Jurassic (Bathonian or Early Callovian) Ammonites From Alaska and Montana

By RALPH W. IMLAY

SHORTER CONTRIBUTIONS TO GENERAL GEOLOGY

GEOLOGICAL SURVEY PROFESSIONAL PAPER 374-C

Descriptions and illustrations of cephalopods of possible late Middle Jurassic (Bathonian) age

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1962

UNITED STATES DEPARTMENT OF THE INTERIOR

STEWART L. UDALL, *Secretary*

GEOLOGICAL SURVEY

Thomas B. Nolan, *Director*

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington 25, D.C.

CONTENTS

	Page
Abstract	C-1
Introduction	C-1
Biologic analysis	C-2
Stratigraphic summary	C-2
Cook Inlet region, Alaska	C-2
Iniskin Peninsula	C-2
Peninsula north of Chinitna Bay	C-3
Talkeetna Mountains	C-3
Western Montana	C-5
Rocky Mountain front north of the Sun River	C-5
Drummond area	C-10
Age of the faunas	C-10
Evidence from Alaska	C-10
Evidence from Montana	C-12
Age of the faunas—Continued	
Callovian versus Bathonian in Greenland	C-12
Callovian versus Bathonian in Alaska and Montana	C-13
Paleogeographic considerations	C-13
Summation of the evidence	C-14
Comparisons with other faunas	C-14
Western interior of Canada	C-14
Arctic region	C-15
other regions	C-15
Geographic distribution	C-15
Summary of results	C-19
Systematic descriptions	C-22
Literature cited	C-28
Index	C-31

ILLUSTRATIONS

[Plates 1-8 follow index]

PLATE 1. *Holcophylloceras*, *Oecotraustes* (*Paroecotraustes*)?, and *Arctocephalites* (*Cranocephalites*).
2. *Arctocephalites*?, *Siemiradzkia*?, and *Arctocephalites* (*Cranocephalites*).
3, 4. *Arctocephalites* (*Cranocephalites*).
5. *Arctocephalites* (*Cranocephalites*) and *Arcticoceras*?.
6. *Arctocephalites*?, *Cobbanites*, and *Xenocephalites*?.
7. *Parareineckeia* and *Cobbanites*.
8. *Cobbanites*.

	Page
FIGURE 1. Index map of the principal areas of Jurassic rocks in the Cook Inlet region, Alaska	C-4
2. Index map showing occurrences of fossils in the *Arctocephalites* (*Cranocephalites*) beds in the Talkeetna Mountains, Alaska	C-5
3. Index map showing occurrences of fossils in the *Arctocephalites* (*Cranocephalites*) beds in the peninsula south of Tuxedni Bay, Alaska	C-6
4. Index map showing occurrences of fossils in the *Arctocephalites* (*Cranocephalites*) beds in the Iniskin Peninsula, Alaska	C-7
5. Index map showing occurrences of fossils in the *Arctocephalites* (*Cranocephalites*) beds in northwestern Montana from the Sun River area northward	C-8
6. Index map showing occurrences of fossils in the *Arctocephalites* (*Cranocephalites*) beds in the Drummond area in western Montana	C-9
7. Correlation of some Middle and Late Jurassic formations in the Cook Inlet region, Alaska, and in western Montana	C-11

TABLES

	Page
TABLE 1. Ammonite genera in the *Arctocephalites* (*Cranocephalites*) beds in Alaska and Montana showing biological relationships and relative numbers available for study	C-2
2. Occurrences and stratigraphic positions of the Callovian ammonites from the upper part of the Bowser member of the Tuxedni formation, above the beds containing *Arctocephalites* (*Cranocephalites*)	C-3
3. Localities at which ammonites of Bathonian or early Callovian age have been collected in the *Arctocephalites* (*Cranocephalites*) beds in the Cook Inlet region, Alaska	C-16
4. Localities at which ammonites of Bathonian or early Callovian age have been collected in the upper member of the Sawtooth formation in western Montana	C-17
5. Geographic distribution of fossils from the *Arctocephalites* (*Cranocephalites*) beds in the Cook Inlet region, Alaska	C-20
6. Geographic distribution of fossils from the Sawtooth formation in northwestern Montana	C-21

JURASSIC (BATHONIAN OR EARLY CALLOVIAN) AMMONITES FROM ALASKA AND MONTANA

By Ralph W. Imlay

ABSTRACT

Jurassic ammonites of possible late Middle Jurassic (Bathonian) age occur in western Montana in the upper member of the Sawtooth formation and in the Cook Inlet area, Alaska, in the middle part of the Bowser member of the Tuxedni formation. They are characterized by *Cranocephalites*, a subgenus of *Arctocephalites*. They include, also, *Holcophylloceras*, *Parareineckeia*, a new genus of the Reineckeiidae, *Cobbanites*, a new genus of the Perisphinctidae, and some specimens assigned questionably to *Oecotraustes*, *Xenocephalites*, *Arcticoceras*, *Siemiradzkia*, and *Arctocephalites*.

Stratigraphically the beds containing these ammonites occupy the position of the Bathonian stage or the basal part of the Callovian stage of Europe. In the Iniskin Peninsula, Alaska, they lie unconformably on beds containing late Bajocian ammonites and grade upward into beds containing early Callovian ammonites. In the Talkeetna Mountains, Alaska, they lie on beds of Early Jurassic age and are overlain by beds containing typical early Callovian ammonites, but are more restricted in distribution than the Callovian beds. The fact that in many places the Callovian beds rest directly on Bajocian beds could mean either that the *Cranocephalites* beds were never deposited in those places or that they were eroded before the deposition of the Callovian beds.

In Montana the *Cranocephalites* beds seem to grade downward into beds containing middle Bajocian ammonites and are overlain sharply with possible disconformity by beds characterized by the early Callovian ammonite *Arcticoceras*. As the *Arcticoceras* beds are equivalent to at least part of the European zone of *Macrocephalus macrocephalites* at the base of the Callovian, the *Cranocephalites* beds cannot be younger than the basal part of that zone. A somewhat older age for the *Cranocephalites* beds in Montana would be favored if a disconformity exists between the *Cranocephalites* and *Arcticoceras* beds. Conceivably the *Cranocephalites* beds could span the entire Bathonian as well as the basal Callovian, but such a long time span for a single ammonite faunule seems unlikely.

Faunally the beds characterized by *Cranocephalites* cannot be dated exactly. They do not contain any genera typical of the Callovian of Europe and only two ammonites that probably belong to the Bathonian genus *Siemiradzkia*. A Callovian age is slightly favored by the presence of the family Reineckeiidae, by the fact that the new genera *Parareineckeia* and *Cobbanites* range upward into beds containing typical Callovian ammonites, and by the probability that *Cranocephalites* gave rise to the Callovian genera *Arcticoceras* and *Cadoceras*. This evidence is not at all conclusive, but it does indicate that the ammonites in the *Cranocephalites* beds are biologically close to ammonites in the Callovian and are not likely to be older than late Bathonian.

Considering both stratigraphic and faunal evidence, the *Cranocephalites* beds are tentatively correlated with the Bathonian rather than the Callovian stage and with the late rather than the early Bathonian. If this correlation is valid, the ammonites of Bathonian time occupied two distinct realms of which one included central and southern Europe and the Tethyan region from Mexico to Indonesia, and the other included the Arctic region and part of the North Pacific Ocean.

INTRODUCTION

The ammonites described herein have been studied primarily to determine whether the middle Jurassic (Bathonian) stage is represented by sedimentary rocks in Alaska and the western interior of the United States. The study was prompted at this time in order to test recent inferences and statements by W. J. Arkell (1956, p. 609) that a retreat of the Arctic Ocean from bordering lands began after early Bajocian time, that the seas retreated from most of the known land areas of the world about middle Bathonian time, that the Arctic Ocean was probably isolated from the other oceans during the Bajocian–Bathonian regression, and that Bathonian rocks are absent in North America north of southern Mexico with the possible exception of one place in northern Alberta. Evaluation of the fossil evidence bearing on the presence or absence of the Bathonian in the United States and Canada should be interesting to many geologists.

The fossils from the Cook Inlet region, Alaska were collected by G. C. Martin in 1913, A. A. Baker in 1921, Helmuth Wedow and L. B. Kellum in 1944, C. E. Kirschner in 1946, D. J. Miller and R. W. Imlay in 1948, Arthur Grantz in 1951–53, R. D. Hoare in 1952, L. F. Fay in 1953, and R. L. Detterman in 1958. The fossils from western Montana were collected by C. F. Deiss in 1940 and 1941, R. M. Garrels in 1940, Josiah Bridge in 1941, R. W. Imlay in 1944–58, J. B. Reeside, Jr. in 1944, W. A. Cobban in 1944–46, William Saalfrank in 1945, H. C. Yingling in 1944, M. R. Mudge in 1958 and 1959, and M. W. Reynolds in 1958 and 1959.

BIOLOGIC ANALYSIS

The Jurassic ammonites of Bathonian or earliest Callovian age discussed herein include 84 specimens from Alaska and 46 from western Montana. Their distribution by genera, subfamilies, and families is shown in table 1. The table shows that the Cardioceratidae is the dominant family and is represented mostly by *Arctocephalites* and *Cranocephalites*. Next in importance is the family Perisphinctidae which is represented mainly by the new genus *Cobbanites* and by two specimens probably belonging to *Siemiradzkia*. The families Phylloceratidae, Oppeliidae, Macrocephalitidae, and Reineckeiidae are of minor importance.

The biological relationships of *Arctocephalites* and *Cranocephalites* are not settled. Generally, they have been included in the Macrocephalitidae (Spath, 1932, p. 9, 32; Donovan, 1953, p. 78; Arkell, 1954, p. 117), but recently they have been included in the Cardioceratidae by Arkell (1957, p. L301), probably because of the presence of a constricted aperture. Also, they appear to be the ancestors of the Cardioceratidae and to have arisen separately from the Macrocephalitidae, according to Arkell (1956, p. 610; 1958, p. 233, 234).

The genus *Arctocephalites* as defined by Spath (1928, p. 174; 1932, p. 32, 33) includes stout to globose involute ammonites in which the ribbing is high and sharp on the inner whorls, becomes blunt on the penultimate whorl, and fades on the body whorl, but on some species may become strong again near the aperture. The aperture is constricted.

The genus *Cranocephalites* was based (Spath, 1932, p. 14–16) on some ammonites from East Greenland that were found only 20 meters stratigraphically below *Arctocephalites*. They resemble *Arctocephalites* in shape and in the sharpness of ribbing on their inner whorls. They differ from *Arctocephalites* by developing a scaphitoid body chamber, by the ribbing remaining strong or fairly strong on the body chamber, and by a tendency of the suture line to simplify. Spath (1932, p. 14) noted that the two genera are connected by transition species and that "separation was prompted chiefly by their difference of horizon."

