	J. F. Hartsock, 1950. Iniskin Peninsula. East bank of Fitz Creek 0.75 mile, S. 37° W. from Cliff Creek. Fitz Creek Siltstone, 300-400 ft above base.
60	19941	44AWW 10	Helmuth Wedow, 1944. Iniskin Peninsula. About 1,300 ft above mouth of a northwest flowing tributary of Fitz Creek and 2.4 miles N. 79° E. from Tonnie Peak. Fitz Creek Siltstone, near middle.
61	27107	58ADt 6	R. L. Detterman, 1958. Iniskin Peninsula on Forky Creek 1.4 miles N. 82° E. of Tonnie Peak. Fitz Creek Siltsotne, 650 ft above base. Gray silty shale and siltstone in faulted sequence.
62	21316	48AI 33	R. W. Imlay, 1948. Iniskin Peninsula. East side of Fitz Creek, 2.02 miles N. 86° E. of Tonnie Peak. Fitz Creek Siltstone, 300-400 ft above base.
62	22440	50 AHa 42	J. K. Hartsock, 1950. Iniskin Peninsula. East bank of Fitz Creek at mouth of Forky Creek. Fitz Creek Siltstone, 300-400 ft above base.
63	22439	50AHa 40	J. K. Hartsock, 1950. Iniskin Peninsula. East bank of Fitz Creek 1.3 miles S. 40° W. of mouth of Cliff Creek. Fitz Creek Siltstone, 300-400 ft above base.
64	20000	F-67	L. B. Kellum, 1944. Southwest Alaska, Cook Inlet, Iniskin Peninusla. Northeast side of Tonnie Creek about 200 ft downstream from a rapids, and 1.23 miles S. 54° E. of Tonnie Peak. Fitz Creek Siltstone, 300 ft below top. Gray shale containing numerous small light gray sandy concretions.
65	19997	44AWWF64	L. B. Kellum, 1944. Iniskin Peninsula. Southwest side of Tonnie Creek 1.30 miles S. 54° E. of Tonnie Peak. Fitz Creek Siltstone, 400 ft above base. Greenish-gray and reddish-brown shale containing thin layers of shaly sandstone.
65	26597	57ADt-2	R. L. Detterman, 1957. Iniskin Peninsula. On Tonnie Creek 1.3 miles S. 55° E. of Tonnie Peak. Fitz Creek Siltstone, 400-450 ft above base. Greenish-gray nodular weathering siltstone containing interbeds of sandstone.
66	21769	49Mr 39	D. J. Miller, 1949. Iniskin Peninsula. On northeast bank of Fitz Creek 0.2 mile below Iniskin Bay Assoc. 1, 1.86 miles S. 62° E. of Tonnie Peak. Fitz Creek Siltstone, about 600 ft above base.
67	27105	58ADt-7	R. L. Detterman, 1958. Iniskin Peninsula. Base of Havenstrite Ridge, 0.1 mile S. 30° E. of Iniskin Bay Assoc. 1. Fitz Creek Siltstone, 400-450 ft above base. Silty shale contains small amount of limestone.
67	20002	44AWWF 69	Helmuth Wedow, Jr., and L. B. Kellum, 1944. Iniskin Peninsula. East side of Fitz Creek at mouth of small tributary about 400 ft southeast of the abandoned oil well, Iniskin Bay Assoc. 1. 1.88 miles S. 54° E. from Tonnie Peak. Fitz Creek Siltstone, 650 ft below top. Gray sandy shale containing thin beds of sandstone.
68	21306	48AMr 144	D. J. Miller, 1948. Iniskin Peninsula. Stream entering Fitz Creek from southeast near Iniskin Bay Assoc. 1, 2.00 miles S. 53° E. of Tonnie Peak. Fitz Creek Siltstone, 450-500 ft sbove base.
69	27111	58AHw 44	R. L. Detterman and D. W. Hinckley, 1958. Iniskin Peninsula. On Twist Creek 0.9 miles N. 72° W. of Iniskin Bay Assoc. 1. Fitz Creek Siltstone, 100-150 ft above base. Gray siltstone and sandstone.
70	22534	50AHa 60	J. K. Hartsock, 1950. Iniskin Peninsula. 1.2 miles S. 45° W. of Iniskin Bay Assoc. 1 near head of Fitz Creek. Fitz Creek Siltstone 980-1,000 ft above base.
71	21768	49AMr 38	D. J. Miller, 1949. Iniskin Peninsula 2.35 miles south of Tonnie Peak. Fitz Creek Siltstone 50-150 ft below top.
72	21304	48AMr 147	D. J. Miller, 1948. Iniskin Peninsula. Fitz Creek, near head, 2.45 miles S. 9° E. of Tonnie Peak. Fitz Creek Siltstone, about 800 ft below the base of the Cynthia Falls Sandstone.
72	21767	49AMr 37	D. J. Miller, 1949. Iniskin Peninsula. Near axis of anticline on north bank of Fitz Creek 2.36 miles S. 10° E. of Tonnie Peak, Fitz Creek Siltstone, about 800 ft below top.

TABLE 11.—*Localities at which fossils of middle Bajocian age have been collected in the Cook Inlet region, Alaska*—Continued

Locality No. on figs. 1–4	Geological Survey Mesozoic localities	Collector's field Nos.	Collector, year of collection, description of locality, and stratigraphic assignment
72	26598	57ADt 15	R. L. Detterman, 1957. Iniskin Peninsula. Upper part of Fitz Creek, 1.72 miles S. 42° W. of Iniskin Bay Assoc. 1. Fitz Creek Siltstone, 400–450 ft above base. Dark gray silty shale and limestone concretions.
72	27108	58ADt 8	R. L. Detterman, 1958. Iniskin Peninsula. On Fitz Creek near axis of anticline 1.72 miles S. 42° W. of Iniskin Bay Assoc. 1. Fitz Creek Siltstone, 400–450 ft above base. Silty shale containing calcareous concretions.
72	27109	58ADt 9	R. L. Detterman, 1958. Middle Jurassic. On Fitz Creek on west limb of anticline, 1.93 miles S. 47° W. of Iniskin Bay Assoc. 1 and 2.38 miles S. 20° E. of Tonnie Peak. Fitz Creek Siltstone, about 600 ft below top. Silty shale containing limy concretions.
73	21303	48AMr 146	D. J. Miller, 1948. Iniskin Peninsula. Near head of Fitz Creek, 2.45 miles S. 11° E. of Tonnie Peak. Fitz Creek Siltstone, 500–550 ft above base.
74	21771	48AMr 42	R. W. Imlay and D. J. Miller, 1948. Iniskin Peninsula. Right side of Fitz Creek, 2,000 ft S. 41° W. of mouth of Cliff Creek and 2.26 miles N. 78° E. of Tonnie Peak. Cynthia Falls Sandstone, lower 150 ft.

TABLE 12.—*Geographic distribution of middle Bajocian ammonites in the Talkeetna Mountains, Alaska*

[Nos. 1–12 refer to numbers in fig. 1. Higher numbers are Geol. Survey Mesozoic loc. numbers.]

	Nelchina area																Boulder Creek area
	1	2	3	4	5		6	7	8		9	10		11			12
	27577	24113	25945	26723	25345	25346	24176	25946	24215	25942	24134	8585	24120	24220	3696	3697	8567
Phylloceras cf. *P. kunthi* Neumayr		X															
Macrophylloceras sp. undet. A		X													X	X	
sp. undet. B													X				X
Holcophylloceras costisparsum Imlay, n. sp		X															
sp. juv							X		X						X		X
Lytoceras cf. *L. eudisianum* d'Orbigny		X												X			
sp																	X
Sonninia cf. *S. projectifer* (Buckman)		X															
cf. *S. nodata* Buckman													X				
cf. *S. patella* Waagen		X											X				
sp. juv																X	
? n. sp. undet				X													
(*Papilliceras*) cf. *S. espinazitensis* Tornquist		X															
Witchellia cf. *W. adnata* Imlay, n. sp		X							X								
cf. *W. laeviuscula* (J. de C. Sowerby)													X				
sp			X												X		
? *aquilonia* Inlay, n. sp		X															
? aff. *W.* ? *aquilonia* Imlay, n. sp		X															
? sp										X				X			
Lissoceras? sp		X															
Bradfordia costidensa Imlay, n. sp		X			X				X								
? *caribouensis* Imlay, n. sp															X		
Otoites cf. *O. pauper* Westermann		X															
Emileia? sp		X						X									
Labyrinthoceras glabrum Imlay, n. sp									X	X							
Chondroceras allani (McLearn)																	X
cf. *C. marshalli* (McLearn)																	X
Normannites (*Itinsaites*?) *variabilis* Imlay, n. sp																	X
Stephanoceras obesum Imlay, n. sp		X															
(*Skirroceras*) *juhlei* Imlay, n. sp		X											X				
(*S.*) *nelchinanum* Imlay, n. sp		X										X	X				
(*S.*) cf. *S. nelchinanum* Imlay, n. sp		X											X	X			
(*S.*) sp. undet											X				X	X	
Stemmatoceras sp. juv						X											
sp																	X
Parabigotites crassicostatus Imlay	X	X															
Leptosphinctes evolutus Imlay, n. sp																	X

SUMMARY OF RESULTS

1. The Alaskan ammonites of middle Bajocian age described herein include 23 genera and subgenera and 49 species. Of these, 18 species are described as new, 9 species are identified or compared with previously described ammonites from Canada, 2 species are identified with previously described species from Alaska, 14 are compared with species from other continents, and 6 are probably new species but are too poorly preserved to merit description. Numerically the dominant families are the Otoitidae and the Stephanoceratidae. The dominant genera in decreasing abundance include *Chondroceras*, *Normannites*, *Zemistephanus*, *Parabigotites*, *Stephanoceras*, *Bradfordia*, and *Sonninia*. *Zemistephanus* is assigned to the Stephanoceratidae rather than to the Otoitidae because of its great resemblance to *Teloceras*.

2. The middle Bajocian ammonites in the Tuxedni Group of the Cook Inlet region consists of two faunules. The lower faunule northwest of Cook Inlet extends through most of the Red Glacier Formation into the Gaikema Sandstone. In the Talkeetna Mountains it has been found throughout most of the Tuxedni Formation. It is characterized by the genera *Sonninia*, *S.* (*Papilliceras*), *Witchellia*, *Bradfordia*, *Otoites*, *Emileia*, *Stephanoceras*, *S.* (*Skirroceras*), *Stemmatoceras*, and *Parabigotites* which in association furnish a correlation with the European zone of *Otoites sauzei*. The presence of a few specimens of *Normannites* in the upper third of the Red Glacier Formation suggests that that part correlates with the upper part of the *Otoites sauzei* zone.

3. The upper faunule of middle Bajocian age northwest of Cook Inlet extends through most of the Fitz Creek Siltstone into the overlying Cynthia Falls Sandstone. In the Talkeetna Mountains it has been sparsely found in the upper part of the Tuxedni Formation. It is characterized by the genera *Normannites*, *Chondroceras*, *Teloceras*, *Stephanoceras*, *Stemmatoceras*, and *Zemistephanus*. Of these the first three in association are good evidence for a correlation with the European zone of *Stephanoceras humphriesianum*. The presence, however, of a few specimens of *Sonninia*

TABLE 13.—*Geographic distribution of middle Bajocian ammonites along the northwest side of Cook Inlet, Alaska*

[Nos. 13–74 refer to numbers on figs. 2–4. Higher numbers are Geol. Survey Mesozoic loc. numbers]

	Tuxedni Bay area																																							
	13	14				15		16	17			18				19	20	21	22							23							24		25	26	27		28	
	3010	3009	21261	21262	21263	3007	3008	3004	21264	21265	21266	3013	21267	21268	21269	24333	24334	22723	2999	3000	10245	10520	20756	21270	26953	2997	2998	10515	10516	21271	21274	21275	2996	21276	22721	22722	21281	22705	22706	22707
Macrophylloceras sp. undet. A	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--
cf. *M.* sp. undet. A	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
sp. undet. B	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Holcophylloceras costisparsum Imlay, n. sp	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	X	X	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
cf. *H. costisparsum* Imlay, n. sp	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
sp. juv	X	--	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lytoceras cf. *L. eudisianum* d'Orbigny	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sonninia tuxedniensis Imlay, n. sp	--	--	--	--	--	--	--	--	--	--	X	--	--	X	--	--	--	--	X	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
cf. *S. tuxedniensis* Imlay, n. sp	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--
(Papilliceras) cf. S. *(P.) arenata* (Quenstedt)	--	--	--	X	X	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
? n. sp. undet	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
? sp. juv	X	X	--	--	--	--	X	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Witchellia adnata Imlay, n. sp	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
sp	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
? sp	X	--	--	--	--	--	X	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pelekodites ? sp	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Strigoceras cf. *S. languidum* Buckman	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
sp. juv	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lissoceras bakeri Imlay	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
cf. *L. semicostulatum* Buckman	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
sp	--	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	X	X	X	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	--
Oppelia stantoni Imlay, n. sp	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--
Bradfordia? cariboüensis Imlay, n. sp	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Otoites cf. *O. contractus* (Sowerby)	--	X	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
? *filicostatus* Imlay, n. sp	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Emileia constricta Imlay, n. sp	--	X	--	X	X	--	--	--	--	--	--	--	--	X	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
cf. *E. constricta* Imlay, n. sp	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chondroceras defonti (McLearn)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	X	X	--	X	X	X	--	--	X	X	X	--	X	--	X	--	--	--	--	--	X
cf. *C.* defonti (McLearn)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--
allani (McLearn)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
cf. *C. allani* (McLearn)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--
cf. *C. oblatum* (Whiteaves)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
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Normannites kialagvikensis Imlay, n. sp	X	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
cf. *N. kialagvikensis* Imlay, n. sp	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
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(Itinsaites) crickmayi (McLearn)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	X	--	--	X	X	--	X	--	--	--	X	--	X	--	--	--	--	--	--	--	--
cf. *(I.) crickmayi* (McLearn)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
(I.) itinsae (McLearn)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--
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(I.?) variabilis Imlay, n. sp	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
cf. *(I.?) variabilis* Imlay, n. sp	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Stephanoceras cf. *S. nodosum* (Quenstedt)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
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(Skirroceras) kirschneri Imlay, n. sp	--	--	--	--	--	--	--	--	X	--	--	X	X	X	--	--	--	--	X	--	--	--	X	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--
(S.) juhlei Imlay, n. sp	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Stemmatoceras n. sp. undet	--	--	--	--	X	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
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cf. *S. palliseri* (McLearn)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ursinum Imlay, n. sp	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	X	--	--
cf. *S. triptolemus* (Morris and Lycett)	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
sp. juv	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
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Teloceras itinsae (McLearn)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	X	--	--	--	X	--	--	X	--	--	--	--	X	--	--	--	--	--	--	--	--
aff. *T. itinsae* (McLearn)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Zemistephanus richardsoni (Whiteaves)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	X	X	X	X	X	--	--	X	X	--	X	X	--	--	--	--	--	--	--	--	--
cf. *Z. richardsoni* (Whiteaves)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
carlottensis (Whiteaves)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	X	--	--	--	--	--	--	X	--	--	--	--	X	--	--	--	--	--	--	--	--
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Parabigotites crassicostatus Imlay	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
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TABLE 13.—*Geographic distribution of middle Bajocian ammonites along the northwest side of Cook Inlet, Alaska*—Continued

[Nos. 13-74 refer to numbers on figs. 2-4. Higher numbers are Geol. Survey Mesozoic loc. numbers]

	Tuxedni Bay area—Continued										Lake Hickerson area			Iniskin Peninsula																												
	29					30				31	32	33	34	35	36		37		38			39	40		41	42	43		44	45	46	47	48		49		50		51			52	
	2995	10513	10514	10519	10523	2993	10511	10512	21280	2994	22695	22529	22528	21766	21295	21296	19956	21293	19957	19958	19959	19964	19966	20017	19951	27115	10980	19961	26600	26601	19989	19984	19981	20025	26599	27110	20020	20021	19975	19977	21305	19973	19974
Macrophylloceras sp. undet. A																																											
cf. *M.* sp. undet. A																																											
sp. undet. B																											X																
Holcophylloceras costisparsum Imlay, n. sp.																																											
cf. *H. costisparsum* Imlay, n. sp.																																											
sp. juv.																																											
Lytoceras cf. *L. eudisianum* d'Orbigny																				X			X			X																	
Sonninia tuxedniensis Imlay, n. sp.																																											
cf. *S. tuxedniensis* Imlay, n. sp.																																											
(*Papilliceras*) cf. S. (*P.*) *arenata* (Quenstedt)																						X																					
? n. sp. undet.																		X																									
? sp. juv.																																											
Witchellia adnata Imlay, n. sp.																	X																										
sp.																X																											
? sp.												X				X			X									X	X														
Pelekodites ? sp.																																											
Strigoceras cf. *S. languidum* Buckman																																											
sp. juv.																																											
Lissoceras bakeri Imlay								X																																			
cf. *L. semicostulatum* Buckman																																											
sp.								X																																			
Oppelia stantoni Imlay, n. sp.																																											
Bradfordia? *caribouensis* Imlay, n. sp.																														X													
Otoites cf. *O. contractus* (Sowerby)																																											
? *filicostatus* Imlay, n. sp.																									X																		
Emileia constricta Imlay, n. sp.																																											
cf. *E. constricta* Imlay, n. sp.																		X			X																						
Chondroceras defontii (McLearn)			X							X																																	
cf. *C. defontii* (McLearn)																																											
allani (McLearn)							X																									X	X	X									
cf. *C. allani* (McLearn)																																											
cf. *C. oblatum* (Whiteaves)	X					X	X																																				
sp.								X																											X								X
Normannites kialagvikensis Imlay, n. sp.																																											
cf. N. *kialagvikensis* Imlay, n. sp.																X																											
sp.					X																																						
(*Itinsaites*) *crickmayi* (McLearn)		X		X																																				X	X		
cf. (*I.*) *crickmayi* (McLearn)								X																											X								X
(*I.*) *itinsae* (McLearn)																																			X								
cf. (*I.*) *itinsae* (McLearn)																																											
(*I.?*) *variabilis* Imlay, n. sp.													X																														
cf. (*I.?*) *variabilis* Imlay, n. sp.																																											
Stephanoceras cf. *S. nodosum* (Quenstedt)																																											
sp.	X								X														X								X												
(*Skirroceras*) *kirschneri* Imlay, n. sp.																								X											X								
(*S.*) *juhlei* Imlay, n. sp.																																											
Stemmatoceras n. sp. undet.																																											
sp.															X								X																				
cf. *S. palliseri* (McLearn)																																											
ursinum Imlay, n. sp.																																											
cf. *S. triptolemus* (Morris and Lycett)																																											
sp juv.																																	X										
? sp.																																											
Teloceras itinsae (McLearn)																																				X			X		X	X	
aff. *T. itinsae* (McLearn)																																											
Zemistephanus richardsoni (Whiteaves)																																			X		X				X		
cf. *Z. richardsoni* (Whiteaves)																																						X					
carlottensis (Whiteaves)		X																																									
? sp.																																											X
Parabigotites crassicostatus Imlay												X											X																				
sp.											X					X																											
? sp.														X																													

TABLE 13.—*Geographic distribution of middle Bajocian ammonites along the northwest side of Cook Inlet, Alaska*—Continued

[Nos. 13–74 refer to numbers on figs. 2–4 Higher numbers are Geol. Survey Mesozoic loc. numbers]

	Iniskin Peninsula—Continued																																										
	53		54				55	56		57		58	59									60	61	62		63	64	65		66	67		68	69	70	71	72					73	74
	19978	20022	19933	21772	22533	22552	21302	21292	26596	26594	26595	19932	10981	11023	11024	11027	11028	11029	19940	21317	22441	19941	27107	21316	22440	22439	20000	19997	26597	21769	27105	20002	21306	27111	22534	21768	21304	21767	26598	27108	27109	21303	21771
Macrophylloceras sp. undet. A	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
cf. *M.* sp. undet. A	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
sp. undet. B	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Holcophylloceras costisparsum Imlay, n. sp.	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--
cf. *H. costisparsum* Imlay, n. sp.	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
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Lytoceras cf. *L. eudisianum* d'Orbigny	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sonninia tuxedniensis Imlay, n. sp.	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
cf. *S. tuxedniensis* Imlay, n. sp.	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
(Papilliceras) cf. S. *(P.) arenata* (Quenstedt)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
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Witchellia adnata Imlay, n. sp	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
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Strigoceras cf. *S. languidum* Buckman	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--
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Lissoceras bakeri Imlay	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
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Oppelia stantoni Imlay, n. sp.	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Bradfordia? cariboüensis Imlay, n. sp.	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Otoites cf. *O. contractus* (Sowerby)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
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Emileia constricta Imlay, n. sp.	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
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Chondroceras defonti (McLearn)	--	X	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	X	--	--	--	--	--	--	--	--	--	--	--	--	X
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cf. *C. allani* (McLearn)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	X	X	--	--	--	--	--	--	--	--	--	--
cf. *C. oblatum* (Whiteaves)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
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Normannites kialagvikensis Imlay, n. sp.	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
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Stephanoceras cf. *S. nodosum* (Quenstedt)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
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(S.) juhlei Imlay, n. sp	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
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cf. *S. palliseri* (McLearn)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ursinum Imlay, n. sp.	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
cf. *S. triptolemus* (Morris and Lycett)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
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aff. *T. itinsae* (McLearn)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--
Zemistephanus richardsoni (Whiteaves)	X	--	--	X	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--	--	X	--	X	X	--	--	--
cf. *Z. richardsoni* (Whiteaves)	--	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--
carlottensis (Whiteaves)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
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Parabigotites crassicostatus Imlay	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
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in the lower three-fourths of the Fitz Creek Siltstone suggests by comparison with the European sequence, that that part of the member is not younger than the lower part of *Stephanoceras humphriesianum* zone. The upper third of the Cynthia Falls Sandstone has not furnished any ammonites and hence cannot be dated definitely as middle Bajocian.

4. Ammonites indicative of the European zone of *Sonninia sowerbyi* have not yet been found in the Red Glacier Formation northwest of Cook Inlet. This failure on the Iniskin Peninsula is related in part to thrust faulting. On the peninsula between Chinitna Bay and Tuxedni Bay, failure to find such ammonites may be related to poor exposures that are difficult to reach. Ammonites of early Bajocian age, however including *Tmetoceras* and *Erycites*, have been found a five places in the lower part of the Red Glacier Formation (table 3). Consequently the absence of any ammonites representing the *Sonninia sowerbyi* zone may have stratigraphic significance rather than reflecting inadequate collecting.

5. Similarly in the Talkeetna Mountains no ammonites definitely belonping to the *Sonninia sowerbyi* zone have yet been found in the Tuxedni Formation. One

small ammonite resembling the inner whorls of *Emileia* or *Docidoceras* could represent that zone, or could represent the *Otoites sauzei* zone. The discovery of *Erycites howelli* (White) at one place in float probably from near the base of the Tuxedni Formation is evidence that the basal beds are of early Bajocian age equivalent to the lower part of the Red Glacier Formation northwest of Cook Inlet.

6. The affinities of the middle Bajocian ammonites in the Tuxedni Group in Alaska are closest with those in other parts of the Pacific coast from Alaska to California. Thus the common ammonites in the Red Glacier Formation are identical specifically with ammonites in the upper part of the Kialagvik Formation on the Alaskan Peninsula. The common ammonites in the Fitz Creek Siltstone are identical specifically with ammonites in the lower beds of the Yakoun Formation in the Queen Charlotte Islands and in the upper part of the Snowshoe Formation in east-central Oregon. In contrast the affinities with middle Bajocian ammonites in the western interior of Canada and of the United States are mostly on the generic level.

7. The ammonites of middle Bajocian age in the Tuxedni Group show affinities on the generic level with ammonites of the same age in South America, Australia, Indonesia, and Europe except for the presence in Alaska of the genera *Zemistephanus* and *Parabigotites* and the absence in Alaska of some genera that occur in beds of middle Bajocian age outside of North America.

SYSTEMATIC DESCRIPTIONS

Family PHYLLOCERATIDAE Zittel, 1884
Genus PHYLLOCERAS Suess, 1865

Phylloceras cf. P. kunthi Neumayr

Plate 2, figures 3, 4

The genus is represented by one septate specimen that has a compressed shell and bears very fine nearly radial lirae. Compared with the Toarcian species *P. heterophyllum* (J. Sowerby) (1820, pl. 226; Zittel, 1869, pl. 1, fig. 11; d'Orbigny, 1844, pl. 109), it has a thinner whorl section, less flexuous lirae, and lacks any trace of radial folds. In these respects it shows more resemblance to *P. kunthi* Neumayr (1871, p. 312, pl. 12, fig. 6; pl. 13, fig. 1) from the Callovian of Europe.

Figured specimen: USNM 131326.

Occurrence: Tuxedni Formation in Talkeetna Mountains at USGS Mesozoic loc. 24113.

Genus MACROPHYLLOCERAS Spath, 1927

Macrophylloceras sp. undet. A

Plate 1, figures 1–7

The species is represented by 18 septate specimens. The shell is moderately compressed, occluded. The whorls are higher than wide and become more compressed during growth. The flanks are gently convex. The ventor is evenly arched. The body chamber is unknown.

On the smallest specimens the surface bears faint growth lines and vague flexuous undulations that are irregular in strength and spacing. Weak lirae appear at diameters of 35–40 mm and weak ribs occur on the ventral region at diameters greater than 50–60 mm.

The sutures have slender diphyllic saddles and high ventral lobe.

The dimensions in millimeters are as follows:

Specimen	Diameter	Whorl height	Whorl thickness
USNM 131327	70	45	30
USNM 131328	58	35	26
USNM 131331	43	27	18
USNM 131332	29	18	13.5

This species is characterized by the presence of flexuous undulations on its smaller septate whorls and by the weakness of the ribbing on its larger septate whorls.

Figured specimens: USNM 131327–131332.

Occurrences: Fitz Creek Siltstone at USGS Mesozoic loc. 10515; Tuxedni Formation in Talkeetna Mountains at Mesozoic locs. 3696, 3697, 24113.

Macrophylloceras sp. undet. B

Plate 1, figures 8, 9, 13

The species is represented by four septate specimens. The shell is compressed, occluded. The whorls are much higher than wide, the flanks are flattened, and the venter is highly arched.

The smaller septate whorls bear fine dense raised lines, or lirae, that incline forward on the flanks but cross the venter transversely. In addition, broad faint regular widely spaced ribs appear on the venter and on the upper two-thirds of the flanks at a diameter of about 25 mm and gradually become stronger adorally. As these ribs become stronger the lirae become weaker. Constrictions are not present.

The suture cannot be traced accurately.

The figured specimen at a diameter of about 55 mm has a whorl height of 33 mm and a whorl thickness of 17 mm.

This species is distinguished from *Macrophylloceras* sp. undet. A by a much more compressed whorl section, flatter flanks, and the earlier development of lirae and ribs.

Figured specimens: USNM 131333, 131334.

Occurrences: Upper part of the Fitz Creek Siltstone at USGS Mesozoic locs. 2999, 22533, 26597; Tuxedni Formation in Talkeetna Mountains at Mesozoic loc. 8567; Gaikema Sandstone at Mesozoic loc. 10980.

Genus HOLCOPHYLLOCERAS Spath, 1927

Holcophylloceras costisparsum Imlay, n. sp.

Plate 1, figures 10–12, 14–17

The genus is represented in the middle Bajocian beds of the Cook Inlet region by 25 specimens of which 10 are less than an inch in diameter. The larger specimens all appear to belong to a single species that is characterized by a moderately compressed shell, a small number of constrictions per whorl, and very weak riblets on the venter and on the upper parts of the flanks. These riblets are not visible at diameters less than 50 mm and are weak at greater diameters even where the shell is preserved. The number of constrictions ranges from five on a specimen 45 mm in diameter to six on the holotype at a diameter of about 90 mm. One large specimen that probably belongs to this species has seven constrictions at a diameter of 160 mm.

The suture line has diphyllic saddles.

The holotype has been crushed laterally, but at a diameter of about 90 mm has a whorl height of 52 mm and a whorl thickness of 31 mm. On the smaller specimens that are not crushed the whorl thickness ranges from 65 to 70 percent of the whorl height.

The Alaskan species is distinguished from *H. mediterraneum* (Neumayr) (1871, p. 340, pl. 17, figs. 2–5) from the Bathonian of Europe by having much weaker ribbing. *H. ultramontanum* (Zittel) (1869, p. 66, pl. 1, figs. 4–6; Roman, 1938, pl. 2, figs. 14, 14a) from the lower Bajocian has fewer constrictions per whorl, develops stronger ribbing on its large outer whorls, and has a more compressed shell.

Types: Holotype USNM 131335; paratypes USNM 131336–131339.

Occurrences: Red Glacier Formation at USGS Mesozoic loc. 21267; Fitz Creek Siltstone at Mesozoic locs. 2999, 3000, 20002, 21270; probably represented in the Fitz Creek Siltstone at Mesozoic loc. 19997; Tuxedni Formation in Talkeetna Mountains at Mesozoic loc. 24113.

Family LYTOCERATIDAE Neumayr, 1875

Genus LYTOCERAS Suess, 1865

Lytoceras cf. L. eudisianum d'Orbigny

The genus is represented by 10 septate fragments from 5 localities. The whorls are ovate in section, higher than wide. The surface bears crinkled growth lines and riblets that incline slightly forward on the flanks. The internal mold bears weak constrictions. The largest fragment (USGS Mesozoic loc. 24113) has a whorl height of 106 mm and a whorl thickness of 82 mm. The ornamentation is similar to that on *Lytoceras fimbriatum* (J. Sowerby) in Buckman (1919, pl. 130a–c) but the whorls are stouter and the constrictions are less pronounced. *L. eudesianum* (d'Orbigny) (1846, pl. 128) differs from the Alaskan specimens mainly by having stouter whorls.

Occurrences: Gaikema Sandstone at USGS Mesozoic loc. 27115; Red Glacier Formation at Mesozoic locs. 19958, 19966; Tuxedni Formation in Talkeetna Mountains at Mesozoic locs. 24113, 24220.

Family SONNINIIDAE Buckman, 1892

Genus SONNINIA Bayle, 1879

Sonninia tuxedniensis Imlay, n. sp.

Plate 2, figures 5–10

The species is based on 11 specimens. The shell is a moderately compressed planulate. The whorls are higher than wide, thickest at about a third of the height of the flank, and bear a single hollow keel. The largest whorl embraces about two-fifths of the preceding whorl. The inner whorls are more evolute. The umbilicus is moderately wide; the umbilical wall is steeply inclined but rounds evenly into the flanks. The length of the body chamber is unknown but is at least half a whorl.

The innermost whorls bear backwardly or radially inclined irregularly strong ribs, some of which bear prominent lateral nodes. Adorally the nodes become less prominent and are absent at diameters greater than 30 mm. As the nodes disappear the ribs become more uniform in strength and spacing. The larger septate whorls bear strong ribs that begin on the upper part of the umbilical wall, are nearly radial on the flanks, and that fade out at about three-fifths of the height of the flanks. On the body chamber the ribs gradually become weaker adorally. Growth striae are gently flexuous on the flanks and curve forward strongly on the venter.

The suture line has a short ventral lobe and a stout first lateral lobe.

The holotype at a diameter of 111 mm (not counting the keel) has a whorl height of 42 mm, a whorl thickness of 30 mm, and an umbilical width of 42 mm. On the largest paratype at an estimated diameter of 120 mm, the same dimensions are 45, 33, and 44 mm respectively. On a smaller paratype the same dimensions are 79, 30, 20, and 29 mm respectively.

This species resembles *Sonninia nodatipinquis* (Buckman) (1923, pl. 398) in evolution and rib pattern, but its ribs are stronger on the larger outer whorl and its whorls are stouter. *S.* cf. *S. nodatipinquis* Buckman in Gillet (1937, p. 43, pl. 4, fig. 6) has closer spaced ribs that are inclined slightly backward on the flanks. *S. pseudocostata* Maubeuge (1951, p. 18, pl. 9, fig. 1) has somewhat stronger ribs that persist higher on the flanks. *Guhsania bella* McLearn (1926, p. 98, pl. 25) is very similar in lateral view and in suture line but has a much narrower venter and an angular umbilical margin.

Types: Holotype USNM 131340; paratypes USNM 131341–131343.

Occurrences: Fitz Creek Siltstone at USGS Mesozoic locs. 2999 (float) and 3000; Red Glacier Formation at Mesozoic locs. 21266, 21268 (float), and probably 3009. The species has been found in the upper 500 ft of the Red Glacier Formation and questionably in the upper 150 ft of the Fitz Creek Siltstone. The species has not been collected in place in the Fitz Creek Siltstone during recent years. One specimen from Mesozoic loc. 3000 is not labeled as float, but it appears to be worn. Fragments of *Sonninia* similar to *S. tuxedniensis* have been found in place in the upper part of the Fitz Creek Siltstone at Mesozoic locs. 22706 and 26596.

Sonninia cf. S. projectifer (Buckman)

Plate 3, figures 1, 5

Three septate fragments from the Talkeetna Mountains resemble *Sonninia projectifer* (Buckman) (1923, pl. 411) in size, coiling, coarseness of ribbing, and in the prominence of their lateral tubercles. They differ mainly by having a higher whorl section. The fragments do not show the characteristics of the innermost whorls.

Figured specimen: USNM 131344.

Occurrence: Tuxedni Formation in Talkeetna Mountains a USGS Mesozoic loc. 24113.

Sonninia cf. S. nodata Buckman

Plate 2, figures 1, 2

One small compressed evolute keeled ammonite bears tuberculate ribs of irregular strength and spacing. The inner whorls are ovate in section. The outer whorl is subquadrate, has flattened flanks, and a tubulate venter. On the innermost whorls every second to fourth rib is tuberculate. On the outermost whorl every fourth to fifth rib is tuberculate. The tubercles become weaker adorally. The ribs are flexuous, incline backward on the flanks, and curve forward on the ventral margins.

The ornamentation resembles that on the small specimens of *Sonninia nodata* Buckman (1893, pl. 89, figs. 1, 4) from England, but it also greatly resembles that on the inner whorls of other spinose species of *Sonninia* (see Buckman, 1892, pl. 65, figs. 1, 3; pl. 73, fig. 1; pl. 74, fig. 4; 1893, pl. 89, fig. 6).

Figured specimen: USNM 131345.

Occurrence: Tuxedni Formation in Talkeetna Mountains at USGS Mesozoic loc. 24120.

Sonninia cf. S. patella Waagen

Plate 3, figures 2–4

This species is represented by one large crushed internal mold that retains about half of a whorl of the adult body chamber. The whorls embrace each other by about half. The smallest inner whorl that is preserved (pl. 3, fig. 2) bears strong widely spaced tubercles low on the flanks from which pass pairs of moderately strong ribs that curve forward on the upper parts of the flanks. Between the paired ribs are two or three ribs of equal strength that arise near the middle of the flanks.

On the next larger whorl (pl. 3, fig. 3) the tubercles have been replaced by radially elongate swellings and the ribs are weaker. On the next whorl both swellings and ribs gradually become weaker adorally. At a diameter greater than about 175 mm the internal mold is nearly smooth.

In size and smoothness the whorl of the Alaskan specimen compares with that of *Sonninia undifer* (Buckman) (1923, pl. 427), but the strong ribbing and tubercles of its inner whorl contrast markedly. *S. trigonalis* (Buckman) (1910, p. 92, pl. 10, figs. 2, 3) has similar pronounced umbilical tubercles on its inner whorls but is much more involute. *S. patella* Waagen (Dorn, 1935, pl. 14, figs. 1, 6) appears to have weaker denser ribbing on its inner whorls and is more involute.

Figured specimen: USNM 131346.

