Late 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 (late Bajocian) age

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LATE BAJOCIAN AMMONITES FROM THE COOK INLET REGION, ALASKA

By Ralph W. Imlay

ABSTRACT

Jurassic ammonites of late Bajocian age occur in the Cook Inlet region, Alaska, along the west side of Cook Inlet, and in the southeastern part of the Talkeetna Mountains. The dominant genera are *Liroxyites*, a subgenus of *Oppelia*, *Megasphaeroceras*, and *Dettermanites*. These have not been recorded outside the Cook Inlet region. The ammonites also include a fair number of specimens of *Macrophylloceras*, *Calliphylloceras*, and *Lissoceras*, but only a few specimens of *Leptosphinctes*. *Lytoceras*, *Spiroceras*?, and *Sphaeroceras* are represented by single specimens.

These ammonites along the west side of Cook Inlet occur only in the lower part of the Bowser member of the Tuxedni formation. This lower part is overlain unconformably by the upper part, which is characterized by *Cranocephalites* of probable Bathonian age. The lower part is underlain abruptly but conformably by the Cynthia Falls sandstone member of the Tuxedni formation, which has furnished the middle Bajocian ammonites *Chondroceras* and *Normannites* from its lower and middle parts. Beneath the Cynthia Falls sandstone member follows an unnamed siltstone member that has furnished many ammonite genera characteristic of the European zone of *Stephanoceras humphriesianum*.

The ammonites from the lower part of the Bowser member are dated as late Bajocian mainly because they include *Sphaeroceras*; *Spiroceras*?, and *Leptosphinctes* that are typically late Bajocian, because they do not include any genera that are typical of the Bathonian or middle Bajocian of Eurasia and north Africa; and because they occur above beds that contain many middle Bajocian ammonites such as *Chondroceras*, *Normannites*, *Teloceras*, *Stemmatoceras*, *Zemistephanus*, *Stephanoceras*, and *Witchellia*. The presence of *Leptosphinctes* itself is good evidence for a late Bajocian age, but its association with *Sphaeroceras* and an uncoiled ammonite that is probably *Spiroceras* is excellent confirmatory evidence. Furthermore, the resemblance of the Alaskan *Leroxyites* and *Dettermanites* to the European *Oxycerites* and *Polyplectites*, respectively, indicates an age not older than late Bajocian. Such an age for the lower part of the Bowser member is in line with the presence of *Cranocephalites* in the overlying beds, as that genus appears to represent much of the Bathonian, according to recent studies in Alaska, Montana, and Greenland.

The dominance of the ammonites *Liroxyites*, *Megasphaeroceras*, and *Dettermanites* in the upper Bajocian rocks of Alaska contrasts with their absence in the Tethyan region. Similarly the upper Bajocian rocks of the Tethyan region have furnished many ammonite genera that have not yet been found in Alaska. These differences indicate that faunal developments were somewhat different in the two regions during Bajocian time.

INTRODUCTION

The ammonites described herein have been studied primarily to demonstrate that rocks of late Bajocian age are present in Alaska above beds containing middle Bajocian ammonites typical of the Tethyan region and below beds characterized by the ammonite *Cranocephalites*, which is known elsewhere only from the Arctic region and the western interior of the United States. The evidence sets a lower limit to the age of the *Cranocephalites* beds. The late Bajocian ammonite faunule is also unusually interesting because the dominant ammonite genera and subgenera present have not been found in other parts of the world.

The fossils from the upper Bajocian rocks of the Cook Inlet region, Alaska, were collected by G. S. Martin in 1913, A. A. Baker in 1921, L. B. Kellum and Helmuth Wedow, Jr. in 1944, R. W. Imlay and D. J. Miller in 1948, Arthur Grantz in 1951 and 1953, L. F. Fay in 1953, and R. L. Detterman in 1957 and 1958.

Many thanks are due Arthur Grantz and R. L. Detterman for preparing locality maps and descriptions and for furnishing and checking all the stratigraphic information. The position of the lower boundary of the Bowser member of the Tuxedni formation shown on the index maps (figs. 3, 4) is based on an unpublished map prepared by R. L. Detterman.

BIOLOGIC ANALYSIS

The Alaskan Jurassic ammonites of late Bajocian age described herein include 154 specimens. Their distribution by genera, subgenera, subfamilies, and families is shown in table 1. The table shows that the Sphaeroceratidae and the Oppeliidae are the dominant families;

Table 1.—*Ammonite genera and subgenera from beds of late Bajocian age in the Cook Inlet region, Alaska, showing biological relationships and relative numbers available for study*

Family	Subfamily	Genus and subgenus	Number of specimens
Phylloceratidae	Phylloceratinae	*Macrophylloceras*	10
	Calliphylloceratinae	*Calliphylloceras*	8
Lytoceratidae	Lytoceratinae	*Lytoceras*	1
Spiroceratidae		*Spiroceras*?	1
Haploceratidae		*Lissoceras*	7
Oppeliidae	Oppeliinae	*Oppelia* (*Liroxyites*)	50
Stephanoceratidae		*Dettermanites*	10
Sphaeroceratidae		*Megasphaeroceras*	63
		Sphaeroceras	1
Perisphinctidae	Leptosphinctinae	*Leptosphinctes*	1
		L. (*Prorsisphinctes*?)	1
		L. ?	1

the Phylloceratidae, Haploceratidae, and Stephanoceratidae are much less common; and the Lytoceratidae, Spiroceratidae, and Perisphinctidae are of minor importance. The most common and characteristic ammonites are *Liroxyites*, *Megasphaeroceras*, and *Dettermanites*. These have not been recorded outside of the Cook Inlet region, Alaska, although they resemble the ammonites *Oxycerites*, *Sphaeroceras*, and *Polyplectites* respectively of the Tethyan region. Their presence supports the idea of Arkell (1956, p. 609, 614) that the Pacific region developed as a faunal province, distinct from the Tethyan and Boreal faunal provinces, during Bajocian time. The other genera and subgenera listed are common in the Middle Jurassic of the Tethyan region.

STRATIGRAPHIC SUMMARY

NORTH SIDE OF COOK INLET

Fossils of late Bajocian age have been found along the west side of Cook Inlet only in the lower part of the Bowser member of the Tuxedni formation (figs. 1, 3, 4). This lower part consists of 600 feet, or less, of interbedded dark-gray siltstone, sandy siltstone, and claystone that contains many ash beds and weathers reddish brown or rusty. Locally it contains small fossiliferous concretions. It rests abruptly on the massive sandstone of the underlying Cynthia Falls sandstone member of the Tuxedni formation and is overlain abruptly by the lowest massive siltstone and sandstone in the upper part of the Bowser. This massive siltstone and sandstone overlaps southward across the underlying rusty beds and at the south end of the Iniskin Peninsula rests directly on the Cynthia Falls sandstone member (written communication, R. L. Detterman, May 15, 1959).

All the late Bajocian fossils from the lower part of the Bowser member appear to have been obtained from concretions. They consist mostly of ammonites and the pelecypod *Inoceramus ambiguus* Eichwald. In addition they include belemnite fragments, the gastropod *Amberleya*, the pelecypod *Pleuromya*, and terebratulid brachiopods.

TALKEETNA MOUNTAINS

Fossils of late Bajocian age have been found in the Talkeetna Mountains at two places (fig. 2). At one place near Boulder Creek (Mesozoic loc. 8572), the fossils appear to have been obtained from concretions and consist only of ammonites. At the second place near the head of Sheep Creek (Mesozoic loc. 24821) the fossils are preserved in a dark-gray coarse-grained pebbly sandstone that contains many fossils other than ammonites. These include in particular belemnite fragments, the gastropod *Amberleya*, the pelecypods *Oxytoma*, *Lima* (*Plagiostoma*), *Isocyprina*?, and *Astarte*. In addition, worm tubes occur in the sandstone matrix, on the internal mold of the pelecypod *Lima*, and also in close association with belemnite fragments that are corroded and rounded.

Stratigraphically, Mesozoic locality 24821 is near the top of the Tuxedni formation (Arthur Grantz, written communication, Nov. 14, 1960). Mesozoic locality 8572 is near Mesozoic locality 8573 (Martin, 1926, p. 225, 228) which has furnished the ammonite *Cranocephalites*. This ammonite elsewhere in the Talkeetna Mountains has been found in a sandstone a few hundred feet below the Chinitna formation (Arthur Grantz, written communication, Apr. 8, 1959). It occurs along the west side of Cook Inlet in the upper part of the Bowser member of the Tuxedni formation, directly above the ammonites herein described. Judging by these occurrences all the late Bajocian ammonites in the Talkeetna Mountains are probably from near the top of the Tuxedni formation. Their exact stratigraphic position is possibly determinable in the sequence exposed along the northwest side of Boulder Creek where ammonites ranging in age from middle Bajocian (Mesozoic loc. 8567) to Callovian (Mesozoic loc. 8571) have been found.

AGE OF THE FAUNA

The ammonite fauna in the lower part of the Bowser member of the Tuxedni formation on the west side of Cook Inlet and in equivalent beds in the Talkeetna Mountains (table 1) is considered to be of late Bajocian age primarily because it includes the genera *Sphaeroceras*, *Spiroceras*?, and *Leptosphinctes*. Of these, *Sphaeroceras* in Europe and in the Tethyan region ranges from the zone of *Stephanoceras humphriesianum* to the top of the Bajocian (Westermann, 1956a, p. 24–35; Arkell, 1952, p. 77; Arkell, 1956, p. 32, 50, 100, 142, 262, 278); *Spiroceras* ranges from the late Bajocian to the late Bathonian (Arkell, 1957, p. L206); and *Leptosphinctes is* typically late Bajocian. There is a possible occurrence of *Leptosphinctes* in the middle Bajocian of Argentina (Jaworski, 1926, p. 262, pl. 2, fig. 4; Westermann, 1956b, p. 268; Arkell, 1956, p. 585), but the report of *Leptosphinctes* in the middle Bajocian of Alaska (Imlay, 1952, p. 979) was based on specimens now referred to *Parabigotites* Imlay (1961, p. 471, pl. 64, figs. 1–3).

Associated with *Sphaeroceras*, *Spiroceras*?, and *Leptosphinctes* in Alaska are other ammonites that suggest a late Bajocian or Bathonian age. These include *Oppelia* (*Liroxyites*), which resembles *Oppelia* (*Oxycerites*), and *Dettermanites*, which resembles *Cadomites* in size, coiling, and ornamentation but bears elongate lateral lappets as in *Polyplectites*. With these also occur the genus *Megasphaeroceras*, whose resemblance to *Sphaeroceras* suggests an age not younger than Bajocian, and the genus *Lissoceras*, which ranges from middle Bajocian to early

Bathonian. Significantly the ammonite faunule in the lower part of the Bowser member of the Tuxedni formation does not contain any genera that are characteristic of the middle Bajocian, although such genera occur in the underlying beds along the north side of Cook Inlet. Thus the immediately underlying Cynthia Falls sandstone member contains *Chondroceras* and *Normannites*, and the next underlying unnamed siltstone member contains these genera plus *Teloceras*, *Zemistephanus*, *Stephanoceras*, *Oppelia* (*Oppelia*), *Witchellia*, and *Sonninia*. Most probably some of these genera would occur in the lower part of the Bowser member, if it were as old as middle Bajocian.

In summation, the ammonite fauna characterizing the lower part of the Bowser member of the Tuxedni formation contains certain genera that are typical of the late Bajocian, others that could be either late Bajocian or Bathonian, and two that range from the middle Bajocian into the Bathonian or Callovian. The fauna does not include any genera characteristic of the middle Bajocian but overlies beds that contain such ammonites. All these facts constitute strong evidence that the ammonite fauna is of late Bajocian age.