TABLE 1.—*Ammonite genera in the* Arctocephalites (Cranocephalites) *beds in Alaska and Montana showing biological relationships and relative numbers available for study.*

Family	*Subfamily*	*Genus or Subgenus*	*Number of specimens in—* Alaska	Montana
Phylloceratidae	Calliphylloceratinae	*Holcophylloceras*	7	--------
Oppeliidae	Oppeliinae	*Oecotraustes?*	1	--------
Macrocephalitidae	--------------------	*Xenocephalites?*	--------	1
Cardioceratidae	Cadoceratinae	*Arctocephalites?*	6	1
		Cranocephalites	47	23
		Cranocephalites?	16	--------
		Arcticoceras?	--------	1
Reineckeiidae	--------------------	*Parareineckeia*	3	--------
Perisphinctidae	Zigzagiceratinae	*Cobbanites*	2	20
	Pseudoperisphinctinae	*Siemiradzkia?*	2	--------

Recent studies by Donovan (1953, p. 78, 130, 133) have shown that *Arctocephalites* and *Cranocephalites* are closely related, that the differences between them were overstressed by Spath, and that *Cranocephalites* is not worthy of more than subgeneric rank under *Arctocephalites*. These conclusions have been supported by Arkell (1956, p. 541; 1957, p. L301).

STRATIGRAPHIC SUMMARY

COOK INLET REGION, ALASKA

INISKIN PENINSULA

The Bowser member of the Tuxedni formation on the Iniskin Peninsula (Kirschner and Minard, 1949) ranges from 1,800 to 2,100 feet in thickness and consists of interbedded claystone, siltstone, sandstone, and conglomerate. At the base are 600 feet, or less, of interbedded dark-gray siltstone, sandy siltstone, and claystone that weathers reddish brown, contains many ash beds, and locally bears small fossiliferous limestone concretions. These beds are absent at the south end of the Iniskin Peninsula, southwest of the pass between Right Arm and Oil Bay. Above them follows abruptly about 430 to 730 feet of gray thick-bedded cliff-forming siltstone and sandstone that are interbedded with some units of gray sandy siltstone, siltstone, claystone, and conglomerate. Above follows from 790 to 1,150 feet of gray thick-bedded sandstone that contains many siltstone interbeds and becomes siltier eastward. In all sections the upper 100 feet consists of thick-bedded sandstone.

The Bowser member rests concordantly but abruptly on the massive sandstone of the Cynthia Falls sandstone member of the Tuxedni formation and grades at its top into shelly beds at the base of the Chinitna formation. Within the Bowser member the abrupt contact between the lowest massive siltstone and sandstone and the underlying few hundred feet of rusty weathering siltstone and claystone represents an unconformity (written communication, R. L. Detterman, May 15, 1959).

Concretions from the rusty-weathering beds in the lower few hundred feet of the Bowser member have furnished late Bajocian ammonites belonging to the genera *Leptosphinctes*, *Sphaeroceras*?, *Oppelia* (*Oxycerites*), *Lissoceras*, and *Polyplectites*. From the 430 to 730 feet of sandstone and siltstone in the middle part of the member have been obtained *Arctocephalites* (*Cranocephalites*), *Arctocephalites*?, *Parareineckeia* n. gen., and a number of pelecypods (table 5). From the 790 to 1,500 feet of cliff-forming sandstone at the top of the member have been obtained a varied pelecypod fauna and the early Callovian ammonites *Grossouvria* sp., *Kheraiceras intermedium* Imlay, *Kherai-*

ceras parviforme Imlay, *K.* sp., *Xenocephalites hebetus* Imlay, *X. vicarius* Imlay, *X.* sp., *Kepplerites* cf. *K. tychonis* (Ravn), *Kepplerites* sp., *Phylloceras bakeri* Imlay, *Calliphylloceras freibrocki* Imlay, *Macrophylloceras grossicostatum* Imlay, and numerous fragments of macrocephalitid ammonites (table 2).

PENINSULA NORTH OF CHINITNA BAY

The Bowser member northward from Chinitna Bay becomes finer grained and consists mostly of massive gray siltstone and sandy siltstone but contains some sandstone and conglomerate in its upper part. Its base is not exposed but its top is marked locally by channel conglomerates. Near Bear Creek the lower 300 feet of the member weathers rusty brown and contains many ash beds, and has furnished specimens of *Sphaeroceras*?, *Lissoceras*, and *Oppelia* (*Oxycerites*) identical with those in the lower few hundred feet of the Bowser member on the Iniskin Peninsula. The overlying 430 feet of massive gray sandy siltstone has furnished *Cranocephalites*. Above follows 820 feet of massive brown to gray siltstone that have furnished the early Callovian ammonites *Xenocephalites hebetus* Imlay and *X. vicarius* Imlay at places about 350 and 500 feet respectively below the top of the Bowser member (table 2). Near Hickerson Lake, north of Chinitna Bay, the ammonites *Cranocephalites*, *Siemiradzkia*?, and *Parareineckeia* n. gen., were obtained from gray siltstone about 1,000 to 1,100 feet below the top of the Bowser member and about 600 feet above the rusty weathering beds. From 200 to 400 feet below the top of the member were obtained specimens of the early Callovian ammonite *Kheraiceras* cf. *K. intermedium* Imlay. At the very top of the Bowser member at the north end of Chisik Island was obtained the Callovian ammonite *Kheraiceras intermedium* Imlay (table 2).

TALKEETNA MOUNTAINS

In the Talkeetna Mountains the *Cranocephalites* beds have been found at three places (table 5). A small collection (Mesozoic loc. 8573) was made by Martin (1926, p. 228) near Boulder Creek 3 miles above the mouth of East Boulder Creek in the Anchorage (D–4) quadrangle. Arthur Grantz and associates in 1952 and 1953 made several collections (Mesozoic locs. 24115–24118, 24825) on the north fork of the upper part of the Little Nelchina River and several other collections (Mesozoic locs. 24822–24824) on a small northward-draining tributary of the Little Oshetna River. Another small collection was made by R. A. Lyon near the Little Oshetna River (Mesozoic loc. 27515).

TABLE 2.—*Occurrences and stratigraphic positions of the Callovian ammonites from the upper part of the Bowser member of the Tuxedni formation above the beds containing* Arctocephalites (Cranocephalites)

[Data on stratigraphic positions furnished by R. L. Detterman]

Mesozoic localities	Fossil	Feet below top of Bowser member	Feet above *Cranocephalites* beds	Collector, year of collection, and description of localities
[1] 3014	*Kheraiceras intermedium* Imlay	At top	820	Stanton, T. W., 1904. North end of Chisik Island, 1.25 miles S. 81° E. of Fossil Point, 1 ft below base of Channel conglomerate.
3038	*Grossouvria* sp	Not determinable	Not determinable	Stanton, W. W., and Martin, G. C., 1904. Shore of Iniskin Bay at entrance to Right Arm, 5.25 miles N. 74° W. of Front Mountain.
11042	*Kheraiceras parviforme* Imlay	600–650	180–230	Baker, A. A., 1921. Iniskin Peninsula, on Edelman Creek, 1.4 miles N. 15° W. of Front Mountain.
20748	*Xenocephalites* sp. juv	500–550	280–320	Kirschner, C. E., 1946, Iniskin Peninsula. On Edelman Creek, 1.2 miles N. 10° W. of Front Mountain.
[1] 21272	*Kheraiceras intermedium* Imlay	At top	820	Miller, D. J., and Imlay, R. W., 1948. North end of, Chisik Island, at same place as Mesozoic loc. 3014.
21311	*Macrophylloceras grossicostatum* Imlay, *Phylloceras bakeri* Imlay, *Calliphylloceras freibrocki* Imlay.	550–600	At least 200–250	Imlay, R. W., and Miller, D. J., 1948, Iniskin Peninsula, 1.92 miles N. 89° E. of dock at mouth of Fitz Creek.
21312	*Xenocephalites hebetus* Imlay, *Kheraiceras intermedium* Imlay, *Macrophylloceras grossicostatum* Imlay, *Calliphylloceras freibrocki* Imlay.	A few feet higher than loc. 21311.	At least 200–250	Imlay, R. W., and Miller, D. J., 1948. Iniskin Peninsula, 1.9 miles N. 86° E. of dock at mouth of Fitz Creek.
[1] 21319	*Kepplerites* cf. *K. tychonis* Ravn	360–390	770–800	Imlay, R. W., and Miller, D. J., 1948. Iniskin Peninsula, 0.65 miles S. 35° E. of Tonnie Peak.
21320	*Parareineckeia* sp	370–420	410–460	Imlay, R. W., and Miller, P. J., 1948. Iniskin Peninsula, 4.7 miles S. 15° E. of Tonnie Peak.
22436	*Macrophylloceras grossicostatum* Imlay	550–600	At least 200–250	Hartsock, J. K., 1950, Iniskin Peninsula, about same position as Mesozoic loc. 21311.
22536	*Kheraiceras* sp	200–300	800–900	Hill, D. M., and Juhle, R. W., 1950. Right arm of Iniskin Bay, about 4.25 miles N. 58° W. of Front Mountain.
22549	*Kepplerites* sp	200–300	700–800	Hartsock, J. K., 1950. Iniskin Peninsula, 4.08 miles N. 41° E. of Front Mountain on tributary to Brown Creek.
22553	*Kepplerites* sp	300–400	700–800	Hill, D. M., 1950. Right arm of Iniskin Bay, about 0.13 mile south of Mesozoic loc. 22536.
[1] 22686	*Kepplerites* sp., *Kheraiceras* sp	At top	820	Grantz, Arthur, 1951. Northwest part of Chisik Island 1.2 miles southwest of the northern tip.
[1] 22699	*Kheraiceras* cf. *K. intermedium* Imlay	360–380	630–650	Grantz, Arthur, 1951. Peninsula south of Tuxedni Bay, on ridge 1.62 miles N. 51° E. of head of Lake Hickerson.
[1] 22700	*Kheraiceras* cf. *K. intermedium* Imlay	200–230	780–810	Grantz, Arthur, 1951, on ridge 1.7 miles N. 51° E. of head of Lake Hickerson.
[1] 22713	*Xenocephalites hebetus* Imlay	500	320	Grantz, Arthur, 1951. 0.62 mile above mouth of tributary entering Bear Creek 2.53 miles from Tuxedni Channel.
[1] 22714	*Xenocephalites vicarius* Imlay	350–370	450–470	Grantz, Arthur, 1951. 0.67 miles above mouth of same tributary described under Mesozoic loc. 22713.

[1] Stratigraphic position is well established.