Occurrences: Tuxedni Formation in Talkeetna Mountains at USGS Mesozoic loc. 24120. A fragment that appears to be an inner whorl of this species occurs at Mesozoic loc. 24113.

Sonninia? n. sp. undet.

Plate 4, figures 5, 6, 10–12

This species is represented by two septate internal molds. The shell is compressed and evolute. The whorls are subquadrate in section, nearly as wide as high, and embrace each other about one-fourth. The flanks are gently convex. The venter is fairly broad and bisulcate. The keel is low. The umbilicus is wide. The umbilical wall is low, steeply inclined, and rounds evenly into the flanks. The body chamber is unknown.

The ribbing on the smallest whorls that are preserved, at diameters of 24–47 mm, consist of very strong fairly regular widely spaced flexuous ribs that become swollen near the middle of the flanks and curve forward considerably on the ventral margins. Between these ribs are intercalated much weaker ribs that begin on the middle third of the flanks and curve forward on the ventral margins. Some of the weaker ribs are connected with the strong ribs.

During growth the ribs remain strong but become broader and many of the strong ribs bifurcate at or below the middle of the flanks. On the largest whorl all secondary and intercalated ribs are swollen where they curve forward along the ventral margins and then fade out rather abruptly.

The suture line is not preserved.

The largest specimen at a diameter of 86 mm has a whorl height of 26 mm, a whorl thickness of 24 mm (between ribs), and an umbilical width of about 42 mm.

The assignment of this species to *Sonninia* is questioned because of the regularity of its ribbing, the tendency of many ribs to bifurcate near the middle of the flanks, and because most species of *Sonninia* with comparable strong ribbing bear pronounced tubercles. The ribbing shows a little resemblance to that on some specimens of *Sonninia* figured by Quenstedt (1887, pl. 63, figs. 2, 4).

Figured specimens: USNM 131347, 131348.

Occurrences: Red Glacier Formation at Mesozoic loc. 21293. Tuxedni Formation in Talkeetna Mountains at Mesozoic loc. 26723.

Subgenus **PAPILLICERAS** Buckman, 1920

Sonninia (Papilliceras) cf. S. arenata (Quenstedt)

Plate 6, figures 1–3

Eight fragments of body chamber and several associated septate fragments belong to a large evolute nearly smooth species comparable with *S.* (*Papilliceras*) *arenata* (Quenstedt) (1887, pl. 60, fig. 10; Buckman, 1927, pl. 709; Dorn, 1935, pl. 7, figs. 1, 2). On the Alaskan specimens the whorl section is quadrate and is somewhat higher than wide. The inner whorls embrace each other about half and the outer whorls about a third. The flanks are flattened and subparallel. The venter is flattened and moderate in width. The keel is fairly low. The umbilicus is moderately wide. The umbilical wall is steeply inclined and rounds abruptly into the flanks. The body chamber is incomplete but occupies at least half a whorl.

The ribbing on the innermost whorls is not known, but the immature specimen shown on plate 6, figures 2, 3 has low broad ribs of irregular strength that are nearly radial on the flanks and curve forward strongly on the margins of the venter. Adorally the ribbing gradually becomes fainter and at a diameter of 80 mm is barely visible on the internal mold. The penultimate and body whorls are nearly smooth except for a row of small round nodes a little above the middle of the flanks. In addition some specimens show flexuous growth lines and some have faint broad ribs on the lower part of the flanks. The strength of the nodes varies considerably from one specimen to another.

The suture line cannot be traced accurately but appears to be very similar to that of *Sonninia tuxedniensis* Imlay, n. sp. illustrated herein.

Most of the specimens are so crushed or fragmentary that measurements are useless. An immature specimen shown on plate 6, figures 2, 3 at a diameter of 82 mm has a whorl height of 35 mm, a whorl thickness of 24 mm, and an umbilical width of 23.5 mm. On a larger septate specimen from Mesozoic locality 19964 the same dimensions are 195, 75, 48, and 65 mm respectively. This specimen includes part of a large body chamber that has a whorl height of 104 mm and a whorl thickness of about 66 mm between the tubercles. The body whorl must have had a diameter of 300 mm.

Judging from these dimensions the species is considerably stouter than *Sonninia* (*Papilliceras*) *blackwelderi* Crickmay (1933, p. 911, pl. 30) from the Mormon Sandstone in California.

Figured specimens: USNM 131349, 131350.

Occurrences: Red Glacier Formation at USGS Mesozoic loc. 19964, 21262, 21263; Gaikema Sandstone at Mesozoic loc. 22723.

Sonninia (Papilliceras) cf. S. espinazitensis Tornquist

Four fragments of which one is part of a body chamber resemble *S.* (*Papilliceras*) *papillatum* (Buckman) (1920, pl. 150A, B) from Europe in strength and density of ribbing. They differ by their ribs being more uniform in strength and by not bearing tubercles on the small septate fragments. In these respects they resemble *Sonninia espinazitensis* Tornquist (1898, p. 20, 21, pl. 3, figs. 2, 3; pl. 4, fig. 1) but they differ by having stouter whorls and by their venter becoming evenly rounded on the adult body chamber.

Occurrence: Tuxedni Formation in Talkeetna Mountains at USGS Mesozoic loc. 24113.

Genus **WITCHELLIA** Buckman, 1889

Witchellia adnata Imlay, n. sp.

Plate 6, figures 6–10

This species is represented by three internal molds of which the smallest retains some shelly material. The shell is compressed and moderately evolute. The whorls are subquadrate, higher than wide and embrace each other nearly half. The lower parts of the flanks are flattened and parallel, but the upper parts converge gently toward a narrow flattened venter. The keel is fairly high. The umbilicus is moderate in width. The wall is vertical, fairly low, and rounds abruptly into the flanks. The body chamber on the holotype occupies a complete whorl and is probably nearly complete.

The ribs are flexuous and variably strong on the flanks, incline forward on the venter, and fade out before reaching the keel. Many ribs arise in pairs on the umbilical margin or low on the flanks. Adorally the ribs gradually become broader, stronger, and more widely spaced.

The ventral lobe is not exposed. The first lateral lobe is well developed and is much longer than the second lateral lobe.

The holotype has been crushed somewhat laterally, but at a diameter of 105 mm has a whorl height of 45 mm, a whorl thickness of 29 mm, and an umbilical width of 30 mm.

This species differs from most species of *Witchellia* by being more evolute, by the tendency for its ribs to be variable in strength, and by the persistence of its ribs on specimens of large size. *W. zugophorus* (Buckman) (1922, pl. 341) is similarly evolute but has much stronger and more uniform ribbing. *W. falcata* (Buckman) (1926, pl. 688) appears to be more involute and has much stronger ribbing. *W. connata* (Buckman) (1927, pl. 750) appears to have stronger and more flexuous ribbing, but its resemblance to the small paratype of *W. adnata* Imlay, n. sp. is striking. *W. propinquans* Bayle (Dorn, 1935, p. 110, pl. 3, figs. 34; pl. 4, fig. 3; pl. 7, fig. 3) has stronger more uniform ribbing. A specimen assigned by Dorn (1935, pl. 9, fig. 2) to *Witchellia corrugata* Sowerby is similar to the immature specimens of *W. adnata* Imlay, n. sp. but appears to have finer denser ribbing.

Types: Holotype USNM 131351; paratypes USNM 131352, 131353.

Occurrences: Red Glacier Formation at USGS Mesozoic locs. 3010 and 19956. Float on surface of Fitz Creek Siltstone and Cynthia Falls Sandstone at Mesozoic loc. 20756 (possibly derived from the Red Glacier Formation by ice movements).

Witchellia cf. W. laeviuscula (J. de C. Sowerby)

Plate 7, figures 1–5

On one large completely septate ammonite from Alaska the small inner whorls (pl. 7, figs. 1, 3) are ovate in section, slightly higher than wide, and embrace each other about half. The umbilical wall is steeply inclined and rounds evenly into the flanks. The venter is evenly rounded, bisulcate, and the keel is low.

During growth the whorls become compressed, much higher than wide, and embrace each other nearly three-fourths. The umbilical wall remains steeply inclined but rounds abruptly into the flanks. The venter becomes narrow, tabulate, and bears a moderate keel.

The ornamentation of the innermost whorls consists of strong irregular ribs of which some bear prominent nodes just below the line of involution. During growth, however, the ribs become weaker, more uniform in size, and the nodes disappear. At a diameter greater than 18 mm the ornamentation consists entirely of rather weak slightly irregular unevenly spaced ribs. These arise on the umbilical margin, are flexuous on the flanks, and incline strongly forward on the ventral margins. They are thin on the lower two-thirds of the flanks and become fairly broad on the ventral margins. A few ribs arise in pairs or are closely associated with other ribs near the umbilical margin. On the largest septate whorl the ribbing weakens considerably adorally suggesting that the body chamber was smooth or nearly smooth.

The ventral lobe is shorter than either the first lateral lobe or second lateral lobes. The first lateral lobe is characterized by a long slanting accessory lobe on its inner side. The second lateral lobe is shorter than the first lateral lobe but is longer comparatively than on the other species of *Witchellia* described herein. The first and second lateral saddles are fairly broad.

At a diameter of 165 mm the whorl height is 75 mm, the whorl thickness 40 mm, and the umbilical width 35 mm.

The Alaskan specimen resembles *S. zitteli* Gottsche (1878, p. 10, pl. 1, figs. 4, 5; Tornquist, 1898, p. 17, pl. 2, figs. 1, 3; Jaworski, 1926, pl. 3, figs. 7a–c) from Argentina in whorl shape and degree of involution, but its small septate whorls appear to have sharper ribbing. Its large septate whorl resembles *Witchellia laeviuscula* (J. de C. Sowerby) (1824, pl. 451, fig. 1; Buckman, 1927, pl. 745; Gillet, 1937, pl. 1, fig. 8; pl. 2, fig. 6; pl. 3, fig. 1; pl. 5, fig. 1) in shape, coiling, and ribbing but attains a much larger size. Other similar appearing ammonites, once referred to *W. laeviuscula* (J. de C. Sowerby), have been illustrated by Buckman (1923, pl. 410; 1926, pls. 642, 659, 687).

Figured specimen: USNM 131354.

Occurrence: Tuxedni Formation in Talkeetna Mountains at USGS Mesozoic loc. 24120.

Witchellia? aguilonia Imlay, n. sp.

Plate 4, figure 9; plate 5, figures 4, 7–9

The species is represented by 16 internal molds of which some show parts of the body chamber. The shell is compressed and involute. The whorls are much higher than wide, become relatively higher during growth, and are thickest at about two-fifths of the height of the flanks. The inner septate whorls embrace each other four-fifths, or more, but the outermost septate whorl becomes gradually less involute, and the adult body whorl embraces only about half of the preceding whorl. The flanks are flattened below, are swollen just below the middle of the flanks, and converge above the middle to a narrow venter. The umbilicus is fairly narrow on the septate whorls but begins to widen near the adoral end of the largest septate whorl and widens markedly on the body whorl. The umbilical wall is nearly vertical, fairly low, and rounds fairly abruptly into the flanks. The adult body chamber occupies about three-fourths of a whorl. The aperture is projected on the venter and is sinuous on the flanks. The keel is fairly low, hollow, and floored.

The ribs on the small septate whorls are low, broad, flexuous, and fasciculate. Most of them arise in bundles on the lower fourth of the flanks. During growth the ribs become weaker on the lower part of the flanks and less flexuous but remain strong on the upper part of the flanks. Near the adapical end of the larger septate whorl the ribs are weak, closely and uniformly spaced, gently flexuous, and inclined forward. They are variably weak on the lower part of the flanks but become fairly broad and a little stronger ventrally. Some ribs begin at the umbilicus, others near the middle of the flanks, and still others begin higher. Toward the adoral end of the largest septate whorl the ribs on the upper part of the flanks become broader and lower but remain uniform in spacing, forwardly inclined, and persist to the end. In contrast the ribs on the lower part of the flanks become much weaker and more widely spaced adorally and finally disappear near the adoral end. The adult body chamber, at least on the internal mold, shows no trace of ribbing.

The suture line is similar to that of *Sonninia patella* Waagen (Dorn, 1935, text-figure table 5, fig. 2). The first lateral lobe is broad, deep, and trifid and twice as long as the second lateral lobe. The suspensive lobe is slightly retracted. The holotype at a diameter of 145 mm has a whorl height of 73 mm, a whorl thickness of 33 mm, and an umbilical width of 22 mm. On the largest paratype at a diameter of 132 mm the same dimensions are 66, 33, and 20 mm, respectively.

A few of the internal molds of *Witchellia*? *aguilonia* Imlay, n. sp. bear faint spiral markings similar to that noted by Dorn (1935, p. 56–58) on several species of *Sonninia*. Similar markings occur on the genus *Strigoceras*, which differs from the Alaska species by having a much smaller umbilicus and a different suspensive lobe.

This Alaskan species is distinguished from any described species of *Witchellia* by the persistence of ribbing on the upper part of the flanks after the ribbing has disappeared from the middle and lower parts. It is comparable in involution and coiling with *W. celans* (Buckman) (1924, pl. 461) but has less projected ribbing on its ventral margins. Its general appearance is similar to that of *Eudmetoceras amplectens* Buckman (1920, pl. 180 a, b; Maubeuge, 1951, p. 34, pl. 6, figs. 45) from the lower part of the European zone of *Sonninia sowerbyi*, but it appears to have more flexuous less regular ribbing that tends to be more fasciculate. It is much more involute than most species of *Eudmetoceras* (Buckman, 1920, pls. 179a, b; 1922, pl. 299; 1923, pls. 396, 397; Jaworski, 1926, pl. 2, figs. 5 a, b, 6 a, b; pl. 4, figs. 12, 29). It also greatly resembles *Fissilobiceras* Buckman (1920, pl. 181 a, b; Dorn, 1935, p. 56–60; Maubeuge, 1951, p. 51, pl. 3, fig. 1) in shape and coiling but is distinguished by the persistence of ribbing on the upper parts of the flanks and by less complicated suture line. Some species of *Dorsetensia* (Buckman, 1892, pls. 55, 56; Dorn, 1935, pl. 24, figs. 1, 5; pl. 26, figs. 1, 4) resemble the Alaskan species in size, shape, and coiling but become fairly smooth at a much smaller size. The genus *Strigoceras* has a much smaller umbilicus and a different suture line.

Types: Holotype USNM 131355; paratype Calif. Univ. at Los Angeles paleont. cat. 34975; paratype USNM 131356.

Occurrences: Tuxedni Formation in the Talkeetna Mountains at USGS Mesozoic locs. 24113; Kialagvik Formation at Mesozoic locs. 12402, 19742, 19773, 19876, 19877, 19923, and 21258.

Witchellia? aff. W? aguilonia Imlay, n. sp.

Plate 4, figures 1–4

One specimen from the Talkeetna Mountains and six specimens from the Alaskan Peninsula are possibly a coarsely ribbed variant of *W*? *aguilonia* Imlay, n. sp. They differ by having a relatively wider umbilicus and stronger more widely spaced primary and secondary ribs that persist to a later growth stage. The primary ribs arise on the umbilical margin, are widely spaced, are variable in strength and spacing, and pass into pairs of somewhat weaker ribs at or below the middle of the flanks. Between these primary ribs on the lower part of the flanks arise from one to three weaker ribs that become stronger ventrally and do not branch. The secondary ribs on the upper parts of the flanks are low, broad, uniform in strength and spacing, are broader than the interspaces, and incline forward on the margins of the venter. During growth the primary ribs become weaker and more widely spaced and the secondary ribs become broader and lower.

The suture line has a well-developed first lateral lobe that is larger than the ventral lobe. The second lateral lobe is small and very narrow. The first lateral saddle is very broad.

Figured specimen: USNM 131357.

Occurrences: Tuxedni Formation in Talkeetna Mountains at USGS Mesozoic loc. 24113. Kialagvik Formation at Mesozoic locs. 12402, 18822, 19823, and 19825.

Pelekodites? sp.

Plate 6, figures 4, 5, 11

One ammonite from the Cook Inlet region appears to represent the genus *Pelekodites* as defined by Arkell (1954, p. 563; Arkell and others, 1957, p. L270). It is small, evolute, and bears lateral lappets. The venter is narrow and bears a low blunt keel that near the aperture is bordered by weak furrows. The whorl section is ovate and higher than wide. The umbilical slope is vertical on the inner whorls, steeply inclined on the outermost whorl, and rounds evenly into the flanks. The body chamber occupies slightly more than half a whorl. The innermost whorls bear prominent tubercles on the flanks, but during growth the tubercles are replaced by blunt swellings. The outer two whorls are marked only by weak widely spaced ribs that incline backward slightly on the flanks and then curve forward considerably near the venter. The ribbing becomes weaker adorally and near the aperture is barely visible.

The suture has a broad bifid first lateral saddle, a shallow trifid first lateral lobe, and three small auxilliary lobes.

Within the genus *Pelekodites*, Arkell (1954, p. 563) included *Nannoceras nannomorphum* Buckman (1923, pl. 445), *Macerites aurifer* Buckman (1928, pl. 766), *Spatulites spatians* Buckman (1928, pl. 765), and *Pelekodites pelekus* Buckman (1923, pl. 399) from the *Sonninia sowerbyi* zone in England. He indicated that the genus also included similar small lappeted ammonites from the lower part of the *Stephanoceras humphriesianum* zone in southern Germany (Dorn, 1935, p. 113, pl. 3, figs. 2a, b; Hiltermann, 1939, p. 170–176, pl. 12, fig. 7). These had been described as immature specimens of *Witchellia* or of *Sonninia deltafalcata* (Quenstedt), differing from typical specimens of that species by being smaller and by bearing lateral lappets. Arkell (1954, p. 563; Arkell and others, 1957, p. L90) contended, however, that specimens with lateral lappets are adults and hence cannot be placed within such genera as *Witchellia* or *Sonninia* that do not have lateral lappets. Interestingly Hiltermann's (1939, p. 171, 177) inclusion of *Pelekodites pelekus* Buckman in the synonymy of his *Sonninia deltafalcata* (Quenstedt) strengthened Arkell's opinion that all the lappeted species mentioned above are closely related.

The lappeted ammonite from Alaska is herein referred questionably to *Pelekodites* because it has appreciably weaker ribbing than the similar European species of *Pelekodites* and because its innermost whorls bear few lateral tubercles that are not apparent in the illustrations of the European species.

The Alaskan ammonite in question should be of about the same age as the lappeted specimens from Germany considering that it is associated with *Sonninia* similar to *S. tuxedniensis* Imlay, n. sp. and that it occurs in a sequence containing *Teloceras*, *Chondroceras*, and *Normannites*.

Figured specimen: USNM 131358.
Occurrence: Fitz Creek Siltstone at USGS Mesozoic loc. 26596

Family STRIGOCERATIDAE Buckman, 1924
Genus STRIGOCERAS Quenstedt, 1886

Strigoceras cf. S. languidum (Buckman)

Plate 23, figures 2–4, 8

One septate specimen from Alaska is a representative of the genus *Strigoceras*. The shell is discoidal. The whorls are more than twice as high as wide. The keel is tall, hollow, and floored. The umbilical wall is low, vertical, and rounds evenly into the flanks. The body chamber is not preserved.

The shell is ornamented with spiral grooves, strigations, and falcoid ribbing. One groove lies just below the middle of the flanks and another lies just above the umbilical margin. The strigations are faint and are visible only at one place where some of the shell is preserved. The falcoid ribs are broad and strong on the upper part of the flanks. They appear to arise in pairs near the middle of the flanks from faint broad ribs on the lower part of the flanks.

The suture line is too poorly preserved to be traced accurately, but it includes a long umbilical lobe consisting of four or five auxiliaries that descend evenly toward the umbilicus.

The specimen at a diameter of about 61 mm has a whorl height of 35 mm, a whorl thickness of 15.5 mm, and an umbilical width of 6 mm.

The Alaskan specimen is closely similar to *Strigoceras languidum* (Buckman) (1924, pl. 477 a, b) from the European zone of *Otoites sauzei*. Its umbilicus is a little wider and its ribs are a little broader, higher, and more sigmoid. *S. protrusus* (Buckman) (1922, pl. 317) from the European zone of *Sonninia sowerbyi* has a much smaller umbilicus and apparently weaker narrower ribbing.

Figured specimen: USNM 131359.
Occurrence: Fitz Creek Siltstone at USGS Mesozoic loc. 27105.

Strigoceras sp. juv.

Plate 23, figures 5–7

One small discoidal shell consists of nearly half a whorl of a body chamber and several septate inner whorls that are exposed mostly in cross section. The outer whorl is nearly twice as high as wide. The inner whorls are relatively stouter. The venter on the body chamber bears a high narrow hollow keel that is not floored. The venter on the septate whorls bears a low keel that appears to be hollow and floored. The umbilicus is very narrow. The umbilical wall is low and rounds evenly into the flanks.

The inner septate whorls bear traces of broad faint flexuous ribs and striae but are only partly exposed. The outer whorl bears a broad spiral groove just below the middle of the flanks and broad falcoid ribs that are weak on the lower part of the flanks but become strong on the upper part. In addition the shell bears fine striae of growth that on the ventral margins incline forward much more strongly than do the falcoid ribs. There is no trace of strigation.

The suture line is not preserved.

The outer whorl at a whorl height of 16 mm has a whorl thickness of 8 mm.

This specimen is possibly an immature representative of the species herein described as *Strigoceras* cf. *S. languidum* (Buckman), but it appears to have somewhat stronger ribbing.

Figured specimen: USNM 131360.
Occurrence: Red Glacier Formation at USGS Mesozoic loc. 21268.

Family HAPLOCERATIDAE Zittel, 1884
Genus LISSOCERAS Bayle, 1879

Lissoceras bakeri Imlay

Plate 23, figure 1

Lissoceras bakeri Imlay, n. sp., 1962, U.S. Geol. Survey Prof. Paper 418–A, p. 6, pl. 1, figs. 1–6, 9–12.

One large specimen of this species agrees very well with the type specimens from the Twist Creek Siltstone, although found some hundreds of feet lower. It includes about half a whorl of the body chamber, of which part is dislocated. The specimen is characterized by its vertical umbilical wall, compressed whorl section, narrowed venter, and fine flexuous striae.

Type: Plesiotype USNM 131361.
Occurrence: Cynthia Falls Sandstone at USGS Mesozoic loc. 10512.

Lissoceras cf. L. semicostulatum Buckman

Plate 4, figures 7, 8

Two laterally crushed internal molds, consisting mostly of body chamber, bear sigmoidal growth striae on the lower and middle parts of the flanks and broad low rursiradiate ribs on the upper part of the flanks. The venter is nearly smooth, but in places is marked by faint continuations of the ribs. The umbilical wall is low, vertical at its base, and rounds evenly into the flanks.

The fairly strong ribbing on these Alaskan specimens resembles that on *Lissoceras semicostulatum* Buckman (1923, pl. 400) from the *Sonninia sowerbyi* zone of England.

Figured specimen: USNM 131362.
Occurrence: Red Glacier Formation at USGS Mesozoic loc. 21268.

Family OPPELIIDAE Bonarelli, 1894
Genus OPPELIA Waagen, 1869

Oppelia (Oppelia) stantoni Imlay, n. sp.

Plate 8, figures 11–18

This species is represented by 11 small to medium-sized specimens and one large septate specimen. Small specimens below 8 mm in diameter are compressed, have a sharpened venter, and their whorls overlap each other about half. During growth the venter becomes somewhat sharper, and the whorls become more compressed and more involute. At diameters greater than 25 mm the outer whorl embraces the preceding whorl almost completely. The flanks are flattened below and converge above to the venter. On the innermost whorls the umbilical wall is low, steep, and rounds evenly into the flanks. During growth it becomes vertical and rounds rather abruptly into the flanks. The body chamber is unknown.

The innermost whorls are entirely smooth. At a diameter of about 8 mm, faint falcoid riblets appear on the upper parts of the flanks, but the lower parts of the flanks remain smooth to a diameter of about 20 mm. At greater diameters the lower parts of the flanks bear faint forwardly inclined striae that bend backward abruptly at the middle of the flanks and then pass into much stronger falcoid riblets on the upper parts of the flanks. These riblets curve backward, then strongly forward, and on internal molds nearly disappear along the midline of the venter. In addition at a diameter of about 38 mm, widely spaced falcoid swellings appear on the upper part of the flanks. These at first are separated by two or three weak falcoid riblets, but during growth the riblets disappear and the swellings become stronger. During this stage of development, the ventrolateral margin is marked by many very fine forwardly inclined riblets of which some arise from the swellings and some arise between the swelling. There are from six to eight such riblets for each swelling on the flanks but the exact number cannot be determined. On some specimens these fine riblets are finer and denser than on other specimens.

One large septate specimen (pl. 8, fig. 18) on the adapical part of its outer whorl shows the same kind of ornamentation as on the specimens just described and, therefore, is considered to be the same species. Its appearance suggests that the adult body whorl was nearly smooth.

The suture line is poorly preserved and does not show the ventral lobe. The second lateral saddle is higher than the first lateral saddle. There are four auxiliary lobes in addition to the second lateral lobe. The specimens are too imperfect for measurements.

This species differs from *Oppelia subradiata* (J. de C.

Sowerby) (1823, v. 5, p. 23, pl. 421, fig. 2; Arkell, 1951, p. 50, text fig. 11) and from the species described by Buckman (1924, pls. 478, 480, 481; 1925, pls. 524, 525 a, b) by having much finer denser ribbing on its ventrolateral margins. The large septate specimen shows considerable resemblance, however, to the large septate specimen of *Oppelia lectotypa* Buckman (1924, pl. 124) which Arkell (1951, p. 50) suggested is probably the adult of *O. subradiata*.

The species is named for T. W. Stanton who collected the type specimens.

Types: Holotype USNM 131363; paratypes USNM 131364–131368.
Occurrences: Fitz Creek Siltstone at USGS Mesozoic locs. 3000 and 22721.

Genus BRADFORDIA Buckman, 1910

Bradfordia costidensa Imlay, n. sp.

Plate 8, figures 1–10

The species is represented by 51 specimens of which most have been crushed laterally. The shell is compressed and moderately involute. The whorls are elliptical in section, much higher than wide, and are thickest at about a third of the height of the flanks. The flanks are gently convex, converging above to a narrowly rounded venter. The umbilicus is fairly narrow. The umbilical wall is vertical, develops a sharp umbilical edge at an early growth stage, and becomes raised on the adult body whorl. The body chamber occupies about half a whorl. The aperture is not perfectly preserved on any specimen, but it terminates simply in a curve that is roughly parallel to the falcoid ribbing.

The septate whorls bear closely spaced fine to moderately fine falcoid ribs that are very weak on the lower third of the flanks, become stronger ventrally, and either fade out or become very weak on the venter. On the smaller whorls the ribs vary somewhat in sharpness and spacing but during growth become nearly uniform in strength on any one specimen. The strength of the ribbing varies, however, from one specimen to another. On most specimens the ribs are nearly radial on the upper part of the flanks, but on some specimens the ribs incline backwards.

On the body whorl the ribbing becomes markedly weaker adorally and near the aperture is replaced by falcoid growth lines. Internal molds of the body chamber are nearly smooth.

The ventral lobe is too poorly preserved to trace accurately but is clearly much shorter than the first lateral lobe. The first lateral saddle is much lower than the second lateral saddle. There are three auxiliary lobes in addition to the second lateral lobe.

The holotype appears to be slightly crushed. At a diameter of 73 mm its whorl height is 36 mm, its whorl thickness is 22 mm, and its umbilical width is 13 mm. The paratype shown on plate 8, figure 6 appears to be uncrushed. At a diameter of 63 mm, the same dimensions are 31, 19, and 12.5 mm, respectively. The largest specimen in the collection has a diameter of about 104 mm.

The Alaskan species is assigned to the genus *Bradfordia* rather than *Lissoceras* because of the presence of a sharp raised umbilical edge, but it is much finer ribbed than the described species of *Bradfordia* (Buckman, 1910, p. 93–95, pls. 9, figs. 2, 3; pl. 10, figs. 4–6; pl. 11, fig. 1; 1922, pl. 303: Douville, 1884, p. 33, pl. 3, figs. 6, 7; Jaworski, 1926, p. 253, pl. 3, figs. 12a–d, 13). Except for its sharp umbilical edge it resembles *Lissoceras semicostulatum* Buckman (1923, pl. 400) in shape, coiling, and ribbing.

Type: Holotype USNM 131369; paratype USNM 131370–131375.
Occurrences: Tuxedni Formation in Talkeetna Mountains at Mesozoic locs. 24113, 24215, and 25345.

Bradfordia? caribouensis Imlay, n. sp.

Plate 5, figures 1–3, 5, 6

The species is represented by four specimens all of which have been crushed a little laterally. The shell is compressed and moderately involute. The whorls are subquadrate in section, much higher than wide, and are thickest slightly below the middle of the flanks. The flanks are slightly convex. The venter is narrow and somewhat flattened. The umbilicus is fairly narrow. The umbilical wall is low, vertical, and develops a raised fairly sharp umbilical edge at an early growth stage. The body chamber is incomplete but occupies at least two-fifths of a whorl. The aperture is unknown.

The septate whorls bear closely spaced broad falcoid ribs on which are superimposed fine falcoid striae. The ribs are faint on the lower fourth of the flanks, become stronger ventrally, are strongest on the margin of the venter, and nearly disappear on the venter. They curve forward strongly on the lower third of the flanks, recurve backward near the middle, curve forward again strongly on the margins of the venter, and arch forward on the venter. The venter is nearly smooth, being marked only by faint continuations of some of the ribs.

Adorally on the body whorl the ribs become less projected forward on the margins of the venter and weaker along the midline of the venter.

The holotype, which is slightly crushed, at a diameter of 29 mm, has a whorl height of 18 mm, a whorl thickness of 12.5 mm, and an umbilical width of 6.5 mm.

The ventral lobe is much shorter than the first lateral lobe. The first lateral saddle is lower than the second. There are three auxiliary lobes in addition to the second lateral lobe.

This species is included in *Bradfordia* rather than *Toxamblyites* because of its raised umbilical margin. Otherwise the projected ribbing on the upper parts of the flanks resembles that on *Toxamblyites arcifer* Buckman (1924, pl. 473). B. *incluse* Buckman (1910, p. 94, pl. 9, figs. 2, 3) from England is similar in shape and in general appearance, but its ribs are only slightly projected forward on the ventral margins.

Types: Holotype, USNM 131376; paratypes USNM 131377–131379.

Occurrences: Gaikema Sandstone at USGS Mesozoic loc. 26601; Tuxedni Formation in Talkeetna Mountains at Mesozoic loc. 3696.

Family OTOITIDAE Mascke, 1907

Genus OTOITES Mascke, 1907

Otoites cf. O. pauper Westermann

Plate 25, figures 1–3

Two specimens bear strong sparse ribbing similar to that on *Otoites pauper* Westermann (1954, p. 106–109, pl. 3, figs. 5a, b, 6; text figs. 10, 26) from Europe. The most complete specimen represents an adult body whorl that has been so crushed vertically that the umbilicus is nearly hidden. It does show the large lateral lappets, the small conical tubercles near the umbilicus, and the long secondary ribs that are characteristic of the genus. The number of tubercles cannot be determined exactly but appears to be 11 or 12. The other specimen, also representing part of a body chamber, has been crushed somewhat laterally. It shows that the umbilicus was moderate in width and that the tubercles are sparser than on the body chamber of most described species of *Otoites*. On both specimens the secondary ribs arise in pairs and cross the venter transversely. Some pairs are separated by single ribs that arise freely on the flanks.

Figured specimen: USNM 131380.

Occurrence: Lower part of Tuxedni Formation in Talkeetna Mountains at USGS Mesozoic loc. 24113.

Otoites cf. O. contractus (Sowerby)

Plate 25, figures 4, 5

Two specimens from Alaska resemble *Otoites contractus* (J. de C. Sowerby) (1825, pl. 500, fig. 2; Buckman, 1920, pl. 158; Westermann, 1954, pl. 1, figs. 4a–c, 5; pl. 2) in whorl shape, coiling, and ribbing and possibly belong to that species. The specimen illustrated has 17 conical umbilical tubercles on its body whorl. These form the terminations of short rounded primary ribs. At the adapical end of the body whorl three secondary ribs arise from each tubercle and a few single ribs arise freely. Toward the aperture the number of secondary ribs decreases to two for each tubercle. The adoral half of the body whorl contracts considerably from the rest of the shell and also decreases in width.

Figured specimen: USNM 131381.

Occurrences: Red Glacier Formation at USGS Mesozoic locs. 3009 and 21263.

Otoites? filicostatus Imlay, n. sp.

Plate 14, figures 9–11

Two ammonite specimens are characterized by large lateral lappets, fairly tightly coiled inner whorls, a contracted body chamber, and fine high dense nontuberculate ribs. The primary ribs incline forward on the lower third of the flank where they pass into two or rarely three secondary ribs. The furcation points are swollen but not tuberculate. The secondary ribs curve backward on the upper part of the flanks and then cross the venter nearly transversely or with a slight backward arching.

The suture line is not preserved.

The holotype at a diameter of 18 mm has a whorl height of 7.5 mm, a whorl thickness of 9.5 mm, and an umbilical width of 4.5 mm. At a diameter of 20 mm the same dimensions are 8.3, 9.8, and 6.2 mm, respectively.

This species is assigned tentatively to *Otoites* rather than to *Normannites* because of the tight coiling of its inner whorls and the strong contraction of its body chamber. It differs from typical species of *Otoites* in having longer and weaker primary ribs that do not terminate in tubercles. Its general appearance, however, is similar to that of *O. delicatus* Buckman (1919, pl. 141, figs. 1–3; Westermann, 1954, pl. 4, figs. 3a–c, 4, 5) which likewise has swollen rather than tuberculate furcation points. The backward curvature of the secondary ribs on the flanks is not a feature of either *Otoites* or *Normannites*.

Types: Holotype USNM 131382; paratype USNM 131383.

Occurrences: Red Glacier Formation at USGS Mesozoic locs. 3010 and 19951.

Genus EMILEIA Buckman, 1898

Emileia constricta Imlay, n. sp.

Plate 11, figures 1–8

This species is represented by nine specimens of which five are adults. The shell is large and moderately stout. The innermost whorls are coronate and much wider than high but during growth they become subovate and only a little wider than high. Most of the septate whorls overlap each other about three-fourths, but the adoral third of the outermost septate whorl begins to contract from the inner whorls. This contraction continues on the body whorl which near the aperture overlaps only a third of the preceding whorl. The umbilicus on the inner whorls is small but open. It enlarges rapidly adorally on the outermost 1⅓ whorls. The body chamber occupies from 1¼ to 1½ whorls. The aperture on the internal mold is marked by a pronounced forwardly inclined constriction that is followed by a collar. Both the constriction and collar are much stronger on the flanks than on the venter.

The small inner whorls (pl. 11, figs. 4, 5, 7) bear moderately strong and numerous primary ribs that trend radially on the umbilical wall and terminate in radially elongate tubercles on the edge of the umbilicus. From the tubercles pass two or three weaker secondary ribs that cross the venter transversely. Other secondary ribs are intercalated along the zone of tuberculation resulting in at least four secondary ribs for each primary rib. All secondary ribs widen ventrally and on the venter are a little wider than the interspaces.

During growth the primary ribs become stronger relative to the secondary ribs. The tubercles gradually disappear but the passage from the primary to the secondary ribs is marked by an abrupt weakening of the ribbing. The secondary ribs broaden ventrally but on the venter are narrower than the interspaces. The ratio of secondary to primary ribs increases to about five to one on the outermost septate whorl.

In addition the outermost septate whorl bears from three to five constrictions of which some are followed by swellings. Those constrictions are present on four such septate whorls and hence appear to be characteristic of the species.