Such an age assignment for the ammonites in the lower part of the Bowser member of the Tuxedni formation is in harmony with the presence in the overlying beds of another ammonite fauna characterized by *Cranocephalites*, of probable Bathonian age. This Bathonian assignment was made by Imlay (1952, p. 980, 981) on the basis of faunal associations and stratigraphic relations and has been supported by his recent studies in Alaska and Montana. Additional information was furnished by Callomon (1959), who claims that the *Cranocephalites* beds of East Greenland not only are of Bathonian age, but probably represent the entire early Bathonian and possibly at their base represent some of the Bajocian. Calloman, of course, did not know of all the faunal evidence, presented herein, for the presence of late Bajocian in Alaska nor that the lower and upper parts of the Bowser member are separated by an unconformity (see stratigraphic summary) that may represent part of the Bajocian or part of the Bathonian, or both. Nevertheless, he presents a strong argument that the *Cranocephalites* beds in East Greenland are equivalent to the lower Bathonian of the European and the Tethyan region. By implication, any faunas beneath the *Cranocephalites* beds are older than Bathonian.

It seems reasonable, therefore, both stratigraphically and faunally to correlate the lower part of the Bowser member of the Tuxedni formation with the upper Bajocian. There is no positive evidence, however, whether that part represents all, or only part of the upper Bajocian. Considering that 3 ammonites zones are recognizable in western Europe (Arkell, 1956, p. 31, 32) and only 1 is recognizable in the lower part of the Bowser member perhaps only part of the upper Bajocian is represented in the Bowser member. It is also possible that the upper third of the Cynthia Falls sandstone member, which has not yielded any ammonites, may be equivalent to part of the upper Bajocian.

COMPARISONS WITH OTHER FAUNAS

NORTH AMERICA, EXCLUSIVE OF ALASKA

Fossils of definite late Bajocian age have not been identified in Canada or in the conterminous United States south of Alaska. However, some ammonites from northern Alberta that Frebold (1957, p. 54–56, pl. 28, figs, 1 a, b, 2; Arkell, 1956, p. 542, 609) compared with species of *Oppelia* (*Oxycerites*) from the lower Bathonian of Europe have very broad, falcoid ribs greatly resembling those on *Oppelia* (*Liroxyites*) *kellumi* Imlay from Alaska. This resemblance suggests that the Canadian specimens may be of late Bajocian rather than of Bathonian age, but their exact age will have to await the discovery of other ammonites that are better preserved or belong to genera that have a more restricted range.

The late Bajocian is probably represented faunally in the States of Oaxaca and Guerrero in southern Mexico, according to statements by Arkell (1956, p. 565) and Erben (1956, p. 27–29, 78, 79, 82–87, 92, 93), but the published evidence is not conclusive. The ammonite fragment that Burckhardt (1927, p. 90, pl. 16, figs. 10, 11, 16) described as *Cosmoceras* (*Strenoceras*) aff. *C. bifurcatum* (Quenstedt [not Zieten]) was cited by him (1927, p. 94; 1930, p. 26) as evidence of a late Bajocian age. The same ammonite, however, was referred questionably to *Garantiana* by Arkell (1956, p. 565) who noted that it could be late Bajocian or Bathonian. The associated fossils listed by Erben include *Oppelia* aff. *O. subradiata* (Sowerby), *Stephanoceras*?, Perisphinctidae (Leptosphinctinae?), and *Sphaeroceras*. These identifications are stated to be preliminary and therefore, do not afford evidence for a close age determination.

ARCTIC REGION

Ammonite faunules of middle or late Bajocian age resembling those in the Tethyan region on a generic level have not been identified in the Arctic region (Arkell, 1956, p. 609), although Callomon (1959, p. 507–511) speculates that some of the lowest *Cranocephalites*-bearing beds in East Greenland are possibly of late Bajocian age. His arguments for such an age are based partly on the resemblance of *Cranocephalites* to the middle Bajocian genus *Chondroceras* and partly on the presence of seven ammonite zones below beds that he considers earliest Callovian. His knowledge of the relative duration of ammonites makes him doubt that all seven zones can be accommodated in the Bathonian stage. He admits that the lowest *Cranocephalites* beds do not contain any ammonite genera typical of the Tethyan Bajocian but neither do the overlying *Cranocephalites* beds, which are assigned to the Bathonian on a stratigraphic basis, contain any genera in common with the Tethyan Bathonian. These faunal differences with the Tethyan province are explained, following Arkell (1956, p. 609, 614), by the separation of ammonites into faunal provinces during the middle Bajocian.

The writer's recent studies of the *Cranocephalites* faunules in western Montana and in the Cook Inlet region, Alaska, show that those faunules are probably of Bathonian age and have much more in common faunally with the Callovian than with the Bajocian. Furthermore, the fact that in Alaska the *Cranocephalites* beds rest unconformably on beds containing the typical late Bajocian ammonite *Leptosphinctes*, described herein, makes a late Bajocian age unlikely for any beds containing *Cranocephalites*.

EURASIA AND NORTH AFRICA

Upper Bajocian ammonites of the Tethyan region have been recorded at many places in northern Africa, in western Europe south of the Baltic sea, in southern U.S.S.R. in Europe, in the Middle East, and in southwestern Asia (Arkell, 1956, p. 31, 50, 77, 122, 142, 176, 208, 240, 249, 263, 278, 291, 300, 325, 355, 362, 364, 371, 377, 474, 483, 487, 515). The most common ammonites are the Parkinsoniidae, including such genera as *Parkinsonia*, *Garantia*, and *Strenoceras*, and the Leptosphinctinae, including such genera as *Bigotites* and *Leptosphinctes*. Genera that are known only from the upper Bajocian include *Bigotites*, *Leptosphinctes*, *Cleistosphinctes*, *Vermisphinctes*, *Prorsiphinctes*, *Strenoceras*, *Pseudogarantia*, *Caumontisphinctes*, and *Ermoceras*. Genera that range from the upper Bajocian into the Bathonian include *Spiroceras*, *Cadomites*, *Polyplectites*, *Morphoceras*, *Garantia*, and *Parkinsonia*. Genera and subgenera that range from the upper Bajocian into the Callovian include *Oxycerites* and *Oecotraustes*. Genera that range from the middle into the upper Bajocian include *Strigoceras*, *Cadomoceras*, *Oppelia* s. s., *Sphaeroceras*, *Stephanoceras*, *Teloceras*, and *Normannites*. The genus *Lissoceras* ranges from middle Bajocian into lower Bathonian. There are also a few genera that are either uncommon or are known from only a small part of the Tethyan region, such as *Thamboceras*, *Trimargina*, and *Magharina* from the Middle East.

In general, assemblages of these ammonites from the Tethyan region are easily recognized and distinguished from middle Bajocian or Bathonian assemblages in that region. Furthermore, in parts of western Europe detailed studies have shown the upper Bajocian may be subdivided into three ammonite zones (Arkell, 1956, 31, 32, 50, 77, 142) based on the ranges of certain genera and species. Interestingly, such genera as *Teloceras*, *Stephanoceras*, and *Normannites* that are typical of the middle Bajocian have been found locally in beds of late Bajocian age (Arkell, 1956, 63, 99, 100, 122, 142, 176, 232, 263, 264, 278, 300, 483). Many of these occurrences are in the lower part of the upper Bajocian, but some are in the middle part (Arkell, 1956, p. 483), and some have not been placed exactly within the substage.

The upper Bajocian ammonite assemblages in the Tethyan region show faunal relationships with the upper Bajocian ammonites in the Cook Inlet region, Alaska, primarily through the genera *Spiroceras*, *Sphaeroceras*, and *Leptosphinctes*. Otherwise marked differences exist. There are as yet no known representatives of the Parkinsoniidae in Alaska, and many other genera that are common in the upper Bajocian of the Tethyan region are unknown in Alaska. Futhermore, the dominant ammonites in the upper Bajocian of Alaska belong to *Dettermanites* and *Megasphaeroceras*, which are unknown outside Alaska, although they resemble *Polyplectites* and *Sphaeroceras* respectively.

AUSTRALASIA AND INDONESIA

In New Guinea and in the Sula Islands (Pulau-pulau Sula) the upper Bajocian is represented, according to Arkell (1956, p. 439, 446, 448), by *Cadomites daubenyi* (Gemmellaro) (Boehm, 1912, p. 148, pl. 34, figs. 5a, b), although he admits that the genus ranges at least as high as middle Bathonian. These occurrences are in the eastern part of the Tethyan realm or region as defined by Arkell (1956, p. 614).

Elsewhere on the lands within or surrounding the Pacific Ocean, except in Alaska, marine upper Bajocian has not been identified, or is missing according to the evidence presented by Arkell (1956, p. 382–462, 542, 555, 585). This is rather surprising considering that marine middle Bajocian has been identified at many places in this region, but is in harmony with the general distribution of marine Bathonian in the same region (Arkell, 1956, fig. 98 on p. 608). In many places, however, not enough is known about the geology to prove definitely that the upper Bajocian is missing.

GEOGRAPHIC DISTRIBUTION

The occurrence by area and locality of the megafossils described in this report is indicated in table 3. The positions of the various areas are shown in figures 1 to 4. Descriptions of the individual localities are shown as follows in table 2.

TABLE 2.—*Localities where megafossils were collected from upper Bajocian strata, Cook Inlet region, Alaska*