582600 O—61——2

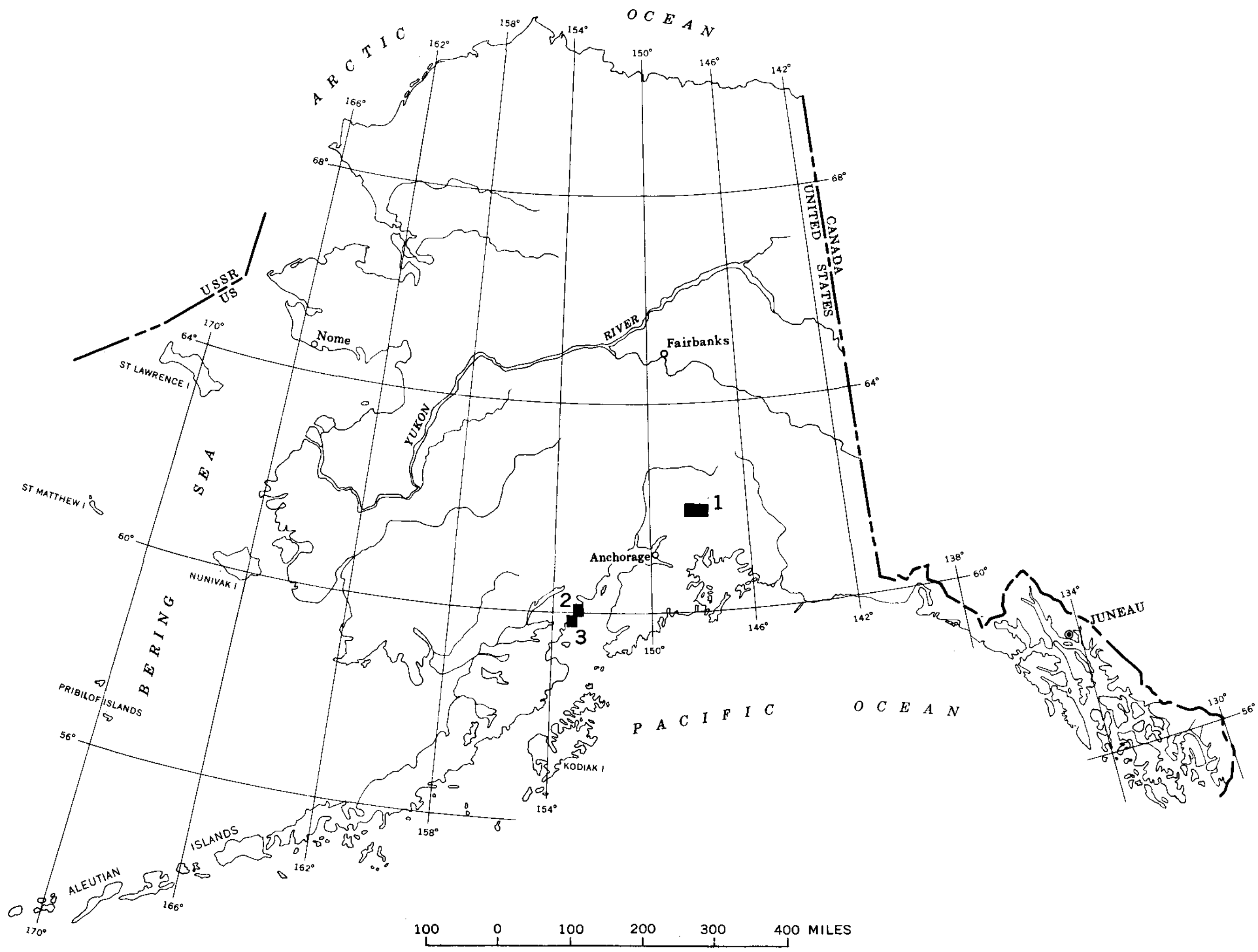


FIGURE 1.—Index map of the principal areas of Jurassic rocks in the Cook Inlet region, Alaska. (1. Talkeetana Mountains; 2. Peninsula south of Tuxedni Bay; 3. Iniskin Peninsula.)

According to Grantz (written communication, Apr. 8, 1959), the ammonite *Cranocephalites* was found near the Little Oshetna River in the middle of a sequence about 650 feet thick (Mesozoic loc. 24822). The sequence consists mostly of gray thick-bedded fine- to coarse-grained sandstone that is locally crossbedded. It includes lenses of conglomerate and some beds of siltstone, claystone, and coal. It rests unconformably on the Lower Jurassic Talkeetna formation and is overlain with apparent disconformity by a conglomeratic sandstone unit about 100 feet thick that also contains *Cranocephalites* (Mesozoic loc. 27515). The overlying Chinitna formation is about 800 feet thick and has furnished the early Callovian ammonite *Paracadoceras tonniense* Imlay about 100 to 150 feet below its top. There is no evidence for a disconformity at the base of the Chinitna formation.

The *Cranocephalites* beds exposed in the upper part of the Little Nelchina River valley, according to Grantz, are about 1,200 feet thick and consist mostly of units of gray medium- to thick-bedded fine- to coarse-grained sandstone and siltstone, but include lenses of pebble and cobble conglomerate in their upper part. The ammonites *Arctocephalites*?, *Cranocephalites*, and *Parareineckeia* n. gen., were found from 400 to 800 feet below the top. The base of the section is not exposed. The *Cranocephalites* beds are overlain concordantly by 100 feet of sandstone and conglomerate that have been mapped as the basal member of the Chinitna formation but have not furnished fossils. Above follows about 850 feet of beds whose lower part has furnished the Callovian ammonites *Cadoceras*, *Cosmoceras*, *Xenocephalites*, and *Kheraiceras*.

The stratigraphic position of *Cranocephalites* near Boulder Creek collected by Martin (1926, p. 228; Capps, 1927, p. 30) has not been determined, although Bajocian and Callovian ammonites have been found in the same area of Jurassic exposures.

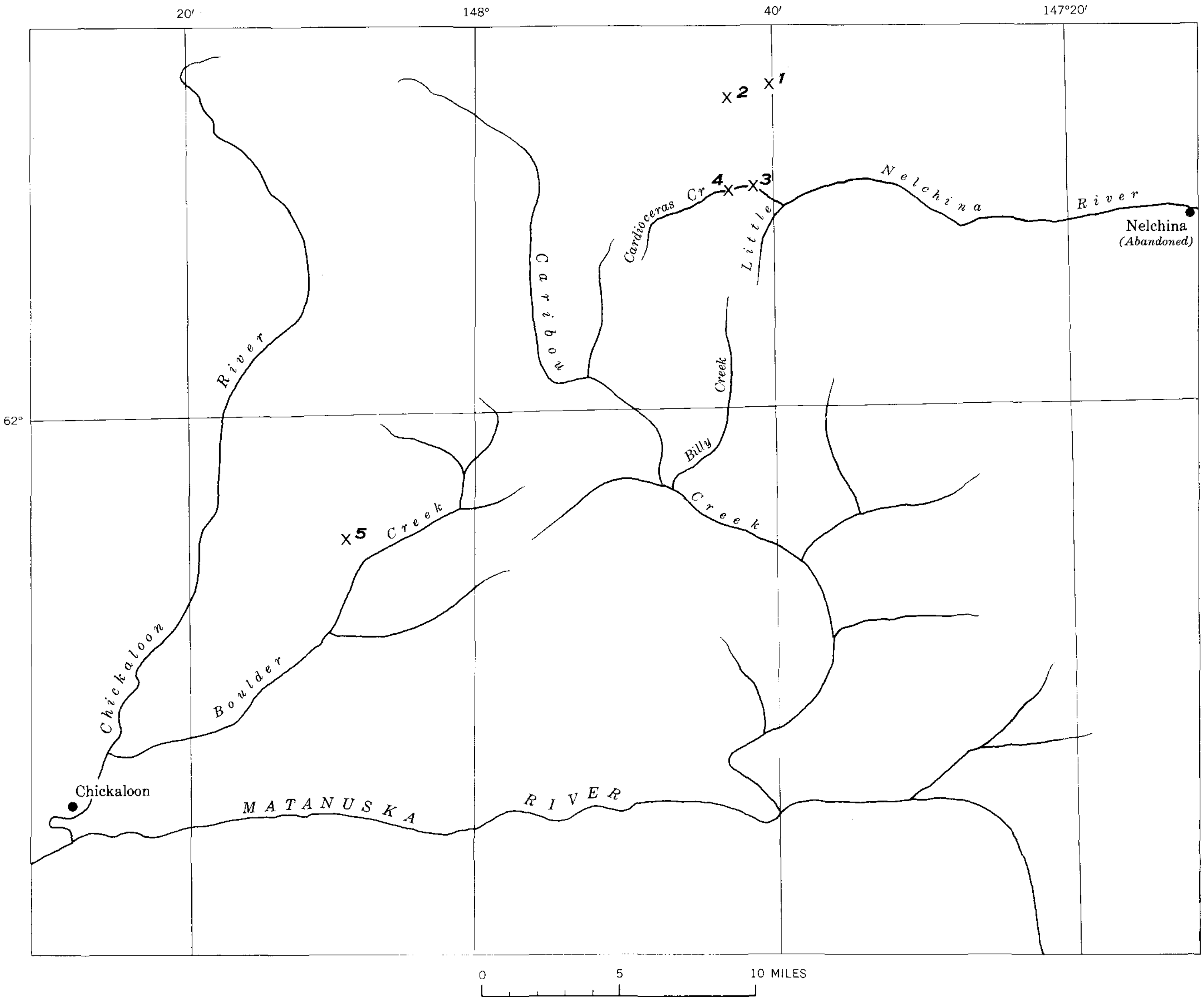


FIGURE 2.—Index map showing occurrences of fossils in the *Arctocephalites* (*Cranocephalites*) beds in the Talkeetna Mountains, Alaska. (Numbers on map refer to those given in tables 3 and 5).

The *Cranocephalites* beds in Cook Inlet region contain a great variety of pelecypods most of which have not been studied (table 5). However, the occurrence of *Gryphaea impressimarginata* (McLearn) (Mesozoic locs. 8573, 24118) is interesting as the species in the western interior of the United States is generally restricted to the upper part of the Sawtooth formation that contains *Cranocephalites* and to the lower part of the Rierdon formation that contains *Arcticoceras*.