Adorally on the adult body whorl the primary ribs gradually become stronger and more widely spaced; whereas the secondary ribs become weaker and more widely spaced. Near the aperture the secondary ribs outnumber the primary ribs only about three to one.

Most of the specimens have been crushed laterally. The holotype at a diameter of 84 mm, however, appears to be only slightly deformed. At this diameter its whorl height is 34 mm, its whorl thickness 47 mm, and its umbilical width 24 mm. On the smallest paratype the same dimensions are 28, 13.5, 23, and 7 mm.

The suture line is very complicated and is not well enough preserved to trace. Its general plan as shown in a specimen from USGS Mesozoic locality 24334 is similar to that of *E. brocchii* (J. Sowerby) as illustrated by Buckman (1908, pl. 4, fig. 1c). Details of part of the suture can be observed in a specimen from USGS Mesozoic locality 22723.

Emileia constricta Imlay, n. sp. greatly resembles *Emileia brocchii* (Sowerby) (Buckman, 1908, pl. 4; 1927, pl. 710a–d) in ribbing but has a much higher whorl section and its body whorl appears to be more contracted. Its immature whorls resemble the equally small *E. subcadiconica* Buckman (1927, pl. 711). *E. vagabunda* Buckman (1927, pl. 723a, b) is more compressed, much larger, and probably has weaker ribbing on the adult. *E. multifida* Buckman (1927, pl. 733) has much sharper ribbing and fewer secondary ribs. None of these species exhibit constrictions such as are present on the Alaskan species.

Types: Holotype USNM 131384; paratypes USNM 131385–131388.

Occurrences: Red Glacier Formation at USGS Mesozoic locs. 3009, 21262, 21263, 21268; Gaikema Sandstone at Mesozoic loc. 22723. Based on these occurrences the species ranges through the upper 500 ft of the Red Glacier Formation and the lower 150 ft of the Gaikema Sandstone. Fragments of *Emileia* that may belong to *E. constricta* Imlay, n. sp., however, have been found in the Red Glacier Formation at Mesozoic locs. 21293 and 24334, which are about 1,200 and 1,800 ft, respectively, below the top of the formation.

Family SPHAEROCERATIDAE Buckman, 1920

Genus LABYRINTHOCERAS Buckman, 1919

Labyrinthoceras glabrum Imlay, n. sp.

Plate 9, figures 1–3; plate 10, figures 1–7

This species is represented by 13 specimens that show the various growth stages and probably also by 5 small specimens less than an inch in diameter.

The shell is a large sphaerocone. The septate whorls are elliptical in section and wider than high. The umbilicus on the early whorls is narrow, but on the body whorl it widens rapidly. The outermost septate whorl embraces about two-thirds of the preceding whorl. Adorally the body chamber contracts from the inner whorls and near the aperture embraces only about a third of the preceding whorl. The body chamber occupies nearly one complete whorl. This whorl adorally diminishes both in height and thickness for more than half of its length and then expands slightly near the aperture. The aperture is marked on the internal mold by a forwardly inclined constriction that is stronger on the flanks than on the venter.

On the septate whorls the ribbing is fine, closely spaced, and nearly radial. The primary ribs divide a little below the middle of the flanks into two or three secondary ribs that are nearly as strong as the primaries. The furcation points are not swollen or tuberculate. At the beginning of the body whorl the ribbing becomes abruptly weaker and sparser. Adorally the flanks become nearly smooth, but the venter retains irregularly spaced and forwardly arched ribs that persist nearly to the aperture.

The holotype at the beginning of the body chamber has a diameter of 95 mm, a whorl height of 42 mm, a whorl thickness of 48 mm, and an umbilical width of 24 mm. On the large paratype, shown on plate 10, figures 4, 5, at a diameter of 108 mm the other dimensions are 40, 49, and 39 mm, respectively. Near the aperture at a diameter of 140 mm the other dimensions are 48, 57, and 56 mm, respectively.

The suture line is very complicated. The auxiliaries are well exposed at the beginning of the body chamber of one adult speciman. Another large specimen shows the plan of the ventral and first lateral lobes and the adjoining saddles. Judging from these examples, the suture line is similar to that of *Emileia brocchii* (J. Sowerby) as illustrated by Buckman (1927, pl. 710b). The first lateral lobe is stockier and less symmetrical and the first lateral saddle is broader. The suture lines of *Labyrinthoceras* illustrated by Buckman (1919, pl. 134, fig. 4; pl. 135, fig. 4) appear likewise to have narrower saddles than the Alaskan species of *Labyrinthoceras*. The comparison may not be valid, however, because the specimens from which Buckman traced the sutures are small and apparently immature.

The Alaskan species in lateral view greatly resembles *Labryrinthoceras perexpansum* Buckman (1921, pl. 134a–d) from England but is much less inflated at all growth stages and appears to have weaker and sparser ribbing on its body chamber.

Types: Holotype USNM 131389; paratypes USNM 131390–131392.

Occurrences: Tuxedni Formation in Talkeetna Mountains at USGS Mesozoic locs. 24215 and 25942.

Genus CHONDROCERAS Mascke, 1907

Chondroceras defontii (McLearn)

Plate 12, figures 8, 11–14

Defonticeras defontii McLearn, 1927, Royal Soc. Canada Trans., 3d ser., v. 21, sec. 4, p. 72, pl. 1, fig. 3.
1929, Canada Natl. Mus. Bull. 54, p. 13, pl. 12, figs. 1–3.
Defonticeras colnetti McLearn, 1929, Canada Natl. Mus. Bull. 54, p. 15, pl. 13, figs. 4, 5.
Chondroceras (*Defonticeras*) *defontii* (McLearn), 1949, Canada Geol. Survey Bull. 12, p. 10, 16.
Westermann, 1954, Geol. Jahrb Beihefte, no. 15, p. 100, pl. 11, fig. 3, text figs. 57, 59, 60.

Chondroceras defontii (McLearn) is characterized by a fairly stout to nearly globose shell, an extremely small umbilicus, a scaphitoid body chamber, and in particular by the secondary ribs on the adult body whorl changing rather abruptly from extremely fine and closely spaced on the adapical end to moderately coarse and widely spaced on the adoral end.

This species, as herein interpreted, is represented by 42 specimens from the Cook Inlet region, Alaska. Compared with the holotype, some are stouter, some are more compressed, and some have slightly coarser ribbing. There does not appear to be any correlation between the amount of stoutness and the strength of the ribbing. Judging from these specimens, "*Defonticeras*" *colnetti* McLearn (1929, p. 15, pl. 13, figs. 4, 5) is a variant of *C. defontii* (McLearn) that differs by having slightly sharper and sparser ribbing and a less robust shell. "*Defonticeras*" *maudense* McLearn (1929, p. 14, pl. 14, figs. 2, 3) is possibly also a stout variant of *Chondroceras defontii* (McLearn) as suggested by Westermann (1954, p. 100), but it appears to have considerably coarser ribbing on the adapical end of the body whorl than any of the specimens of that species from Alaska. "*Saxitoniceras*" *marshalli* McLearn (1928, p. 22, pl. 8, figs. 3, 4; Frebold, 1957a, p. 54, pl. 25, figs. 3a, b; pl. 26, figs. 2a, b) is similar to *C. defontii* (McLearn) in stoutness of whorls but has somewhat coarser and sparser ribbing.

Types: Holotype Canada Natl. Mus. 9009; plesiotypes USNM 131393–131395.

Occurrences: Cynthia Falls Sandstone at USGS Mesozoic locs. 2994, 10514, 10515, 10519, 21771 and 22707. Fitz Creek Siltstone at Mesozoic locs. 2997, 2999, 3000, 10245, 10516, 20022, 20756, 21270, 21271, 21275, 21276, 21769, and 26597.

Chondroceras defontii (McLearn) near Tuxedni Bay ranges through the upper 150 ft of the Fitz Creek Siltstone and the basal 40 ft of the Cynthia Falls Sandstone. The species on the Iniskin Peninsula has been found at and just below the middle of the Fitz Creek Siltstone and in the lower 400–500 ft of the Cynthia Falls Sandstone.

Chondroceras allani (McLearn)

Plate 12, figures 4–7, 9, 10

Saxitoniceras allani McLearn, 1927, Royal Soc. Canada Trans., 3d ser., v. 21, sec. 4, p. 72, pl. 1, fig. 4.
1928, Canada Geol. Survey Bull. 49, p. 21, pl. 8, figs. 1, 2.
Chondroceras (*Saxitoniceras*) *allani* (McLearn). Westermann, 1956a, Geol. Jahrb. Beihefte, no. 24, p. 107, pl. 12, fig. 3 a–d.
Chondroceras allani (McLearn). Frebold, 1957a, Canada Geol. Survey Mem. 287, p. 53, pl. 27, figs. 2a, b.

The collections from the Cook Inlet region contain 30 specimens of *Chondroceras* that are closely similar to the type specimens of *C. allani* (McLearn). They are characterized by coarse rather short primary ribs that incline or curve forward strongly on the lower two-fifths of the flanks. From them arise somewhat weaker secondary ribs that recurve backward slightly near the middle of the flanks and then cross the venter transversely. At the adapical end of the adult body chamber there are three secondary ribs for each primary rib, but adorally secondary ribs become scarcer and near the aperture number two for each primary rib. The type specimens have 16–17 primary ribs on the adult body whorl. The specimens from Alaska have from 17 to 22 depending on the size of the adult body whorl. The specimens from Alaska agree with the type specimens in whorl shape and in the gradual umbilical enlargement of the adoral half of the adult body whorl. Some of them are a little stouter or finer ribbed than the type specimens, but the species includes similar variants judging by a collection (USGS Mesozoic loc. 14630) from the mountains west of the Turner Valley oil field, Alberta.

These specimens of *Chondroceras allani* (McLearn) from Alaska appear to differ from *C. oblatum* (Whiteaves) by having sparser coarser and more strongly inclined primary ribs and a more depressed whorl section. Comparisons are difficult, however, because the holotype of *C. oblatum* is poorly preserved. If that species includes both *C. marchandi* (McLearn) (1929, p. 14, pl. 12, figs. 4, 5) and *C. ellsi* (McLearn) (1929, p. 16, pl. 13, figs. 2, 3; pl. 14, fig. 1), as considered probable by Westermann (1956a, p. 102, 103), it is very different than *C. allani* (McLearn).

Types: Holotype Canada Natl. Mus. 9021; plesiotype Canada Geol. Survey 12893; plesiotypes, USNM 131396–131399.

Occurrences: Cynthia Falls Sandstone at USGS Mesozoic loc. 10511; Fitz Creek Siltstone at Mesozoic locs. 19981, 19984, 20000, 20025, 21317, 21768. Specimens comparable with *C. allani* (McLearn) occur in the Fitz Creek Siltstone at Mesozoic locs. 20002, 21276, 21306, 27105; Tuxedni Formation in the Talkeetna Mountains, at Mesozoic loc. 8567.

Chondroceras allani (McLearn) near Tuxedni Bay occurs in the upper 50 feet of the Fitz Creek Siltstone and in the lower 40 feet of the Cynthia Falls Sandstone. The species on the Iniskin Peninsula ranges through the middle and upper parts of the Fitz Creek Siltstone.

Chondroceras cf. C. marshalli (McLearn)

Plate 12, figures 1–3

Several specimens from the Talkeetna Mountains, Alaska, greatly resemble *Chondroceras marshalli* (McLearn) 1928, p. 22, pl. 8, figs. 3, 4; Frebold, 1957a, pl. 25, figs. 3a, b; pl. 26, figs. 2a, b) from the Rock Creek Member of the Fernie Group in Alberta and eastern British Columbia. They differ from *C. allani* (McLearn) by having a much wider more depressed whorl section, somewhat weaker more closely spaced primary ribs, and more secondary ribs for each primary near the aperture. They differ from the holotype of *C. oblatum* (Whiteaves) (1876, p. 29, pl. 4, figs. 2, 2a: 1884, p. 209) by having a much wider whorl section and more closely spaced primary and secondary ribs on the adoral half of the adult body whorl.

Figured specimen: USNM 131400.

Occurrence: Tuxedni Formation in the Talkeetna Mountains at USGS Mesozoic loc. 8567.

Family STEPHANOCERATIDAE Neumayr, 1875

Genus NORMANNITES Munier-Chalmas, 1892

Normannites kialagvikensis Imlay, n. sp.

Plate 13, figures 1–8, 10, 11, 17

Dactylioceras sp. A, 1945, Kellum, Daviess, and Swinney, U.S. Geol. Survey Spec. Pub., figs. 5 C–E (not A, B).

This species is represented by six specimens. The shell is small and compressed. The inner whorls are depressed ovate, wider than high, and embrace about two-fifths of the preceding whorls. During growth they become more depressed and nearly quadrate. The umbilicus is fairly wide and shallow. The body chamber occupies about half a whorl. The aperture bears lateral lappets.

The septate whorls bear high sharp primary ribs that curve gently forward and terminate in pointed tubercles near the middle of the flanks. From most tubercles pass pairs of slightly weaker secondary ribs that arch slightly forward on the venter. From a few tubercles pass only single secondary ribs.

Adorally on the body chamber the ribs become higher and thicker, the primary ribs incline more strongly forward, tubercles disappear, and some of the secondary ribs are indistinctly connected with the primary ribs.

The suture line is fairly simple. The ventral and first lateral lobes are nearly of the same length.

The holotype at a diameter of 36 mm has a whorl height of 11 mm, a whorl thickness of 14.5 mm, and an umbilical width of 17 mm. On the paratype shown on plate 13, figures 1–3, the same dimensions are 26.5, 8.5, 11.5, and 11.5 mm, respectively.

This species bears a general resemblance to *Normannites rugosus* Westermann (1954, p. 231–235, pl. 19, figs. 4–6; pl. 20, figs. 1–3) from Germany but is much smaller, has more widely spaced primary ribs on its inner whorls, and loses its tubercles on its body chamber.

Types: Holotype USNM 131401; paratypes USNM 131402–131404.

Occurrences: Red Glacier Formation at USGS Mesozoic locs. 3010, 21261; probably present in the Red Glacier Formation at Mesozoic loc. 21296; Kialagvik Formation on Wide Bay, Alaskan Peninsula, at Mesozoic loc. 19773.

Subgenus ITINSAITES McLearn, 1927

Normannites (Itinsaites) crickmayi (McLearn)

Plate 14, figures 3–8, 13

Kanastephanus crickmayi McLearn, 1927, Royal Soc. Canada Trans., 3d ser., v. 21, sec. 4, p. 73, pl. 1, figs. 5, 6.

1929, Canada Natl. Mus. Bull. no. 54, p. 22. pl. 16, figs. 7, 8.

?*Kanastephanus canadensis* McLearn, 1929, Canada Natl. Mus. Bull. no. 54, p. 25, pl. 15, figs. 4, 5.

?*Kanastephanus mackenzii* McLearn, 1929, Canada Natl. Mus. Bull. no. 54, p. 23, pl. 16, figs. 1–3.

?*Kanastephanus altus* McLearn, 1929, Canada Natl. Mus. Bull. no. 54, p. 24, pl. 16, figs. 4–6.

Normannites (*Kanastephanus*) *crickmayi* (McLearn), 1949, Canada Geol. Survey Bull. 12, p. 16.

Itinsaites crickmayi (McLearn), Westermann, 1954, Geol. Jahrb. Beihefte, no. 15, p. 290, pl. 27, fig. 3, text figs. 102, 123.

The species is characterized by a stout to moderately stout shell, a depressed whorl section, and fairly wide umbilicus that enlarges on the adult body whorl owing to contraction of the body chamber. The ribbing is coarse and fairly widely spaced. On the inner whorls the secondary ribs outnumber the primary ribs about three to one. On the adult body chamber there are about two secondary ribs for each primary. The tubercles are acute and prominent.

This species may include all four species of *Kanastephanus* described by McLearn (1929, p. 22–25) on the basis of four specimens from a single locality in the Queen Charlotte Islands. These four specimens were described as similar in general proportions and in ribbing but differentiated specifically by minor differences in size, whorl shape, number of primary ribs, and sharpness of ribs. They can all be matched very well, however, by specimens from the Cook Inlet region, Alaska, that appear to belong to a single variable species.

The 55 specimens from Alaska assigned to *Normannites crickmayi* (McLearn) vary mainly in the stoutness of their whorls. Some are more compressed than the holotype specimen described by McLearn and some are stouter, but most of the specimens are intermediate in stoutness.

Likewise the variation in the number of primary ribs, in the sharpness of the ribs, and in the size of the adult shell among the 55 Alaskan specimens does not afford means of separating them into species. The number of primary ribs ranges from 20 to 26 on the adult whorls but is directly related to the size of the adult whorl. The larger adults are nearly twice the size of the smaller adults, but size appears to have no relation to whorl shape or to ribbing. Sharpness of ribbing is related mainly to preservation of shell material. Where the shell is preserved the ribs are high and rounded; but on the internal mold the ribs are lower, sharper, and more widely spaced.

The European species most similar to *Normannites crickmayi* (McLearn) have been fully discussed, illustrated, and compared by Westermann (1954, p. 247–292, pls. 22–27, table 5).

Types: Holotype Canada Natl. Mus. 9016; plesiotypes USNM 131405–131406, 131452.

Occurrences: Fitz Creek Siltstone at USGS Mesozoic locs. 2997, 2999, 3000, 19977, 19978, 19997, 20756, 21270, 21271, 21275, 21305; Cynthia Falls Sandstone at Mesozoic locs. 10513 and 10519. The species is probably represented also in the Fitz Creek Siltstone at Mesozoic locs. 19974, 21302, and 26599 and in the Cynthia Falls Sandstone at Mesozoic loc. 10512. One comparable specimen was found in the upper part of the Red Glacier Formation on Tuxedni Bay at Mesozoic loc. 21269.

Normannites crickmayi (McLearn) near Tuxedni Bay ranges through the upper fourth of the Fitz Creek Siltstone and the lower sixth of the Cynthia Falls Sandstone. On the Iniskin Peninsula it ranges from 200 to 480 feet above the base of the Fitz Creek Siltstone which varies from 1,100 to 1,300 feet in thickness.

Normannites (Itinsaites) itinsae (McLearn)

Plate 14, figures 1, 2

Itinsaites itinsae McLearn, 1927, Royal Soc. Canada Trans., 3d. ser., v. 21, sec. 4, p. 73, pl. 1, fig. 7.

1929, Canada Natl. Mus. Bull. no. 54, p. 26, pl. 15, figs. 2, 3.

(McLearn). Westermann, 1954, Geol. Jahrb. Beihefte, no. 15, p. 251–254, pl. 26, fig. 5; pl. 27, fig. 1, text figs. 101–107.

Normannites (*Itinsaites*) *itinsae* (McLearn), 1949, Canada Geol. Survey Bull. 12, p. 16.

This species is represented by 11 specimens from the Cook Inlet region. It resembles *Normannites crickmayi* (McLearn), with which it is associated, in general proportions but on the adult body whorl has much finer closer spaced secondary ribs that outnumber the primary ribs about three to one instead of two to one.

Types: Holotype Canada Natl. Mus. 9020; plesiotype USNM 131407.

Occurrences: Fitz Creek Siltstone at USGS Mesozoic locs. 2997, 2999, 19997, 26599 and probably 21271; Red Glacier Formation at Mesozoic loc. 21268 (float).

Normannites (Itinsaites?) variabilis Imlay, n. sp.

Plate 13, figures 9, 12–16; plate 14, figures 12, 14

This species is represented by 20 specimens of which all are somewhat crushed laterally. The shell is planulate, moderately stout, moderately evolute. The whorls are rounded, wider than high on inner whorls, becoming as high as wide on the adult whorl. The inner whorls overlap one another about half. The outer adult body whorl contracts gradually from the inner whorls and overlaps the penultimate whorl only about ⅓–⅔. The umbilicus is moderate to fairly wide. The umbilical wall is steep and rounds evenly into the flanks. The body chamber occupies about three-fourths of a whorl. The aperture is marked by elongate lateral lappets. On the internal mold it is marked by a constriction, followed by a collar, and then by lappets.

The ribbing on the inner whorls consists of sharp fairly closely spaced primary ribs that are nearly radial on the umbilical wall and then curved forward slightly to the middle of the flanks where they terminate in tiny acute tubercles. From these pass bundles of two or three much weaker secondary ribs that incline forward slightly on the flanks but cross the venter transversely. Between successive bundles may occur one or rarely two ribs that begin along the zone of furcation.

On the body chamber all ribs become markedly coarser and more widely spaced adorally. The secondary ribs in particular become coarser and sparser relative to the primary ribs and near the aperture are nearly as strong as the primary ribs. The shell at the apertural constriction and on the lappets bears only growth striae.

The suture line, partly exposed on the holotype, has a long symmetrical first lateral lobe and a much shorter second lateral lobe. The character of the ventral lobe is not known.

The adult body whorl bears from 33 to 39 primary ribs and from about 95 to 110 secondary ribs. There does not appear to be any relation between the number of primary and of secondary ribs; however, the specimens having fewest ribs have the coarsest ribs.

The holotype at a diameter of 103 mm has a whorl height of 37 mm and an umbilical width of 42 mm. The paratype shown on plate 13, figures 12–14, at a diameter of 84 mm has a whorl height of 30 mm, a whorl thickness of 32 mm, and an umbilical width of 33 mm. Both specimens have been compressed a little laterally.

This species shows considerable variation in the coarseness of its ribbing. The holotype has the coarsest and sparsest ribbing. The specimen shown on plate 14, figure 14, has the finest and densest ribbing. The specimen shown on plate 13, figures 12–14, has ribbing of intermediate coarseness, but it is associated (Mesozoic loc. 8567) with a specimen as coarsely ribbed as the holotype. Seven specimens exhibiting ribbing of fine to intermediate coarseness were obtained at one spot on the Iniskin Peninsula (Mesozoic loc. 11023, 11024, 11027–11029, 19940). About 50–100 feet higher was obtained the coarsely ribbed holotype (Mesozoic loc. 20002) and about a hundred feet still higher was obtained a large finely ribbed specimen (Mesozoic loc. 19941). One specimen obtained near the top of the formation (Mesozoic loc. 21768) has ribbing of intermediate coarseness. These associations and occurrences indicate that the differences in coarseness of ribbing have no stratigraphic or taxonomic significance.

The fine ribbing on the inner whorls of this species is similar to that of species of *Cadomites* and *Polyplectites* (Arkell, 1952b, p. 79, 80; Westermann, 1954, p. 335–348, pl. 32, figs. 3–6). The presence of lateral lappets and coarse ribbing on the body chamber, however, rules out an assignment to *Cadomites*. *Polyplectites* is much smaller and does not develop as coarse ribbing on its body chamber.

The coarsely ribbed specimen of *N. variabilis* Imlay, n. sp., such as the holotype, shows some resemblance to *N.* (*I.*) *formosus* (Buckman) (1920, pl. 151; Westermann, 1954, pl. 23, figs. 1a–c) but have somewhat weaker tubercles and secondary ribs. Most of the specimens of *N. variabilis* have weaker and denser ribbing than the holotype and are comparable with *N.* (*Itinsaites*) *gracilis* Westermann (1954, pl. 26, figs. 3a, b, 4). They appear, however, to have stronger tubercles and to develop sparser ribbing near the aperture. The most finely ribbed specimen of *N. variabilis* has ribbing as dense as that on *N.* (*I.*) *densus* (Buckman) (1920, pl. 152).

N. variabilis Imlay, n. sp. is characterized by its rounded whorl section, by having fine dense ribbing on its septate whorls, and by its ribbing becoming coarse and sparse on the adult body chamber.

Types: Holotype USNM 131408; paratypes USNM 131409–131412.

Occurrences: Fitz Creek Siltstone at USGS Mesozoic locs. 11023, 11024, 11027–11029, 19940, 19941, 20002, 21303, 21316, 21768, 22440, 22528 and probably at 20000, 21306, 22439. Tuxedni Formation in the Talkeetna Mountains at Mesozoic loc. 8567.

Most of the specimens of this species from the northwest side of Cook Inlet were obtained at or just below the middle of the Fitz Creek Siltstone and from 300 to 550 ft above its base. The species, however, is represented by one specimen obtained from 50 to 150 ft below the top of the formation at Mesozoic loc. 21768 and is probably represented by two fragments obtained 300 ft below the top at Mesozoic loc. 20000.

Genus STEPHANOCERAS Waagen, 1869

Stephanoceras obesum Imlay, n. sp.

Plate 18, figures 5–11

Five specimens of this species are available. The shell is an evolute serpenticone. The whorls are depressed, much wider than high. The innermost whorls embrace each other about half. The outermost septate whorl embraces the preceding whorl about a third. The complete aperture is unknown, but one fragment shows that it was terminated by a collar.

The primary ribs are sharp, prominent, fairly widely spaced, incline forward slightly on the flanks, and terminate at about two-fifths of the height of the flanks in acute tubercles. From each tubercle pass three weaker secondary ribs that cross the center transversely or with a slight backward arching. Other ribs arise freely along the zone of furcation, resulting in about four secondary ribs for every primary rib.

The suture line is poorly exposed and has not been traced.

The holotype at an estimated diameter of 96 mm has a whorl height of 29 mm, a whorl thickness of 39 mm, and an umbilical width of 46 mm. On the small paratype the same dimensions are 55, 22, 30, and 21 mm, respectively.

This species compared with *Stephanoceras* (*Skirroceras*) *nelchinanum* Imlay, n. sp. has a much stouter form, a more depressed whorl section, stronger, sparser primary

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ribs, and is more involute. *S. kreter* (Buckman) (1927, pl. 755) is more evolute, has a higher whorl section, and much coarser secondary ribs. *S. brodiaei* (J. de C. Sowerby) (1823, p. 383, pl. 351; Buckman, 1908, pl. 5, fig. 1; pl. 7, fig. 3; Fallot and Blanchet, 1923, pl. 13, figs 2a–c) differs mainly by having a higher whorl section and somewhat stronger sparser secondary ribs.

Types: Holotype USNM 131413; paratypes USNM 131414, 131415.

Occurrence: Lower part of the Tuxedni Formation in the Talkeetna Mountains at USGS Mesozoic loc. 24113.

Stephanoceras cf. S. nodosum (Quenstedt)

Plate 16, figures 7, 8

This species is represented by one large specimen and by one fragment of a body whorl. The shell is compressed and evolute. The inner septate whorls embrace the preceding whorls about half. At diameters greater than 65 mm the umbilical seam rises higher on the flanks resulting in an overlap of about a third by the body whorl. The whorls are ovate in section, slightly wider than high. The flanks, venter, and umbilical wall round evenly into each other. The umbilicus is fairly wide and shallow, and the umbilical wall is steeply inclined. The body chamber is incomplete, is represented by about five-sixths of a whorl, and the imprint of the umbilical seam indicates that the body chamber occupied about 1½ whorls.

The outermost septate whorl has 19 primary ribs. The succeeding body whorl has about 21 primary ribs. These are moderately strong, nearly radial, and terminate at about two-fifths of the height of the flanks in prominent round tubercles. From each tubercle on the penultimate whorl pass three weaker secondary ribs that incline forward on the flanks and then cross the venter transversely. Other ribs arise freely along the zone of tubercles resulting in about four secondary ribs for each primary. On the body chamber the secondary ribs become sparser adorally and on the part nearest the aperture number three for each primary rib.

The suture line cannot be traced accurately.

The illustrated specimen at the beginning of the body chamber has a diameter of 87 mm, a whorl height of 29 mm, a whorl thickness of 35 mm, and an umbilical width of 54 mm.

The Alaskan specimen is very similar to *S. nodosum* (Quenstedt) (1858, pl. 54, fig. 4; 1887, p. 532, pl. 65, fig. 17; Weisert, 1932, p. 136–138, pl. 15, figs. 1, 2) in involution, whorl shape, and ornamentation. It may have sparser secondary ribbing, but the resemblances are striking.

Figured specimen: USNM 131416.

Occurrence: Red Glacier Formation at USGS Mesozoic loc. 21269.

Subgenus SKIRROCERAS Marcke, 1907

Stephanoceras (Skirroceras) nelchinanum Imlay, n. sp.

Plate 15, figures 1, 3, 4–6; plate 16, figure 2

This species is represented by 13 specimens of which 6 show the adult body whorl. The shell is an evolute serpenticone. The whorls are ovate depressed, wider than high. The inner whorls embrace each other nearly half but at diameters greater than 50 mm the whorls gradually uncoil, and the adult body whorl embraces only a fourth of the preceding whorl. The body chamber occupies about 1⅓ whorls. The aperture on the internal mold is marked by a forwardly inclined constriction that is followed by a collar that is flared on the lower part of the flanks.

The holotype at a diameter of 83 mm has 28 primary ribs and 95 secondary ribs. The large paratype at a diameter of about 170 mm has 43 primary ribs and 133 secondary ribs. The primary ribs on the septate whorls are sharp, fairly prominent, incline slightly forward, and terminate at about two-fifths of the height of the flanks in small acute tubercles. From the tubercles pass two or three much weaker secondary ribs that incline forward on the flank and then cross the venter transversely or with a slight backward arching. Other ribs arise freely along the zone of furcation. On the septate whorls there are about 3½ secondary ribs for each primary rib. On the adult whorl the ratio is about three to one. On the adult body whorl the ribs weaken somewhat toward the aperture and the tubercles on the internal mold become inconspicuous.

The suture line is characterized by its first lateral lobe being slender, trifid, and appreciably longer than the ventral lobe.

The holotype at a diameter of 83 mm has a whorl height of 26 mm, a whorl thickness of 33 mm, and an umbilical width of 38 mm. On the large paratype at a diameter of 170 mm the same dimensions are 38, 43, and 104 mm, respectively.

Compared with the European species of *Stephanoceras* (*Skirroceras*), such as *S. macrum* (Quenstedt) (1886, pl. 65, fig. 11; Buckman, 1921, pl. 248), this species is distinguished by having fewer whorls and weaker ornamentation on its adult body whorl.

It differs from *S.* (*Skirroceras*) *kirschneri* Imlay, n. sp. by its depressed whorl section, slower rate of uncoiling, stronger ribbing on its inner whorls, weaker ribbing in its outer whorls, and by its tubercles being higher on the flanks. Its inner whorls have denser primary ribs than those of *S. humphriesianum* (J. de C. Sowerby) (1825, pl. 500, fig. 1; Buckman, 1921, pl. 238; Weisert, 1932, pl. 17, fig. 5), and its outer body whorl has much weaker ribbing.

Types: Holotype USNM 131417; paratypes USNM 131418, 131419.

Occurrences: Lower part of Tuxedni Formation in Talkeetna Mountains at USGS Mesozoic locs. 8585, 24113, and 24120.

Stephanoceras (Skirroceras) cf. S. nelchinanum Imlay, n. sp.

Plate 15, figure 2

Ten specimens from USGS Mesozoic locality 24113 and single specimens from Mesozoic localities 24120 and 24220 in the Talkeetna Mountains differ from the typical forms of *S. nelchinanum* Imlay, n. sp. by having somewhat stronger more widely spaced primary ribs that remain fairly strong on the adult body whorl. Most of the specimens are crushed or are poorly preserved. They may represent a distinct species or may be a coarsely ribbed variant of *S. nelchinanum.*

Figured specimens: USNM 131420.

Stephanoceras (Skirroceras) kirschneri Imlay, n. sp.

Plate 18, figures 1–4; plate 19

This species is represented by 20 specimens of which most have been crushed laterally. The shell is moderately compressed. The whorls are wider than high at diameters less than 45 mm but at larger diameters become somewhat higher than wide. The coiling is serpenticonic in the middle and adult growth stages. At diameters less than about 45 mm, the whorls embrace each other about two-thirds and the lateral tubercles are barely exposed below the umbilical seam. The coiling then becomes much more evolute and after one volution, at a diameter of about 80 mm, the umbilical seam rises to about two-thirds of the height of the flanks. During further growth uncoiling continues but at a slower rate, and on the large adult whorl of the holotype the umbilical seam is about four-fifths of the height of the flanks. The body chamber on the holotype and on another equally large specimen occupies nearly 1½ whorls. The aperature bears a prominent collar.

At a diameter of 79 mm the paratype shown on plate 19, figures 3–5, has 27 primary ribs and 112 secondary ribs. The primary ribs are fairly sharp, curve forward slightly, and pass into conical tubercles at about a third of the height of the flanks. From these tubercles pass three or rarely four weaker secondary ribs that incline forward slightly on the flanks but cross the venter transversely. Other secondary ribs arise freely on the flanks at or above the zone of tubercles.

On the same paratype within one volution the number of secondary ribs diminishes to about three for each primary rib. Likewise on the much larger holotype the outer two whorls bear nearly three secondary ribs for each primary. Otherwise the changes during growth are very slight. The conical tubercles and secondary ribs gradually become stronger. The primary ribs gradually become lower and broader. Near the aperture the lower half of the flank becomes smooth, and the upper half bears several weak secondary ribs.

The holotype is too crushed for accurate measurements. An equally large paratype (pl. 18, fig. 4) about half a whorl from the aperture has a diameter of 285 mm, a whorl height of 69 mm, a whorl thickness of 58 mm, and an umbilical width of 210 mm. On the smaller paratype at a diameter of about 45 mm, the same dimensions are 16.5 mm, 20.5 mm, and 16 mm, respectively. At a diameter of 79 mm the same dimensions are 27, 28, and 33 mm, respectively. At a diameter of 110 mm the same dimensions are 38, 36, and 70 mm, respectively. These measurements show that the umbilicus becomes wider and the whorl section higher during growth.

The suture line, partly exposed at the end of the last septate whorl of the largest paratype, shows broad deeply dissected saddles and a long narrow first lateral lobe.

This species greatly resembles *Stephanoceras* (*Skirroceras*) *macrum* (Quenstedt) (1887, pl. 65, fig. 11; Buckman, 1921, pl. 248; Weisert, 1932, pl. 15, fig. 3) in ribbing and coiling but has a much higher whorl section in the adult growth stages.

The species is named for C. E. Kirschner who made many excellent collections of fossils in the Cook Inlet region.

Types: Holotype USNM 131421; paratype USNM 131422–131424.

Occurrences: Fitz Creek Siltstone at USGS Mesozoic locs. 2999, 20756, 21274 and 26599; Red Glacier Formation at Mesozoic locs. 3013, 20017, 21264, 21267 and 21268. The specimens at Mesozoic locs. 2999, 20756 and 20017 are labeled float. The collections at Mesozoic locs. 21274 and 26599 contain single weathered specimens of *Stephanoceras* that may represent float. The only collections that were definitely obtained in place are from the upper 250 ft of the Red Glacier Formation.

Stephanoceras (Skirroceras) juhlei Imlay, n. sp.

Plate 16, figure 1, 3–6; plate 17

The species is represented by three specimens of which the holotype has been crushed laterally. The shell is a highly evolute serpenticone. The whorls are ovate depressed and much wider than high. The inner whorls embrace each other nearly a third but during growth gradually uncoil, and the adult body whorl embraces only about a sixth of the preceding whorl. The body chamber occupies about 1⅙ whorls. The aperture on the internal mold is marked by a shallow constriction that is followed by a low collar.

One small septate specimen, shown on plate 16, figures 1, 6, at a diameter of 93 mm, has 37 primary ribs and about 140 secondary ribs. The primary ribs are sharp, fairly low, incline forward on the flanks, and terminate in acute tubercles at about two-fifths of the height of the flanks. From the tubercles pass two or three weaker secondary ribs that cross the venter transversely or in places arch forward. Other ribs arise freely along the zone of furcation resulting in four secondary ribs for each primary rib.

On the holotype the inner whorls are not well preserved but they bear the same sharp dense ribbing as on the specimen just described. During growth the zone of tuberculation gradually becomes lower on the flanks and the secondary ribs become sparser. On the adult body whorl the ratio of secondary to primary ribs is about 2½–1.