Locality on figures 2-4	Geological Survey Mesozoic locality	Collectors' field Nos.	Collector, year of collection, description of locality, and stratigraphic assignment
1	24821	53AGz144	Arthur Grantz and L. F. Fay, 1953. Talkeetna Mountains, Anchorage D-2 quad., on Sheep Creek. Lat 61°59′17″ N., long 147°38′35″ W., Tuxedni formation, near top.
2	8572	13AM21	G. C. Martin, 1913. Talkeetna Mountains, at altitude of 4,200 ft on ridge west of creek that enters the main Boulder Creek from the north, 3 miles above its junction with the East Fork. Tuxedni formation.
3	21282	48AI81	R. W. Imlay and D. J. Miller, 1948. Tuxedni Bay area, on tributary entering Bear Creek from the southeast, 4.75 miles S. 22° W. of Fossil Point. Bowser member of the Tuxedni formation, 300 ft above base.
4	22709	51AGz140	Arthur Grantz, 1951. Tuxedni Bay area, about 0.3 mile above mouth of tributary entering Bear Creek from southeast at a point 2.53 miles from Tuxedni channel. Bowser member of the Tuxedni formation, about 100 ft above base.
5	22710	51AGz141	Arthur Grantz, 1951. Tuxedni Bay area, about 0.5 mile above mouth of same tributary described under Mesozoic loc. 22709. Bowser member of the Tuxedni formation, about 260 ft above base.
6	11034	21ABF-42	A. A. Baker, 1921. Iniskin Peninsula, on right fork of Cliff Creek about 2,700 ft above junction with left fork and 2.46 miles S. 15° W. of mouth of Fitz Creek. Bowser member of the Tuxedni formation, about 100 ft above base.
6	19934	44AWWF-3	Helmuth Wedow, Jr., 1944. Iniskin Peninsula, small tributary on right side of Cliff Creek about 5,100 ft above junction with Fitz Creek and 2.42 miles S. 14° W. of mouth of Fitz Creek. Bowser member of the Tuxedni formation, about 85 ft above base.
6	21314	48AI30	R. W. Imlay and D. J. Miller, 1948. Iniskin Peninsula, on Cliff Creek 3.66 miles N. 87° E. of Tonnie Peak. Same location as Mesozoic locs. 11034 and 19934. Bowser member of the Tuxedni formation, from 10 to 100 ft above base.
7	11036	21ABF-43	A. A. Baker, 1921. Iniskin Peninsula, on right fork of Cliff Creek about 8,000 ft above junction with Fitz Creek and 2.58 miles S. 15° W. of mouth of Fitz Creek. Bowser member of Tuxedni formation, 125 to 175 ft above base.
7	19943	44AWWF-12	Helmuth Wedow, Jr., 1944. Iniskin Peninsula, on Cliff Creek about 200 ft downstream from a prominent cascade, 1¼ miles above junction with Fitz Creek and 3.35 miles east of Tonnie Peak. Bowser member of the Tuxedni formation, 125 to 175 ft above base.
7	21313	48AI29	R. W. Imlay and D. J. Miller, 1948. Iniskin Peninsula, on Cliff Creek just below a cascade. Same location and stratigraphic position as Mesozoic locs. 11036 and 19943.
7	21315	48AI31	R. W. Imlay and D. J. Miller, 1948. Iniskin Peninsula, on Cliff Creek near Mesozoic locs. 21313 and 19943. Bowser member of the Tuxedni formation, float from lower 175 ft.
8	26593	57ADT5	R. L. Detterman, 1957. Iniskin Peninsula, on Cliff Creek near location of Mesozoic loc. 21313, lat 59°49′20″ N., long 153°11′00″ W. Bowser member of the Tuxedni formation, 200 ft above base.
9	11035	21ABF-44	A. A. Baker, 1921. Iniskin Peninsula, on right fork of right fork of Cliff about 9,000 ft above junction with Fitz Creek and 2.68 miles S. 16° W. of mouth of Fitz Creek. Bowser member of Tuxedni formation, lower part.
10	20001	44AWWF-68	Helmuth Wedow, Jr., and L. B. Kellum, 1944. Iniskin Peninsula, on northeast side of Tonnie Creek about 200 ft downstream from top of a cascade which is 0.9 mile S. 48° E. of Tonnie Peak, Bowser member of the Tuxedni formation, about 100 ft above base.
11	21318	48AI35	R. W. Imlay and D. J. Miller, 1948. Iniskin Peninsula, on Tonnie Creek 1.00 to 1.05 miles S. 51° E. of Tonnie Peak. Same location as Mesozoic loc. 27099. Bowser member of the Tuxedni formation, from 50 to 125 ft above base.
11	27099	58ADt2	R. L. Detterman, 1958. Iniskin Peninsula, on Tonnie Creek 0.81 mile N. 55° W. of Iniskin Bay Association No. 1 well. Lat 59°45′30″ N., long 153°15′05″ W. Same location as loc. 21318. Bowser member of the Tuxedni formation, 75 to 100 ft above base.

SYSTEMATIC DESCRIPTIONS

Genus MACROPHYLLOCERAS Spath, 1927

Macrophylloceras cf. M. grossicostatum Imlay

Plate 5, figures 6, 7

Ten septate specimens from the Bowser member of the Tuxedni formation are closely similar to *Macrophylloceras grossicostatum* Imlay (1953, p. 74, pl. 25, figs. 11-13, 15, 16) from the Chinitna formation of Alaska in shape, coiling, and ribbing on the larger septate whorls. They appear to have slightly coarser ribbing on the smaller whorls at diameters of about 60 mm.

Figured specimen.—USNM 130903.

Occurrence.—Lower part of Bowser member of the Tuxedni formation, Iniskin Peninsula, at USGS Mesozoic locs. 11035, 21313, 21314, and 26593. Talkeetna Mountains from upper part of the Tuxedni formation at Mesozoic loc. 24821.

Genus CALLIPHYLLOCERAS Spath, 1927

Calliphylloceras sp.

Plate 1, figure 8

The genus is represented by eight internal molds that

TABLE 3.—*Geographic distribution of the upper Bajocian ammonites from the Cook Inlet Region, Alaska*

[Numbers 1-11 refer to numbers on figs. 2-4. Higher numbers are Geological Survey Mesozoic locality numbers]

	Talkeetna Mountains		North side of Cook Inlet														
			Tuxedni Bay			Iniskin Peninsula											
	Tuxedni formation		Bowser member (lower part) of Tuxedni formation														
	1	2	3	4	5	6			7				8	9	10	11	
	24821	8572	21282	22709	22710	11034	19934	21314	11036	19943	21313	21315	26593	11035	20001	21318	27099
Macrophylloceras cf. *M. grossicostatum* Imlay	×							×			×		×	×			
Calliphylloceras sp	×							×				×			×	×	
Lytoceras sp																	×
Spiroceras? sp			×														
Lissoceras bakeri Imlay, n. sp			×	×	×	×	×	×				×					
Oppelia (*Liroxyites*) *kellumi* Imlay			×					×	×	×	×	×		×	×	×	×
Megasphaeroceras rotundum Imlay	×		×					×	×	×	×	×	×	×		×	×
M. cf. *M. rotundum* Imlay							×					×				×	
M. sp															×		
Sphaeroceras talkeetnanum Imlay, n. sp		×															
Dettermanites vigorosus Imlay	×	×				×	×	×	×					×		×	
Leptosphinctes cliffensis Imlay, n. sp											×						
L. (*Prosisphinctes*?) *delicatus* Imlay, n. sp																×	
L.? sp								×									
Belemnite fragments	×							×							×	×	
Amberleya cf. *A. densinodosa* Huddleston	×		×		×			×			×				×	×	×
Oxytoma sp	×																
Inoceramus ambiguus Eichwald	×						×	×	×	×	×				×	×	×
Lima (*Plagiostoma*) sp	×																
Astarte sp	×																
Isocyprina? sp	×																
Pleuromya sp																×	
Brachiopods undet											×				×	×	
Worm tubes	×																

bear sigmoidal constrictions and faint traces of sigmoidal lirae. Fragments of shell, preserved on the specimen illustrated, show that the constrictions are confined to the internal molds. Compared with *Calliphylloceras freibrocki* Imlay (1953, p. 73, pl. 26, figs. 7–11), the constrictions are more strongly sigmoidal.

Figured specimen.—USNM 130906.

Occurrence.—Lower part of Bowser member of the Tuxedni formation, Iniskin Peninsula, at USGS Mesozoic locs. 20001, 21314, 21315, and 21318. Talkeetna Mountains from upper part of the Tuxedni formation at Mesozoic loc. 24821.

Genus LYTOCERAS Suess, 1865
Lytoceras sp.

The genus is represented only by one septate fragment of an internal mold that shows traces of growth lines spaced from 2 to 3 mm apart.

Occurrence.—Lower part of the Bowser member of the Tuxedni formation at USGS Mesozoic loc. 22709.

Genus SPIROCERAS Quenstedt, 1858
Spiroceras? sp.

Plate 1, figure 7

One fragment of a small uncoiled ammonite is similar in lateral view to the small specimens of *Spiroceras* from the upper Bajocian of western Europe (Roman and Petourand, 1927, pl. 3, figs. 13–31, pl. 4, pl. 5, figs. 6–11, 15–19; Potonie, 1929, pl. 17, figs. 4–12). A definite generic identification cannot be made, however, because the venter is not preserved. The flanks bear high widely spaced forwardly inclined ribs that are swollen at about three-fifths of the height of the flanks. The ribs ventral to these swellings weaken slightly and then terminate in conical tubercles on the venter. On the dorsum the ribs are broader and lower than on the flanks.

Figured specimen.—USNM 130908.

Occurrence.—Lower part of Bowser member of the Tuxedni formation, Tuxedni Bay area, USGS Mesozoic loc. 21282.

Genus LISSOCERAS Boyle, 1879
Lissoceras bakeri Imlay, n. sp.

Plate 1, figures 1–6, 9–12

This species is represented by seven specimens. The shell is compressed and involute. The whorls are subovate, much higher than wide, widest at about one-third their height, and embrace about two-thirds of the preceding whorls. The flanks are slightly convex and converge in the upper two-thirds to a narrowly

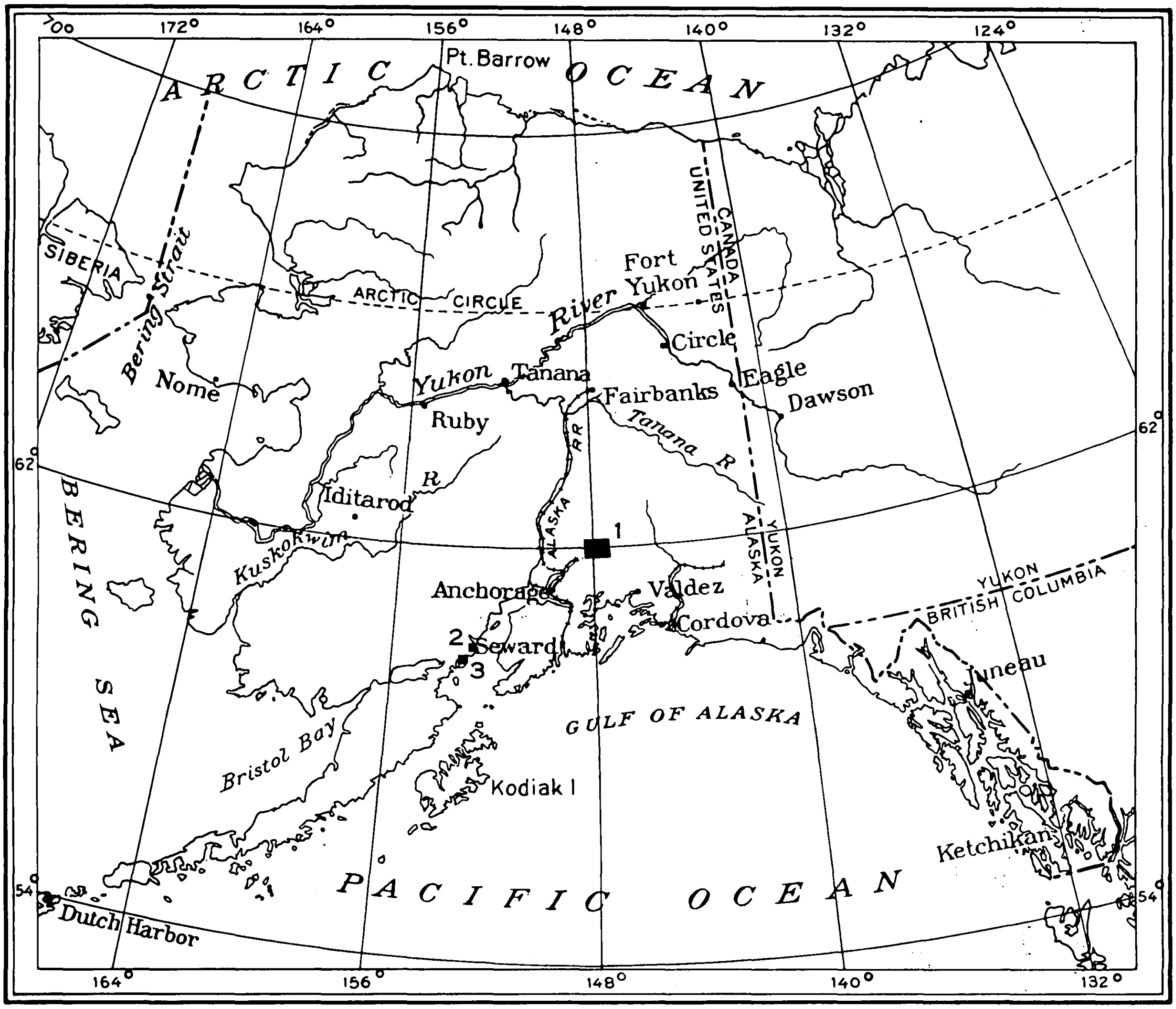

FIGURE 1.—Index map showing the principal areas of upper Bajocian (Jurassic) rocks in the Cook Inlet region, Alaska. (1) Eastern part of the Talkeetna Mountains; (2) Tuxedni Bay area; (3) northern part of the Iniskin Peninsula.

arched venter. The umbilicus is fairly narrow, steplike; wall fairly low, vertical, rounding evenly into flanks. The incomplete body chamber comprises at least half a whorl.