WESTERN MONTANA

ROCKY MOUNTAIN FRONT NORTH OF THE SUN RIVER

An ammonite faunule characterized by *Arctocephalites* (*Cranocephalites*) has been found in calcareous siltstone in the upper part of the Sawtooth formation within the front ranges of the Rocky Mountains in Montana extending from the headwaters of the Sun River northward about 60 miles to Glacier Park. The Sawtooth formation (Cobban, 1945, p. 1270–1277; Imlay and others, 1948) within this area comprises 3 members of which the upper 2 are transitional into each other. The lower member consists mostly of sandstone that is generally cemented with silica, is pyritic, and attains 15 feet in thickness but is locally absent. It contains interbeds of dark-gray to black fissile shale and locally contains more shale than sandstone. Near the Sun River the lower member is capped at many places by a thin conglomerate consisting mostly of chert, quartzite, and limestone particles but containing some particles derived from the lower number. The middle member

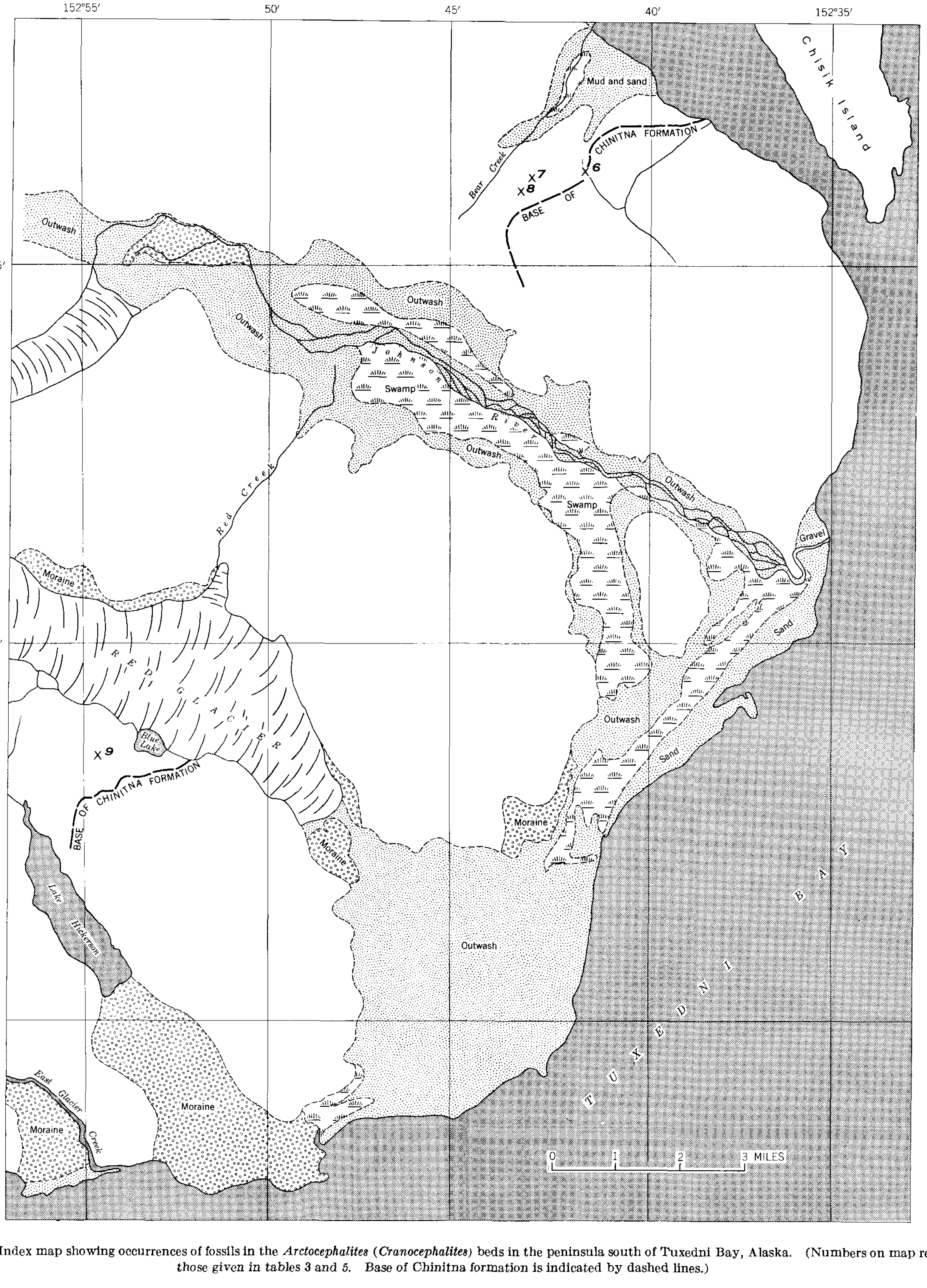


FIGURE 3.—Index map showing occurrences of fossils in the *Arctocephalites* (*Cranocephalites*) beds in the peninsula south of Tuxedni Bay, Alaska. (Numbers on map refer to those given in tables 3 and 5. Base of Chinitna formation is indicated by dashed lines.)

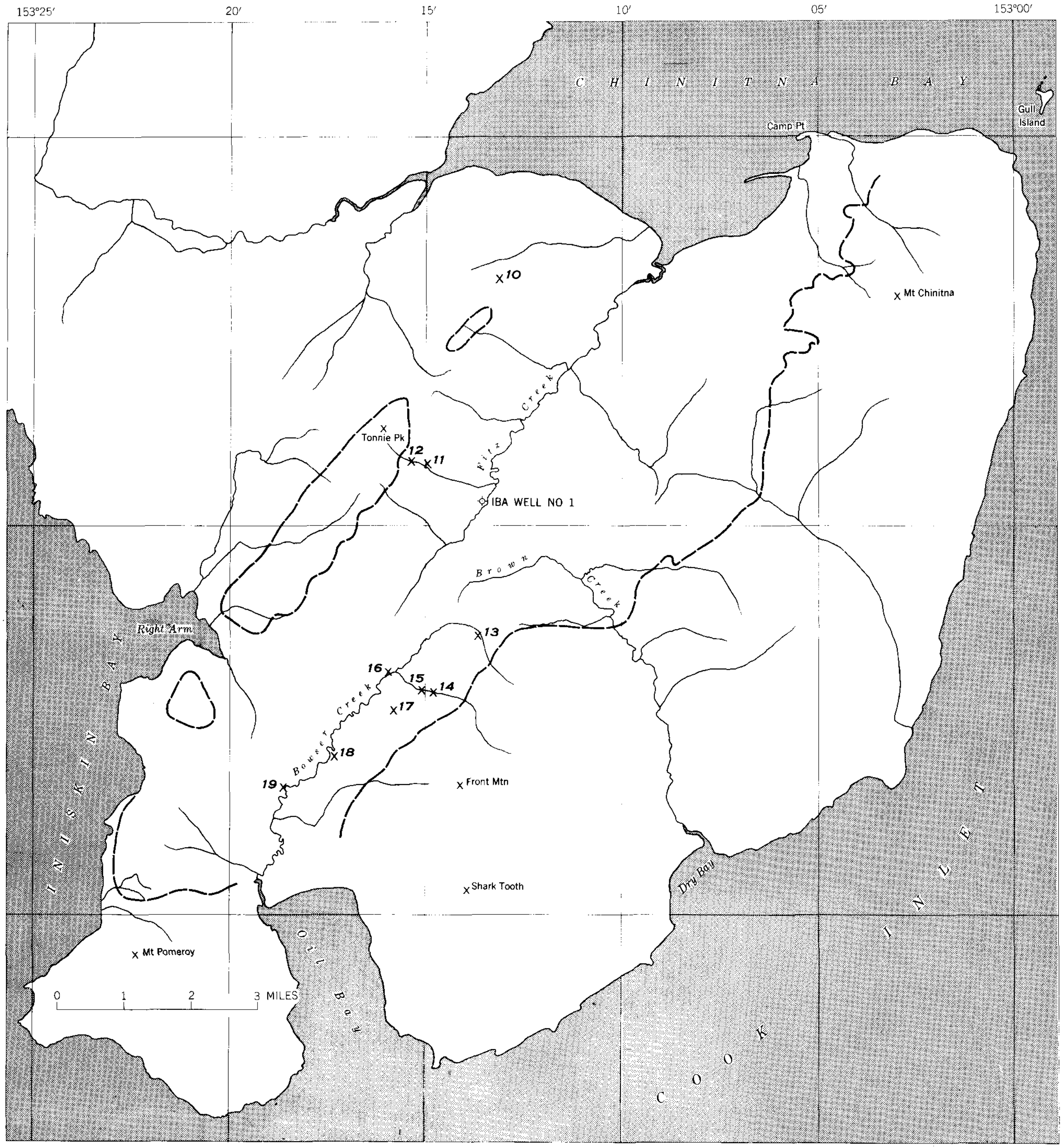


FIGURE 4.—Index map showing occurrences of fossils in the *Arctocephalites* (*Cranocephalites*) beds in the Iniskin Peninsula, Alaska. (Numbers on map refer to those given in tables 3 and 5. Base of Chinitna formation is indicated by dashed lines.)

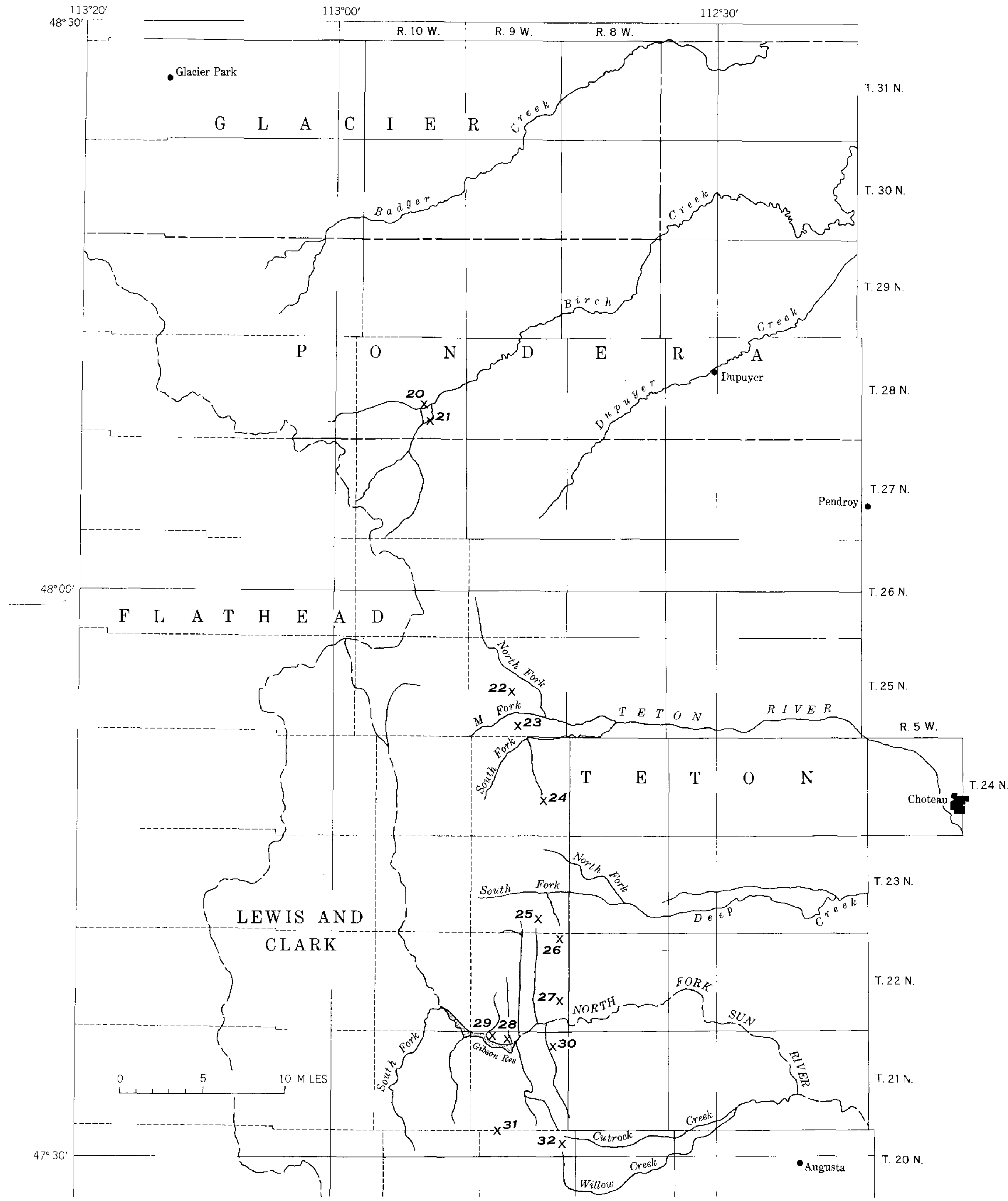


FIGURE 5.—Index map showing occurrences of fossils in the *Arctoecphalites* (*Cranocephalites*) beds in northwestern Montana from the Sun River area northward. (Numbers on map refer to those given in tables 4 and 6.)