The suture line has a narrow first lateral lobe that is slightly longer than the ventral lobe. The saddles are broad. The second lateral lobe is much shorter than the first. The auxiliary lobes incline steeply to the umbilical seam.

The paratype at a diameter of 93 mm has a whorl height of 25 mm, a whorl thickness of 32 mm, and an umbilical width of 50 mm.

This species differs from *S.* (*Skirroceras*) *nelchinanum* Imlay, n. sp. in its more evolute coiling, more depressed whorl section, and finer denser ribbing. It differs from *S.* (*Skirroceras*) *kirschneri* Imlay, n. sp. by having somewhat finer ribbing, smaller tubercles that are lower on the flanks, more slowly enlarging whorls, and a much lower whorl section. The fineness of its ribbing compares with that of *S. rhytus* (Buckman) (1921, pl. 250 a, b), but it has longer primary ribs on its septate whorls. The rather weak ribs and tubercles on its body chamber suggests comparisons with *S.* (*Skirroceras*) *baylei* (Oppel) (d'Orbigny, 1846, pl. 133; Fallot and Blanchet, 1923, pl. 5, figs. 1–3) rather than with *S.* (*Skirroceras*) *macrum* (Quenstedt) (1887, pl. 65, fig. 11; Buckman, 1921, pl. 248).

The species is named in honor of Werner Juhle, geologist of the U.S. Geological Survey, who collected the holotype specimen.

Types: Holotype USNM 131425; paratypes USNM 131426, 131427.

Occurrences: Tuxedni Formation in the Talkeetna Mountains at USGS Mesozoic locs. 24113 and 24120; Red Glacier Formation at Mesozoic loc. 24333.

Genus STEMMATOCERAS Mascke, 1901

Stemmatoceras n. sp. undet.

Plate 20, figures 1–4

The species is represented by two specimens. The shell is moderately stout, has evolute coiling and becomes more evolute during growth. The whorls are quadrate in section, thickest above the middle, much wider than high but become less depressed adorally on the body chamber. The umbilicus is moderately wide and rather shallow. The flanks diverge outward from the umbilical seam and round fairly abruptly into the broadly rounded venter. The body chamber is incomplete but is represented by at least half a whorl. The aperture is unknown.

The primary ribs are strong, widely spaced, and nearly radial or inclined slightly forward. On the septate whorls they terminate near the middle of the flanks in acute tubercles. On the body whorl they terminate at about two-fifths of the height of the flanks in prominent tubercles. From the tubercles pass three or four rather weak secondary ribs that cross the venter transversely. Other ribs arise freely along the zone of tuberculation, resulting in nearly five secondary ribs for each primary rib.

The suture line is not preserved. The largest specimen at an estimated diameter of 122 mm has a whorl height of 24 mm, a whorl thickness of 40 mm not counting the tubercles, and an umbilical width of 69 mm.

The species is characterized by its strong widely spaced primary ribs, its prominent tubercles high on the flanks, and its rather weak secondary ribs. The sparse coarse ribbing on its flanks is similar to that on some species of *Teloceras*, such as *T. multinodum* (Quenstedt) as figured by Weisert (1932, pl. 19, fig. 2), but its whorl section is narrower, and its umbilicus wider and shallower than in *Teloceras*.

Figured specimens: USNM 131428; USNM 131429.

Occurrences: Red Glacier Formation at USGS Mesozoic locs. 21263 and 21296. Small specimens possibly representing this species occur at Mesozoic locs. 19966 and 21295 in the Red Glacier Formation.

Stemmatoceras cf. S. palliseri (McLearn)

Plate 20, figures 5, 6; plate 21, figures 2, 4

This species is represented by one adult specimen. The shell is a very stout serpenticone. The whorls are ovate and depressed. The septate whorls are more than twice as wide as high, but during growth gradually become less wide. The adult body whorl is less than twice as wide as it is high and becomes progressively higher toward the aperture owing to whorl contraction. The septate whorls embrace the preceding whorls about half. The body whorl becomes progressively more evolute and near the aperture embraces the penultimate whorl about a third. On the inner septate whorls the flanks are strongly divergent to near the middle of the whorl and then round abruptly into a broad gently arched venter. During growth both flanks and venter become evenly rounded. The umbilicus is moderately wide and widens during growth in proportion to the diameter. The body chamber occupies a little more than one complete whorl. The aperture terminates simply.

The outermost septate whorl has 24 primary ribs and about 115 secondary ribs, or nearly 5 secondaries for each primary. The next smaller septate whorl has 20 primary ribs and from 4 to 5 secondaries for each primary. The body whorl is incomplete but is estimated to have had 27 primaries. At the beginning of the body whorl there are four secondaries for each primary. Near the aperture there are only three secondaries for each primary.

The primary ribs on the septate whorls are fairly prominent, nearly radial, and terminate in prominent tubercles near the middle of the flanks. From these pass three or four much weaker secondary ribs that arch forward gently on the venter. The primary ribs and tubercles on the body whorl remain strong for three-fourths of a whorl and then weaken considerably near the aperture. The secondary ribs on the body whorl become considerably stronger and more widely spaced adorally and near the aperture are nearly as strong as the primary ribs.

The suture line cannot be traced accurately.

The dimensions in millimeters and ratios of the diameter (in parentheses) are as follows:

Diameter	Whorl height	Whorl thickness	Umbilical width
91	26(0.28)	48(0.52)	41(0.45)
130	33(0.25)	55(0.42)	67(0.51)
160	45(0.28)	58(0.36)	87(0.54)

This species resembles *Stemmatoceras albertense* McLearn (1928, p. 20, pls. 5–7; Warren, 1947, p. 67, pl. 5, fig. 1; Frebold, 1957a, p. 50, pl. 21, figs. 2a, b; pl. 23, figs. 1a–c) in whorl shape, coiling, and density of secondary ribs. It differs by having considerably fewer ribs at a comparable diameter and much stronger tubercles. It differs from *S. palliseri* (McLearn) (1932b, p. 114, pl. 2; pl. 5, fig. 1; Warren, 1947, p. 68, pl. 3, fig. 1) by having a much broader whorl section. Its inner whorls at diameters less than 90 mm are similar to the inner whorls of *Teloceras dowlingi* McLearn (1932b, p. 112, pl. 1; pl. 5, figs. 2, 3), but its larger whorls are much less arched. *S. coronatum* (Quenstedt) 1887, pl. 66, fig. 11; Weisert, 1932, p. 159, pl. 18, figs. 1, 4) at a comparable size has a higher whorl section, fewer secondary ribs, and weaker tubercles.

Figured specimen: USNM 131430.
Occurrence: Fitz Creek Siltstone at USGS Mesozoic loc. 21270.

Stemmatoceras ursinum Imlay, n. sp.

Plate 22, figures 1–3

The species is represented by four specimens of which all are crushed somewhat laterally. The sectional view illustrated was drawn from near the adoral end of the largest septate whorl where the shell appears to be only slightly deformed. The shell is a moderately stout serpenticone. The whorls are ovate depressed and become higher during growth. The septate whorls embrace each other nearly half. The body whorl gradually contracts from the remainder of the shell and near the aperture embraces only about a third of the penultimate whorl. As a consequence the umbilicus widens during growth. The flanks round evenly into the venter and into the umbilical wall. The body chamber occupies a little more than one complete whorl. The aperture on the internal mold is slightly flared on the upper part of the flanks and rather strongly flared on the lower third.

On the septate whorls the primary ribs are only moderate in strength, are nearly radial or are curved slightly forward, and terminate slightly below the middle of the flanks in pronounced tubercles. From these pass three or four slightly weaker secondary ribs that arch forward on the venter. Other ribs arise by intercalation along the zone of tuberculation. The penultimate whorl has 19 primary ribs and about 95 secondary ribs.

Adorally on the adult body whorl the primary ribs become broader, lower, and finally indistinct, the secondary ribs become sparser and much stronger, and the tubercles remain strong to near the aperture where the last two weaken somewhat. This whorl has 23 primary ribs and about 90 secondary ribs.

Accurate measurements cannot be made because the specimens are crushed.

The suture line has broad deeply dissected saddles. The first lateral lobe is narrow, trifid and a little longer than the ventral lobe. The first auxiliary lobe is long and obliquely inclined.

This species shows considerable resemblance to *S.* cf. *S. palliseri* (McLearn), described herein, but has a higher whorl section, weaker and fewer primary ribs on its outer two whorls, and sparser secondary ribs that become much stronger adorally on the adult body whorl. It resembles *S. palliseri* McLearn (1932b, p. 114, pl. 2; pl. 5, fig. 1; Warren, 1947, p. 68, pl. 3, fig. 1) in whorl shape and coiling, but its body whorl has fewer primary ribs and much stronger tubercles.

Type: Holotype USNM 131431.
Occurrences: Fitz Creek Siltstone at USGS Mesozoic locs. 21281 and 22705.

Stemmatoceras cf. S. triptolemus (Morris and Lycett)

Plate 21, figures 1, 3

The figured specimen is crushed laterally, but allowing for crushing its form must have been very stout. An inner whorl at a diameter of about 40 mm has a whorl thickness of 21 mm and a whorl height of 11 mm. The outer whorls were probably nearly as broad. The whorl section on the inner whorls is ovate depressed, but during growth both flanks and venter become less convex. The inner whorls embrace the preceding whorls about half but during growth the coiling become more evolute and the outermost whorl embraces only a third of the preceding whorl. The umbilicus is moderately wide and becomes wider during growth. The body chamber is incompletely preserved but is represented by at least half a whorl. The aperture terminates simply.

The primary ribs are prominent, moderately spaced, radial or inclined slightly backward, and terminate near the middle of the flanks in acute tubercles. From the tubercles on the penultimate whorl pass three or less commonly two weaker secondary ribs. In addition a few secondary ribs arise freely along the zone of tubercles resulting in nearly four secondary ribs for each primary. On the adult body whorl secondary ribs become less common but coarser relative to the primary ribs and number about three per primary. The secondary ribs cross the venter with a slight forward arching. Both ribs and tubercles persist to very near the aperture.

The ventral lobe is not preserved. The saddles are fairly broad and descend regularly to the umbilical seam. The first auxiliary lobe is inclined obliquely.

This species compared with *S. albertense* McLearn (1928, p. 20, pls. 7–8) is more evolute and has much stronger and sparser ribbing; compared with *S. coronatum* (Quenstedt, 1887, pl. 66, fig. 11; Weisert, 1932, pl. 18, figs. 1, 4), it is more evolute and has sparser secondary ribs. It shows even greater resemblance to *S. triptolemus* (Morris and Lycett) (1851, p. 111, pl. 14, fig. 1; Arkell, 1954, p. 582, 583) but has sparser primary ribs. The coarseness of its ribbing is similar to that on species of *Teloceras*, such as *T. acuticostatum* Weisert (1932, p. 180, pl. 19, fig. 3), but it appears to have a more shallow umbilicus than any species of *Teloceras*.

Figured specimen: USNM 131432.

Occurrence: Red Glacier Formation at USGS Mesozoic loc. 21261.

Genus TELOCERAS Mascke, 1907

Teloceras itinsae McLearn

Plate 23, figures 9, 10; plate 24, figures 1–5, 7

Teloceras itinsae McLearn, 1932a, Royal Soc. Canada Trans., 3d ser., v. 26, sec. 4, p. 51, pl. 10, figs. 1, 2.

The holotype of *Teloceras itinsae* McLearn from the Queen Charlotte Islands is an immature specimen of a species that is represented by 28 specimens in the middle Bajocian beds of the Cook Inlet region.

The septate whorls are much wider than high and embrace nearly half of the preceding whorls. The adult body whorl gradually becomes higher adorally and near the aperture is nearly as high as wide. This change is accompanied by contraction of the body chamber which near the aperture embraces the preceding whorl only about a third. The body chamber occupies slightly more than one complete whorl. The aperture terminates abruptly and simply.

On the septate inner whorls the primary ribs are nearly radial, moderately stout, widely spaced, and terminate in pronounced conical tubercles. From these pass two or three somewhat weaker secondary ribs that arch gently forward on the venter. Between successive bundles of secondary ribs are intercalated one or rarely two ribs that arise above the zone of tuberculation.

On the adult body whorl the primary ribs gradually become lower and broader; the secondary ribs gradually become stronger and more arched; and the tubercles become stronger, more widely spaced, and arise somewhat higher on the flanks. This condition persists to near the aperture where the last tubercle is slightly weaker than the preceding tubercles. The shell bordering the apertural margin is marked only by growth striae.

The holotype at a diameter of about 71 mm has 19 primary ribs and 63 secondary ribs. The plesiotype shown on plate 24, figures 1, 2, at a diameter of 123 mm has 15 primary ribs and 57 secondary ribs. The complete adult plesiotype shown on plate 23, figure 9, at a diameter of 163 mm has 18 primary ribs and 66 secondary ribs. The similar adult specimen shown on plate 23, figure 10, has 19 primary ribs and 65 secondary ribs. This indicates that there are 3.3–3.8 secondary ribs for each primary rib.

The suture line is not well exposed on any of the specimens.

The holotype at a diameter of 68 mm has a whorl height of 24 mm, a whorl thickness of 36 mm, and an umbilical width of 32 mm. On the plesiotype shown on plate 24, figures 5, 7, the same dimensions measured at the beginning of the body chamber are 106, 41, 60, and 41 mm, respectively. On the plesiotype shown on plate 23, figure 10, these dimensions measured near the adoral end of the body chamber are 163, 45, 51, and 82 mm, respectively.

Teloceras itinsae McLearn was compared by McLearn (1932a, p. 52) with *T. multinodum* (Quenstedt) (1887, p. 545, pl. 67, fig. 2; Weisert, 1932, p. 175, pl. 19, fig. 2), but it has fewer and much weaker primary ribs, and its adult body whorl becomes higher and more evolute. It shows more resemblance to *T. sparsinodum* (Quenstedt) as figured by Weisert (1932, p. 177, pl. 19, fig. 1) but differs by having weaker primary ribs, somewhat stronger secondary ribs, and a more evolute body chamber.

Types: Holotype Canada Natl. Mus. 6481; plesiotypes USNM 131433–131436

Occurrences: Fitz Creek Siltstone at USGS Mesozoic locs. 2998, 2999, 3000, 19973, 19975, 21270, 21275, 21305, 27107, 27109, 27110.

Teloceras itinsae McLearn near Tuxedni Bay has been found from 75 to 150 ft below the top of the Fitz Creek Siltstone which is about 650 ft thick. In the Iniskin Peninsula it has been found from 200 to 650 ft above the base of the Fitz Creek Siltstone which ranges in thickness from 1,100 to nearly 1,300 ft.

Genus ZEMISTEPHANUS McLearn, 1927

Zemistephanus richardsoni (Whiteaves)

Plate 25, figures 6, 7; plate 26, figures 1–7

Ammonites richardsoni Whiteaves, 1876. Canada Geol. Survey, Mesozoic Fossils, v. 1, pt. 1, p. 32, 33, pl. 5, figs. 1, 2.

Zemistephanus richardsoni (Whiteaves). McLearn, 1929, Canada Natl. Mus. Bull., no. 54, p. 19, pl. 9, figs. 1, 2; pl. 10, fig. 2.

Arkell, 1954, Royal Soc. London Philos. Trans., ser. B, Biol. Sci., no. 651, v. 237, p. 587, text fig. 10.

This species is abundant in the Cook Inlet region, being represented in the Geological Survey collections by 95 specimens. These show all stages of growth and amount of variation within the species.

The shell is an evolute cadicone. The whorls are coronate and much wider than they are high but vary appreciably in these dimensions. On the septate whorls the ratio of the height to the width of the whorl ranges from 35 to 45 percent. On the adult body whorl the ratio of height to width increases toward the aperture as a result of contraction of the body chamber, and at the aperture may be from 60 to 80 percent. The umbilicus is wide and craterlike and enlarges considerably on the adult body whorl. The body chamber occupies about 1⅙ whorls. The aperture terminates simply. On the internal molds the aperture is preceded by a weak constriction but such is not apparent where the shell is preserved.

The inner septate whorls bear narrow weak radial widely spaced primary ribs that terminate in conical tubercles at the edge of the umbilicus. From the tubercles pass three or four secondary ribs that arch forward gently on the venter. In addition one or two secondary ribs arise freely between the branched ribs above the zone of furcation. All secondary ribs are round, become broader ventrally, and on the venter are as broad as the interspaces. They vary somewhat in coarseness and in spacing from one specimen to another.

During growth the primary ribs gradually become broader and less conspicuous; the tubercles gradually become stouter except for the last tubercles preceding the adult aperture; and the secondary ribs gradually become broader and more widely spaced except where they are replaced locally by small riblets and striations at diameters ranging from 50 to 100 mm. Such riblets and striations in places are superimposed on the much larger secondary ribs as well as the interspaces but in other places may replace the secondary ribs entirely. They may replace the secondary ribs for as little as a fourth of a whorl or as much as 1½ whorls and may dominate over the normal secondary ribs on part of the adult body whorl.

The adoral ½–⅔ of the adult body chamber is characterized by a rejuvenation of broad secondary ribs averaging about three per tubercle. These ribs where the shell is preserved are overlain by striae and riblets.

The suture line is characterized by its first lateral saddle being broad and deep and much larger than the second lateral saddle. The first lateral lobe is irregularly trifid and as long as the ventral lobe. The second lateral lobe is short, wide, and trifid. The auxiliaries descend regularly to near the umbilical seam. The suspensive lobe is highly retracted.

The dimensions in millimeters and ratios of the diameters (in parentheses) are as follows:

Specimen	Diameter	Whorl height	Whorl thickness	Umbilical width
Plesiotype (pl. 26, figs. 3, 5)	54	14 (0.26)	36 (0.66)	20.5 (0.38)
Do	81	18.5 (0.23)	53 (0.65)	31 (0.38)
Plesiotype (pl. 26, fig. 1)	71	19 (0.27)	42 (0.59)	23 (0.32)
Plesiotype (pl. 26, fig. 2)	94	25 (0.26)	58 (0.61)	31.5 (0.33)
Plesiotype (pl. 26, figs. 6, 7)	118	26 (0.22)	72.5 (0.61)	46 (0.39)
Plesiotype (pl. 25, fig. 7)	128	28 (0.22)	65 (0.51)	51 (0.40)
Plesiotype (pl. 25, fig. 6)	148	42 (0.28)	54 (0.36)	73 (0.49)

This species shows considerable variation in width of whorls, in coarseness and density of ribbing, and in the first appearance and extent of the fine riblets that replace the regular secondary ribs. These features show no correlation with each other. The most finely ribbed variant of *Z. richardsoni* (Whiteaves) has six secondary ribs per tubercle which is fewer than is reported to occur on *Z. funteri* McLearn (1929, p. 20, pl. 10, fig. 1).

Types: Holotype Canada Natl. Mus. 5013; plesiotype Canada Natl. Mus. 9006; plesiotypes USNM 131437–131443.

Occurrences: Fitz Creek Siltstone at USGS Mesozoic locs. 2998, 2999, 3000, 10245, 10515, 10520, 19978, 19997, 20020, 20756, 21270, 21271, 21274, 21304, 21305, 21772, 22533, 26598, 26599, 27108. Specimens probably belonging to this species occur in the Fitz Creek Siltstone Mesozoic locs. 20021, 21302, 21767.

This species near Tuxedni Bay occurs in the upper fourth of the Fitz Creek Siltstone and ranges from 100 to 150 ft below its top. On the Iniskin Peninsula most of the occurrences of the species are well below the middle of the Fitz Creek Siltstone and range from 200 to 480 ft above its base. One occurrence (Mesozoic loc. 22533), however, is near the top of the siltstone

Zemistephanus carlottensis (Whiteaves)

Plate 24, figure 6; plate 27, figures 1–3; plate 28, figures 1–3

Ammonites carlottensis Whiteaves, 1876. Canada Geol. Survey, Mesozoic Fossils, v. 1, pt. 1, p. 38, pl. 6.

Perisphinctes carlottensis (Whiteaves). Neumayr, 1885, K. Akad. Wiss., Math.-naturh. Cl. Denkschr., v. 50, p. 96.

Stephanoceras? carlottense (Whiteaves). Martin, 1926, p. 142, 149, 152.

?Zemistephanus vancouveri McLearn. 1929, Canada Natl. Mus. Bull. 54, p. 20, 21, pl. 11, figs. 1, 2.

Pseudotoites carlottense (Whiteaves). Arkell, 1954, p. 587, figs. 11 and 12 on p. 588 and 589.

Five specimens from the Tuxedni Group on the northwest side of Cook Inlet were labeled by T. W. Stanton as *Perisphinctes* cf. *P. carlottensis* (Whiteaves). These identifications were listed by Martin (1926, p. 142, 149, 152) variously as *Stephanoceras carlottensis* (Whiteaves) and *Perisphinctes* cf. *P. carlottensis* (Whiteaves).

The largest specimen is comparable in size with the holotype of *A. carlottensis* (Whiteaves), includes the complete adult body chamber and part of the penultimate septate whorl, and has been slightly compressed laterally. The other four specimens are much smaller, are crushed laterally, and are closely similar in coiling, tuberculation, and ribbing with the penultimate whorl of the largest specimen.

In addition the species is represented in more recent collections by three well-preserved specimens, including one adult, from the Cook Inlet area.

The shell during growth changes from stout to cadicone on the septate whorls and then to planulate ellipticone on the adult body chamber. The smaller septate whorls embrace each other about three-fifths and are probably nearly circular in section. During growth the coiling of the septate whorls become more involute and the whorls become much stouter. The adult body whorl is characterized by abrupt contraction and at the aperture embraces only about a fourth of the penultimate whorl. Accompanying this contraction the body whorl develops a lower rounder whorl section that is not much wider than it is high. The innermost whorls have a fairly wide umbilicus and the umbilical wall rounds evenly into the flanks. On the larger septate whorls the umbilicus becomes relatively less wide, and the umbilical wall becomes nearly vertical and rounds fairly abruptly into the flanks. On the adult body whorl the umbilicus becomes very wide and the umbilical wall becomes low and gently inclined. The adult body chamber occupies a complete whorl. The aperture terminates simply. It is not constricted or collared.

The smaller septate whorls bear high widely spaced primary ribs that terminate in small acute tubercles at about two-fifths of the height of the flanks. From these tubercles pass pairs of weaker secondary ribs that incline forward slightly on the flanks. Between the rib pairs are one or two secondary ribs that arise freely along the zone of tuberculation.

During growth the primary ribs on the septate whorls become stouter, the tubercles become much stronger and much lower on the flanks, and the secondary ribs become more numerous. On the penultimate whorl three secondary ribs arise from each tubercle. In addition one or two ribs arise freely on the flanks between successive rib bundles. All secondary ribs incline forward gently on the flanks but cross the venter nearly transversely.

On the adult body chamber the ornamentation changes considerably adorally. The tubercles gradually become weaker, elongate radially, and nearly disappear. The secondary ribs become more prominent sparser, and more strongly inclined forward but weaken near the aperture. The number of secondary ribs decreases from four to five per tubercle to two per tubercle.

The suture line is closely similar to that of *Zemistephanus richardsoni* (Whiteaves) as illustrated herein, differing mainly by its narrower second lateral lobe. The most conspicuous feature is the very broad and deep first lateral saddle.

All the Alaskan specimens assigned to *A. carlottensis* Whiteaves have been crushed or distorted so much that measurements would have little value. Allowing for deformation, however, the two large adults probably had nearly the same relative dimensions as the holotype specimen (Arkell, 1954, p. 588, 589).

The identification of certain Alaskan specimens with *Ammonites carlottensis* (Whiteaves) from the Queen Charlotte Islands is based solely on comparisons of the adult body whorl, as the holotype specimen does not show the inner whorls and no other specimens of the species from the Queen Charlotte Islands have been described. The resemblances are so close, however, that the identification seems reasonable.

The assignment of these specimens to the genus *Zemistephanus* is based on the rather marked uncoiling of the body chamber, the low position of the tubercles on the flanks of the body chamber, a tendency for the tubercles to weaken near the aperture of the large adult specimens, and a striking resemblance in the pattern of the suture line. The genus *Teloceras* has a coronate adult body chamber, its tubercles occur higher on the flanks and remain strong on the adult body chamber, and the adult body whorl contracts little or none at all from the preceding whorl, The genus *Pseudotoites* differs mainly by having a much narrower first lateral saddle (Arkell, 1954, pl. 34, figs. 3a, b, 5a, b; pl. 36, fig. 3c), but its inner whorls appear to have much weaker and denser primary ribs.

"Ammonites" carlottensis Whiteaves was assigned by Arkell (1954, p. 587–589) to *Pseudotoites* rather than to *Zemistephanus* because its adult body whorl shows great resemblance to that of some Australian species such as *P. robiginosus* (Crick) (Arkell, 1954, p. 574, pl. 34, figs. 1–4; pl. 35). He did not know, however, the features of the suture line of *"A." carlottensis* Whiteaves or of *Z. richardsoni* (Whiteaves), or that the adult body whorls of both species are similar in coiling and in the simple terminations of their apertures.

Z. carlottensis (Whiteaves), as herein defined, differs from *Z. richardsoni* (Whiteaves) by being much less coronate, by having stronger ribbing on its septate whorls, by not developing riblets or striae in place of ribs during its development, and perhaps by its narrower second lateral lobe. The septate specimens of *Z. carlottensis* (Whiteaves) appear to be identical specifically with the completely septate holotype of *Z. vancouveri* McLearn (1929, p. 20, pl. 11, figs. 1, 2).

Most of the Alaskan specimens of *Zemistephanus carlottensis* (Whiteaves) are from the upper 150 feet of the Fitz Creek Siltstone and from the basal beds of the Cynthia Falls Sandstone on Tuxedni Bay. Their common associates are *Teloceras itinsae* McLearn, *Zemistephanus richardsoni* (Whiteaves), *Normannites crickmayi* (McLearn), *N. itinsae* (McLearn), and *Chondroceras defontii* (McLearn).

The exact geographic and stratigraphic position of the holotype of *Ammonites carlottensis* Whiteaves is unknown although Arkell (1956, p. 542) stated that it is probably from the lower part of the Yakoun Formation on the northwest shore of Maude Island. If so, its associates (McLearn, 1949, p. 13) would be the same as listed above from the Fitz Creek Siltstone. On the basis of the ammonite succession in Alaska, these are considered to correspond with the European zone of *Stephanoceras humphriesianum*. Their age is somewhat younger, therefore, than the *Pseudotoites*-bearing beds in Australia that Arkell (1954, p. 559, 594) correlated with the European zone of *Sonninia sowerbyi*.

Plesiotypes: USNM 131444–131447.

Occurrences: Fitz Creek Siltstone at USGS Mesozoic locs. 2998, 2999, 3000, 21275; Cynthia Falls Sandstone at Mesozoic loc. 10513.

Arkelloceras? sp. juv.

Plate 28, figures 7–9

One small septate ammonite from Wide Bay is worth recording because of its resemblance to *Arkelloceras* Frebold (1957b, p. 9–12, pls. 9–13; 1960, p. 8–10, pl. 3, fig. 1; pl. 4; pl. 5, figs. a–c) from which it differs by the presence of distinct lateral tubercles. The inner whorls of *A. mclearni* Frebold (1957b, pl. 12, figs. 2d and 2g), however, show thickening of the ventral ends of the primary ribs which are similar to tubercles.

On the Alaskan specimen the outer whorl embraces about three-fifths of the preceding whorl. The whorl is subhexagonal in section and much wider than it is high. The primary ribs are strong, incline slightly forward, and terminate at about two-fifths of the height of the flanks in prominent acute tubercles. From the lateral tubercles pass pairs of fairly strong forwardly inclined secondary ribs that are weakest near the furcation points and terminate on the edge of a fairly broad venter in radially elongate tubercles. These tubercles alternate in position with tubercles on the opposite side of the venter and are connected with those tubercles in a zigzag manner by ribs that weaken along the midventral line. The ventral tubercles are lower and much more elongate than the lateral tubercles. All tubercles become somewhat weaker during growth. The lateral tubercles are especially prominent in the two small inner whorls exposed in the umbilicus. Wherever the shell is preserved, its surface is marked by weak radial striae that occur on both ribs and interspaces.

The suture line is not well preserved. The ventral lobe, however, is of about the same length as the first lateral lobe.

The specimen at a diameter of 15.5 mm has a whorl height of 4.2 mm, a whorl thickness of 9 mm, and an umbilical width of 5.7 mm.

The shape and ornamentation of the Alaskan specimen is similar to that of immature specimens of *Garantia*, as figured by Robert Douville (1915, pl. 1, figs. 2, 2a; pl. 2, figs. 3, 5, 5a), and it could belong to that genus. However, it occurs in older beds than any known genus of the Parkinsoniidae, it does show resemblances to the immature whorls of *Arkelloceras* from northern Canada, and the suture line suggests a relationship with *Arkelloceras* rather than with *Garantia*. Like *Arkelloceras* it is associated with *Inoceramus lucifer* Eichwald, which in Alaska has not been found above beds containing *Otoites*, *Emileia*, *Parabigotites*, and *Sonninia* (*Papilliceras*).

Arkelloceras? sp. juv. was found with the ammonites *Bradfordia* and an immature sonniniid, probably representing *Witchellia*, at a position about 400 feet below the top of the Kialagvik Formation. Eighty feet higher were found *Parabigotites* and *Bradfordia* (Mesozoic loc. 21256). Directly above were found *Otoites* sp., *Stephanoceras* (*Skirroceras*) sp., *Bradfordia costidensa* Imlay, n. sp., and *Inoceramus lucifer* Eichwald (Mesozoic loc. 21257).

On the basis of associated fossils the age of *Arkelloceras*? sp. juv. must correspond either to the zone of *Sonninia sowerbyi* or to the zone of *Otoites sauzei*. (See table 10.) Its stratigraphic position only a little below beds containing *Otoites* and *Skirroceras* suggests that it is probably not older than the zone of *Otoites sauzei*. This is supported by the presence of ammonites representing the zone of *Sonninia sowerbyi* at a lower position in the Kialagvik Formation.

Figured specimen: USNM 132014.

Occurrence: Kialagvik Formation, 400 ft below top, at USGS Mesozoic loc. 21255, on north side of Wide Bay, 4.7 miles N. 74° W. of west end of Hartman Island, Alaska Peninsula.

Family PERISPHINCTIDAE Steinmann, 1890

Genus PARABIGOTITES, Imlay, 1961

The original description (Imlay, 1961, p. 472) is as follows:

This genus is characterized by highly evolute coiling; by ovate depressed whorl sections; by high, sharp, forwardly inclined ribs that bifurcate above the middle of the flanks and are not interrupted on the venter; by the ribbing remaining strong on the body chamber; by the peristome terminating simply, and by the suspensive lobe being strongly retracted.

It greatly resembles *Bigotites* Nicolesco (1918, p. 36) in shape, coiling, and ribbing. It differs by lacking a smooth band along the midventral line, by the secondary ribs merely arching forward gently on the venter instead of forming an obtuse angle, by its constrictions being less strongly developed, and by having a strongly retracted suspensive lobe. Furthermore its constrictions are not followed by segmental enlargements of the shell or by changes in the ribbing such as described by Nicolesco (1931, p. 9–12) for *Bigotites*.

Parabigotites shows great resemblances, also, to *Prorsisphinctes* Buckman (1921, pl. 200; Siemeradzki, 1899, pl. 22, fig. 27) which Arkell (1957, L 314) consider to be a subgenus of *Leptosphinctes*. It differs by having sharper, higher ribbing that becomes stronger adorally on the adult whorls instead of weakening or fading. It appears also to be more evolute and to have a lower whorl section.

The type species of *Parabigotites* is *Parabigotites crassicostatus* Imlay, n. sp.

Parabigotites crassicostatus Imlay

Plate 29, figures 1–16

Dactylioceras sp. A. 1945, Kellum, Daviess, and Swinney, U.S. Geol. Survey, figs. 5A–B (not C–E).

Parabigotites crassicostatus Imlay, 1961, Jour. Paleontology, v. 35, no. 3, p. 472–473, pl. 64, figs. 4–10.

The original description is as follows:

This species is represented by about 65 specimens of various sizes of which most are crushed and fragmentary. The shell is discoidal and moderately compressed. The whorls are ovate in section, a little wider than high, and embrace about one-fourth of the preceding whorls. The flanks and venter are evenly rounded. The umbilicus is wide and shallow. The umbilical wall is low, nearly vertical, and rounds evenly into the flanks. The incomplete body chamber on the holotype is represented by four-fifths of a whorl. The apertural margin is simple, is projected forward slightly on the venter, and is preceded by a nearly smooth area.

The small and intermediate sized whorls bear prominent, widely spaced primary ribs that incline forward gently on the lower parts of the flanks and pass abruptly into weaker secondary ribs at about two-fifths of the height of the flanks. The ventral ends of the primary ribs are strongly swollen but are not distinctly tuberculate. The secondary ribs arise in pairs that incline forward on the flanks more strongly than the primary ribs. All secondary ribs arch forward gently on the venter which they cross without interruption. Two or three weak constrictions occur on each whorl.

Adorally on the penultimate and body whorls the ribbing becomes increasingly coarser, the secondary ribs become nearly as strong as the primary ribs and the constrictions become more pronounced. Many of the secondary ribs are indistinctly connected with the primary ribs and some arise freely along the zone of furcation. All secondary ribs arch forward on the venter which they cross without weakening.

The suture line, partly exposed on the holotype, is characterized by broad saddles, by the second lateral saddle being almost as wide and high as the first lateral saddle, and by the suspensive lobe being well retracted.

The holotype has been crushed somewhat laterally, but at a diameter of 102 mm, has a whorl height of 28 mm, a whorl thickness of 32 mm, and an umbilical width of 54 mm. On paratype USNM 130910, the same dimensions are 83, 20, 23, and 46 mm respectively.

The appearance of this species in lateral view is strikingly similar to that *Bigotites pulcher* Nicolesco (1931, p. 21, pl. 2, fig. 1) from Europe, differing mainly in its somewhat higher, sharper, and more closely spaced ribs, and less pronounced constrictions. In ventral view it is readily differentiated however, by lacking a smooth midventral area and by the ribs arching evenly across the venter instead of meeting at an angle along the midventral line. It differs from most of the species of *Leptosphinctes* (*Prorsisphinctes*) (Buckman, 1921, pl. 200, 211, 247; 1922, pl. 326; 1923, pl. 386, 446; 1925, pl. 544, 545) by having much coarser ribbing that becomes stronger on the body chamber instead of becoming weaker. However, its inner whorls are similar in appearance to the small specimen described as *Phanerosphinctes phanerus* Buckman (1921, pl. 211), which Arkell (1958, p. 168) assigns questionably to *Prorsisphinctes*.

The ammonite most commonly associated with *Parabigotites* is *Stemmatoceras*. In the Talkeetna Mountains (Mesozoic loc. 24113) the associated ammonites include *Otoites, Stemmatoceras, Sonninia, Witchellia* and *Lissoceras*. This assemblage probably corresponds to the lower part of European *Otoites sauzei* zone.

Types: Holotype USNM 130909; paratypes USNM 130910–130916.

Occurrences: Kialagvik Formation at USGS Mesozoic locs. 11349, 11352, 12402, 12404, 19773, 19796, 19800, 19811, 19824, 19926, 21258 in the Alaska Peninsula; Fitz Creek Siltstone at Mesozoic locs. 3010, 19966, 22529, on the north side of Cook Inlet; Tuxedni Formation in the Talkeetna Mountains at Mesozoic locs. 24113, 27577.

Genus LEPTOSPHINCTES Buckman, 1920

Leptosphinctes evolutus Imlay, n. sp.