The shell bears fine gently flexuous growth lines that become slightly stronger ventrally. These incline forward on the lower part of the flanks, recurve backward just above the middle of the flanks, and then curve forward again. The suture line is characterized by the second lateral saddle, being much higher than the first. The first lateral lobe is much longer than the ventral lobe.

Most of the specimens are too crushed or incomplete for accurate measurements. One small specimen at a diameter of 37 mm has a whorl height of 19 mm, a whorl thickness of 13 mm, and an umbilical width of 7.5 mm.

This species is distinguished from all described species of *Lissoceras* by its larger size and more highly frilled suture line. *L. oolithicum* (d'Orbigny) (1846, p. 383, pl. 126, figs. 1–4; Roman and Petourand, 1927, p. 48, pl. 5, figs. 12–14) from the upper Bajocian of Europe is probably the most similar, but it has more convex flanks, inclined instead of vertical umbilical wall, and a more narrow second lateral saddle.

This species is named in honor of Arthur A. Baker of the Geological Survey, who collected the holotype specimen.

Types: Holotype USNM 130891; paratypes, USNM 130892, 130893a, b, 130894.

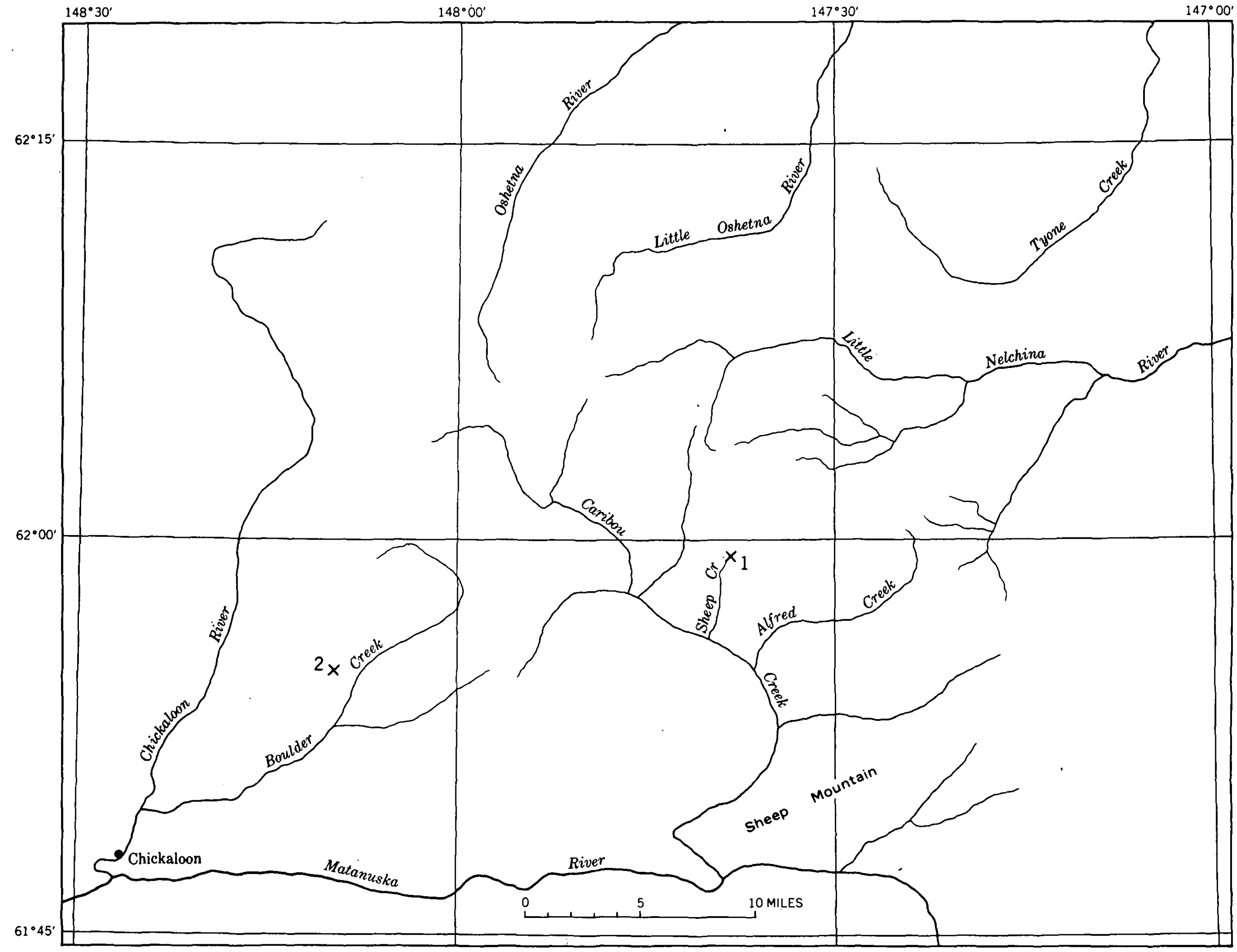

FIGURE 2.—Index map showing occurrences of upper Bajocian (Jurassic) fossils in the Talkeetna Mountains, Alaska. (Numbers on map refer to those given in the locality list (table 2) and in the distribution table.)

Occurrence: Lower part of Bowser member of the Tuxedni formation, Iniskin Peninsula, at USGS Mesozoic locs. 11034, 19934, 21282, 21314, 21315; Tuxedni Bay area at Mesozoic locs. 22709 and 22710.

Genus OPPELIA Waagen, 1869

Subgenus LIROXYITES Imlay, 1961

The original description of this subgenus (Imlay, 1961, p. 469) is as follows:

This subgenus resembles *Oxycerites* Rollier in its highly involute coiling, discoid shape, sharp venter, and presence of numerous auxiliary lobes in its suture line. It differs by its falcoid ribs being much broader and more closely spaced, by the presence of conspicuous falcoid striae, and by the ribs and striae persisting well onto the adult body chamber instead of fading. Other possible distinctions are the weak crenulations on the keel formed by the continuations of the ribs and the striae; the presence on some specimens of two raised spiral bands instead of a single median spiral band; and the development of eccentric coiling on the adult body chamber. The type species of *Liroxyites* is *Oppelia* (*Liroxyites*) *kellumi* Imlay, n. sp.

Oppelia (Liroxyites) kellumi Imlay

Plate 2, figures 1–12

?*Oppelia* (*Oxycerites*) ex gr. *fallax* Gueranger. Frebold, 1957, Canada Geol. Survey Mem. 287, p. 54–56, pl. 28, fig. 2 [not figs. 1a, b].

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

The original description is as follows:

This species is represented by 50 specimens of which most retain some shelly material. The shell is a discoidal, highly involute compressed oxycone. The coiling becomes slightly eccentric on the body chamber. The lower parts of the flanks are subparallel, but the upper parts converge toward the venter. The venter is acute and bears a narrow open keel that is generally slightly pinched at its base and, wherever the shell is preserved, is marked by faint continuations of the ribbing. The umbilicus is extremely small on the septate part of the shell but widens on the body chamber. The umbilical wall is low, vertical, and rounds rather abruptly into the flanks. The body chamber occupies half a whorl. The aperture terminates abruptly in a gentle, forwardly inclined falcoid curve.

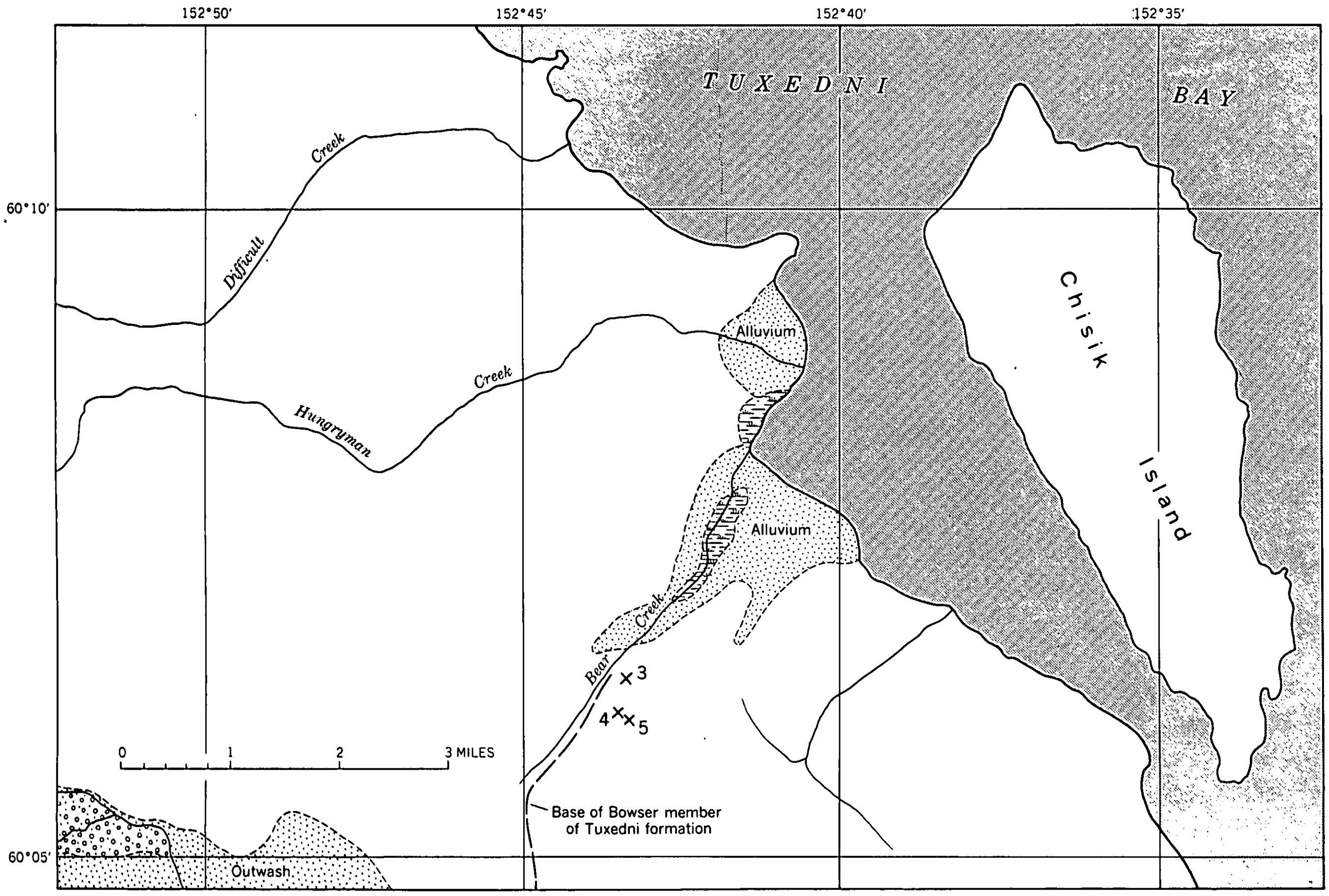

FIGURE 3.—Index map showing occurrences of upper Bajocian (Jurassic) fossils in the Tuxedni Bay area, Alaska. (Numbers on map refer to those given in the locality list (table 2) and in the distribution table.)