consists of dark shale that is pyritic and that thickens northward from 18 feet on the Sun River to nearly 170 feet near Badger Creek. From the Teton River area northward it includes many lenses of black phosphatic pellets that are generally associated with well-rounded belemnite fragments. The upper member consists mostly of siltstone, becomes finely sandy upward, and thickens northward from 25 to 60 feet. Glauconite occurs throughout the formation and some sandstone beds in the middle member are highly glauconitic. Phosphate pellets and waterworn belemnites are common in the formation as high as the lower part of the upper member in the area north of the Teton River. Waterworn belemnites have been found locally near the top of the formation.

The Sawtooth formation does not exhibit any evidence of a major unconformity during its deposition except possibly at the top of the lower member in the area near the Sun River. Minor interruptions in sedimentation probably occurred, however, as its lithologic and faunal characteristics suggest that it was deposited slowly in shallow water under reducing conditions (Imlay, 1957, p. 491–493). Such is indicated in particular by the presence of lenses of phosphatic pellets and worn belemnites.

The contact of the Sawtooth formation with the overlying Rierdon formation is sharp but without positive evidence of an unconformity as exposed in the Rocky Mountains north of the Sun River. A minor unconformity is indicated, however, by the presence of pebbly beds at the top of the Sawtooth formation in the Sweetgrass Arch area (Cobban, 1945, p. 1273, 1274), in southern Alberta (Weir, 1949, p. 551), and in the Drummond area, Montana (Imlay and others, 1948). In Alberta the pebbles are associated with broken and worn belemnite guards. An unconformity at such a position would correspond stratigraphically with a marked unconformity between the Rierdon and Piper formations in south-central Montana (Imlay, 1956a, p. 575) and between the Sundance and Gypsum Spring formations in northern Wyoming (Imlay, 1956a, p. 579–580) and western South Dakota (Mapel and Bergendahl, 1956, p. 88–90).

Some of the pelecypods in the lower sandstone member of the Sawtooth formation (table 6) are identical with or closely similar to species described by Warren (1932) from the Rock Creek member (Warren, 1934) of the Fernie formation in southeastern British Columbia and western Alberta. As the Rock Creek member has furnished an ammonite assemblage of middle Bajocian age (McLearn 1928, 1932; Warren, 1947), the basal sandstone of the Sawtooth formation is probably likewise of that age.

582600 O—61——3

The middle shale member of the Sawtooth formation has furnished the middle Bajocian ammonite *Chondroceras* 20 feet above the base of the formation and 5 feet above the top of the lower member at Swift Reservoir, Pandera County, Mont. (Imlay, 1948, p. 19, pl. 5, figs. 1–5). It has furnished, also, at various localities many species of pelecypods (table 6) which elsewhere in the western interior region range in age from middle Bajocian to early Callovian (Imlay, 1956b, p. 70, 71). A few of the species are identical with species described by McLearn (1924) from the *Corbula munda* and *Gryphaea* beds on Grassy Mountain near Blairmore, Alberta; these beds have furnished ammonites of early Callovian age (Frebold, 1957a, p. 21, 23–25, 76). Lithologically the medial shale member is similar to the Rock Creek member of the Fernie formation in the broad sense used by Frebold, (1957a, p. 14) and it may be equivalent. The Rock Creek member, however, has furnished middle Bajocian ammonites at various levels from top to bottom, whereas the medial shale member of the Sawtooth formation is dated as middle Bajocian only near its base at one locality. At most other fossil localities, the fossil evidence concerning the age of the middle shale member is inconclusive. However, the presence of *Gryphaea impressimarginata* McLearn from the highest beds of the middle shale member at Hannan Gulch, Teton County, Mont. (written communication, M. R. Mudge, Nov. 18, 1959) indicates that those beds are only slightly older than the overlying upper siltstone member in which that species is fairly common.

The upper siltsone member of the Sawtooth formation in the area between Sun River and Glacier Park has furnished species of ammonites similar to those in the *Arctocephalites* (*Cranocephalites*) beds in Alaska and Greenland (table 6). It has furnished, also, many species of pelecypods most of which in the western interior region range from the middle Bajocian into the lower Callovian. However, one of the species *Gryphaea impressimarginata* McLearn has not been found below

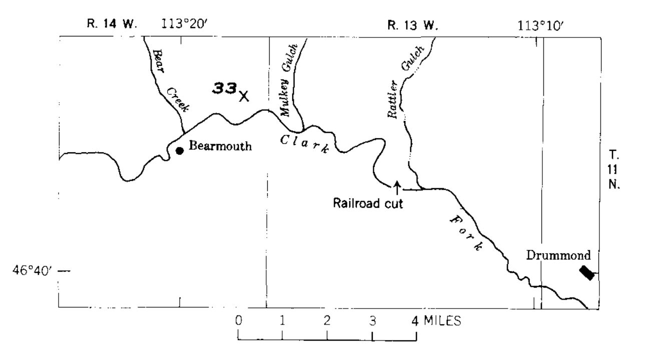


FIGURE 6.—Index map showing occurrences of fossils in the *Arctocephalites* (*Cranocephalites*) beds in the Drummond area in western Montana. (Numbers on map refer to that given in the tables 4 and 6.)

the transitional beds at the top of the middle shale member of the Sawtooth formation, nor above the *Arcticoceras* beds in the lower part of the Rierdon formation (Imlay, 1948, p. 14, 18). In Alberta it has been found near Blairmore associated with ammonites of early Callovian age (Frebold, 1957a, p. 19, 73–79). In Alaska it has been found in the Talkeetna Mountains associated with *Arctocephalites* (*Cranocephalites*).

DRUMMOND AREA

In the Drummond area, Montana, the basal 15 to 30 feet of the Sawtooth formation consist of calcareous yellowish- to reddish-brown siltstone. This is overlain by 110 to 150 feet of highly calcareous medium-gray shale that in its upper part contains beds of shaly limestone at intervals of 4 to 10 feet. Above the calcareous shale are silty to sandy beds identical with the upper member of the formation in the area north of the Sun River. This member, as exposed 1 mile west of Mulkey Gulch just north of the highway, consists mostly of 59 feet of interbedded yellowish-gray siltstone, silty shale, and silty to sandy limestone, but at its top includes 6 feet of hard gray calcareous pebbly sandstone that makes a sharp contact with oolitic limestone at the base of the Rierdon formation. The entire sequence appears to be perfectly conformable except possibly that part at the contact with the Rierdon formation (Imlay and others, 1948).

The basal siltstone of the Sawtooth formation in the Drummond area contains the ammonites *Stemmatoceras* aff. *S. palliseri* McLearn and *Normannites* sp. and the pelecypods *Pleuromya subcompressa* (Meek) and *Trigonia montanaensis* Meek, collected by M. E. Kauffman of Princeton University. The overlying calcareous shales contain *Pleuromya subcompressa* (Meek) and *Trigonia montanaensis* Meek. The upper silty member contains *Camptonectes platessiformis* White, *Pleuromya subcompressa* (Meek), *Modiolus* sp., *Lopha* sp., *Ostrea* sp., *Gryphaea impressimarginata* McLearn, and *Arctocephalites*? *saypoensis* Imlay, n. sp. (table 6). The presence of the last two species furnishes a correlation with the upper member of the Sawtooth formation in the area north of the Sun River.

AGE OF THE FAUNAS

EVIDENCE FROM ALASKA

In the Iniskin Peninsula, Alaska, as discussed under "Stratigraphic summary," the *Cranocephalites* beds in the middle part of the Bowser member of the Tuxedni formation appear to grade upward into beds of early Callovian age in the upper part of the Bowser member but rest abruptly and unconformably on beds of late Bajocian age in the lower part of the Bowser member (fig. 7). These relations favor a late Bathonian or very early Callovian age for the *Cranocephalites* beds, provided that there is really no unconformity between those beds and the overlying beds containing such typical Callovian ammonites as *Kepplerites*, *Kheraiceras*, and *Grossouvria*. (See table 2.)

The possibility of an unconformity being present between the middle and upper parts of the Bowser member, although undetected lithologically, is suggested by the fact that not a single example of the ammonite *Arcticoceras* has been found in the upper part of the Bowser member, whereas the genus is common in the lower part of the Callovian sequences in the western interior of North America and in the Boreal region (Imlay 1953a, p. 5; 1953b, p. 53–55). However, above the *Cranocephalites* beds in the Bowser member are at least 200 feet of beds that have not furnished any Callovian ammonites (see table 2) and that might correspond to the *Arcticoceras* beds of other regions. Also, the absence of *Arcticoceras* in collections from the Bowser member might be related to unfavorable ecological conditions or to insufficient collecting.

Stratigraphically the upper part of the Bowser member cannot be younger than the lower part of the *Sigaloceras calloviense* zone of Europe because it underlies the Chinitna formation whose lower third may be correlated reasonably with that zone (Imlay, 1953b, p. 51–53). It might, however, be as old as the *Macrocephalites macrocephalus* zone. Faunally it has nothing in common with either of those European zones, but the fact that all the Callovian species in the Bowser member range up into the lower third of the Chinitna formation suggests that the upper part of the Bowser member may be equivalent to part of the *Sigaloceras calloviense* zone. Against this correlation is the fact that none of the collections from the Bowser member contain such typical early to middle Callovian ammonites as *Cadoceras*, *Paracadoceras*, *Gowericeras*, *Cosmoceras*, and *Lilloettia*, which are common in the lower third of the Chinitna formation. Their absence in the collections is difficult to explain by unfavorable facies, considering the number and variety of other Callovian ammonites that have been found in the upper part of the Bowser member (table 2), but might be explained if they were rare or did not exist during the time that the upper part of the Bowser member was being deposited. Such a time during the early Callovian would correspond to the *Macrocephalites macrocephalus* zone of Europe, judging by the European ranges of certain Callovian ammonites reported by Callomon (1955, p. 254, 255).