Plate 28, figures 4–6

The species is represented by two internal molds. The coiling is highly evolute. The whorls are ovate in section, nearly as wide as high, and embrace the preceding whorls about one-fifth. The flanks and venter are evenly rounded. The umbilicus is very wide and shallow. The body chamber occupies about three-fourths of a whorl and is nearly complete. It is terminated by a broad forwardly inclined constriction that is followed by a broad collar.

The ornamentation of the septate inner whorls, as exposed in the umbilicus, consists of deep, forwardly inclined constrictions and high, sharp, widely spaced primary ribs that terminate in tubercles just below the umbilical seam. On the outermost septate whorl the primary ribs divide at about three-fifths of the height of the whorl into pairs of secondary ribs that arch forward strongly on the venter. The body chamber is marked by similar deep constrictions and by moderately strong primary ribs that gradually weaken adorally and ventrally. The ribs incline forward gently on the lower three-fifths of the flanks and then curve forward strongly. Some pass into pairs of ribs high on the flanks and others remain single. All ribs arch forward strongly and become much weaker on the venter.

The suture line cannot be traced accurately. The holotype, which is slightly distorted, at a diameter of 91 mm has a whorl height of 25 mm, a whorl thickness of 24 mm and an umbilical width of 51 mm.

This species is differentiated by its coarse, widely spaced ribbing, its deep constrictions and its highly evolute coiling from any described European species of *Leptosphinctes*.

Types: Holotype USNM 131448; paratype USNM 131449, 131450.

Occurrence: Tuxedni Formation in the Talkeetna Mountains at USGS Mesozoic loc. 8567.

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INDEX

[Italic numbers indicate descriptions]

PLATES 1–29

PLATE 1

[All figures natural size]

FIGURES 1–7. *Macrophylloceras* sp. undet. A (p. B31).

1. Specimen USNM 131332 from USGS Mesozoic loc. 3697.
2. Specimen USNM 131331 from USGS Mesozoic loc. 3697.
3. Specimen USNM 131329 from USGS Mesozoic loc. 24113. Note fine ribbing.

4, 5. Specimen USNM 131328 from USGS Mesozoic loc. 24113.

6. Specimen USNM 131327 from USGS Mesozoic loc. 24113.
7. Specimen USNM 131330 from USGS Mesozoic loc. 3696. Illustrates sutures.

8, 9, 13. *Macrophylloceras* sp. undet. B (p. B31).

8, 9. Figured specimen USNM 131333 from USGS Mesozoic loc. 8567.

13. Figured specimen USNM 131334 from USGS Mesozoic loc. 2999.

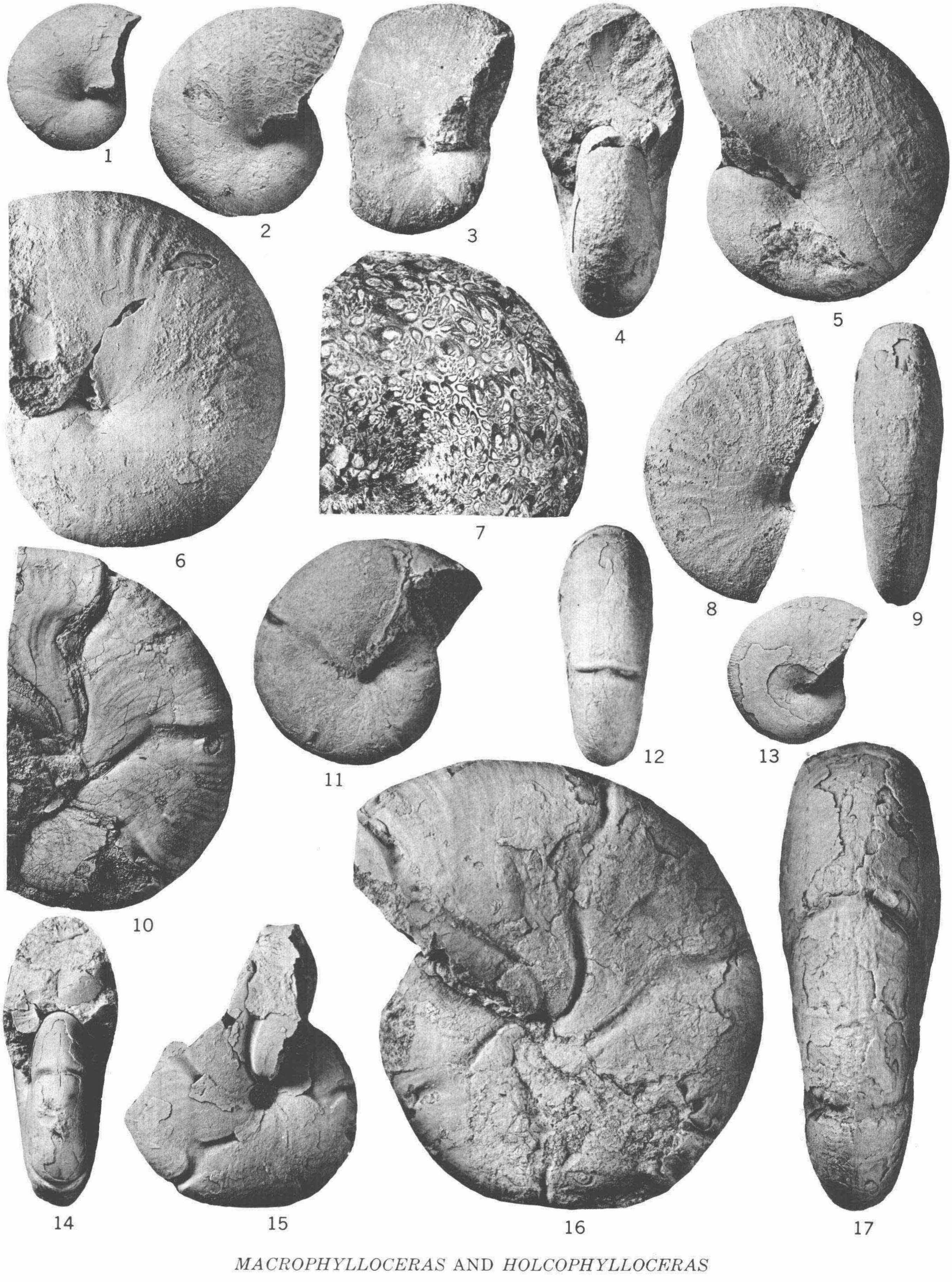
10–12, 14–17. *Holcophylloceras costisparsum* Imlay, n. sp. (p. B32).

10. Paratype USNM 131337 from USGS Mesozoic loc. 24113.

11, 12. Paratype USNM 131336 from USGS Mesozoic loc. 24113.

14, 15. Paratype USNM 131339 from USGS Mesozoic loc. 2999.

16, 17. Holotype USNM 131335 from USGS Mesozoic loc. 24113.



MACROPHYLLOCERAS AND *HOLCOPHYLLOCERAS*

PLATE 2

[All figures natural size unless otherwise indicated]

FIGURES 1, 2. *Sonninia* cf. *S. nodata* Buckman (p. B33).

Figured specimen USNM 131345 from USGS Mesozoic loc. 24120.

3, 4. *Phylloceras* cf. *P. kunthi* Neumayr (p. B31).

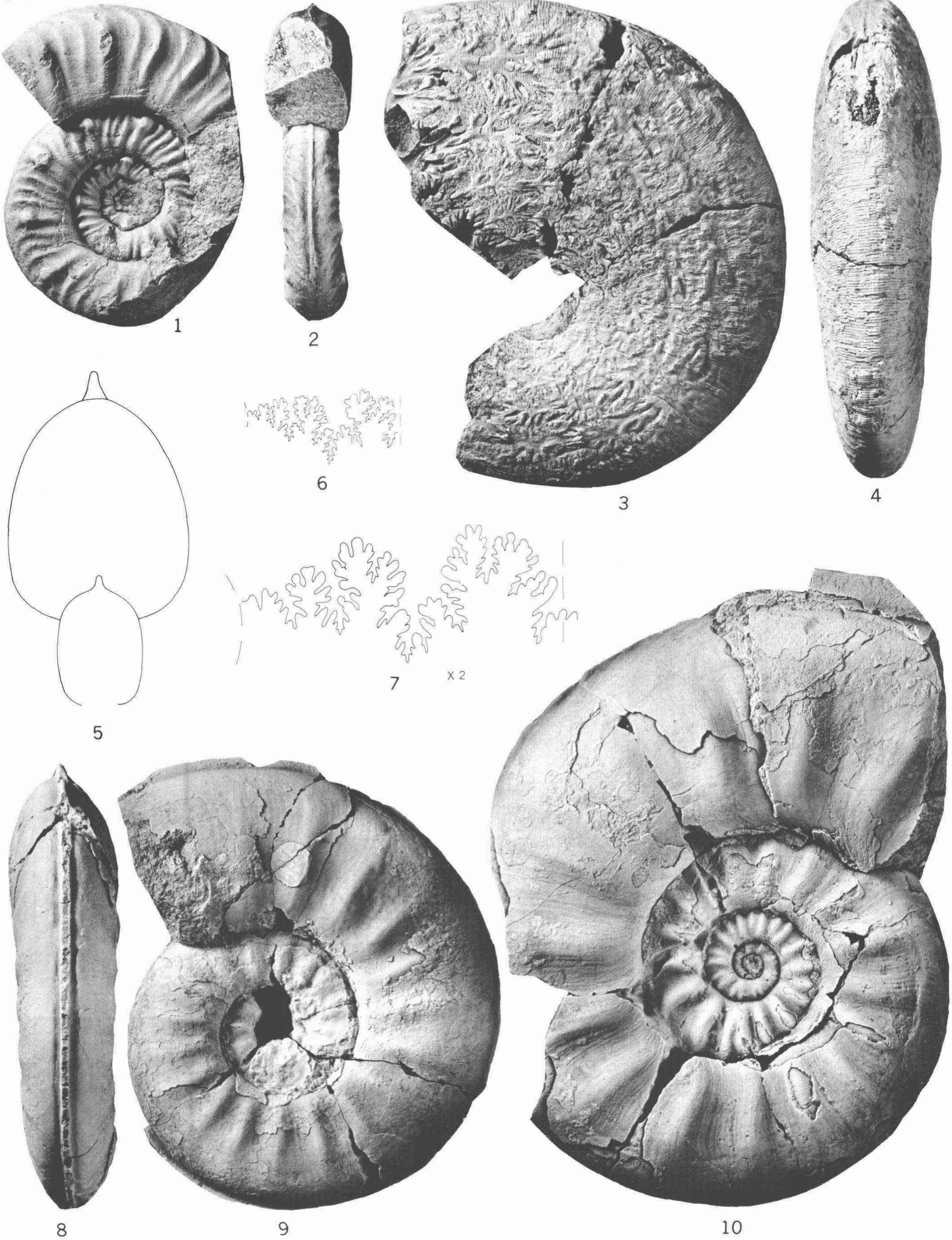
Figured specimen USNM 131326 from USGS Mesozoic loc. 24113.

5–10. *Sonninia tuxedniensis* Imlay, n. sp. (p. B32).

5, 6. Cross section and suture line of paratype USNM 131342 from USGS Mesozoic loc. 2999. Suture line drawn at diameter of 60 mm and whorl height of 23 mm.

7, 10. Suture line (× 2) and lateral view of holotype USNM 131340 from USGS Mesozoic loc. 21266. About one-third of largest whorl represents body chamber.

8, 9. Paratype USNM 131341 from USGS Mesozoic loc. 2999.



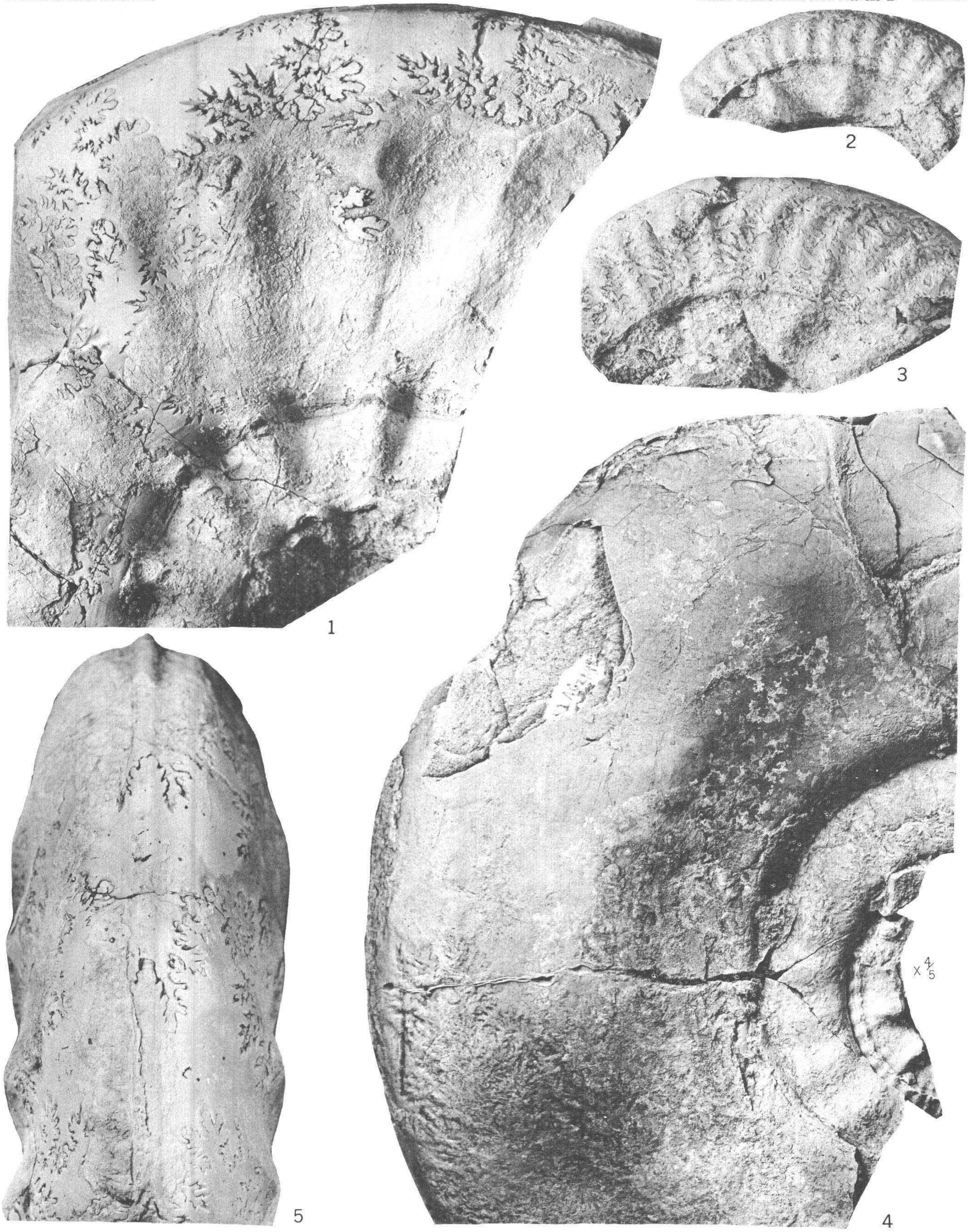
SONNINIA AND *PHYLLOCERAS*

PLATE 3

[All figures natural size unless otherwise indicated]

FIGURES 1, 5. *Sonninia* cf. *S. projectifer* (Buckman) (p. B33).
Lateral and ventral views of figured specimen, USNM 131344 from USGS Mesozoic loc. 24113.

2–4. *Sonninia* cf. *S. patella* Waagen (p. B33).
Lateral views of parts of two inner whorls and of part of large whorl (× 4/5) of figured specimen, USNM 131346 from USGS Mesozoic loc. 24120. The inner whorl shown in fig. 2 is illustrated also in fig. 4.



SONNINIA

713-993 O - 64 - 4

PLATE 4

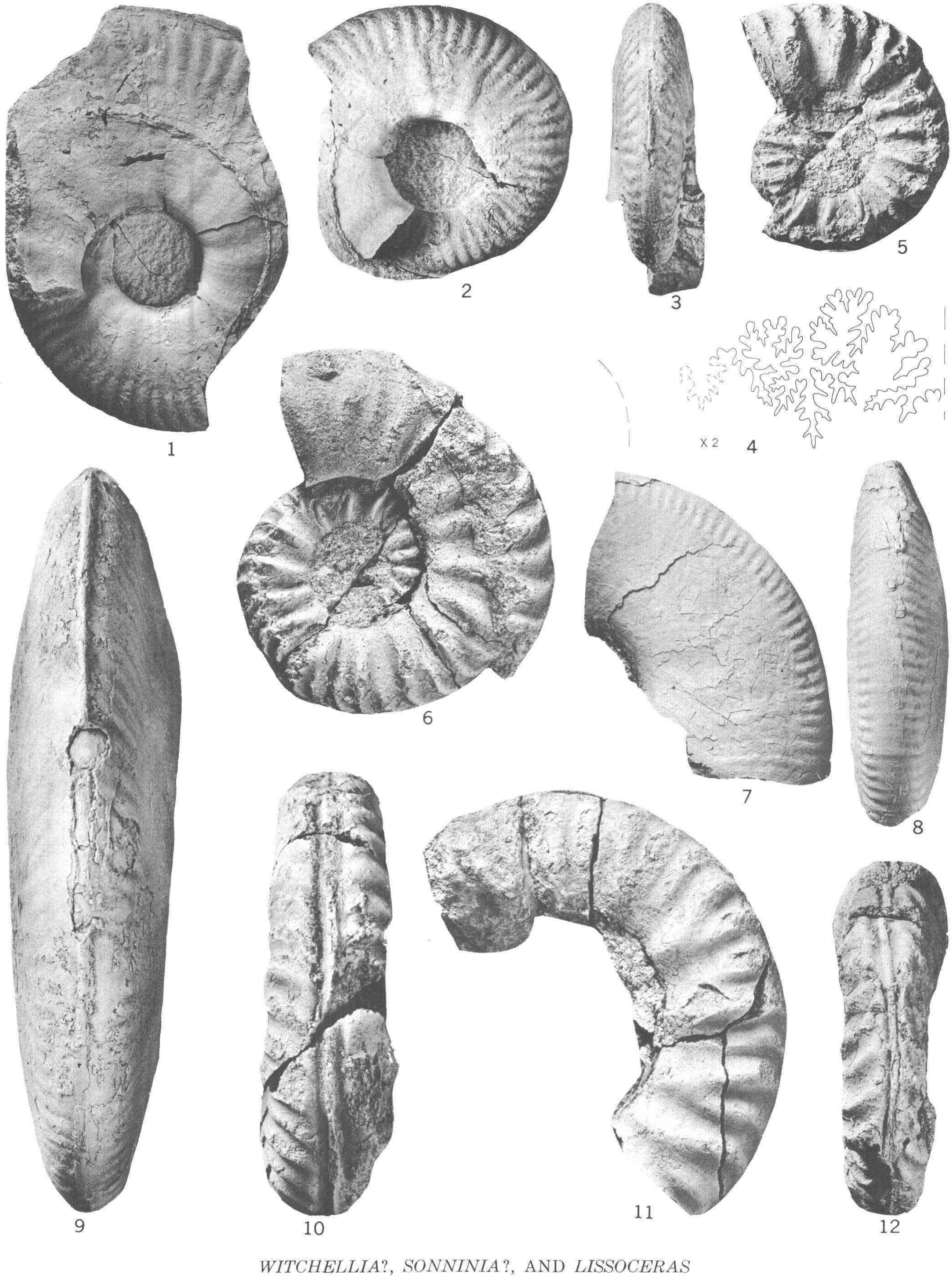
[All figures natural size unless otherwise indicated]

FIGURES 1–4. *Witchellia*? aff. W.? *aguilonia* Imlay, n. sp. (p. B36).
Lateral and ventral views and suture line (× 2) of figured specimen USNM 131357 from USGS Mesozoic loc. 24113. Note faint spiral markings shown in fig. 1.

5, 6, 10–12. *Sonninia*? n. sp. undet. (p. B33).
5, 6, 12. Lateral and ventral views of specimen USNM 131348 from USGS Mesozoic loc. 26723.
10, 11. Ventral and lateral views of specimen USNM 131347 from USGS Mesozoic loc. 21293. In both views the adoral end is pointed downward.

7, 8. *Lissoceras* cf. *L. semicostulatum* (Buckman (p. B38).
Figured specimen USNM 131362 from USGS Mesozoic loc. 21268.

9. *Witchellia*? *aguilonia* Imlay, n. sp. (p. B35).
Ventral view of holotype USNM 131355 from USGS Mesozoic loc. 24113. Note lateral view on pl. 5, fig. 9.



WITCHELLIA?, *SONNINIA*?, AND *LISSOCERAS*

PLATE 5

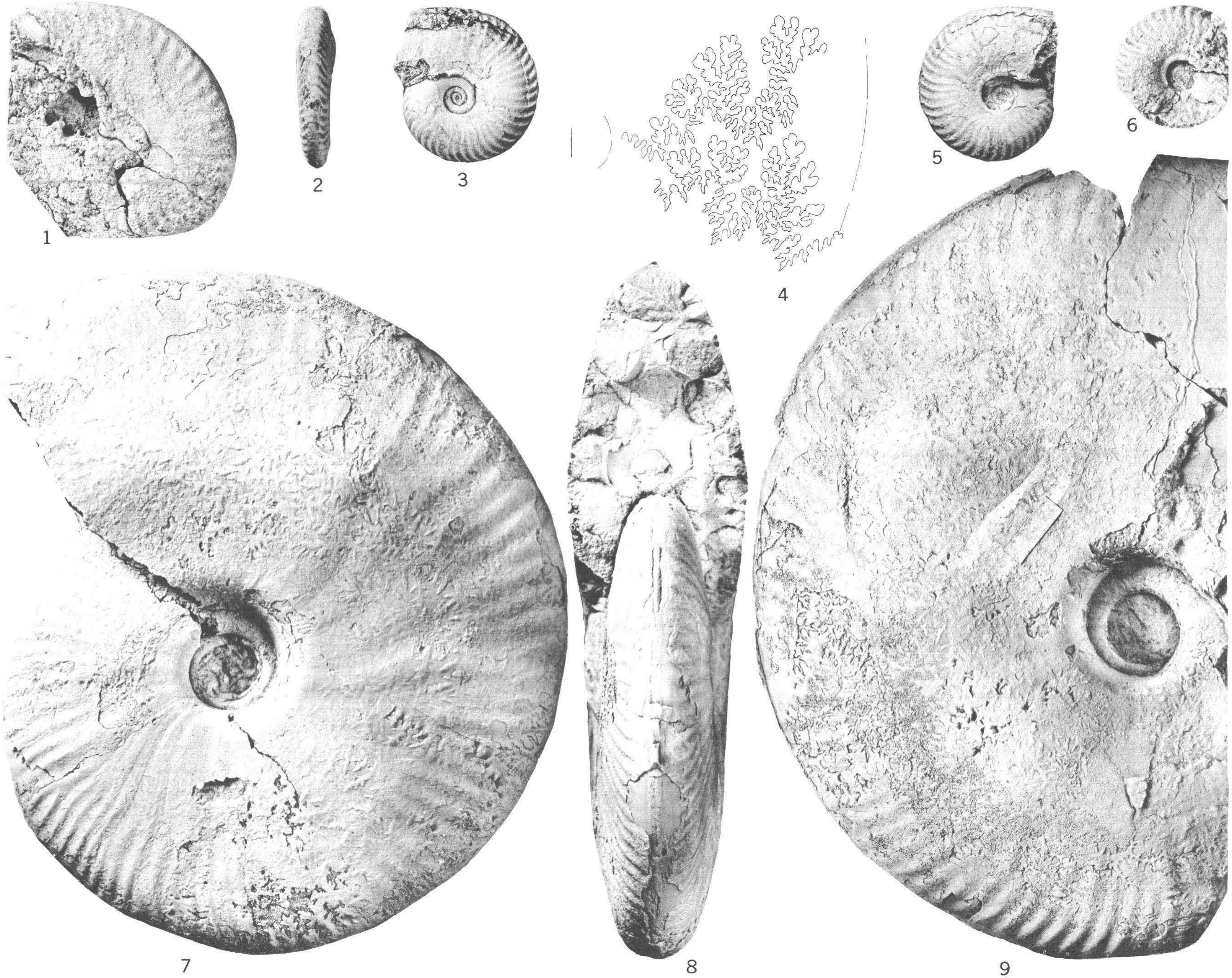
[All figures natural size]

FIGURES 1–3, 5, 6. *Bradfordia*? *caribouensis* Imlay, n. sp. (p. B39).

1. Lateral view of paratype USNM 131378 from USGS Mesozoic loc. 26601.
2, 3, 5. Holotype USNM 131376 from USGS Mesozoic loc. 3696.
6. Paratype USNM 131379 from USGS Mesozoic loc. 26601.

4, 7–9. *Witchellia*? *aguilonia* Imlay, n. sp. (p. B35).

4. Suture line from paratype USNM 131356 from USGS Mesozoic loc. 21258, drawn at diameter of about 94 mm.
7, 8. Paratype UCLA paleont. cat. 34975 from same place as USGS Mesozoic loc. 24113.
9. Holotype USNM 131355 from USGS Mesozoic loc. 24113. Note ventral view on pl. 4, fig. 9.



WITCHELLIA AND *BRADFORDIA*?

PLATE 6

[All figures natural size unless otherwise indicated]

FIGURE 1–3. *Sonninia* (*Papilliceras*) cf. *S. arenata* (Quenstedt) (p. B34).

1. Lateral view of a part of body chamber, USNM 131349 from USGS Mesozoic loc. 22723.

2, 3. Inner whorls of a larger immature specimen, USNM 131350 from USGS Mesozoic loc. 21262.

4, 5, 11. *Pelekodites*? sp. (p. B36).

4. Lateral view of adult bearing a lateral lappet, USNM 131358 from USGS Mesozoic loc. 26596.

5. Lateral view of rubber cast made from external mold of same specimen shown in fig. 4.

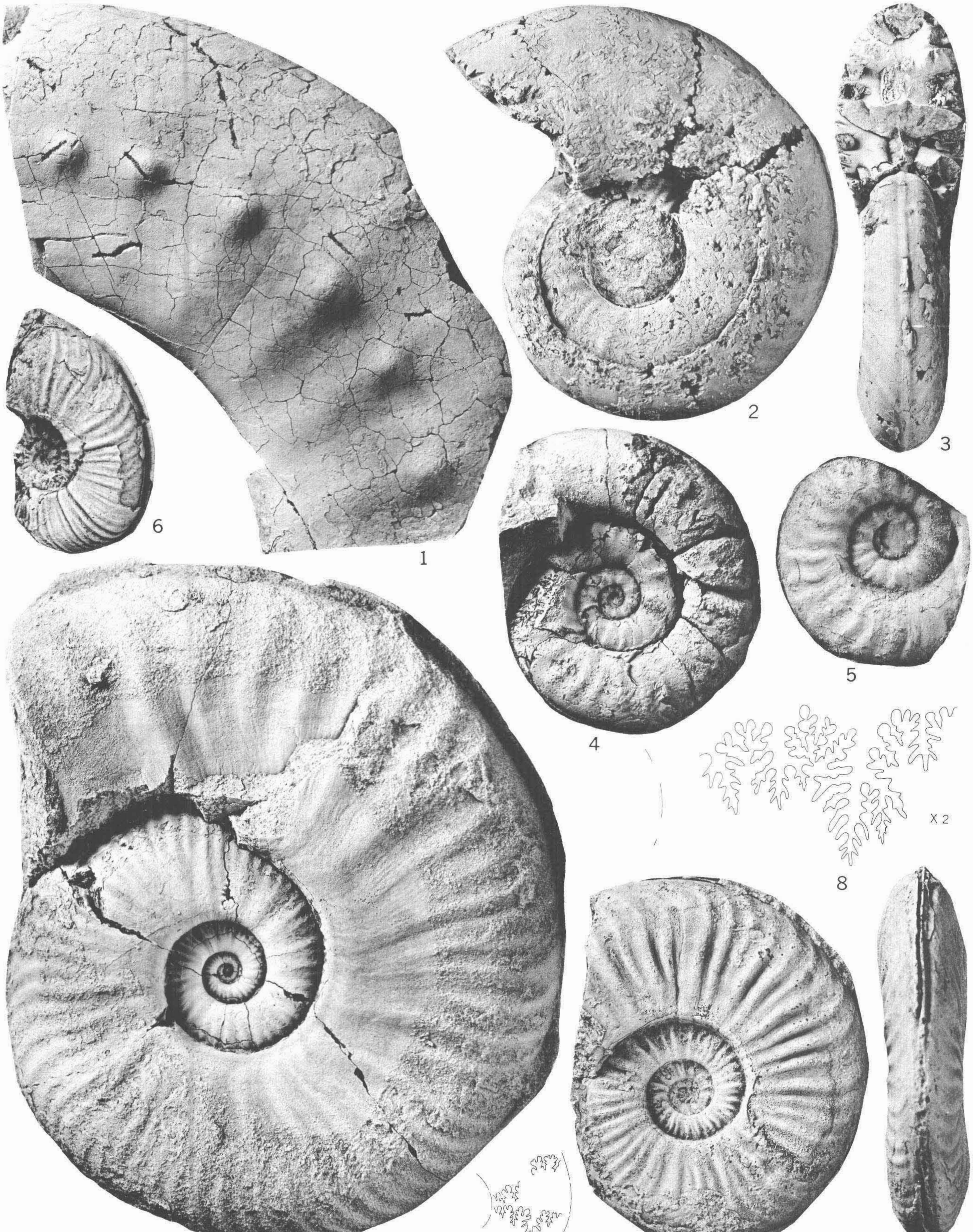
11. Suture line near adoral end of outermost septate whorl of same specimen shown in figs. 4 and 5.

6–10. *Witchellia adnata* Imlay, n. sp. (p. B34).

6. Paratype USNM 131353 from USGS Mesozoic loc. 3010.

7, 8. Lateral view and suture line (× 2) of holotype USNM 131351 from USGS Mesozoic loc. 19956. Suture line drawn at whorl height of 28 mm near adoral end of outermost septate whorl.

9, 10. Paratype USNM 131352 from USGS Mesozoic loc. 20756.



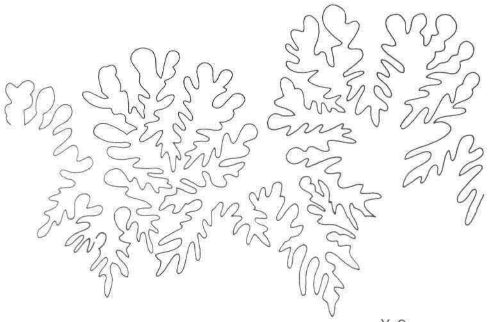
SONNINIA, PELEKODITES?, AND *WITCHELLIA*

PLATE 7

[Fig. 2 is × 2. Figs. 4 and 5 are slighty reduced]

FIGURES 1–5. *Witchellia* cf. *W. laeviuscula* (J. de C. Sowerby) (p. B35).
Specimen, USNM 131354 from USGS Mesozoic loc. 24120. Fig. 1 shows inner whorls. Suture line (× 2) drawn at whorl height of 43 mm. Cross section drawn at diameter of 165 mm near adoral end of largest preserved whorl.

1



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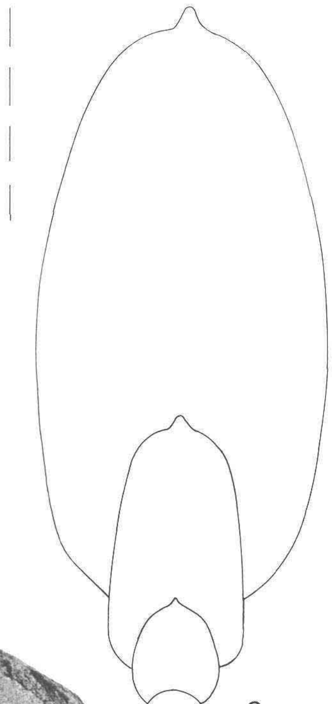

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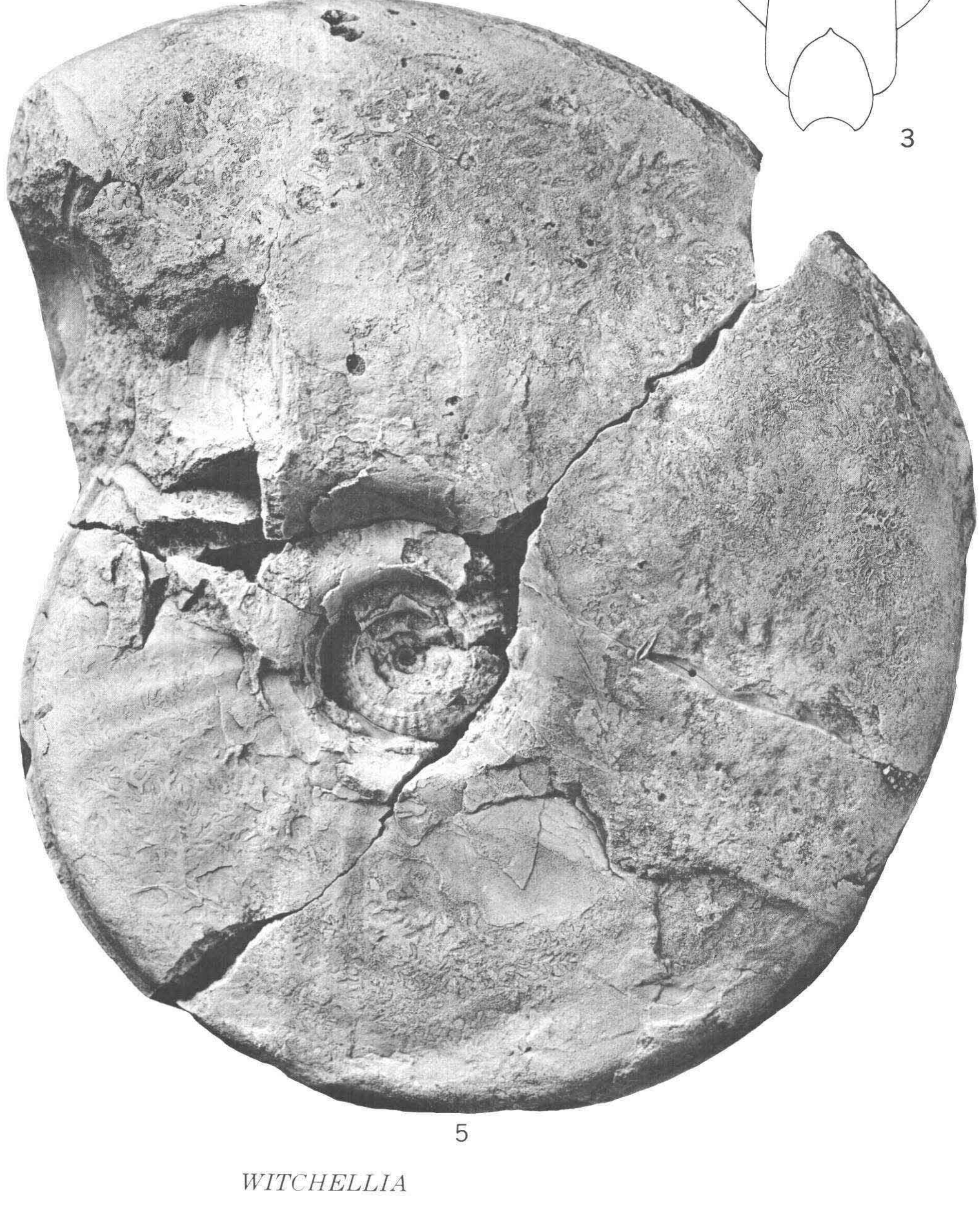


5

WITCHELLIA

PLATE 8

[All figures natural size unless otherwise indicated]

FIGURES 1–10. *Bradfordia Costidensa* Imlay, n. sp. (p. B39).