The ornamentation consists of weak to moderately strong falcoid ribs, falcoid striae and faint, broad spiral bands. The falcoid ribs are low and nearly as broad as the interspaces. They are barely visible at a diameter of 22 mm and gradually become higher and broader during growth except near the aperture of the adult where they weaken. They arise near the middle of the flanks as bundles of striae, become stronger ventrally, weaken considerably at the keel and are faintly indicated on the keel wherever the shell is preserved. On internal molds, however, the ribs end abruptly at the keel. They do not split into secondary ribs. The falcoid striae cover the entire surface of the shell parallel to the ribs but unlike the ribs are not visible on the internal molds. On some specimens a faint spiral band occurs at about two-fifths of the height of the whorl and another at three-fifths of the height of the whorl.

The suture line is finely frilled, has a longer ventral than lateral lobe, and has seven auxiliary lobes that diminish regularly toward the umbilical seam.

Most of the specimens are too imperfect for accurate measurements. However, the specimen shown on plate 63, figure 9 at a diameter of 62 mm has a whorl height of 35 mm, a whorl thickness of 13 mm, and an umbilical width of 4 mm.

This species bears broad falcoid ribbing closely similar to that of an ammonite from the Fernie group of Alberta, Canada, described by Frebold (1957, p. 54–56, pl. 28, fig. 2) as *Oppelia (Oxycerites)* ex. gr. *fallax* Gueranger and it may be identical specifically. However, it differs from the European *Oppelia (Oxycerites) fallax* (Gueranger), as described by Arkell (1951, p. 56–60, pl. 5, figs. 1–3; pl. 8, figs. 11a, b; text-figs. 15, 16) by having broader, lower, and more closely spaced falcoid ribs that persist onto the adult body chamber. The large smooth adults of the European species of *Oxycerites* contrast markedly with the ribbed adult whorls of *Oppelia (Liroxyites) kellumi* Imlay, n. sp. from Alaska.

The eccentric coiling of the Alaskan species contrasts also with the tight coiling of most species of *Oxycerites*, but does occur on *Oxycerites knapheuticus* (Buckman) (1924, pl. 479) from the lower Bathonian of England and on *Oxycerites tilli* (Loczy) (1915, pl. 4, fig. 3) from the Callovian of Hungary.

The weak spiral banks on the Alaskan species are not nearly as well developed as the spiral grooves and ridges on *Strigoceras* (Arkell, 1957, p. L272) and are not accompained by fine furrows and ridges, or by a hollow keel, as in that genus.

This species is named in honor of Lewis B. Kellum of the University of Michigan who collected some of the type specimens.

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

Occurrence.—Lower part of the Bowser member of the Tuxedni formation, Iniskin Peninsula, at USGS Mes. locs. 11035, 11036, 19943, 20001, 21282, 21313, 21314, 21315, 21318, and 27099.

Genus MEGASPHAEROCERAS Imlay, 1961

The original description of this genus (Imlay, 1961, p. 470) is as follows:

This genus resembles *Sphaeroceras* Bayle in its globular shape, tiny umbilicus, sharp, wiry ribbing, and a tendency for the inter-

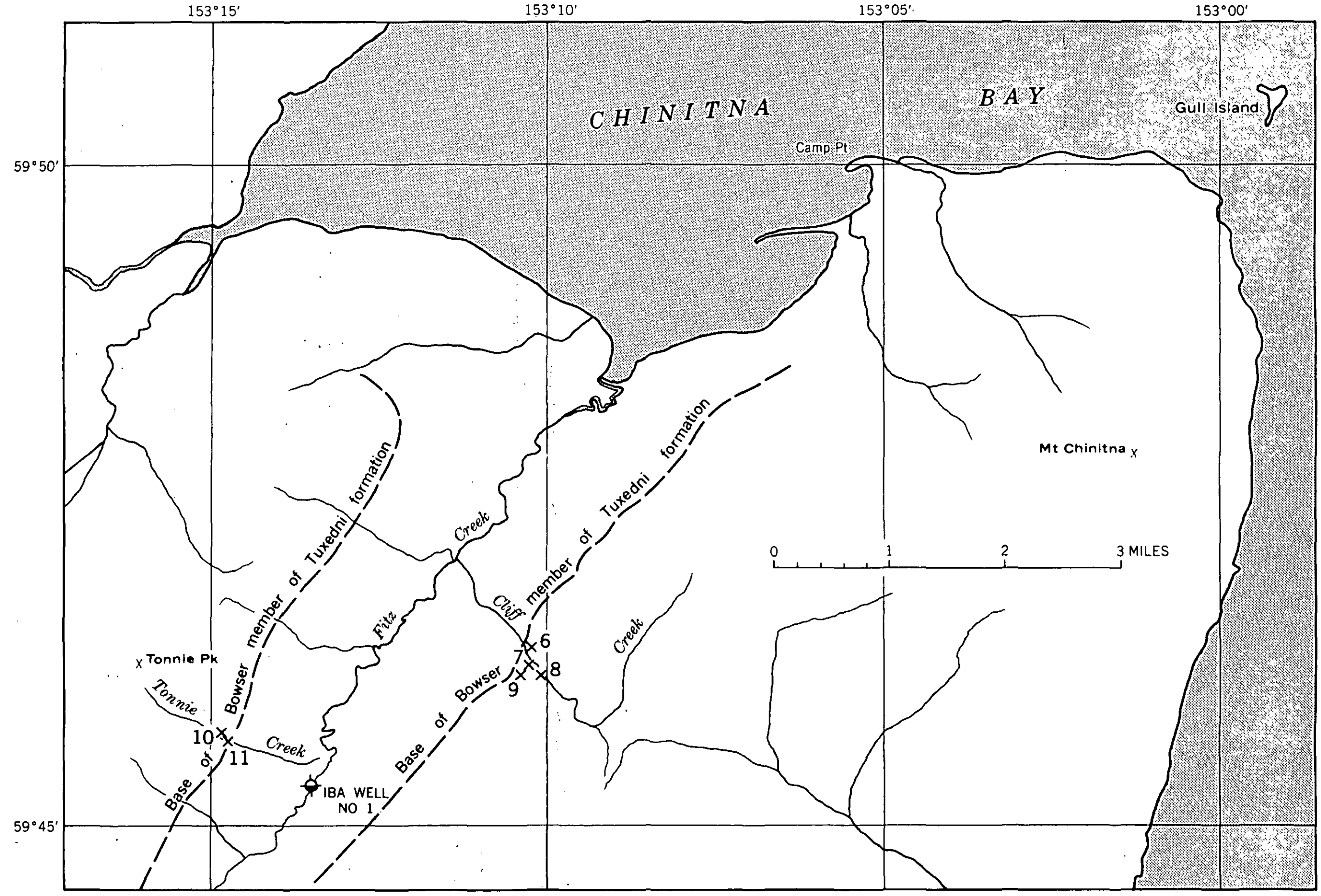

FIGURE 4.—Index map showing occurrences of upper Bajocian (Jurassic) fossils in the northern part of the Iniskin Peninsula. (Numbers on map refer to those given in the locality list (table 2) and in the distribution table.)

nal mold to be smooth or nearly smooth. It differs markedly, however, by the adult body chamber remaining tightly coiled, enlarging adorally instead of contracting, and bearing much weaker ribbing than the septate whorls. Furthermore, the apertural constriction is followed by a weak swelling rather than by a flared collar and the adults are much larger than in any described species of *Sphaeroceras*. The suture line has moderately broad lobes and saddles, has an irregularly trifid first lateral lobe that is slightly longer than the ventral lobe, and bears a general resemblance to that of the genus *Labyrinthoceras* Buckman (1919, pls. 134, 135).

The type species of *Megasphaeroceras* is *Megasphaeroceras rotundum* Imlay, n. sp.

Megasphaeroceras rotundum Imlay

Plate 3, figures 1, 4–12

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

The original description of this species is as follows:

The species is represented by about 60 specimens. The shell is stout to moderately stout and is tightly coiled. The whorls are depressed, wider than high, widest on the lower fourth of the flanks, becoming more depressed with growth, embracing preceding whorls nearly completely. The flanks and venter are evenly convex. The umbilicus is extremely small. The umbilical wall is low, vertical at base, and rounds fairly abruptly into flanks. The body chamber is represented by three-fifths to three-fourths of a whorl. The aperture curves strongly forward and terminates abruptly. It is marked on the internal mold by a broad constriction followed by a weak swelling that is not apparent where the shell is preserved. At the apertural constriction there is a slight contraction of the body whorl.

The ribbing on the septate part of the shell is sharp and gently flexuous. The primary ribs are radial on the umbilical wall and curve forward on the lower fourth of the flank where some of them bifurcate. From 1 to 3 secondary ribs arise freely near the zone of furcation between the primary ribs. All secondary ribs become higher and sharper ventrally, curve forward on the flanks, and cross the venter with a slight forward arching.

The ribbing on the adult body chamber weakens considerably but persists adorally to near the aperture as low broad ribs and striae. The shell at the apertural constriction is marked only by striae.

The ribbing on the internal molds of the septate whorls is much weaker than on the shell, but the greatest weakening occurs on the internal molds of the adult body chamber where the ribbing becomes very weak and on some specimens is indistinct.

The suture line is rather finely divided and has moderately broad saddles and lobes. The first lateral lobe is irregularly trifid and slightly longer than the ventral lobe. The second lateral saddle is broader and lower than the first lateral saddle. The general sutural pattern is similar to that of *Labyrinthoceras* *intricatum* Buckman (1919, pl. 135). The suture line of *Sphaeroceras brongniarti* (J. Sowerby) illustrated by Westermann (1956a, text-fig. 6 on p. 31) has a broader first lateral lobe and a narrower second lateral saddle.

The dimensions of the type specimens in millimeters are as follows:

Specimen	*Diameter*	*Whorl height*	*Whorl thickness*
Paratype 130899c	92 ?	53	?
Holotype 130898	62	33	42 ?
Paratype 130899a	63	35	?
Paratype 130899d	48	30	34
Paratype 130899b	41	25	25

This species shows considerable variation in the density and coarseness of its ribbing, in the persistence of the ribbing on the body chamber, in the imprint of the ribbing on the internal mold, and in the stoutness of its whorls. All these characteristics vary independently of each other and consequently separation of the species into subspecies has not been possible. Although certain specimens differ markedly from other specimens in stoutness of whorls or in coarseness of ribbing, there are many other specimens that are intermediate in appearance between the extreme variants.

Types.—holotype USNM 130898; paratypes USNM 130899a–d, 130900.

Occurrence.—Lower part of Bowser member of the Tuxedni formation at USGS Mesozoic locs. 11035, 11036, 19943, 21282, 21313, 21314, 21315, 21318, 22709, 26593. Talkeetna Mountains from the Tuxedni formation at Mesozoic loc. 24821.

Megasphaeroceras cf. M. rotundum Imlay

Plate 3, figures 2, 3

Several adult specimens bearing considerable shell material differ from *M. rotundum* Imlay by having much finer denser ribbing that disappears at an earlier growth stage. Their shells exhibit faint ribbing on the adapical end of the body whorl but the body chambers are marked only by weak forwardly curved striae. The internal molds of the body chambers are quite smooth. These specimens possibly represent a finely ribbed variant of *M. rotundum* Imlay in which the body chamber becomes almost smooth.

Figured specimen.—USNM 130904.

Occurrence.—Lower part of Bowser member of the Tuxedni formation at USGS Mesozoic locs. 19934, 21315, and 21318.

Genus SPHAEROCERAS Boyle, 1878

Sphaeroceras talkeetnanum Imlay, n. sp.

Plate 5, figures 1–4

The genus *Sphaeroceras* is represented in the Geological Survey collections from Alaska by one specimen that shows only the adult body whorl. The septate part of this whorl is globose and tightly coiled. The body chamber includes about three-fifths of a whorl, is semicircular in section, and becomes depressed near the aperture. Its adoral part is abruptly contracted from the septate part of the shell so that the umbilical seam trends radial and then bends forward at a right angle near the aperture. The aperture terminates in a pronounced flared collar that is followed by a constriction, then by a minor swelling, and then by a nearly smooth area that is projected forward ventrally.