This dating of the upper part of the Bowser member of the Tuxedni formation with the *Macrocephalites macrocephalus* zone implies that the *Cranocephalites* beds in the middle of the Bowser member cannot be younger than the lower part of that zone even if the

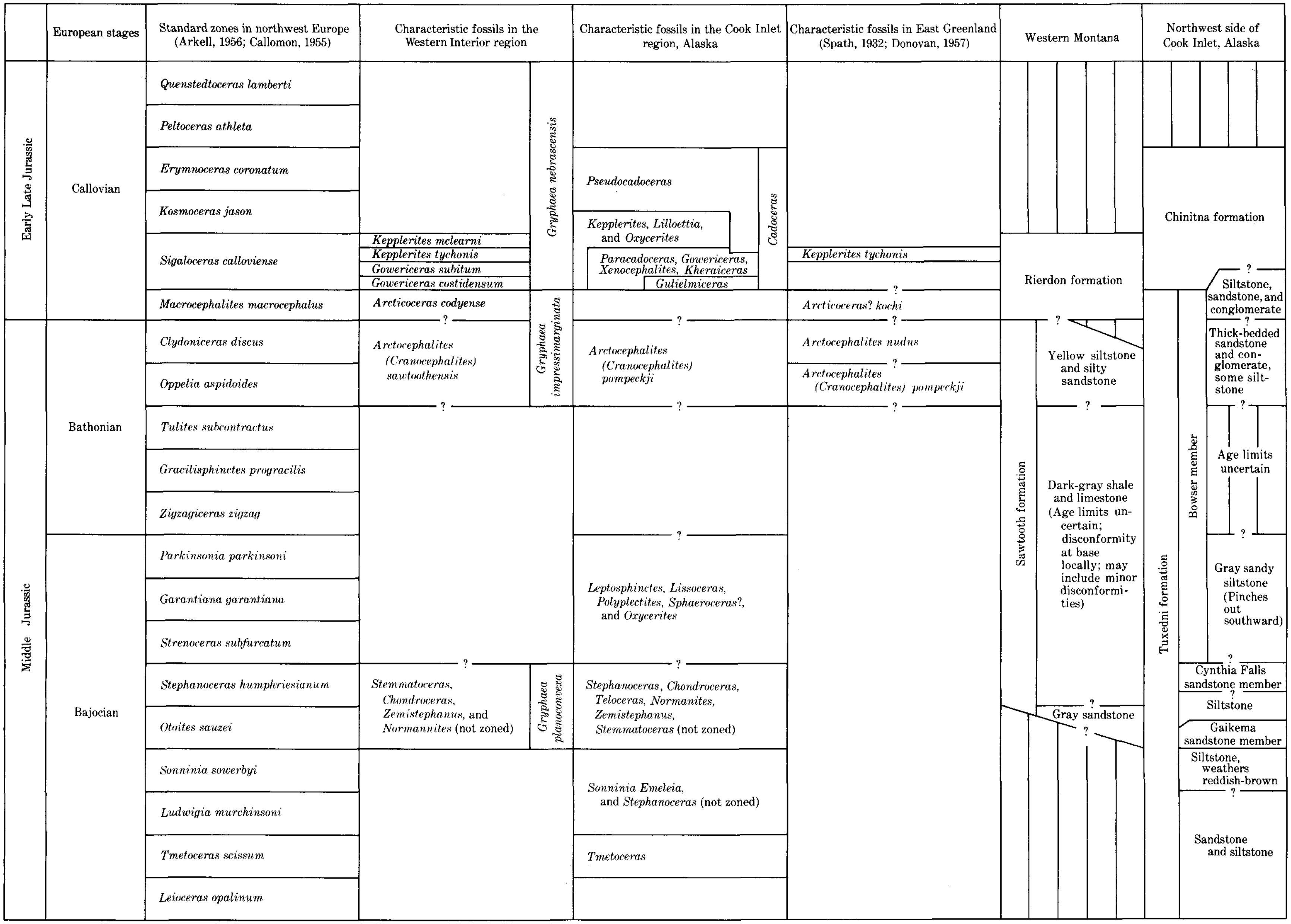


FIGURE 7.—Correlation of some Middle and Late Jurassic formations in the Cook Inlet region, Alaska, and in western Montana.

middle part of the member is gradational into the upper part as reported by field geologists. Stratigraphically, a correlation of the *Cranocephalites* beds with the upper Bathonian seems just as reasonable. Faunally the evidence from the *Cranocephalites* beds is indecisive, but the absence in those beds of any ammonite genera typical of the Callovian of Europe contrasts with the presence of such genera in the upper part of the Bowser member and suggests a somewhat older age.

In the Talkeetna Mountains, Alaska, the *Cranocephalites* beds on the Little Oshetna River, as mapped by Arthur Grantz, of the U.S. Geological Survey, rest unconformably on beds of Early Jurassic age and are directly overlain at that locality and near the Little Nelchina River by beds of early Callovian age. They are much more restricted in distribution than the early Callovian beds which at many places rest directly on beds of late to middle Bajocian age. It is not known whether the absence of the *Cranocephalites* beds at these places is due to erosion or to nondeposition. If due to erosion, a Bathonian age for the *Cranocephalites* beds would be favored. If due to nondeposition the beds could be either Bathonian, or earliest Callovian, or both.

EVIDENCE FROM MONTANA

In western Montana, *Cranocephalites* has been found only in yellow calcareous siltstone and fine-grained sandstone comprising the upper member of the Sawtooth formation. This member passes downward gradationally into gray to black shales, known as the middle member of the Sawtooth formation. These shales have furnished the same pelecypod fauna as the upper member except at Swift Reservoir where the Bajocian ammonite *Chondroceras* was found about 5 feet above the basal member. Near Drummond these gray shales rest on calcareous buff to reddish-brown siltstone that has furnished the Bajocian ammonites *Stemmatoceras* and *Normannites*. The middle member is underlain at many places north of the Sun River by a thin siliceous sandstone or sandy limestone known as the lower member of the Sawtooth formation. This member contains Jurassic pelecypods identical with or closely similar to those in the Bajocian Rock Creek member of the Fernie formation in Canada. The top of this siliceous lower member is marked in many places near the Sun River by a thin bed of pebble to cobble conglomerate of which some of the fragments are identical with the matrix of the lower member. The presence of such a conglomerate suggests that locally the lower and middle members are separated by a disconformity. No evidence for such a disconformity has been found north of the Sun River area.

The *Cranocephalites* beds in western Montana are overlain abruptly and with possible local unconformity by beds (Rierdon formation) that contain early Callovian ammonites such as *Arcticoceras* and *Cadoceras* and that are equivalent at least in part to the *Macrocephalites macrocephalus* zone of Europe. An unconformity at such a position beneath several ammonite zones of early Callovian age (Imlay, 1953a, p. 5–8) would favor a Bathonian age for the *Cranocephalites* beds and possibly explain the absence of *Arctocephalites* in the strict sense from the western interior region. However, an age not much older than the early Callovian beds is indicated by the fact that the pelecypod species and the ammonite genus Cobbanites continue upward from the *Cranocephalites* beds into the early Callovian beds and by the fact that one specimen probably belonging to *Arcticoceras* has been found in the highest part of the *Cranocephalites* beds. (See pl. 5, fig. 7.)

CALLOVIAN VERSUS BATHONIAN IN GREENLAND

In East Greenland the beds containing *Arctocephalites* and *Cranocephalites* were considered by Spath (1932, p. 138, p. 138–146) as probably uppermost Bathonian. He correlated the *Arctocephalites* beds with the European zone of *Macrocephalites macrocephalus*, which he reclassified as Bathonian; the immediately underlying *Cranocephalites* beds with the European zone of *Clydoniceras discus;* and the overlying *Arcticoceras* beds with the zone of *Proplanulites koenigi*. He thought that these ammonite genera were closely related to each other faunally and followed each other closely in time. He noted that *Cranocephalites* occurred only 20 meters below *Arctocephalites* (Spath, 1932, p. 14, 133–135) and that the highest beds containing *Arctocephalites* also contain immature specimens of *Arcticoceras* (1932, p. 135, 143).

His assignment of the *Arctocephalites* beds to the upper Bathonian was contested by Donovan (1953, p. 133) and Arkell (1956, p. 506) on the basis that the zone of *Macrocephalites macrocephalus* is early Callovian according to prevailing usage. Arkell (1954, p. 117) also assigned the *Cranocephalites* beds to the Callovian because in Alaska *Cranocephalites* was reported to occur with the Callovian genus *Reineckeia* (Imlay, 1952, p. 980). This report is in error, however, as the specimens identified as *Reinckeia* are herein described as a new genus *Parareineckeia*. Nevertheless, the Callovian age assignment may be justified by the fact that the family Reineckeiidae is to date known only from beds of Callovian age.

Recent studies in East Greenland by Donovan (1957, p. 129–136) have not furnished any additional evidence concerning the ages of the *Arctocephalites* and *Cranocephalites* beds, although Donovan tentatively assigns them to the late Bathonian. He suggests that *Cadoceras* probably evolved from *Arcticoceras* or *Arctocephalites* in the Boreal region, spread rapidly from there into North America and Europe, and that its lowest occurrence in Greenland at the top of the *Arcticoceras* beds (Spath, 1932, p. 131) "would fall at about the beginning of the range of *Cadoceras* in Europe; that is, in the *Macrocephalus* zone" (Donovan, 1957, p. 131). He speculates further that "if *Cranocephalites*, *Arctocephalites*, and *Arcticoceras* are closely related and not widely separated in time," as Spath thought, then the "*Cranocephalites* and *Arctocephalites* zones would be expected to be upper Bathonian." However, he does not rule out the possibility that those zones may span the entire Bathonian (Donovan, 1957, p. 136), and he emphasizes that his assignment of those zones to the upper Bathonian is very uncertain.

Still more recent studies in east Greenland have been made by Callomon (1959, p. 505–513) who correlates the beds characterized by *Kepplerites tychonis* with the European zone of *Macrocephalites macrocephalus* on the basis of the presence of identical species of *Kepplerites*. He notes that this correlation is confirmed by the presence in the overlying beds of ammonites representing the European zone of *Sigaloceras calloviense*, such as *Pseudocadoceras*, *Proplanulites*, *Gowericeras*, and *Kosmoceras*. He considers that the underlying beds, characterized by the ammonite genera *Arcticoceras*, *Arctocephalites*, and *Cranocephalites*, are pre-Callovian and in greater part Bathonian. These correlations supports a Bathonian age for the *Arctocephalites*-*Cranocephalites* beds elsewhere and imply that the Boreal Province during Bathonian time developed a different ammonite assemblage than the European and Tethyan provinces.