1, 2. Paratype USNM 131372 from USGS Mesozoic loc. 24113.

3–5. Holotype USNM 131369 from USGS Mesozoic loc. 24113. Shows nearly complete body chamber.

6. Paratype USNM 131371 from USGS Mesozoic loc. 24113.

7. Paratype USNM 131374 from USGS Mesozoic loc. 24113.

8. Paratype USNM 131373 from USGS Mesozoic loc. 24113.

9. Paratype USNM 131375 from USGS Mesozoic loc. 24113.

10. Paratype USNM 131370 from USGS Mesozoic loc. 24113. Suture line ($\times$ 2) drawn at whorl height of 24.5 mm.

11–18. *Oppelia (Oppelia) stantoni* Imlay, n. sp. (p. B38).

11, 17. Suture line and lateral view of paratype USNM 131365 from USGS Mesozoic loc. 3000. Suture line drawn at whorl height of 28 mm.

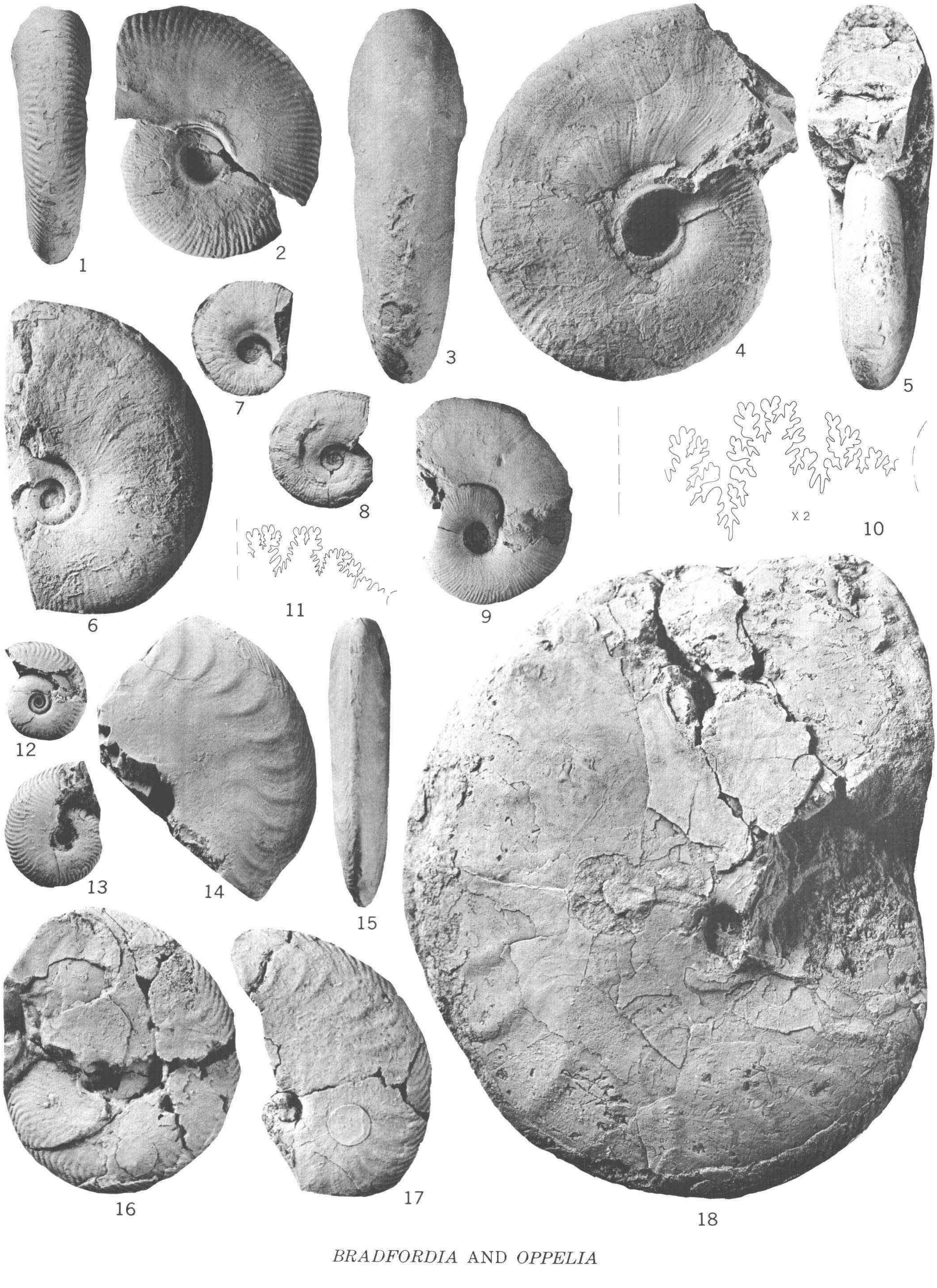
12. Lateral view of immature specimen, paratype USNM 131367 from USGS Mesozoic loc. 3000.

13. Lateral view of immature specimen, paratype USNM 131366 from USGS Mesozoic loc. 3000.

14, 15. Lateral and ventral views. Holotype USNM 131363 from USGS Mesozoic loc. 3000.

16. Paratype USNM 131364 from USGS Mesozoic loc. 3000.

18. Paratype USNM 131368 from USGS Mesozoic loc. 22721. Note specimen is entirely septate.

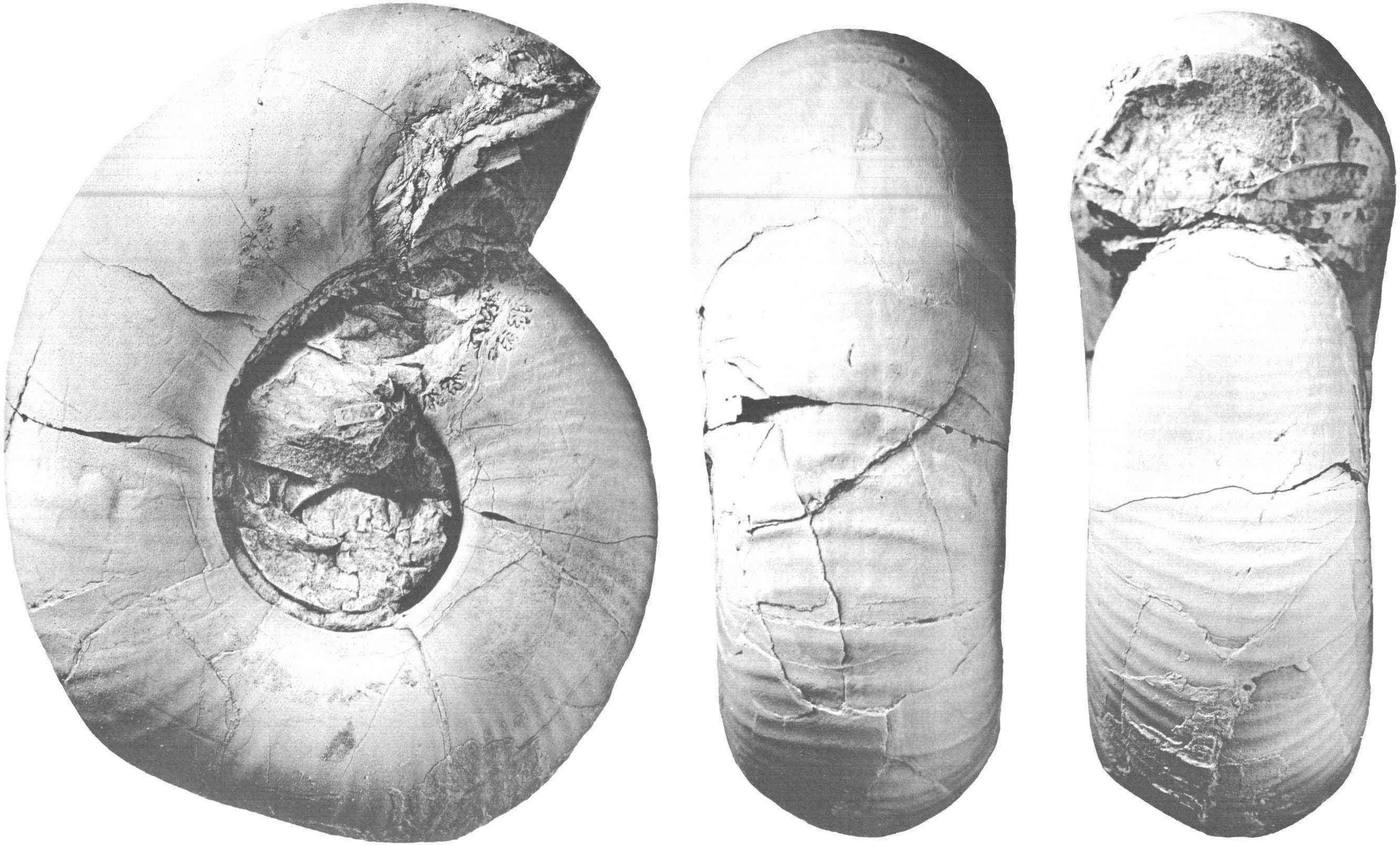


BRADFORDIA AND *OPPELIA*

PLATE 9

[All figures natural size]

FIGURES 1–3. *Labyrinthoceras glabrum* Imlay, n. sp. (p. B41).
Paratype USNM 131390 from USGS Mesozoic loc. 25942. Shows complete adult whorl.



1 2 3

LABYRINTHOCERAS

PLATE 10

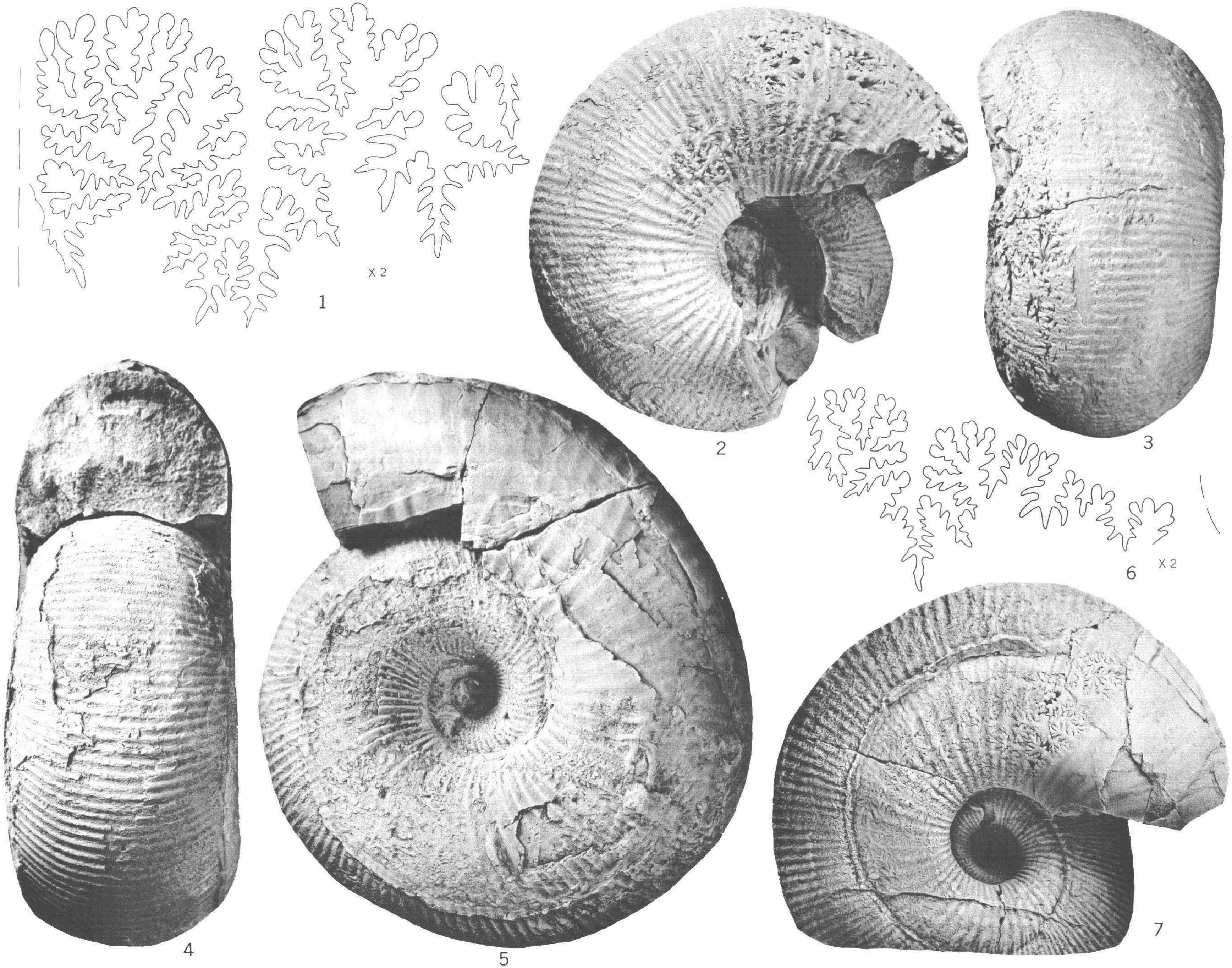
[All figures natural size unless otherwise indicated]

FIGURES 1–7. *Labyrinthoceras glabrum* Imlay, n. sp. (p. B41).

1–3. Paratype USNM 131391 from USGS Mesozoic loc. 24215. Suture line drawn at whorl height of 38 mm and diameter of 84 mm.

4, 5. Holotype USNM 131389 from USGS Mesozoic loc. 24215. Note trace of umbilical seam of contracting body chamber.

6, 7. Last suture line and lateral view of paratype USNM 131392 from USGS Mesozoic loc. 24215.



LABYRINTHOCERAS

PLATE 11

[All figures natural size]

FIGURES 1–8. *Emileia constricta* Imlay, n. sp. (p. B40).

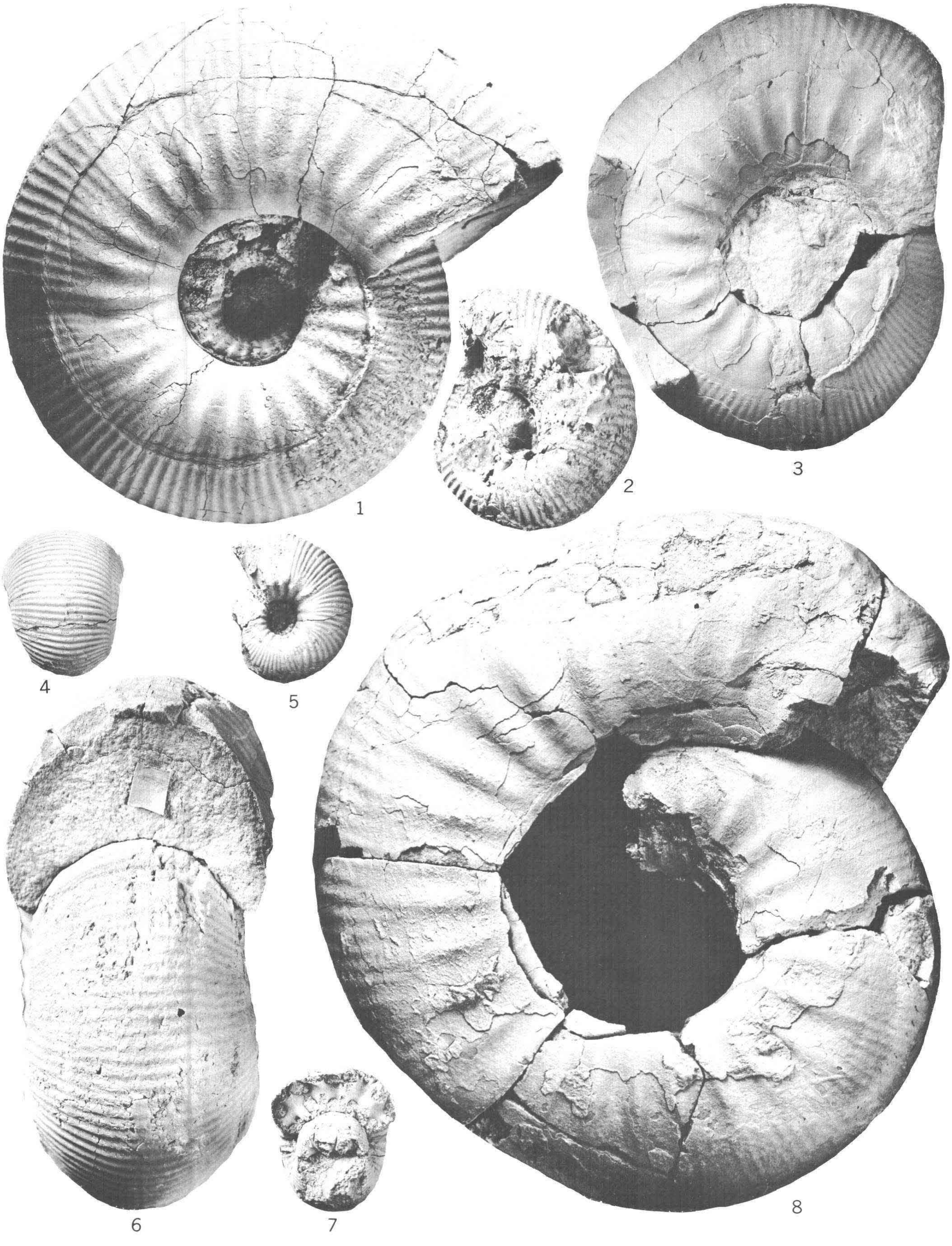
1, 6. Holotype USNM 131384 from USGS Mesozoic loc. 3009.

2. Paratype USNM 131387 from USGS Mesozoic loc. 21268.

3. Paratype USNM 131386 from USGS Mesozoic loc. 3009.

4, 5, 7. Paratype USNM 131388 from USGS Mesozoic loc. 21262.

8. Complete body chamber of paratype USNM 131385 from USGS Mesozoic loc. 3009.



EMILEIA

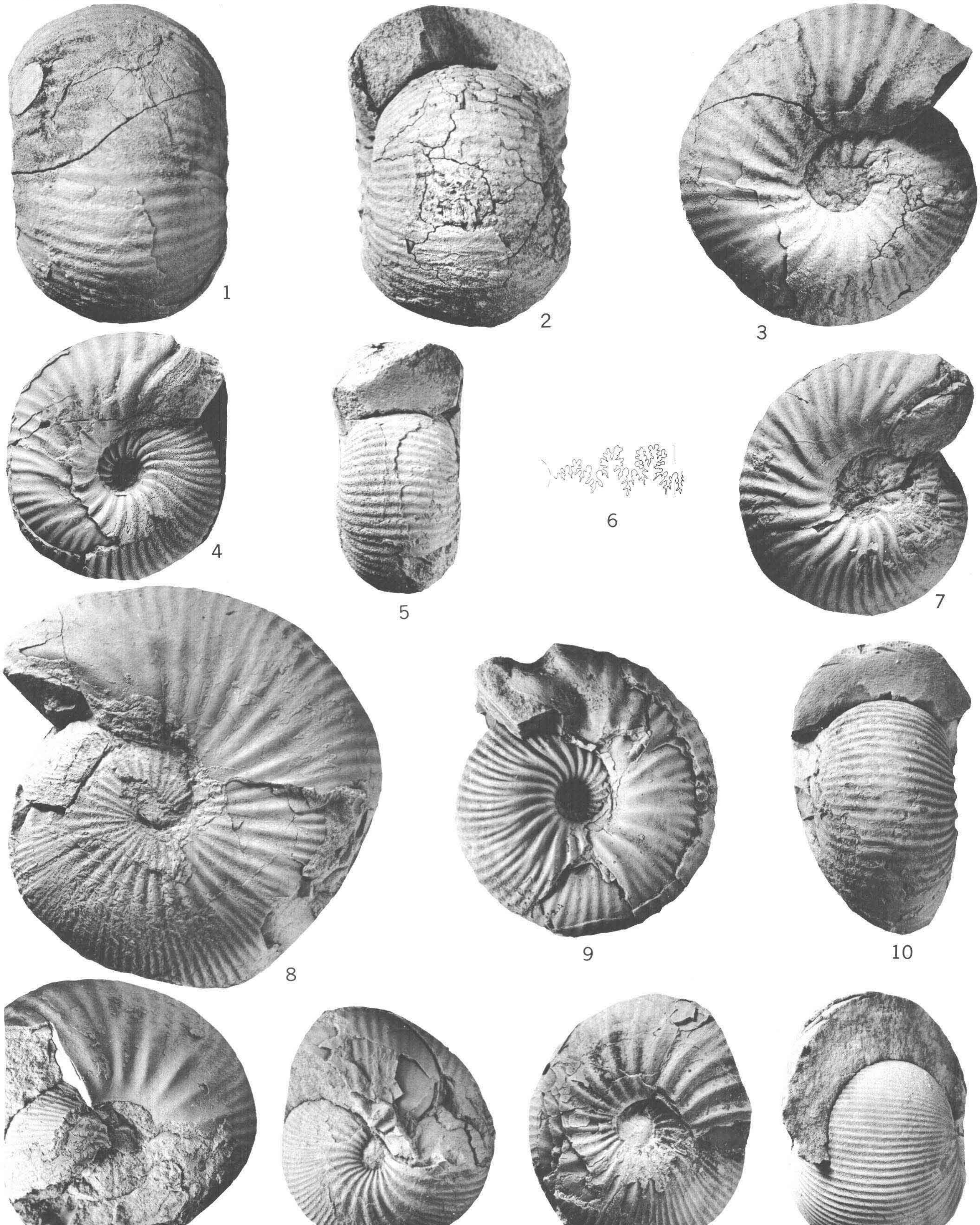
PLATE 12

[All figures natural size]

FIGURES 1–3. *Chondroceras* cf. *C. marshalli* (McLearn) (p. B43).
Figured specimen USNM 131400 from USGS Mesozoic loc. 8567.

4–7, 9, 10. *Chondroceras allani* (McLearn) (p. B42).
4, 5. Plesiotype USNM 131399 from USGS Mesozoic loc. 21768.
6. Plesiotype USNM 131397 from USGS Mesozoic loc. 21317. Suture line drawn at whorl height of 14 mm near adoral end of last septate whorl.
7. Plesiotype USNM 131398 from USGS Mesozoic loc. 21768.
9, 10. Plesiotype USNM 131396 from USGS Mesozoic loc. 19981.

8, 11–14. *Chondroceras defontii* (McLearn) (p. B42).
8. Adult showing complete body chamber, plesiotype USNM 131393 from USGS Mesozoic loc. 10516.
11. Plesiotype USNM 131394 from USGS Mesozoic loc. 22707. Part of body chamber removed to show fine ribbing on penultimate whorl.
12–14. Plesiotype USNM 131395 from USGS Mesozoic loc. 21270. Lateral views show marked coarsening of ribbing at adapical end of body chamber.



CHONDROCERAS

PLATE 13

[All figures natural size unless otherwise indicated]

FIGURES 1–8, 10, 11, 17. *Normannites kialagvikensis* Imlay, n. sp. (p. B43).

1–3. Paratype USNM 131403 from USGS Mesozoic loc. 3010.

4, 5. Paratype USNM 131404 from USGS Mesozoic loc. 19773.

6–8, 10. Holotype USNM 131401 from USGS Mesozoic loc. 19773. Suture line drawn near adoral end of outermost septate whorl.

11. Paratype USNM 131402 from USGS Mesozoic loc. 3010.

17. Paratype USNM 131451 from USGS Mesozoic loc. 3010.

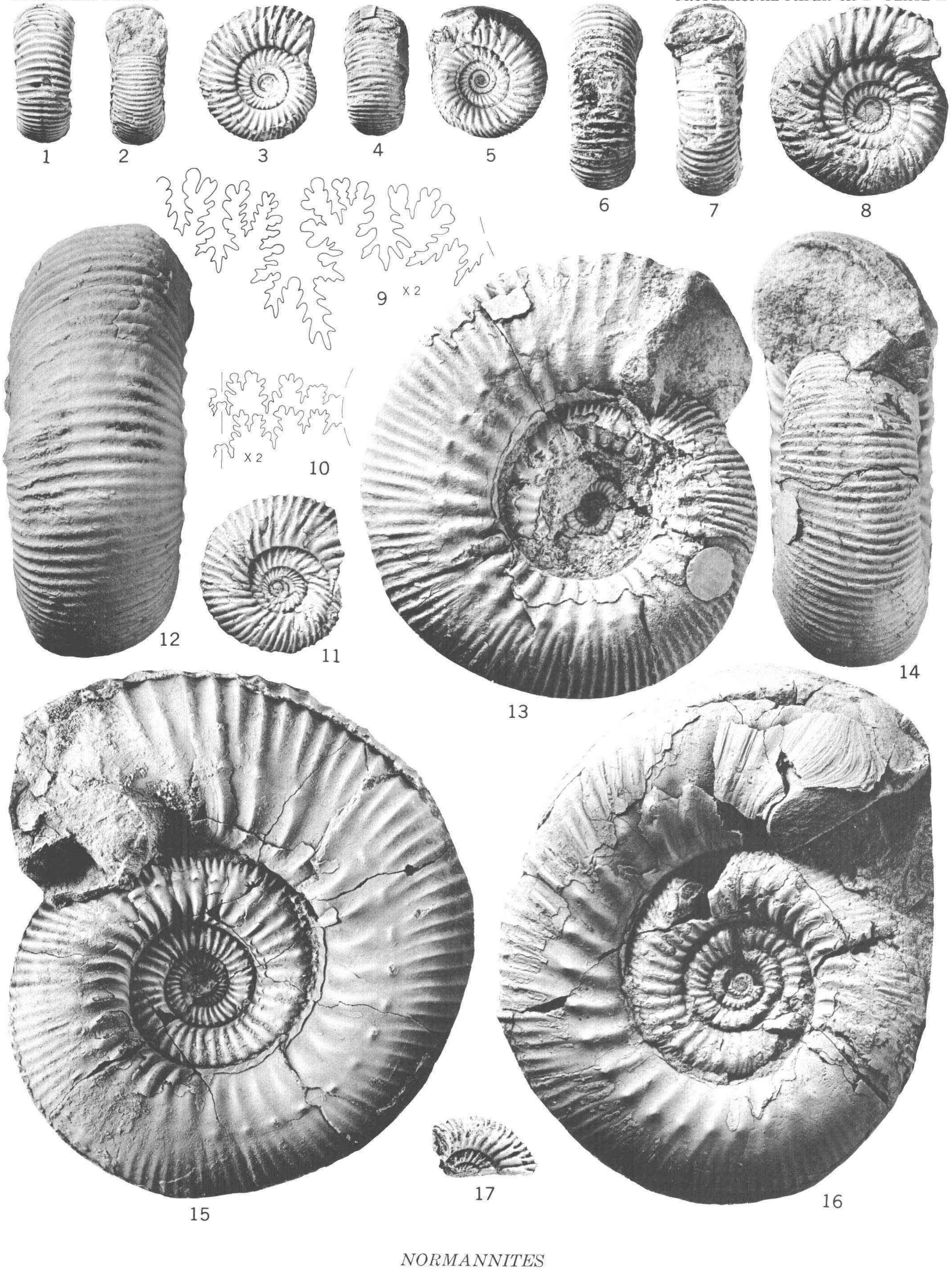
9, 12–16. *Normannites* (*Itinsaites*?) *variabilis* Imlay, n. sp. (p. B44).

9. Suture line (× 2) of paratype USNM 131409 from USGS Mesozoic loc. 19941. Suture line drawn at adoral end of outermost septate whorl.

12–14. Paratype USNM 131411 from USGS Mesozoic loc. 8567.

15. Holotype USNM 131408 from USGS Mesozoic loc. 20002.

16. Paratype USNM 131412 from USGS Mesozoic loc. 19940.



NORMANNITES

PLATE 14

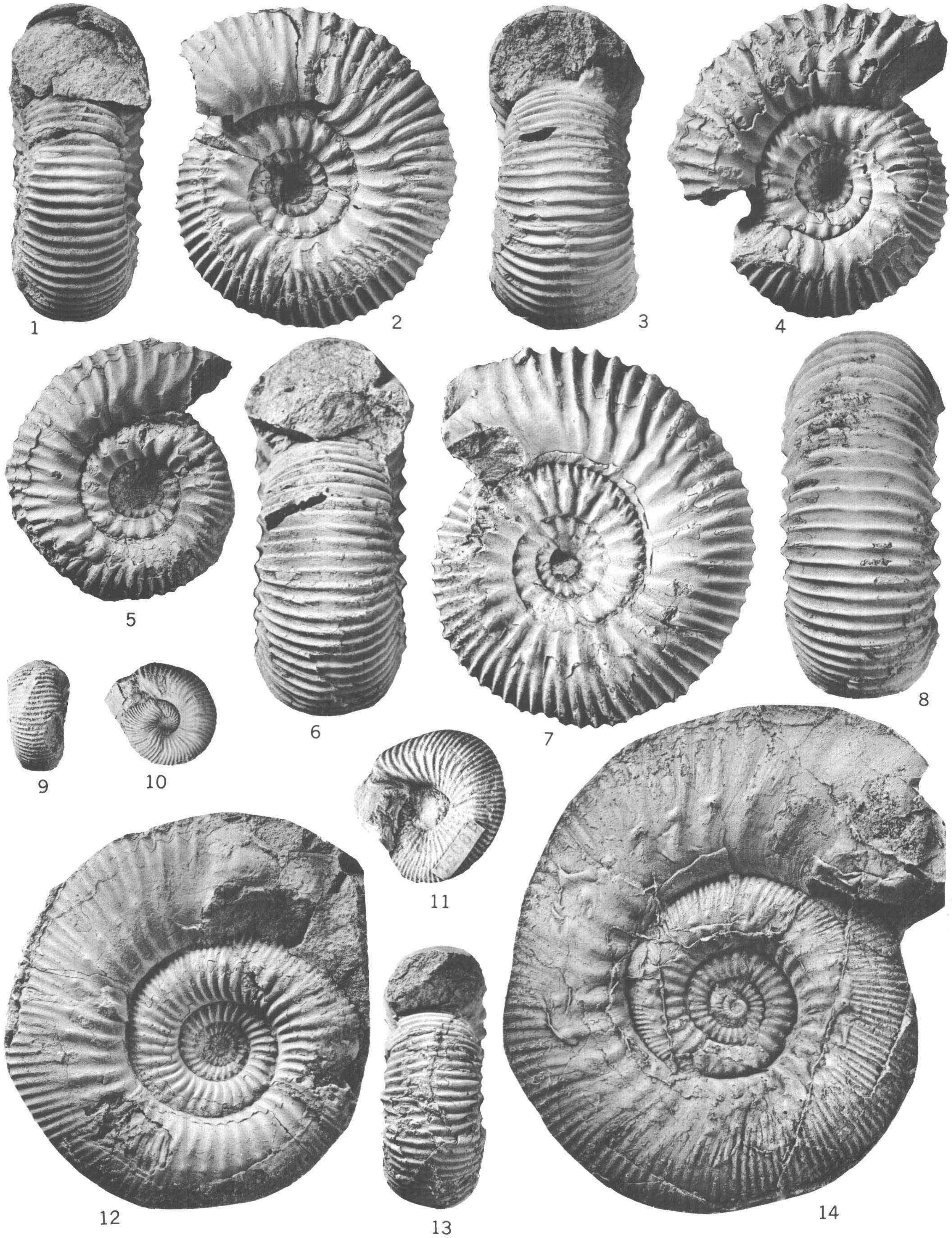
[All figures natural size]

FIGURES 1, 2. *Normannites (Itinsaites) itinsae* (McLearn) (p. B44).
Plesiotype USNM 131407 from USGS Mesozoic loc. 26599.

3–8, 13. *Normannites (Itinsaites) crickmayi* (McLearn) (p. B43).
3, 4. Plesiotype USNM 131406 from USGS Mesozoic loc. 21270.
5, 13. Plesiotype USNM 131452 from USGS Mesozoic loc. 21270.
6–8. Plesiotype USNM 131405 from USGS Mesozoic loc. 21270.

9–11. *Otoites? filicostatus* Imlay, n. sp. (p. B40).
9, 10. Holotype USNM 131382 from USGS Mesozoic loc. 3010.
11. Paratype USNM 131383 from USGS Mesozoic loc. 19951.

12, 14. *Normannites (Itinsaites?) variabilis* Imlay, n. sp. (p. B44).
12. Paratype USNM 131410 from USGS Mesozoic loc. 21303.
14. Paratype USNM 131409 from USGS Mesozoic loc. 19941. Photograph made from rubber cast of external mold. Suture line of same specimen shown on pl. 13, fig. 9.



NORMANNITES (*ITINSAITES*) AND *OTOITES*?

PLATE 15

[All figures natural size]

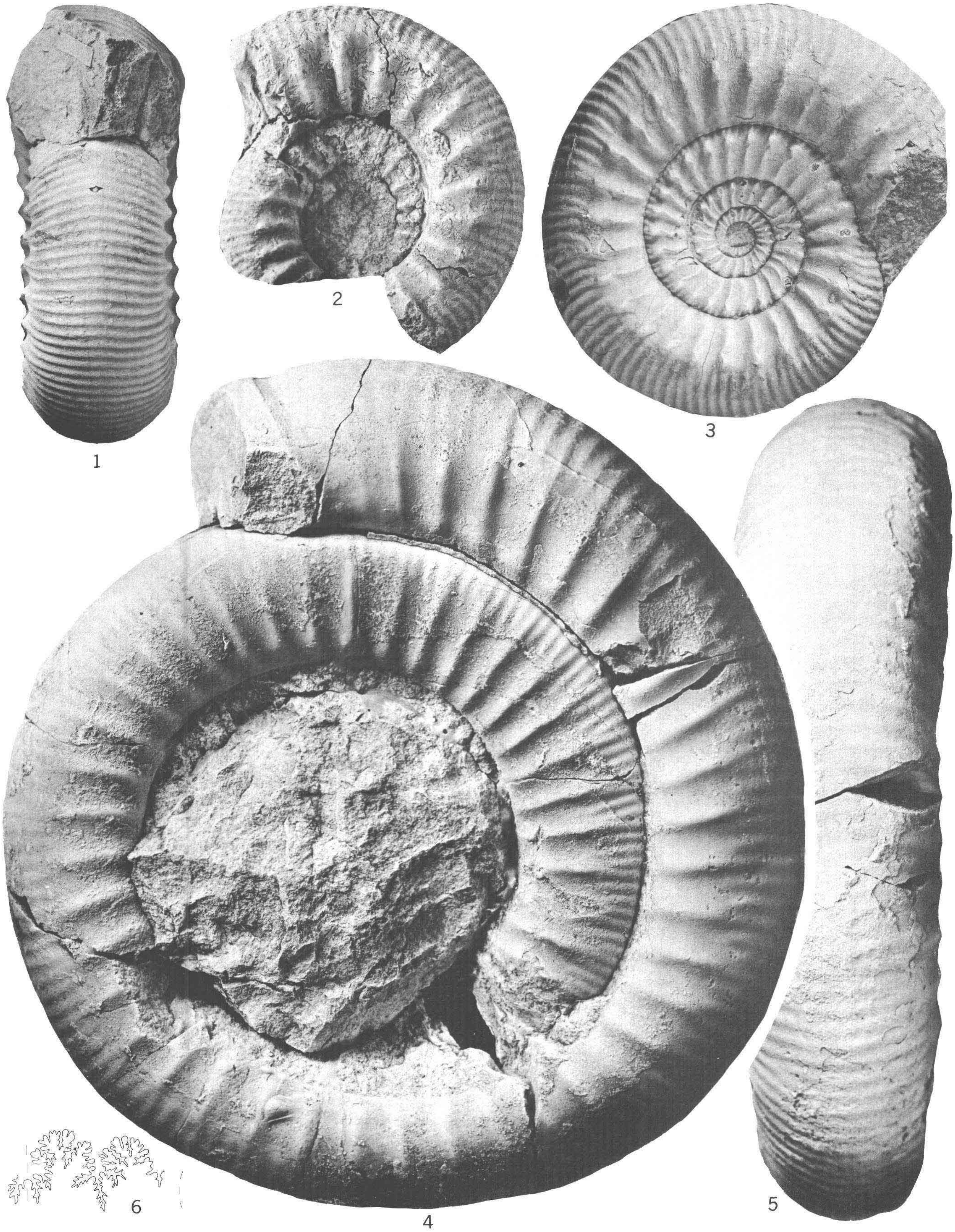
FIGURES 1, 3, 4–6. *Stephanoceras* (*Skirroceras*) *nelchinanum* Imlay, n. sp. (p. B46).