The body whorl is marked by about 38 primary and 89 secondary ribs. These are high and sharp where the shell is preserved but are low and weak on the internal mold. The primary ribs are slightly stronger than the secondary ribs, are radial on the septate part of the shell, and incline forward near the aperture. Bifurcation occurs mainly a little above the middle of the flanks. Some secondary ribs arise freely on the upper parts of the flanks.

The suture line is too poorly exposed to be traced accurately.

About one-fifth of a whorl behind the aperture the specimen has a maximum diameter of 49 mm and an estimated thickness of 36 mm. At the adapical end of the body chamber the whorl height is about 16 mm and the whorl thickness to 33 mm. Half a whorl adorally the same dimensions are 26 and 34 mm respectively, but the specimen is somewhat compressed laterally. Near the apertural flare the same dimensions are 19 and 32 mm respectively.

This Alaskan specimen is assigned to *Sphaeroceras* because of its extremely narrow umbilicus, fine superficial ribbing, its abruptly contracted body chamber, flared collar, and deep terminal constrictions. The genus *Sphaeroceras* has been discussed in detail by Westermann (1956a, p. 24–35, pl. 14), who shows that it differs from *Chondroceras* mainly by having a smaller umbilicus, a more abruptly contracted body chamber, generally finer sharper ribbing on the adult body chamber, and generally a less strongly flared collar. He notes that the genus in western Europe ranges from the middle Bajocian zone of *Stephanoceras humphriesianum* to the end of the Bajocian, but is most common in the lower part of the upper Bajocian. This range is supported by Arkell (1957, p. L292), but most of the individual occurrences listed by him (1952, p. 77; 1956, p. 32, 50, 142) are from the lower part of the upper Bajocian. One possible middle Bajocian occurrence is listed (Arkell, 1956, p. 268) from north Africa.

Concerning species of *Sphaeroceras*, Westermann recognizes only *S. brongniarti* (J. Sowerby) and two subspecies. He places *S. globus* Buckman (1927, pl. 725) in synonymy with *S. brongniarti* and suggests that *S. tutthum* Buckman (1921, pl. 258) is possibly synonymous.

The Alaskan specimen compares closely in shape and ribbing with *S. brongniarti* (J. Sowerby) as figured by Arkell (1952, fig. 20, p. 77) and Westermann (1956a, pl.

14, figs. 1–6). The only conspicuous difference is its considerably larger size and its more strongly flared collar. A few specimens of *S. brongniarti* (J. Sowerby) (Roman, 1938, pl. 18, fig. 187; Buckman, 1927, pl. 725; Westermann, 1956a, fig. 4, p. 30) have a moderately prominent ventral flare of similar shape, but on most specimens the flare is not as prominent.

Type.—Holotype USNM 130902.

Occurrence.—Upper part of Tuxedni formation in the Talkeetna Mountains at USGS Mesozoic loc. 8572.

Genus Dettermanites Imlay, 1961

The original description of this genus (Imlay, 1961, p. 471), is as follows:

This genus resembles *Stephanoceras* in coiling, shape, ornamentation and sutural pattern, but differs by having elongate lateral lappets. In this respect it is similar to *Polyplectites*, but it differs by being much larger, by developing coarser ribbing on its body chamber, and by its ventral lobe being appreciably longer than its first lateral lobe. In *Polyplectites* these lobes as illustrated by Westermann (1954, p. 337, 341, 345) are nearly of the same length. The genus *Normannites*, whose long lateral lappets somewhat resemble those of *Dettermanites*, has fewer secondary ribs that are much stronger relative to the primary ribs. Both ribbing and sutural pattern indicate an assignment of *Dettermanites* to the Stephanoceratidae rather than to the Otoitidae.

The type species of *Dettermanites* is *D. vigorosus* Imlay, n. sp. This genus is named in honor of Robert L. Detterman of the U.S. Geological Survey.

Dettermanites vigorosus Imlay

Plate 4, figures 1–9

Dettermanites vigorosus Imlay, 1961, Jour. Paleontology. v. 35, no. 3, p. 472, pl. 64, figs. 1–3.

The original description of this species is as follows:

This species is represented by 10 specimens preserved in concretions that with 3 exceptions reveal only one side of the specimen. The whorls are nearly coronate in section, much wider than high, and embrace the preceding whorls nearly one-half. The body whorl is slightly contracted from the penultimate whorl. The umbilicus is moderately wide. Its wall is steeply inclined and rounds evenly into the flanks. The body chamber occupies about three-fourths of a whorl. The aperture bears lateral lappets. It is marked on internal molds by a constriction, followed by a collar, and then by lappets.

The ribbing consists of prominent widely-spaced primary ribs that incline forward slightly and terminate near the middle of the flanks in acute tubercles. From these pass bundles of two, or rarely three, much weaker secondary ribs that incline forward on the flanks and cross the venter transversely. Many rib bundles are separated by single ribs that arise freely along the zone of furcation. Both ribs and tubercles become gradually stronger and sparser during growth.

The suture line is characterized by its ventral lobe being appreciably longer than the first lateral lobe and by the second lateral lobe being much shorter. The first lateral lobe is irregularly trifid.

The holotype at a diameter of 89 mm, has a whorl height of 32 mm, an estimated whorl thickness of 36 mm, and an umbilical width of 41 mm.

This species has much coarser ribbing than any described species of *Polyplectites* except possibly *P. dorni* (Roche) (1939, p. 222; Dorn, 1927, p. 240, pl. 5, fig. 6; Westermann, 1954, p. 342, pl. 32, figs. 4a, b) which is much smaller and apparently less evolute.

Types—Holotype, USNM 130895; paratypes, USNM 130896, 130897a, b.

Occurrence—Lower part of Bowser member of the Tuxedni formation, Iniskin Peninsula, at USGS Mesozoic locs. 11034–11036, 19934, 21314 and 21318. Talkeetna Mountains at USGS Mesozoic locs. 8572 and 24821.

Genus LEPTOSPHINCTES Buckman, 1920
Leptosphinctes cliffensis Imlay, n. sp.

Plate 5, figures 10, 11

One internal mold exhibits highly evolute coiling, a compressed whorl section, and an incomplete body chamber that occupies about four-fifths of a whorl. The septate whorls bear deep constrictions and fairly strong, forwardly inclined primary ribs that terminate in acute tubercles high on the flanks. The ribbing on the upper parts of the flanks and on the venter of the inner whorls is not exposed. However, the ventral area on the adoral half of the outermost septate whorl and the adjoining part of the body chamber is marked by fairly weak secondary ribs that arise in pairs from the lateral tubercles and incline strongly forward. Adorally on the body chamber all ribs become much weaker, the venter becomes nearly smooth, and the tubercles disappear. The body chamber bears two deep, forwardly inclined constrictions and several weak constrictions.

The suture line is only partly exposed near the middle of the outermost septate whorl. It appears to be less frilled and to have a stockier first lateral lobe than on the described European species of *Leptosphinctes*, although showing some resemblance to the suture line of *L. coronarius* Buckman (1921, pl. 202).

As only one side of the specimen is preserved, accurate measurements cannot be made. At a diameter of about 80 mm, the whorl height is 22 mm, and the umbilical width is 46 mm.

This specimen resembles *Leptosphinctes* (*Vermisphinctes*) *vermiformis* (Buckman) (1920, pl. 162) in coiling, strength of ribbing, and presence of deep constrictions. It is distinguished by the presence of lateral tubercles, by somewhat sparser ribbing, and by the secondary ribs arising higher on the flanks of the body whorl. Compared with *L. leptus* Buckman (1920, pl. 160) it is more evolute, has sparser ribbing, and probably has a lower whorl section. Compared with

L. coronarius Buckman (1921, pl. 202), its lateral tubercles appear to be much higher on the flanks and its coiling more evolute.

Type.—Holotype USNM 130907.

Occurrence.—Lower part of the Bowser member of the Tuxedni formation at USGS Mesozoic loc. 21313.

Leptosphinctes (Prorsisphinctes?) delicatus Imlay, n. sp.

Plate 5, figures 8, 9

One laterally crushed internal mold of which only one side is preserved consists of 1½ septate whorls and about three-fifths of a body chamber. The coiling is highly evolute. The whorls are ovate and compressed. The septate whorls bear deep constrictions and fairly weak forwardly inclined primary ribs that extend to near the middle of the flanks and do not bear tubercles. From them pass pairs of much weaker secondary ribs that incline strongly forward. The body whorl bears deep constrictions and low forwardly inclined primary ribs that fade out on the venter.

The ventral lobe is longer than the first lateral lobe. The second lateral lobe is a little shorter. The saddles are much wider than the lobes. The first lateral saddle is unevenly divided into a large outer branch and a small inner branch.

At a diameter of 94 mm, the whorl height is 24 mm and the umbilical width is 52 mm.

This specimen shows considerable resemblance to *Glyphosphinctes glyphus* Buckman (1925, pl. 544) which Arkell (1958, p. 168) provisionally assigns to the subgenus *Prorsisphinctes*. It differs in its sparser and weaker ribbing that tends to fade more on the venter of the larger whorls. In this respect it shows more resemblance to *Leptosphinctes davidsoni* Buckman (1921, pl. 201), but it differs by having slightly stronger ribbing and by lacking tubercles on its outer septate whorls. As its innermost whorls are not preserved, the presence or absence of tubercles cannot be demonstrated, and hence the subgeneric assignment to *Prorsisphinctes* is uncertain.

Type.—Holotype USNM 130901.

Occurrence.—Lower part of the Bowser member of the Tuxedni formation at USGS Mesozoic loc. 21318.

Leptosphinctes? sp.

Plate 5, figure 5

One internal mold of an immature ammonite has much coarser ribbing than the other specimens of *Leptosphinctes* described herein. It is highly evolute, bears several weak constrictions per whorl, and the primary ribs terminate in tubercles just below the umbilical seam. From these pass pairs of secondary ribs. The characteristics of the middle part of the venter are unknown. The coarseness of the ribbing is comparable with that on *Bigotites hennigi* Bentz (1925, p. 180, pl. 9, figs. 1–4) from northern Germany.

Figured specimen.—USNM 130905.

Occurrence.—Lower part of the Bowser member of the Tuxedni formation at USGS Mesozoic loc. 21314.

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INDEX

[Italic numbers indicate descriptions]

PLATES 1–5

PLATE 1

[Figures natural size unless otherwise indicated]

FIGURES 1–6, 9–12. *Lissoceras bakeri* Imlay, n. sp. (p. A–6).

1, 2. Paratype USNM 130894 from USGS Mesozoic loc. 22709.

3. Paratype USNM 130893a from USGS Mesozoic loc. 21282. Offset marks beginning of crushed body chamber.

4, 6. Paratype USNM 130893b from USGS Mesozoic loc. 21282. Offset marks beginning of crushed body chamber. Suture line (× 2) drawn at whorl height of 31.5 mm.

5, 9, 11, 12. Holotype USNM 130891 from USGS Mesozoic loc. 11034. Suture line (× 2) drawn at whorl height of 47 mm. A small part of the large septate whorl has been removed to show the next inner whorl.