CALLOVIAN VERSUS BATHONIAN IN ALASKA AND MONTANA

The ammonite genera associated with *Cranocephalites* in western Montana and in Alaska do not furnish positive evidence concerning the age of the beds in which they occur. A Callovian age is favored slightly by the following facts:

1. One ammonite fragment from the Sawtooth formation of western Montana probably belongs to the genus *Xenocephalites*, which has been found mainly in Callovian beds in Mexico (Burckhardt, 1927, p. 33), Argentina (Stehn, 1924, p. 86–88, 92), Montana (Imlay, 1953a, p. 18–19), Alaska (Imlay, 1953b, p. 78, 79).
2. One ammonite questionably assigned to *Arcticoceras* occurs with *Cranocephalites* at the top of its range in Montana.
3. The family Reineckeiidae, represented in the *Cranocephalites* beds in Alaska by a new genus, *Parareineckeia*, has not previously been reported below the Callovian.
4. The new genera *Parareineckeia* and *Cobbanites* range upward from the *Cranocephalites* beds into beds containing typical early Callovian ammonites.
5. The *Cranocephalites* beds do not contain any ammonite genera typical of the Bathonian of northwest Europe or of the Tethyan region, except two fragments that probably belong to *Siemiradzkia*. The age value of this genus is suspected because it greatly resembles the Callovian ammonite *Grossouvria*.

Against this faunal evidence favoring a Callovian age may be listed the following:

1. The total ranges of *Xenocephalites*, *Arcticoceras*, *Parareineckeia* n. gen., and *Cobbanites* n. gen. are not known. They could have existed during the Bathonian as well as during the early Callovian. In fact, the presence of *Xenocephalites* and *Arcticoceras* in Greenland below beds containing the typical Callovian ammonites *Cadoceras* and *Kepplerites* (Spath, 1932, 45, 133, 135, 143) might be interpreted as evidence that they existed before the Callovian.
2. If the family Reineckeiidae was derived from the Bathonian Morphoceratidae or Parkinsonidae, as Arkell (1955, p. 130; 1957, p. L311) suggests, it may have begun in the Bathonian.
3. Two ammonites from the *Cranocephalites* beds in Alaska probably belong to the genus *Siemiradzkia* of Bathonian age, although their preservation does not permit positive identification.
4. The *Cranocephalites* beds do not contain any ammonite genera typical of Callovian beds.
5. The *Cranocephalites* beds in Montana and Alaska underlie a succession of beds that contain ammonite genera of early Callovian age, such as *Cadoceras Paracadoceras*, *Kepplerites* (*Seymourites*), *Gowericeras*, and *Kheraiceras*. Surely some of these genera would occur in the *Cranocephalites* beds, if those beds were of early Callovian age.
6. Most of the pelecypods in the *Cranocephalites* beds in the western interior belong to species that range from the middle Bajocian into the early Callovian. This might not hold if the entire Bathonian was represented by an unconformity in the western interior.

PALEOGEOGRAPHIC CONSIDERATIONS

The peculiar faunal characteristics of the *Arctocephalites* and *Cranocephalites* beds that make correlations with the European stages difficult are possibly related to major epeirogenic movements in the Boreal region during Middle Jurassic time. Such movements, according to Arkell (1956, p. 608, 609), are indicated by an absence in the Arctic region of ammonite faunas of middle to late Bajocian age and of Bathonian age. He notes that the Bathonian is missing, also, in many other parts of the world, or is represented by brackish-water sediments that lack ammonites. Marine beds containing Bathonian ammonites have been found mostly in northwest Europe and the Tethyan region. (*See* map in Arkell, 1956, p. 608, fig. 98.) Exceptions include one small area in southern Mexico (Burckhardt, 1927, p. 19, 20, 25, 80, 94, 95; Arkell, 1956, p. 564) and possibly another area in northern Alberta (Frebold, 1953, p. 1237; 1957a, p. 18, 54, 55). This great contraction of the area of ammonite distribution, as compared with the Bajocian stage, was accompanied, according to Arkell (1956, p. 3, 4), by a great reduction in ammonites, both in numbers and in biological categories, and by evolutionary stagnation.

From these facts, Arkell (1956, p. 609, 610, 641) deduces that after early Bajocian time a major regression began in the Boreal region and that about middle Bathonian time the seas retreated from most parts of the world that are now land. He infers that during this Bajocian-Bathonian regression, the Arctic Ocean was isolated from the other oceans and consequently that the faunas that lived in the Arctic Ocean developed special characteristics. He speculates that those faunas are now buried beneath the present Arctic Ocean. Establishment of connections with other oceans early in the Callovian permitted the Boreal faunas to spread outward from the Arctic Ocean over the lands now bordering that ocean, into the western interior of the United States and into Japan. According to Arkell (1956, p. 610) the first Boreal ammonites to appear were *Cranocephalites* and *Arctocephalites*. These were soon followed in the early Callovian by *Cadoceras*, *Arcticoceras*, and *Kepplerites* (*Seymourites*), which in time gave rise to other genera of the Cardioceratidae and Kosmoceratidae.

Arkell's explanation for the origin of the dominantly Boreal ammonite families mentioned above seems reasonable, but it is not clear why the Arctic Ocean need have been completely isolated from the Pacific or Atlantic Ocean during Bathonian time, or why *Arctocephalites* and *Cranocephalites* are necessarily of Callovian age. Partial isolation, owing to emergence of the continents, coupled with differences in temperatures of the oceans may have been sufficient to bring about the development of endemic ammonite faunas. Also, considering that proof is lacking for the Callovian age of *Arctocephalites* and *Cranocephalites*, they could be the Boreal and northern Pacific Ocean equivalents of the Bathonian of Europe and the Tethyan region.

SUMMATION OF THE EVIDENCE

The exact age of the beds characterized by the ammonite *Cranocephalites* has not been determined. Stratigraphically, they could represent all or part of the Bathonian stage, or the basal part of the Callovian stage, or could extend from the Bathonian into the Callovian. Geologists aware of the problem have found a stratigraphic break in the Cook Inlet region, Alaska, that might account for the absence of typical Bathonian ammonites, but in Montana the evidence is inconclusive and contradictory.

Faunally, the beds in question cannot be definitely correlated with either the Bathonian or the Callovian. The ammonites present have little in common on the generic level with the Bathonian ammonites of Europe and of the Tethyan region. (See discussion in Arkell, 1956, p. 608, 609.) They show slightly more resemblance to ammonites in the Callovian than to those in the Bathonian, but the evidence is weak. If they are Callovian age they cannot be younger than the earliest Callovian zone of *Macrocephalites macrocephalus*, and that zone is at least partly represented by the *Arcticoceras* beds in Greenland and in the western interior of North America. If they are of Bathonian age, they are probably only slightly older than the Callovian, considering that the new genera *Cobbanites* and *Parareineckeia* range up into definite Callovian beds. It seems improbable that the *Arctocephalites* and *Cranocephalites* beds of the Arctic region span the entire Bathonian, as pointed out by Donovan (1957, p. 136), unless the Bathonian stage represents much less time than the adjoining stages. Considering all available evidence, the *Cranocephalites* beds are herein tentatively correlated with the upper Bathonian of Europe.

COMPARISONS WITH OTHER FAUNAS

WESTERN INTERIOR OF CANADA

Ammonites identical with those in the upper member of the Sawtooth formation of Montana have not yet been found in the Fernie formation in the western interior of Canada. However, some small ammonites resembling immature specimens of *Arctocephalites* (*Cranocephalites*) have been found on Grassy Mountain, near Blairmore, Alberta. These were described by Buckman (1929) under several new generic names, but Spath (1932, p. 13, 14, 33, 36, 145) decided that the specimens described by Buckman (1929, pl. 1, figs. 4–7, pl. 3, figs. 1–11) under the names *Metacephalites* and *Miccocephalites* are immature representatives of his genus *Arctocephalites* (1928, p. 174). Warren (1947, p. 73) suggested that they are closer to *Cranocephalites*, which is now considered to be a subgenus of *Arctocephalites* (Arkell, 1957, p. L301). Imlay (1948, p. 14, 19, 20) noted their resemblances to species of *Arctocephalites* (*Cranocephalites*) in the upper member of the Sawtooth formation. Frebold (1957a, p. 18, 19, 57) decided that the ammonites from Grassy Mountain described by Buckman are not determinable generically but that they are definitely of Callovian age as they are associated with *Cadoceras* (Frebold, 1957a, p. 76). Such an association suggests, however, that they are not immature specimens of *Arctocephalites* or *Cranocephalites* because in Montana *Cadoceras* is not associated with those ammonites.

ARCTIC REGION

Species of *Arctocephalites* and its subgenus *Cranocephalites* similar to those in the Cook Inlet region of Alaska and in western Montana have been found at many places in the lands bordering the Arctic Ocean. *Arctocephalites* (strict sense) has been recorded from the Richardson Mountains in northern Canada (Frebold, 1953, p. 1240; 1957b, p. 28), from East Greenland (Spath, 1932, p. 14–32, pls. 1–19 in part; Donovan, 1953, p. 78–84; Donovan, 1957, p. 32–40, 129–136), from Franz Josef Land (Newton and Teall, 1897, p. 500, pl. XL, figs. 1, 1a; Whitfield, 1906, p. 131, pl. 18, fig. 2; Pompeckj, 1899, p. 70, pl. 2, figs. 12a–c; Spath, 1932, pl. 13, figs. 6a, b), from King Charles Land (Frebold, 1951, p. 79) from gravels in Novaya Zemlya (Salfeld and Frebold, 1924, p. 1; Frebold, 1930, p. 71, pl. 23, figs. 1–3), from the Bureya basin of eastern Siberia (Krimholz, 1939, p. 59, pl. 2, figs. 5–6), and have been reported from the Kharaulakh Mountains of northeastern Siberia (Nikolaev, 1938, p. 5; Arkell, 1956, p. 514).

Cranocephalites has been recorded from Prince Patrick Island, Canada (Frebold, 1957b, p. 8, 9, 25, 26, pl. 7, figs. 1a–c, 2, pl. 8, figs. 1a–c), from East Greenland (Spath, 1932, p. 14–32, pls. 1–13 in part), from Novaya Zemlya (Frebold, 1930, p. 95; 1951, p. 81), and has been reported from islands near the mouth of the Khatanga River in northern Asia (Moor, 1937, p. 232, 284; Arkell, 1956, p. 513). An ammonite from the basin of the Bureya River in northern Asia described as *Sphaeroceras era* Krimholz (1939, p. 29, 59, pl. 2, figs. 1–3) was referred by Arkell (1954, p. 117; 1956, p. 516) to *Cranocephalites*, but it is not a typical *Cranocephalites* because it does not have a scaphitoid body chamber.