1, 3. Inner septate whorls of holotype USNM 131417 from USGS Mesozoic loc. 24113. Outer whorl shown on pl. 16, fig. 2.

4, 5. Adult body chamber of paratype, USNM 131419 from USGS Mesozoic loc. 8585.

6. Suture line of paratype, USNM 131418 from USGS Mesozoic loc. 24113. Suture line drawn at whorl height of 19 mm and diameter of 79 mm.

2. *Stephanoceras* (*Skirroceras*) cf. *S. nelchinanum* Imlay, n. sp. (p. B47). Figured specimen USNM 131420 from USGS Mesozoic loc. 24113.



STEPHANOCERAS

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PLATE 16

[All figures natural size]

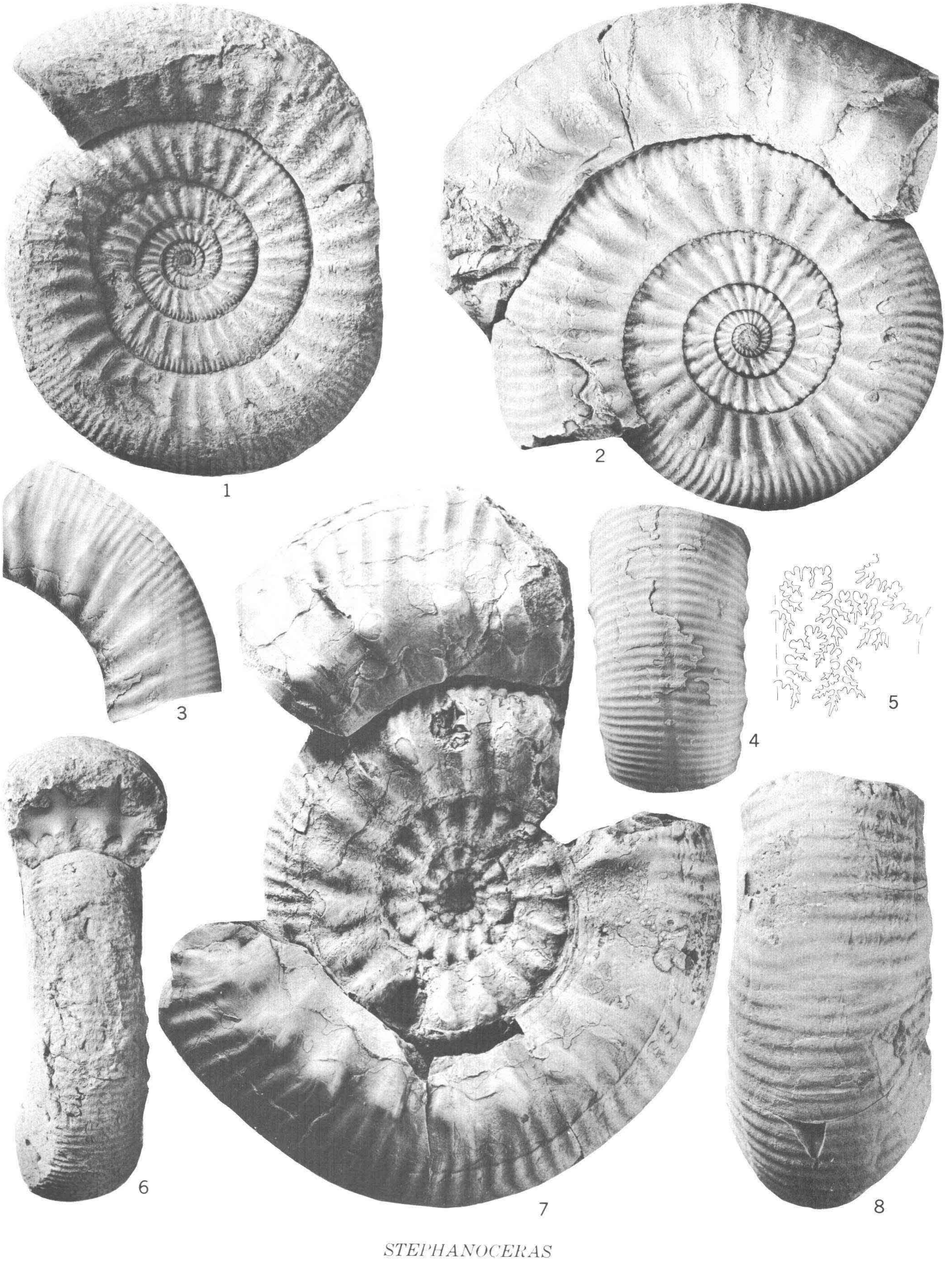
FIGURES 1, 3–6. *Stephanoceras* (*Skirroceras*) *juhlei* Imlay, n. sp. (p. B47).

1, 5, 6. Paratype USNM 131426 from USGS Mesozoic loc. 24120. Suture line drawn at whorl height of 18 mm and diameter of 76 mm.

3, 4. Lateral and ventral views of paratype USNM 131427 from USGS Mesozoic loc. 24113.

2. *Stephanoceras* (*Skirroceras*) *nelchinanum* Imlay, n. sp. (p. B46).
Holotype USNM 131417 from USGS Mesozoic loc. 24113. Inner septate whorls shown on pl. 15, figs. 1, 3.

7, 8. *Stephanoceras* cf. *S. nodosum* (Quenstedt) (p. B46).
Figured specimen USNM 131416 from USGS Mesozoic loc. 21269.

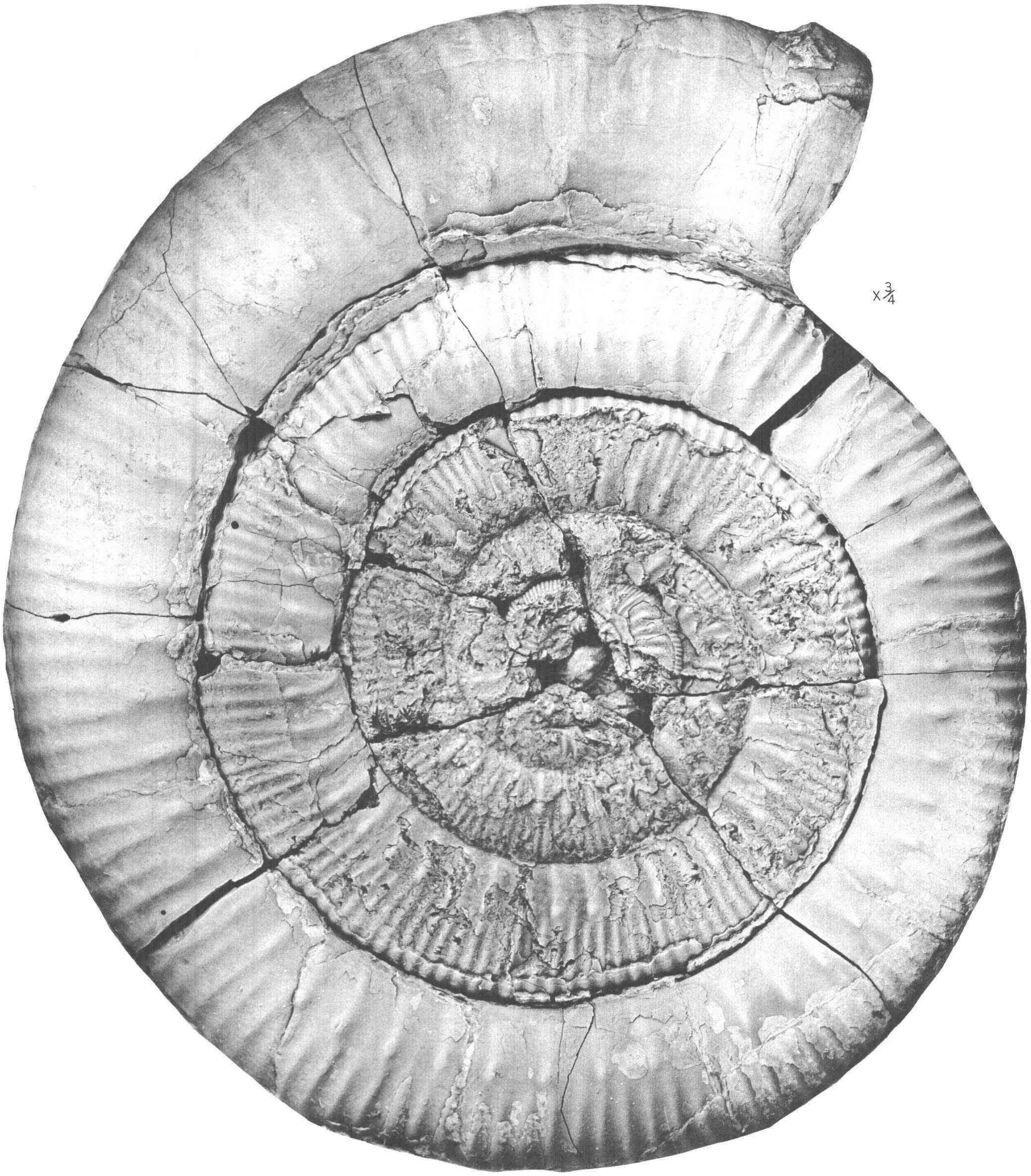


STEPHANOCERAS

PLATE 17

[Figure three-fourths natural size]

FIGURE 1. *Stephanoceras (Skirroceras) juhlei* Imlay, n. sp. (p. B47).
Lateral view of holotype ($\times$ 3/4) showing 1⅓ whorls of body chamber, USNM 131425 from USGS Mesozoic loc. 24333.



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STEPHANOCERAS

PLATE 18

[All figures natural size]

FIGURES 1–4. *Stephanoceras* (*Skirroceras*) *kirschneri* Imlay, n. sp. (p. B47).

1, 2. Small septate paratype, USNM 131424 from USGS Mesozoic loc. 2999.

3. Ventral view of inner whorls of paratype, USNM 131423 from USGS Mesozoic loc. 20756. Lateral view of same specimen shown on pl. 19, fig. 3.

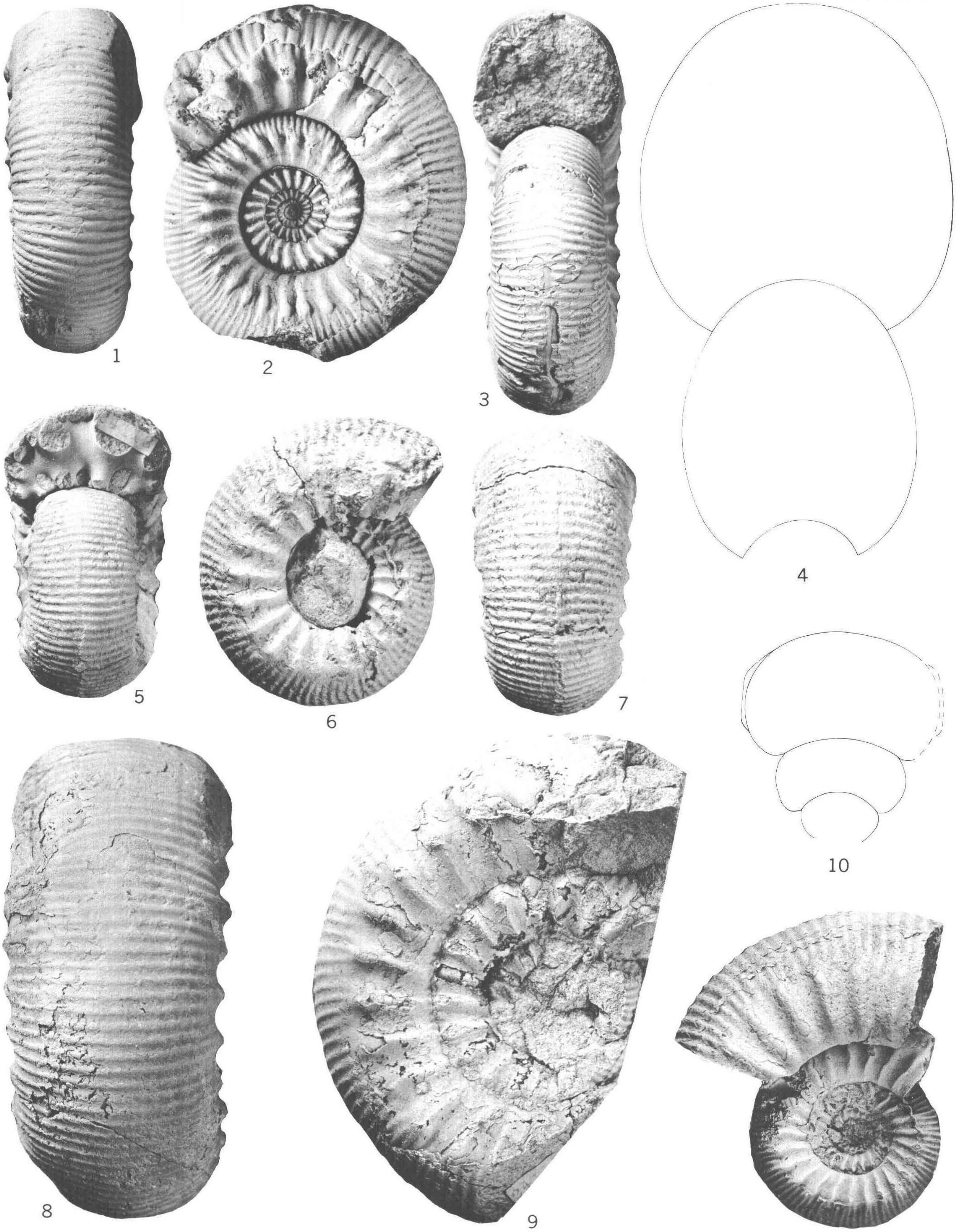
4. Cross section of two outer whorls at adapical and of adult body chamber of paratype, USNM 131422 from USGS Mesozoic loc. 3013.

5–11. *Stephanoceras obesum* Imlay, n. sp. (p. B45).

5–7. Small septate paratype, USNM 131414 from USGS Mesozoic loc. 24113.

8, 9. Septate holotype, USNM 131413 from USGS Mesozoic loc. 24113.

10, 11. Cross section and lateral view of paratype, USNM 131415 from USGS Mesozoic loc. 24113.



STEPHANOCERAS

PLATE 19

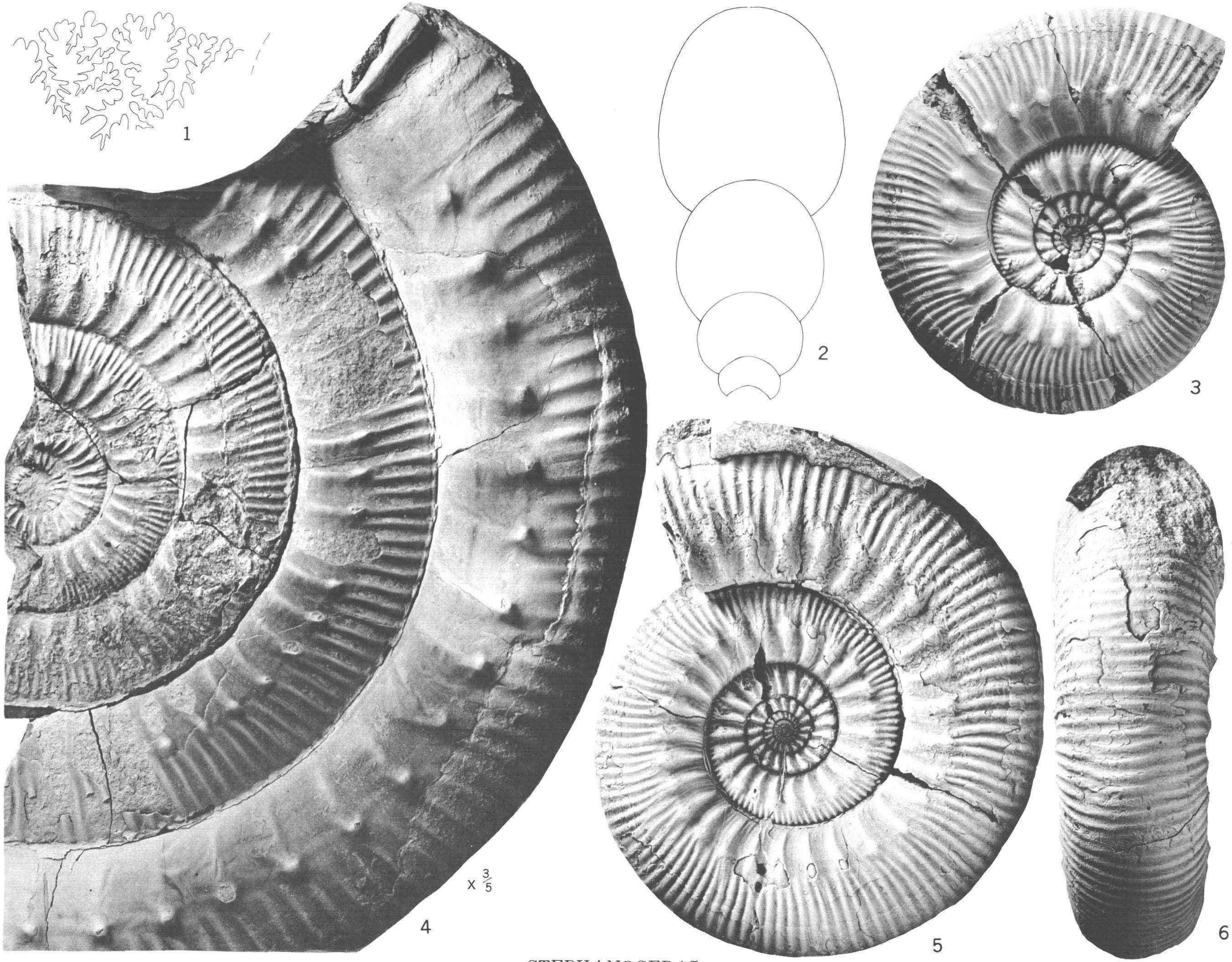
[All figures natural size unless otherwise indicated]

FIGURES 1–6. *Stephanoceras (Skirroceras) kirschneri* Imlay, n. sp. (p. B47).

1. Suture line drawn from adoral end of outermost septate whorl of paratype, USNM 131422 at USGS Mesozoic loc. 3013. Cross section of same specimen is shown on pl. 18, fig. 4.

2, 3, 5, 6. Cross section, lateral and ventral views of inner whorls of paratype, USNM 131423 from USGS Mesozoic loc. 20756.

4. Large adult reduced to three-fifths natural size showing adult body chamber and aperture. Holotype, USNM 131421 from USGS Mesozoic loc. 21274.



STEPHANOCERAS

PLATE 20

[All figures natural size]

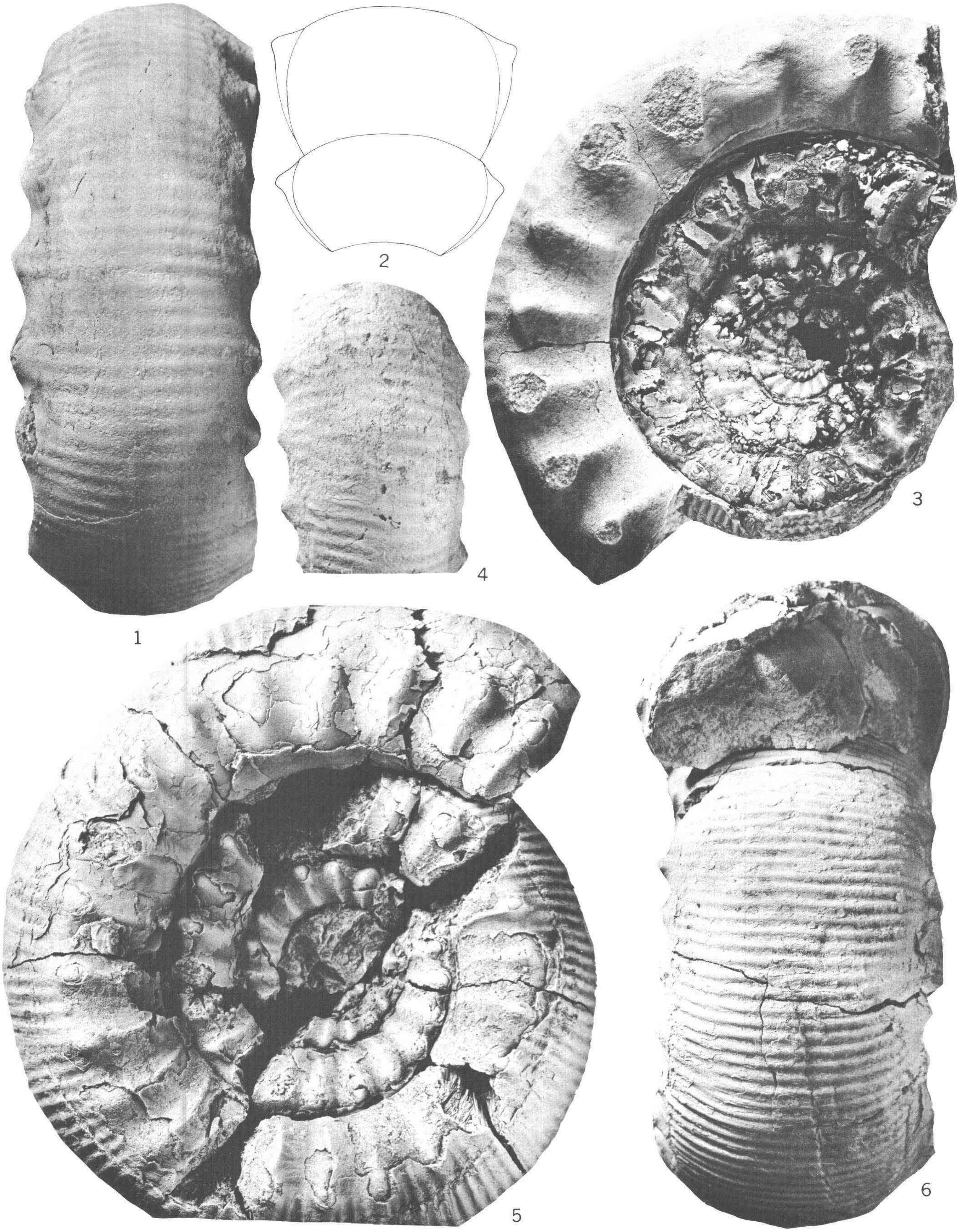
FIGURES 1–4. *Stemmatoceras* n. sp. undet. (p. B48).

1–3. Ventral, cross sectional, and lateral views of specimen USNM 131428 from USGS Mesozoic loc. 21263.

4. Ventral view of specimen USNM 131429 from USGS Mesozoic loc. 21296

5, 6. *Stemmatoceras* cf. *S. palliseri* (McLearn) (p. B48).

Inner septate whorls and adapical end of adult body chamber of specimen USNM 131430 from USGS Mesozoic loc. 21270. Body whorl of same specimen is shown on pl. 21, fig. 4.



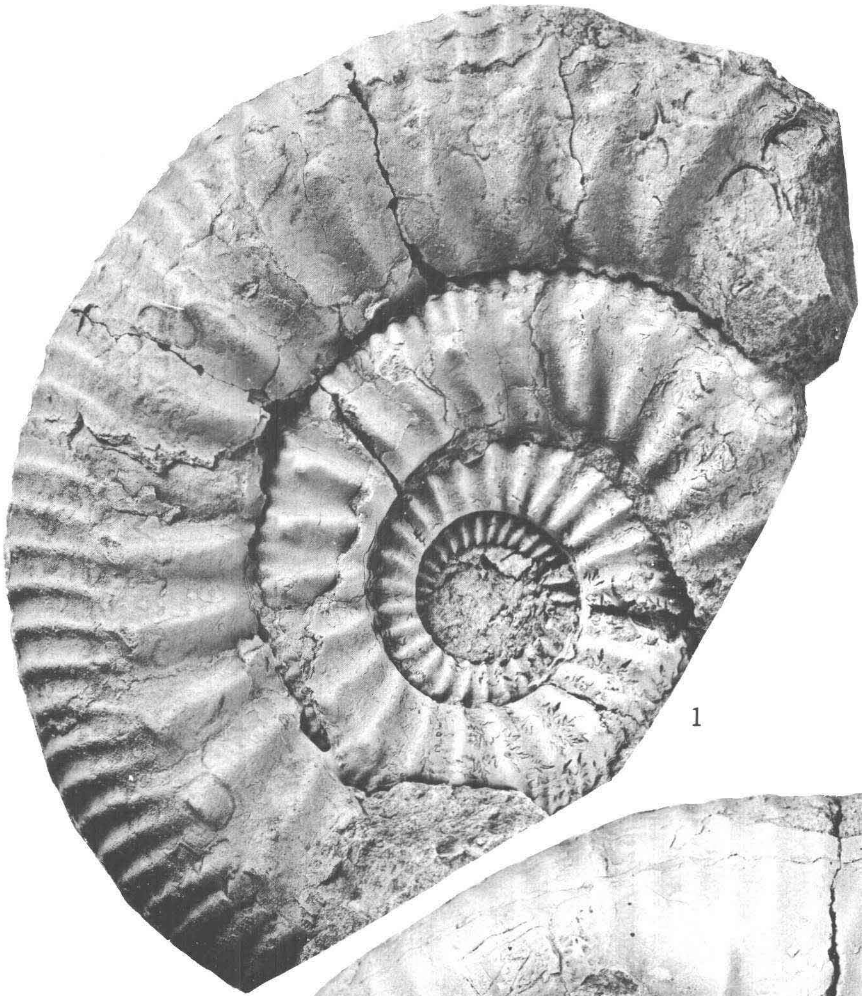
STEMMATOCERAS

PLATE 21

[All figures natural size]

FIGURES 1, 3. *Stemmatoceras* cf. *S. triptolemus* (Morris and Lycett) (p. B49).
Lateral view and partial suture line of specimen USNM 131432 from USGS Mesozoic loc. 21261. Suture line drawn about 30 mm from adoral end of outermost septate whorl.

2, 4. *Stemmatoceras cf. S. palliseri* (McLearn) (p. B48).
Cross section and lateral view of specimen, USNM 131430 from USGS Mesozoic loc. 21270. Shows aperture and parts of adult body chamber. For other views of septate whorls see pl. 20, figs. 5 and 6.



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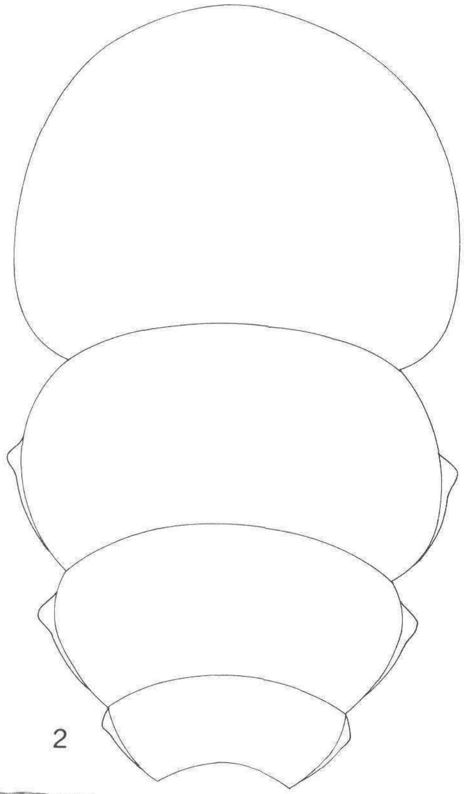

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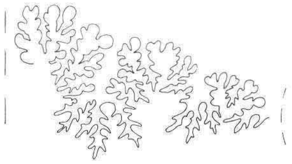

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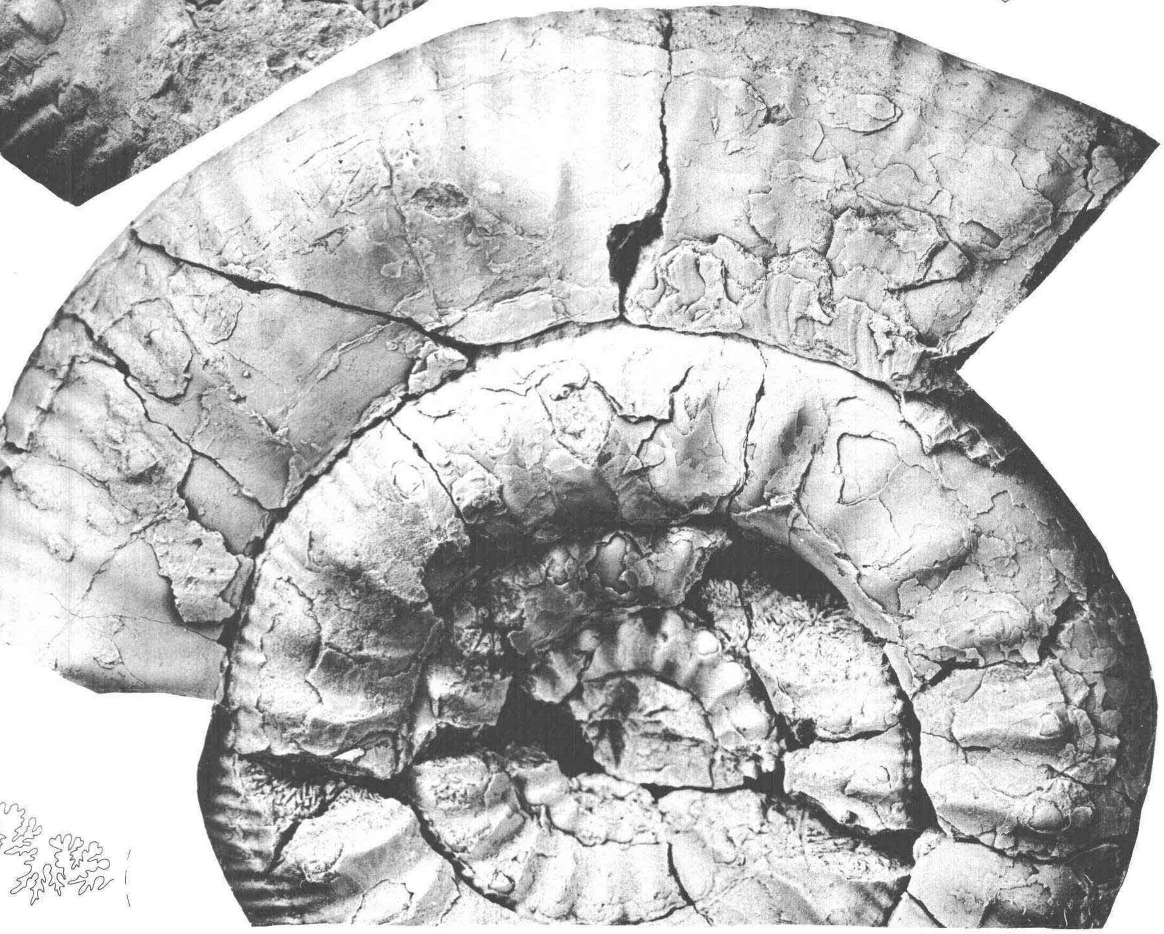

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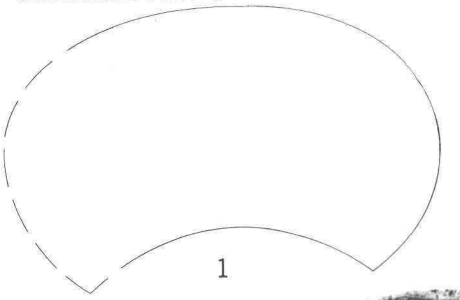
STEMMATOCERAS

PLATE 22

[All figures natural size]

FIGURES 1–3. *Stemmatoceras ursinum* Imlay, n. sp. (p. B49).

Holotype USNM 131431 from USGS Mesozoic loc. 22705. Cross section drawn near adoral end of outermost septate whorl. Suture line drawn at whorl height of 30 mm about 50 mm from adoral end of outermost septate whorl.