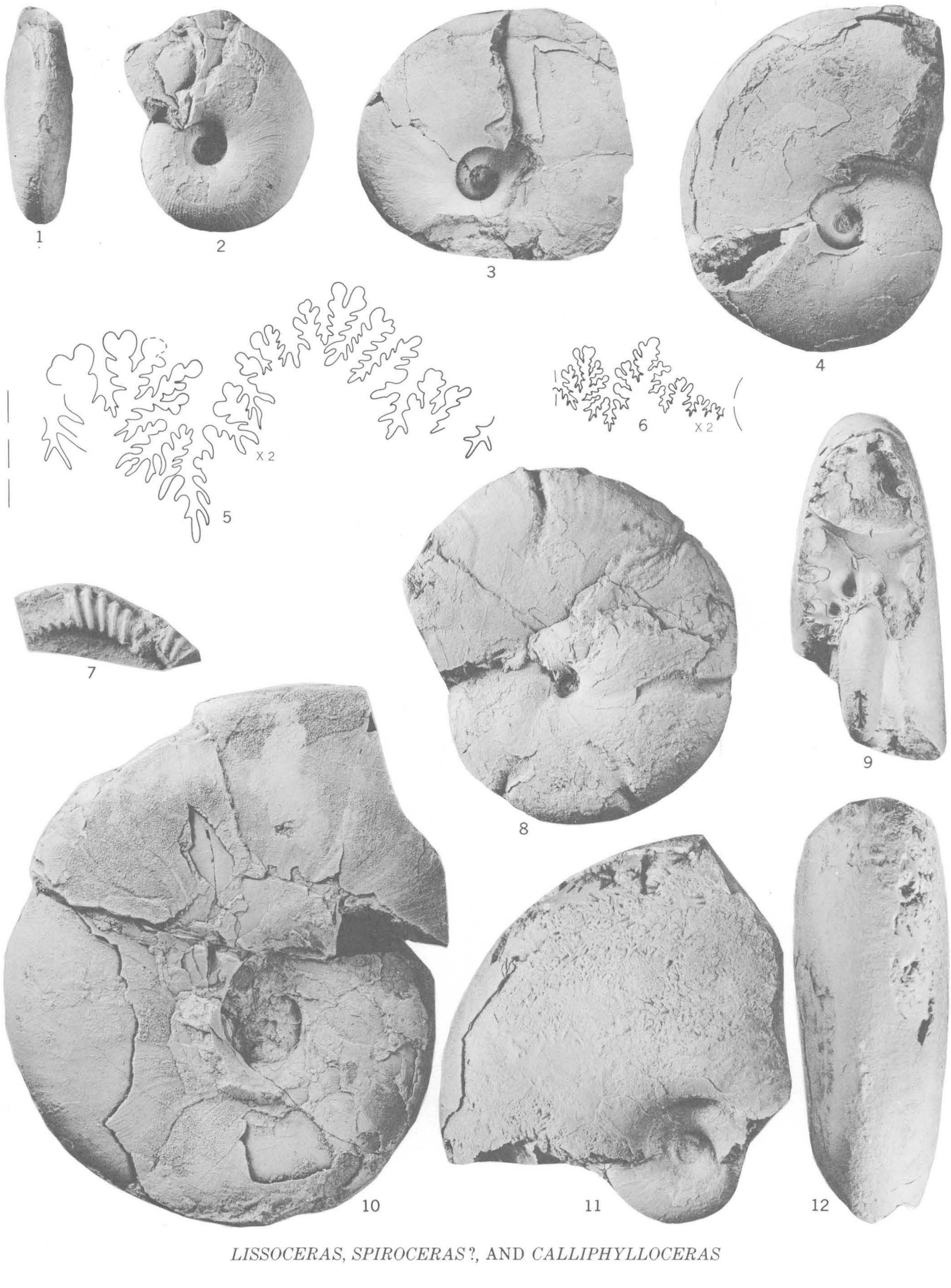
10. Paratype USNM 130892 from USGS Mesozoic loc. 19934. Shows slightly more than half a whorl of the body chamber.

7. *Spiroceras*? sp. (p. A–6).

Figured specimen USNM 130908 from USGS Mesozoic loc. 21282. Side view.

8. *Calliphylloceras* sp. (p. A–5).

Figured specimen USNM 130906 from USGS Mesozoic loc. 21315.



LISSOCERAS, SPIROCERAS ?, AND *CALLIPHYLLOCERAS*

PLATE 2

[Figures natural size unless otherwise indicated]

FIGURES 1–12. *Oppelia (Liroxyites) kellumi* Imlay (p. A–8).

1–4. Sutured paratype USNM 130888 from USGS Mesozoic loc. 19943. Apertural, lateral, and ventral views.

5. Suture line (× 2) of paratype USNM 130889a from USGS Mesozoic loc. 21318 drawn at whorl height of 28 mm.

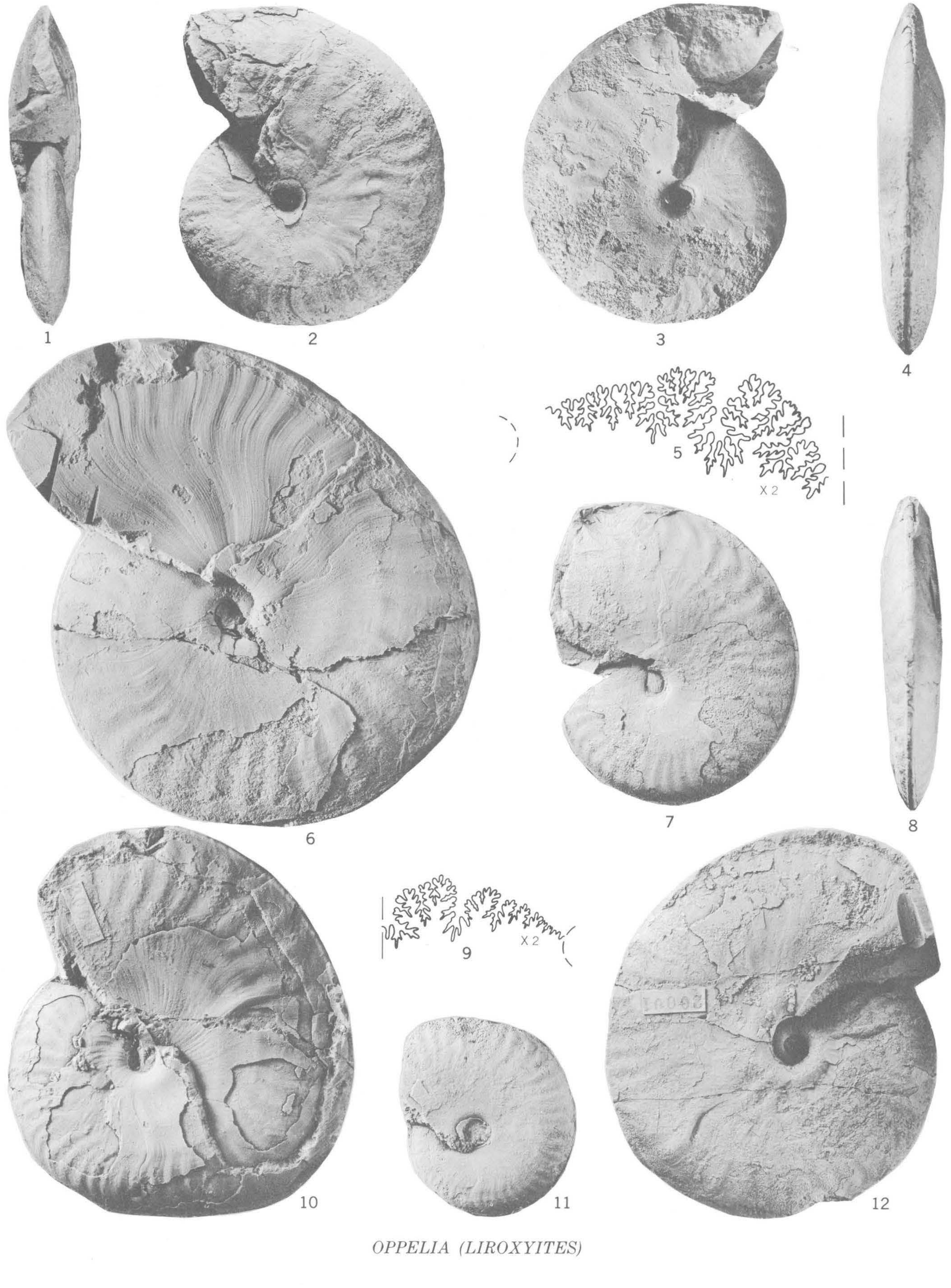
6. Holotype USNM 130886 from USGS Mesozoic loc. 20001. Shows complete body chamber occupying half a whorl and eccentric coiling.

7, 8. Paratype USNM 130889b from USGS Mesozoic loc. 21318.

9. Suture line (× 2) of paratype, USNM 130889c from USGS Mesozoic loc. 21318.

10, 12. Paratypes USNM 130887a, b from USGS Mesozoic loc. 20001. Show eccentric coiling of adult body chamber. Fig. 10 shows crenulations on the keel.

11. Paratype USNM 130890 from USGS Mesozoic loc. 11035. Shows ribbing of an inmature specimen.



OPPELIA (LIROXYITES)

PLATE 3

[Figures natural size unless otherwise indicated]

FIGURES 1, 4–12. *Megasphaeroceras rotundum* Imlay (p. A–10).

1. Paratype USNM 130899a USGS Mesozoic loc. 21314. Shows constriction and contraction of body whorl at aperture. Note how the sharpness of the ribbing where shell is preserved contrasts with the weak ribbing on the internal mold.

4, 7, 9. Holotype USNM 130898 from USGS Mesozoic loc. 21314. Note smoothness of internal mold on body chamber. Suture line (× 2) drawn at whorl height of 31 mm about one-quarter of a whorl from the body chamber.

5, 6. Paratype USNM 130899b from USGS Mesozoic loc. 21314. Shows the sharp ribbing typical of the shell of most immature specimens.

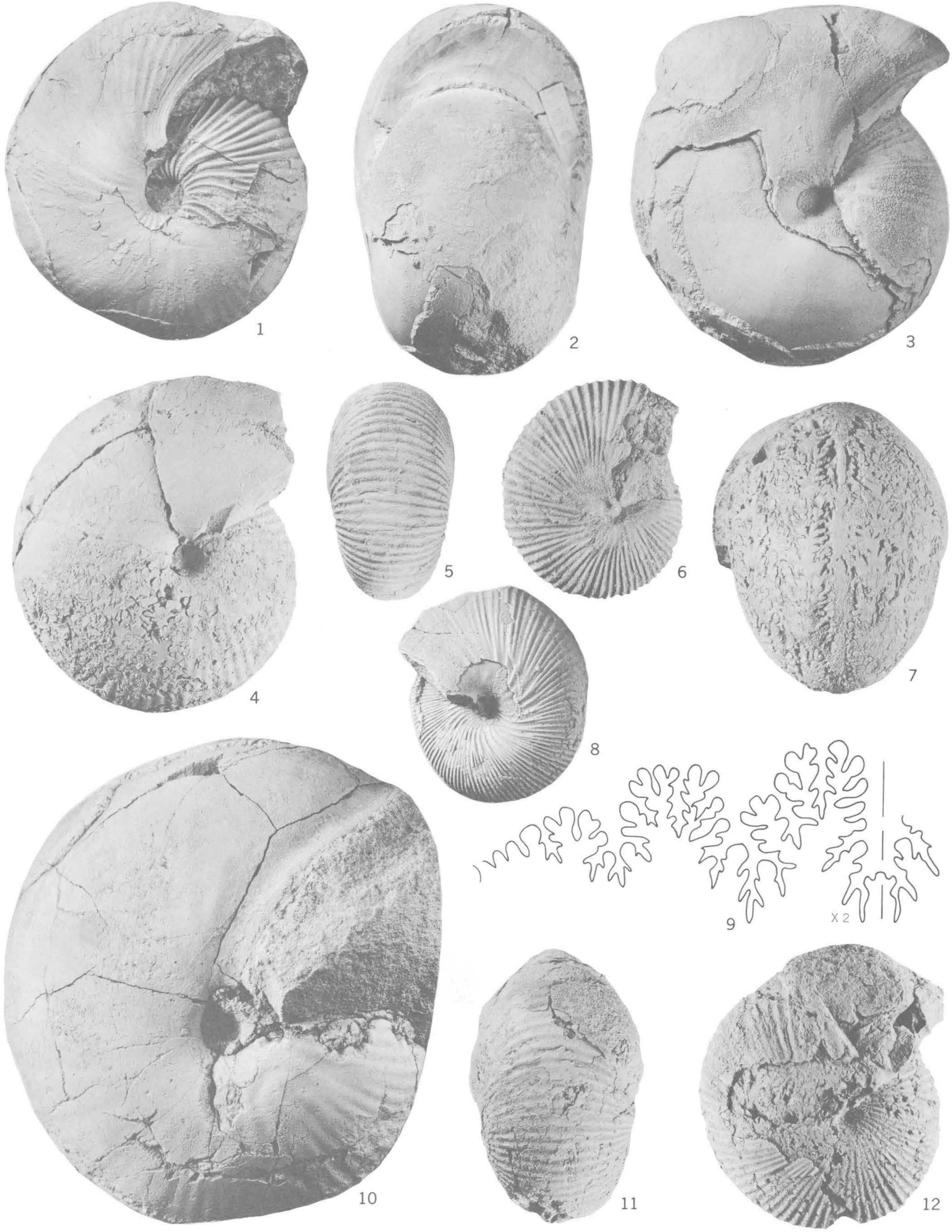
8. Paratype USNM 130900 from USGS Mesozoic loc. 21318. Shows finer denser ribbing than most immature specimens of the species.

10. Paratype USNM 130899c from USGS Mesozoic loc. 21314. Shows the weak ribbing on the internal mold of a large adult whorl.

11, 12. Paratype USNM 130899d from USGS Mesozoic loc. 21314. Shows ribbing intermediate in coarseness between that shown on figs. 6 and 8. Note absence of ribbing where the shell is removed.

2, 3. *Megasphaeroceras* cf. *M. rotundum* Imlay (p. A–11).

Figured specimen USNM 130904 from USGS Mesozoic loc. 19934.



MEGASPHAEROCERAS

PLATE 4

[Figures natural size unless otherwise indicated]

FIGURES 1–9. *Dettermanites vigorosus* Imlay (p. A–12).

1–3. Paratype USNM 130897a from USGS Mesozoic loc. 11036. Shows ornamentation of inner whorls and beginning of body chamber.

4, 7, 8. Holotype USNM 130895 from USGS Mesozoic loc. 21318. The suture line (× 2) was drawn at a whorl height of 18.5 mm about one-third of a whorl from the adoral end of the outermost septate whorl.

5, 6. Paratype USNM 130896 from USGS Mesozoic loc. 8572. Shows half a whorl of the adult body chamber from which a small part has been removed.

9. Paratype USNM 130897b from USGS Mesozoic loc. 11036.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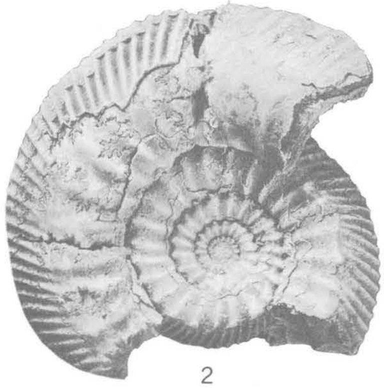
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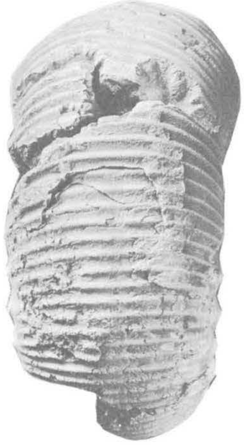
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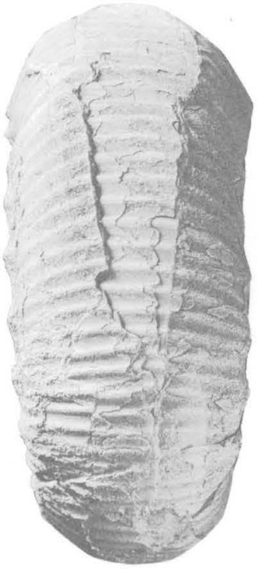
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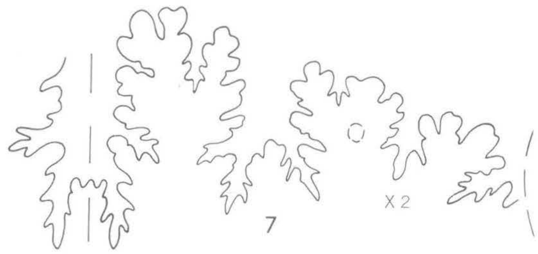

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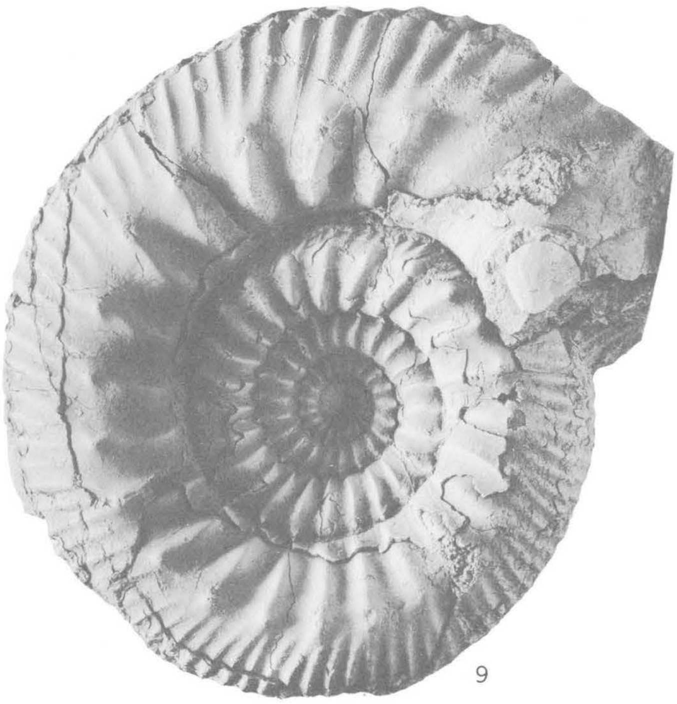
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DETTERMANITES

PLATE 5

[Figures natural size unless otherwise indicated]

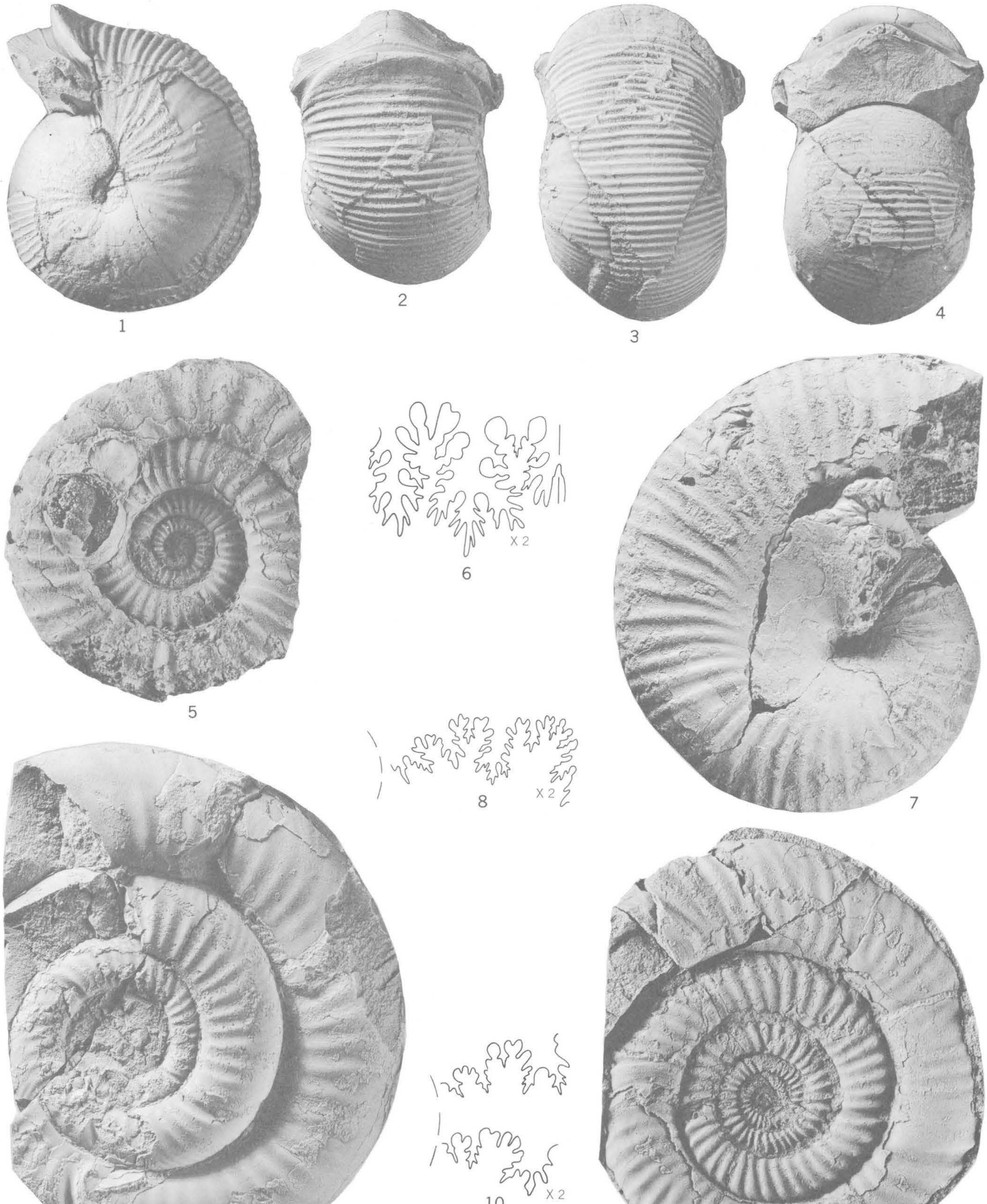
FIGURES 1–4. *Sphaeroceras talkeetnanum* Imlay, n. sp. (p. A–11).
Holotype USNM 130902 from USGS Mesozoic loc. 9572. Lateral, ventral (2 views) and apertural views. The sinuous ventral margin of the aperture is shown on fig. 2.

5. *Leptosphinctes*? sp. (p. A–13).
Figured specimen USNM 130905 from USGS Mesozoic loc. 21314.

6, 7. *Macrophylloceras* cf. *M. grossicostatum* Imlay (p. A–5).
Figured specimen USNM 130903 from USGS Mesozoic loc. 21313. Partial suture line drawn at whorl height of 29mm.

8, 9. *Leptosphinctes* (*Prorsisphinctes*?) *delicatus* Imlay, n. sp. (p. A–13).
Holotype USNM 130901 from USGS Mesozoic loc. 21318. Suture line (× 2) drawn at whorl height of 14 mm.

10, 11. *Leptosphinctes cliffensis* Imlay, n. sp. (p. A–12).
Holotype USNM 130907 from USGS Mesozoic loc. 21315. Suture line (× 2) drawn at whorl height of about 13 mm near middle of outermost septate whorl.



SPHAEROCERAS, *LEPTOSPHINCTES*, AND *MACROPHYLLOCERAS*