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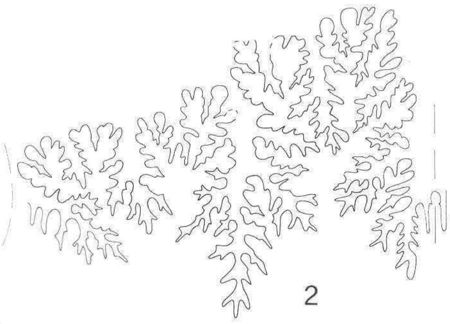

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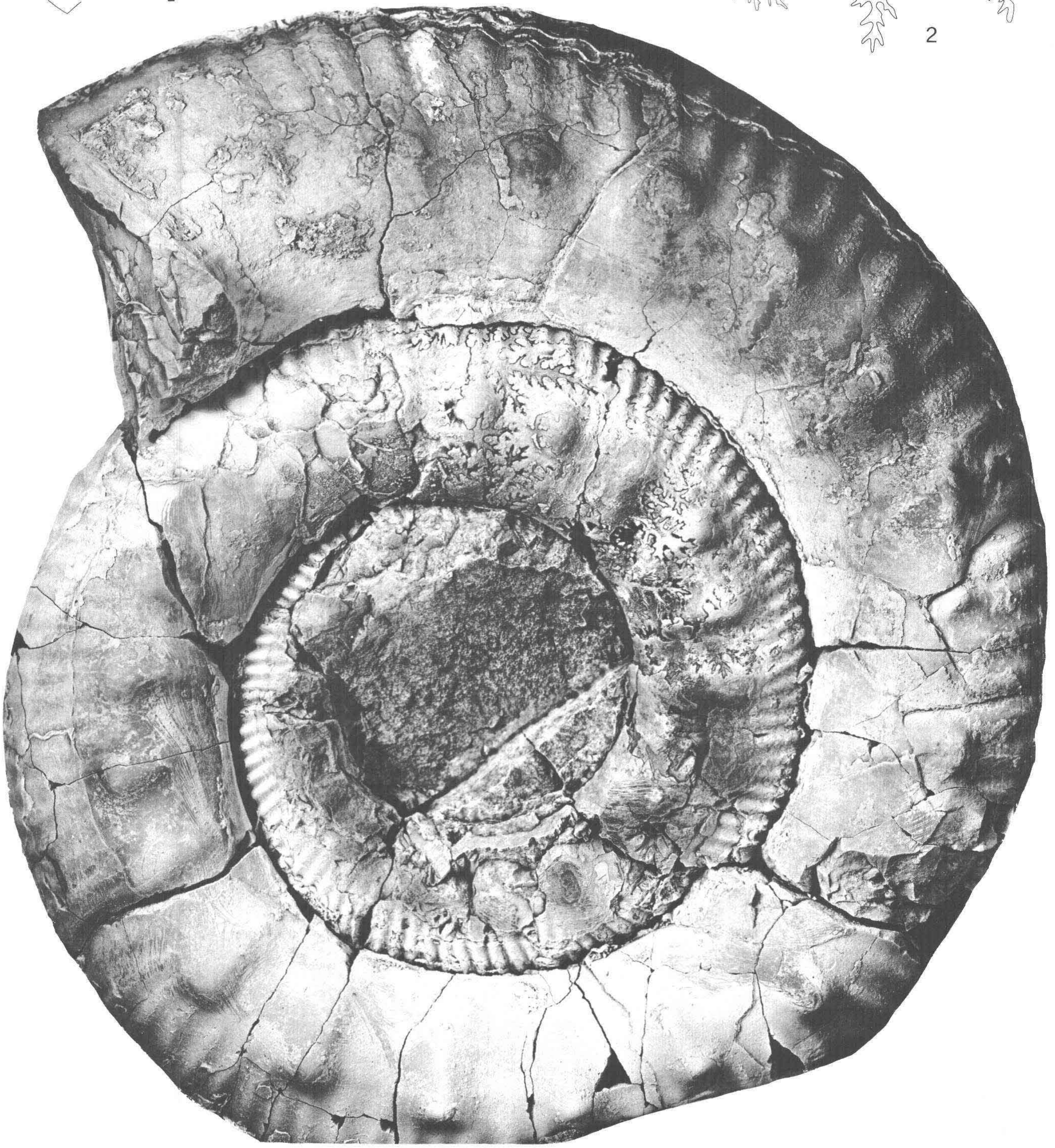

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STEMMATOCERAS

PLATE 23

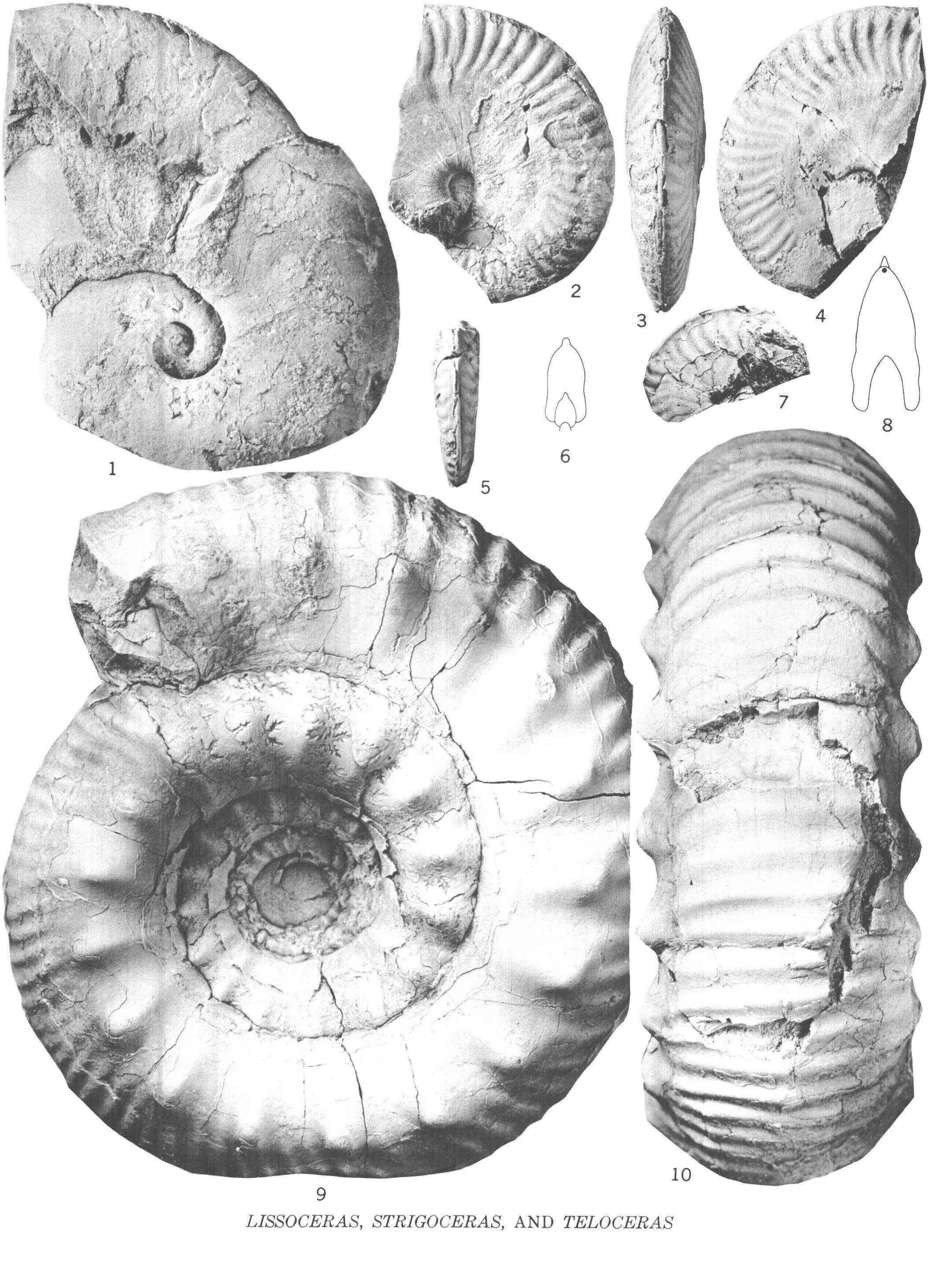
[All figures natural size]

FIGURE 1. *Lissoceras bakeri* Imlay (p. B38).
Plesiotype USNM 131361 from USGS Mesozoic loc. 10512.

2–4, 8. *Strigoceras* cf. *S. languidum* (Buckman) (p. B37).
Lateral, ventral, and cross sectional views of specimen USNM 131359 from USGS Mesozoic loc. 27105.

5–7. *Strigoceras* sp. juv. (p. B37).
Figured specimen, USNM 131360 from USGS Mesozoic loc. 21268.

9, 10. *Teloceras itinsae* McLearn (p. B50).
9. Plesiotype USNM 131433 from USGS Mesozoic loc. 21270 showing complete adult body chamber.
10. Plesiotype USNM 131434 from USGS Mesozoic loc. 21270 showing ventral view of adult body chamber.



LISSOCERAS, STRIGOCERAS, AND *TELOCERAS*

PLATE 24

[All figures natural size]

FIGURES 1–5, 7. *Teloceras itinsae* McLearn (p. B50).

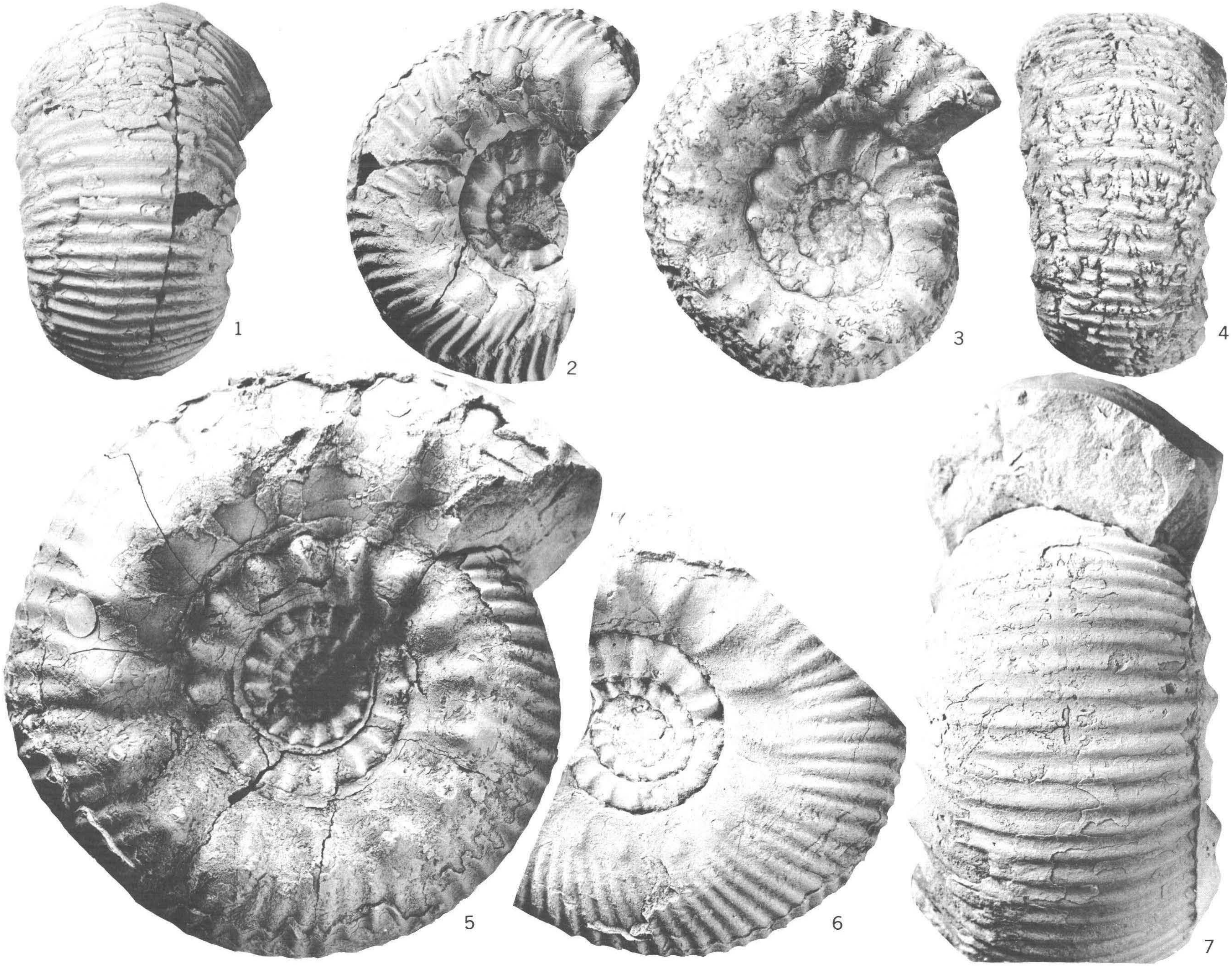
1, 2. Plesiotype USNM 131436 from USGS Mesozoic loc. 21270.

3, 4. Holotype Canada Natl. Mus. 6481. Views from plaster cast of holotype.

5, 7. Plesiotype USNM 131435 from USGS Mesozoic loc. 3000. Shows nearly half a whorl of adult body chamber.

6. *Zemistephanus carlottensis* (Whiteaves) (p. B52).

Crushed specimen showing strong primary ribbing in umbilicus. Plesiotype USNM 131447 from USGS Mesozoic loc. 10513.



TELOCERAS AND *ZEMISTEPHANUS*

PLATE 25

[All figures natural size]

FIGURES 1–3. *Otoites* cf. *O. pauper* Westermann (p. B40).

1, 3. Lateral and ventral views of body chamber of specimen, USNM 131380a from USGS Mesozoic loc. 24113.

2. Lateral view body chamber of specimen, USNM 131380b from USGS Mesozoic loc. 24113.

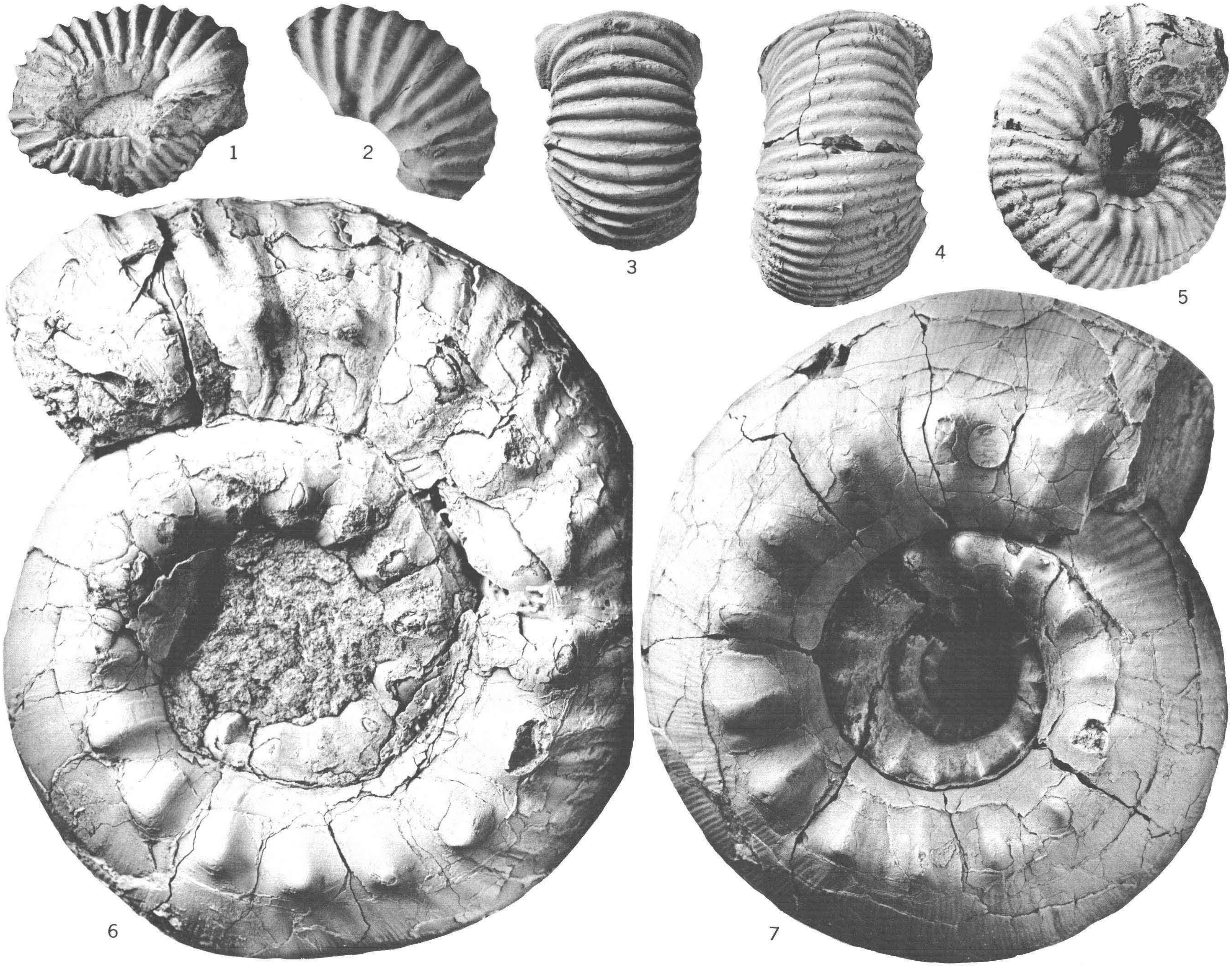
4, 5. *Otoites* cf. *O. contractus* (Sowerby) (p. B40).

Ventral and lateral views of body chamber of specimen, USNM 131381 from USGS Mesozoic loc. 3009.

6, 7. *Zemistephanus richardsoni* (Whiteaves) (p. B51).

6. Plesiotype USNM 131437 from USGS Mesozoic loc. 21270. Adult body chamber showing aperture and rejuvenation of coarse ribbing on adoral half of body chamber.

7. Plesiotype USNM 131438 from USGS Mesozoic loc. 3000. Shows fine ribbing on penultimate whorl.



OTOITES AND *ZEMISTEPHANUS*

PLATE 26

[All figures natural size]

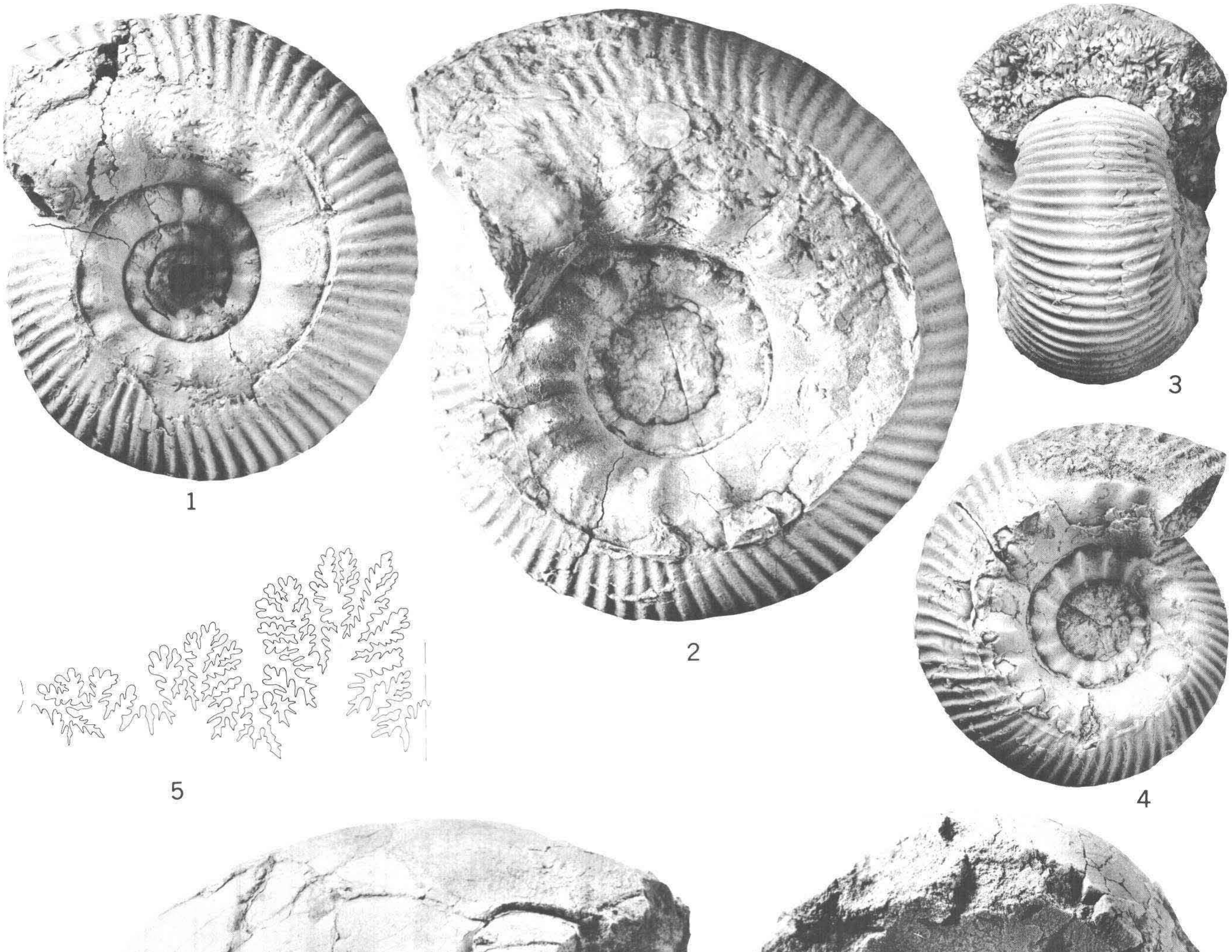
FIGURES 1–7. *Zemistephanus richardsoni* (Whiteaves) (p. B51).

1. Plesiotype USNM 131441 from USGS Mesozoic loc. 3000.
2. Plesiotype USNM 131440 from USGS Mesozoic loc. 3000.

3, 4. Small inner whorls of a larger specimen. Plesiotype USNM 131442 from USGS Mesozoic loc. 10520.

5. Suture line drawn at whorl height of 31 mm and approximate diameter of 88 mm. Plesiotype USNM 131439 from USGS Mesozoic loc. 21274.

6, 7. Penultimate whorl and part of body chamber showing rather abrupt change from coarse to fine ribbing. The adoral part of the body chamber, which has been removed, bears moderately strong ribbing on the venter. Plesiotype USNM 131443 from USGS Mesozoic loc. 2999.



ZEMISTEPHANUS

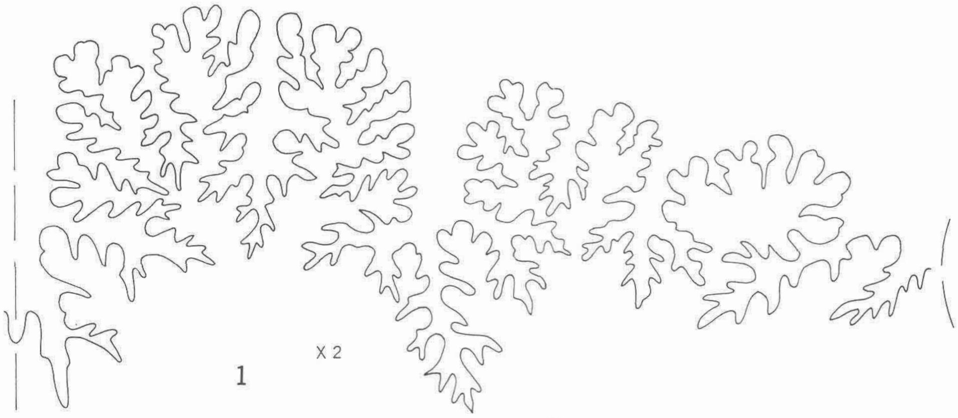
PLATE 27

[All figures natural size unless otherwise indicated]

FIGURES 1–3. *Zemistephanus carlottensis* (Whiteaves) (p. B52).

1. Suture line (× 2) drawn at whorl height of 38 mm on plesiotype, USNM 131445 from USGS Mesozoic loc. 2999. Same specimen is shown on pl. 28, fig. 2.

2, 3. Plesiotype USNM 131444 from USGS Mesozoic loc. 3000. Shows complete body chamber and aperture. Cross section drawn near adoral end of body chamber.



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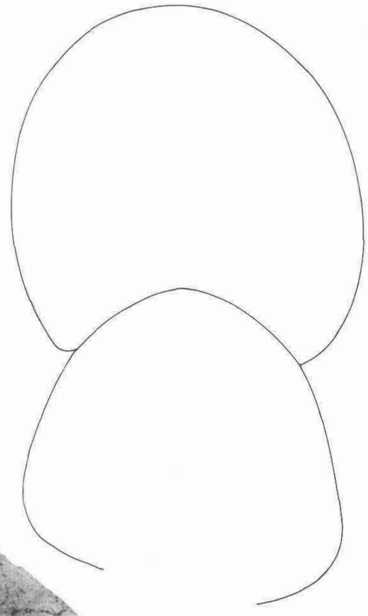

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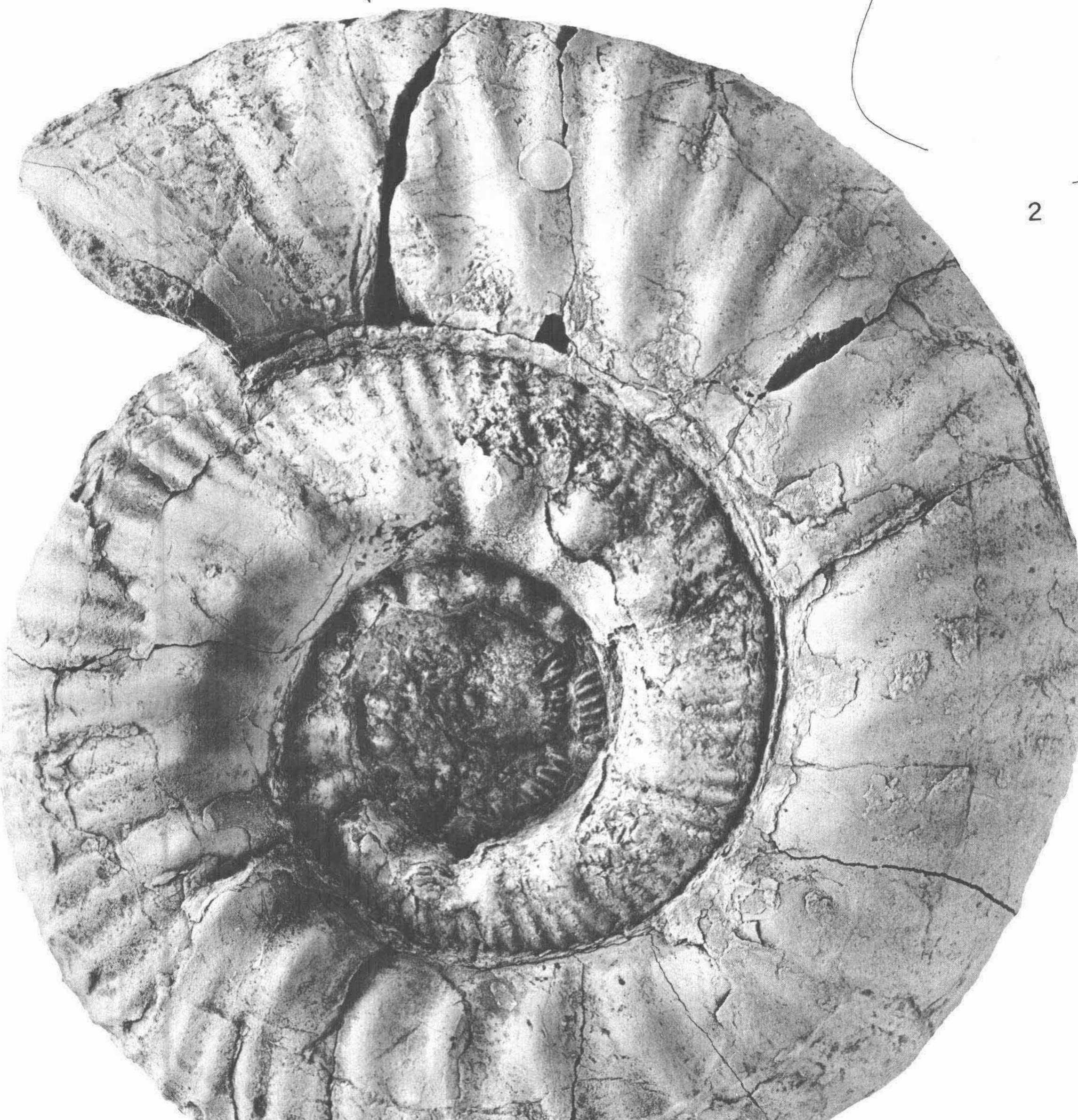

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ZEMISTEPHANUS

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PLATE 28

[All figures natural size unless otherwise indicated]

FIGURES 1–3. *Zemistephanus carlottensis* (Whiteaves) (p. B52).

1, 3. Lateral and apertural views of plesiotype, USNM 131446 from USGS Mesozoic loc. 21275.

2. Plesiotype USNM 131445 from USGS Mesozoic loc. 2999. Suture line drawn near adoral end of same specimen is shown on pl. 27, fig. 1.

4–6. *Leptosphinctes evolutus* Imlay, n. sp. (p. B54).

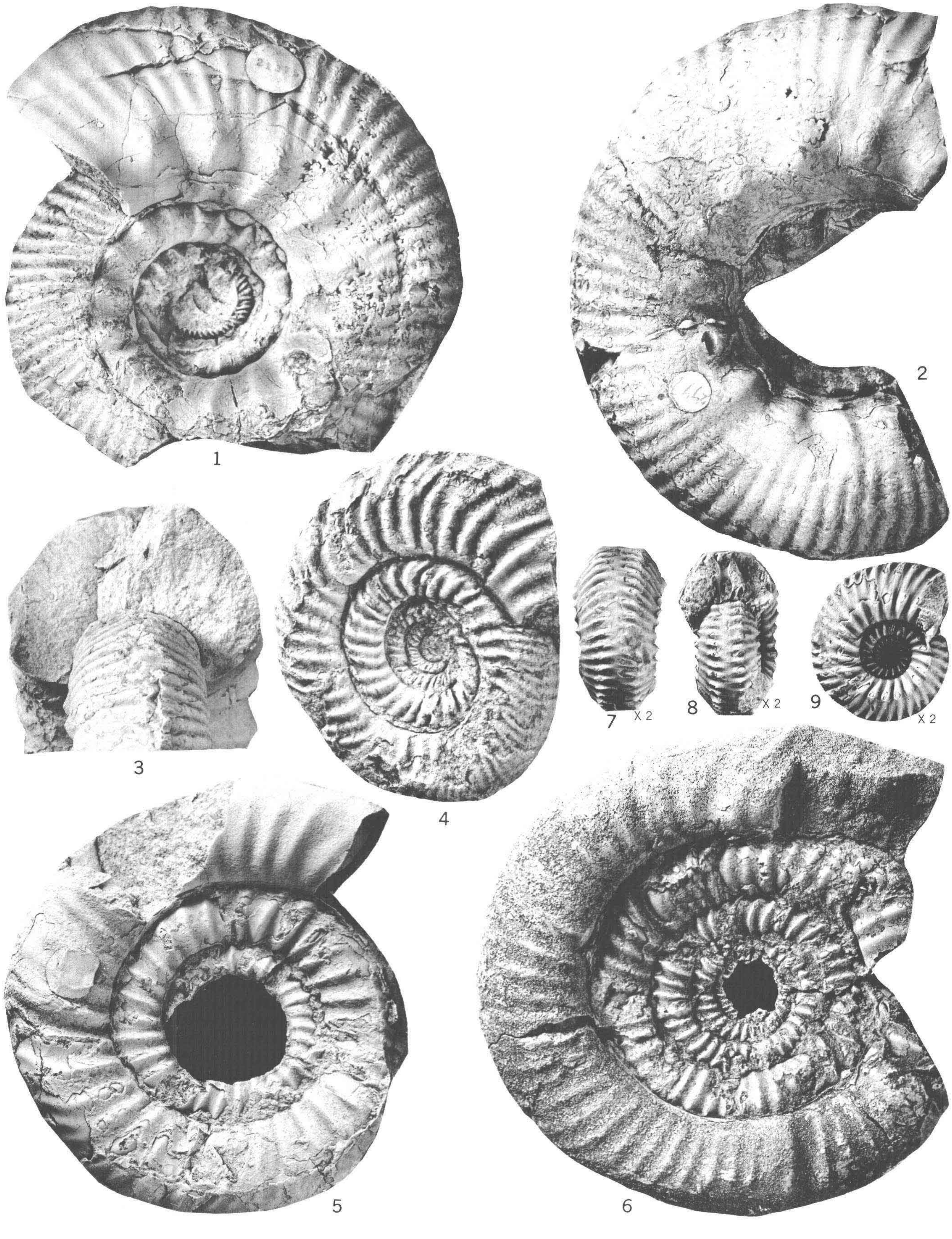
4. Paratype USNM 131450 from USGS Mesozoic loc. 8567.

5. Paratype USNM 131449 from USGS Mesozoic loc. 8567.

6. Holotype USNM 131448 from USGS Mesozoic loc. 8567.

7–9. *Arkelloceras*? sp. juv. (p. B53).

Figured specimen USNM 132014 (× 2) from USGS Mesozoic loc. 21255.



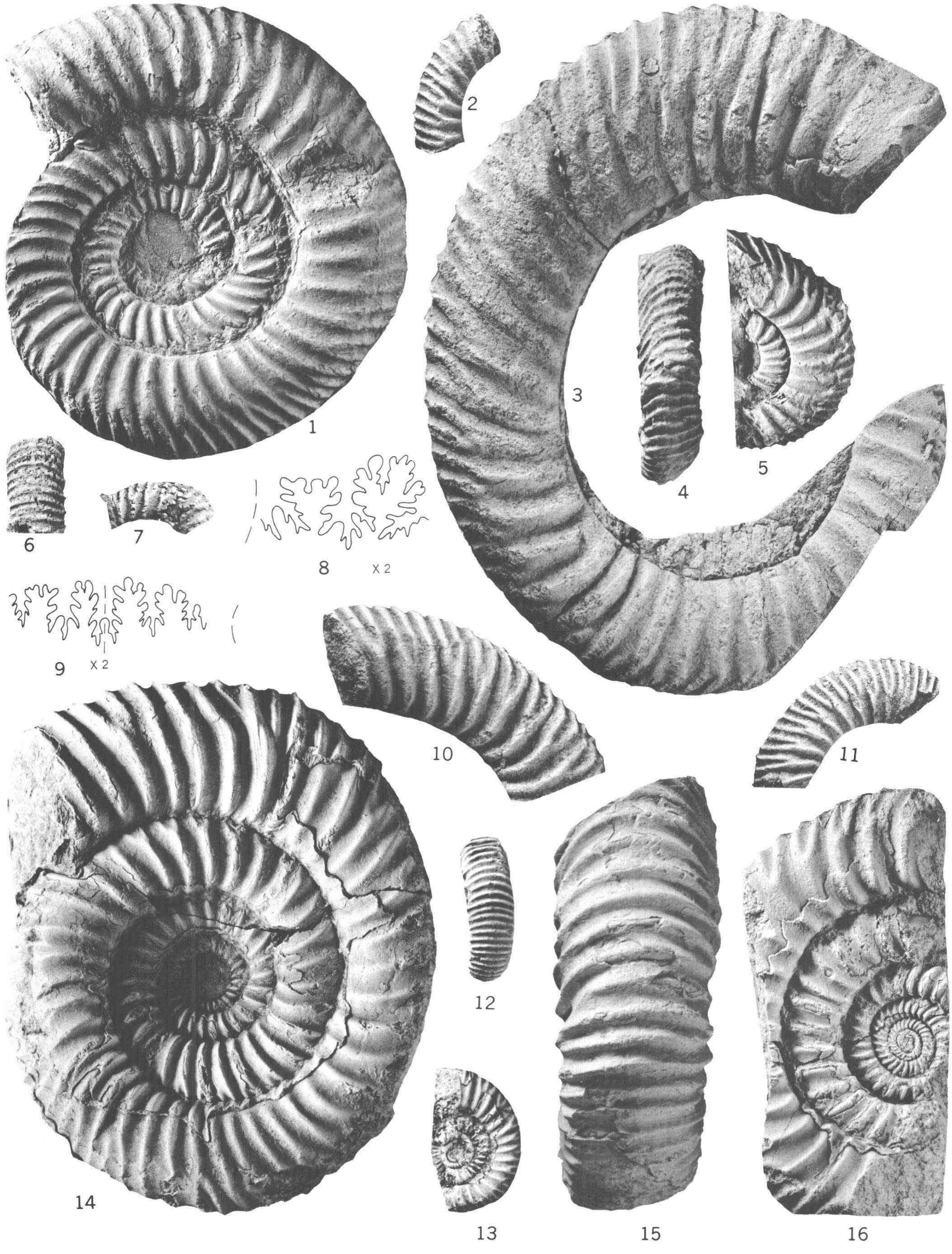
ZEMISTEPHANUS, *LEPTOSPHINCTES*, AND *ARKELLOCERAS*?

PLATE 29

[All figures natural size unless otherwise indicated]

FIGURES 1–16. *Parabigotites crassicostatus* Imlay (p. B54).

1. Paratype USNM 130916 from USGS Mesozoic loc. 27577.
2, 11. Paratypes USNM 130913 from USGS Mesozoic loc. 21258.
3. Adult body chamber showing aperture. Paratype USNM 130911a from USGS Mesozoic loc. 19773.
4, 5. Ventral and lateral views of paratype USNM 130912 from USGS Mesozoic loc. 19966.
6, 7, 9. Ventral and lateral views and suture line (× 2) of paratype, USNM 130914 from USGS Mesozoic loc. 22529. Suture line drawn at whorl height of 7.5 mm.
8, 14, 15. Holotype USNM 130909 from USGS Mesozoic loc. 11352. Suture line (× 2) drawn near adoral end of outer septate whorl.
10. Paratype USNM 130911b from USGS Mesozoic loc. 19773.
12,13. Ventral and lateral views of paratype, USNM 130911c from USGS Mesozoic loc. 19773.
16. Paratype USNM 130910 from USGS Mesozoic loc. 11352.



PARABIGOTITES

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