Very few other ammonite genera have been found with *Arctocephalites* and *Cranocephalites* in the Boreal region. The ammonite *Xenocephalites* (Spath, 1932, p. 44, 133, 134, pl. 14, figs. 4a–d) was found loose on the slope of Mount Hjornefjaeld in East Greenland at the same altitude as a specimen of *Cranocephalites pompeckji* (Madsen). It could have been derived from a bed containing *Cranocephalites* at an altitude of 740 meters (2,400 feet), or from a bed containing *Arctocephalites* and *Arcticoceras* at an altitude of 760 meters (2,450 feet) near the top of the mountain, or it could have come from a different bed below either main ammonite bed.

The association of *Arcticoceras* with *Arctocephalites* at the top of Mount Hjornefjaeld was considered by Spath (1932, p. 132, 135, 143) to be in the upper part of the range of *Arctocephalites*. He did not consider that *Arctocephalites* ranged higher into the beds characterized by abundant *Arcticoceras* although he mentioned (1932, p. 142, pl. 11, fig. 3) one fragment of *Arcticoceras* from the *Arcticoceras* beds that appeared to be transitional between *Arctocephalites* and *Arcticoceras*. Recently Donovan (1957, p. 133) interpreted one of Spath's species, *Arcticoceras kochi* Spath, to be an *Arctocephalites*. If this interpretation is valid, the genus *Arctocephalites* ranges higher than Spath considered and is associated at the top of its range with the lowest occurrence of *Cadoceras*. The subgenus *Cranocephalites*, however, has not yet been found in Greenland with either *Arcticoceras* or *Cadoceras*.

OTHER REGIONS

Arctocephalites and *Cranocephalites* have not been found outside of the Arctic region, the Cook Inlet region, Alaska, and western Montana. This is rather astonishing because their ocurrence in the Cook Inlet area bordering the North Pacific Ocean suggests that they had free access to that ocean. Perhaps they will yet be found in British Columbia, or farther south on the Pacific coast. The record from Oregon and California is not encouraging, however. In central Oregon the writer has collected the Callovian ammonites *Lilloettia*, *Xenocephalites*, and *Choffatia* in the upper part of the Snowshoe formation (of Lupher, 1941) within 100 feet stratigraphically of middle Bajocian ammonites. Likewise in the Taylorsville area, California, occur such typical Callovian ammonites as *Reineckeia*, *Choffatia*, *Pseudocadoceras*, and *Paracadoceras*, but no trace exists of any Bathonian, or late Bajocian ammonites.

GEOGRAPHIC DISTRIBUTION

The occurrence by area and locality of the fossils described in this report are indicated in tables 5 and 6 The positions of the areas are shown in figures 1-6. Detailed descriptions of the individual localities are shown in tables 3 and 4.

582600 O—61——4

TABLE 3.—*Localities at which ammonites of Bathonian or early Callovian age have been collected in the* Arctocephalites (Cranocephalites) *beds in the Cook Inlet region, Alaska*

Locality on figs. 2-4	Geol. Survey Mesozoic locality	Collector's field No.	Collector, year of collection, description of locality, and stratigraphic assignment
1	27515	RAL115	Lyon, R. A., 1959. Talkeetna Mountains (A-2) quad. Lat 62°10′36″ N., long 147°40′09″ W. From 35 to 55 ft below base of Chinitna formation equivalent in unit of sandstone and conglomerate 100 ft thick. Upper part of Tuxedni formation.
2	24822	53AGz216	Grantz, Arthur, and Fay, L. F., 1953. Talkeetna Mountains (A-2) quad. Lat 62°10′21″ N., long 147°42′25″ W. On a small south tributary of the Little Oshetna River. Near middle of a sandstone unit 650 ft thick at top of the Tuxedni formation.
3	24115	52AGz152	Grantz, Arthur, Hoare, R. D., and Imlay, R. W., 1952. Talkeetna Mountains (A-2) quad. Lat 62°07′33″ N., long 147°40′20″ W., north fork of upper part of the Little Nelchina River. Upper part of Tuxedni formation form 400 to 800 ft below base of Chinitna formation.
4	24116	52AGz154	Grantz, Arthur, Hoare, R. D., and Imlay, R. W., 1952. Talkeetna Mountains (A-2) quad. Lat 62°07′15″ N., long 147°42′02″ W., north fork of upper part of the Little Nelchina River. Upper part of Tuxedni formation 400-800 ft below base of Chinitna formation.
4	24117	52AGz154A	Grantz, Arthur, Hoare, R. D., and Imlay, R. W., 1952. Same description as Mesozoic loc. 24116, except on south side of stream.
4	24118	52AGz155	Grantz, Arthur, 1952. Talkeetna Mountains (A-2) quad. Same location as Mesozoic loc. 24116, but 0.18 mile farther upstream. Tuxedni formation, upper part. 400-800 ft below top.
4	24825	53AFy14	Fay, L. F., and Grantz, Arthur, 1953. Talkeetna Mountains (A-2) quad. Lat 62°07′15″ N., long 147°41′29″ W. North fork of the upper Little Nelchina River. Upper part of the Tuxedni formation, 400-800 ft below base of the Chinitna formation.
5	8573	13AMa22	Martin, G. C., 1913. Talkeetna Mountains. At altitude of 3,400 ft on north side of knob, 1 mile north of Boulder Creek and about 3 miles above mouth of East Boulder Creek. In Anchorage D-4 quad. Tuxedni formation.
6	21284	48AI84	Imlay, R. W., and Miller, D. J., 1948. Tuxedni Bay area, near head of first stream entering Tuxedni Bay southeast of Bear Creek, 4.1 miles S. 12° W. of Fossil Point. Gray siltstone just below sandstone beds marking top of Bowser member of Tuxedni formation.
7	21283	48AI82	Imlay, R. W., and Miller, D. J., 1948. Tuxedni Bay area, from stream entering Bear Creek from the southeast at first outcrop above mouth, 4.2 miles S. 20° W. of Fossil Point. Gray siltstone in upper lower part of Bowser member of Tuxedni formation, about 1,000-1,100 ft below base of Chinitna formation.
8	22711	51AGz142	Grantz, Arthur, 1951. Tuxedni Bay area; 0.38 mile above mouth of tributary entering Bear Creek from the southeast, 2.53 miles from Tuxedni Bay, about 1,200 ft below base of Chinitna formation.
8	22712	51AGz143	Grantz, Arthur, 1951. Tuxedni Bay area; 0.45 mile above mouth of tributary entering Bear Creek from southeast, 2.53 miles from Tuxedni Bay. Upper part of Bowser member of the Tuxedni formation, about 1,100 ft below base of Chinitna formation.
9	22698	51AG2115	Grantz, Arthur, 1951. Peninsula north of Chinitna Bay. On ridge 1.5 miles N. 39°50′ E. of head of Lake Hickerson. Upper part of Bowser member of Tuxedni formation, about 1,000-1,100 ft below base of Chinitna formation.
10	21308	48AI1	Imlay, R. W., and Miller, D. J., 1948. Iniskin Peninsula, gulch draining northward into Gaikema Creek from peak on axis of Tonnie syncline, 2.3 miles S. 84° W. from dock at mouth of Fitz Creek. From siltstone about 800 ft above base of Bowser member of the Tuxedni formation.
10	21309	48AI2	Imlay, R. W., and Miller, D. J., 1948 Iniskin Peninsula. Float in gulch described under Mesozoic loc. 21308, but about 100 ft lower. Bowser member of the Tuxedni formation.
10	21310	48AI3	Imlay, R. W., and Miller, D. J., 1948. On same gulch described under Mesozoic loc. 21308. About 500 ft above base of Bowser member of the Tuxedni formation.
11	20005	44AWW F-72	Kellum, L. B., 1944. Iniskin Peninsula. Northeast side of Tonnie Creek about 700 ft upstream from top of lower cascade and 0.85 mile S. 56½° E. of Tonnie Peak. 400 ft above base of Bowser member of the Tuxedni formation.
11	27100	58ADt3	Detterman, R. L., 1958. Iniskin Peninsula. On Tonnie Creek 0.94 mile N. 61° W. of I. B. A. No. 1 well. Coordinates 9.02, 12.22. Lat 59°45′31″ N., long 153°15′09″ W. From 25-50 ft above lowermost conglomerate in greenish-gray siltstone and silty shale. Bowser member of the Tuxedni formation, about 1,750 ft below base of the Chinitna formation.
12	20011	44AWw78	Wedow, Helmuth, and Kellum, L. B., 1944. Iniskin Peninsula. In Tonnie Creek, 1.0 mile upstream from trail at mouth of creek just above crest of third falls and S. 48.6° E. of Tonnie Peak. Near middle of the Bowser member of the Tuxedni formation, about 1,000 ft below Chinitna formation.

TABLE 3.—*Localities at which ammonites of Bathonian or early Callovian age have been collected in the* Arctocephalites (Cranocephalites) *beds in the Cook Inlet region, Alaska*—Continued

Locality on figs. 2-4	Geol. Survey Mesozoic locality	Collector's field No.	Collector, year of collection, description of locality, and stratigraphic assignment
13	11038	21AB46	Baker, A. A., 1921. Iniskin Peninsula. Near head waters of Bowser Creek about 1,700 ft southeast of point where creek changes course from northeast to southeast, about 2.2 miles N. 8° E. of Front Mountain. From upper middle part of Bowser member of Tuxedni formation, about 700–800 ft below base of Chinitna formation.
14	20746	46AKr156	Kirschner, C. E., 1946, Iniskin Peninsula, on Edelman Creek, 1.4 miles N. 17° W. of Front Mountain. Upper part of Bowser member of the Tuxedni formation, about 800 ft below Chinitna formation.
15	20745	46AKr155	Kirschner, C. E., 1946, Iniskin Peninsula. On Edelman Creek 1.5 miles N. 22° W. of Front Mountain. Fine-grained sandstone in upper part of Bowser member of the Tuxedni formation, about 900–1,000 ft below Chinitna formation.
16	20754	46AKr177	Kirschner, C. E., 1946, Iniskin Peninsula, 2.0 miles N. 32° W. of Front Mountain, fine-grained sandstone in lower middle part of Bowser member of the Tuxedni formation, about 1,800 ft below base of Chinitna formation.
17	20751	46AKr164	Kirschner, C. E., 1946, Iniskin Peninsula. Tributary of Bowser Creek, 1.5 miles N. 40° W. of Front Mountain. Lower middle part of Bowser member of the Tuxedni formation, about 1,300–1,400 ft below base of Chinitna formation.
17	20752	46AKr166	Kirschner, C. E., 1946. Iniskin Peninsula. Tributary of Bowser Creek, 1.5 miles N. 40° W. of Front Mountain. Lower middle part of Bowser member of the Tuxedni formation, about 1,300–1,400 ft below base of Chinitna formation.
18	20743	46AKr152	Kirschner, C. E., 1946, Iniskin Peninsula, on Bowser Creek 1.8 miles N. 80° W. of Front Mountain. Sandy siltstone in lower middle part of Bowser member of Tuxedni formation, about 1,500–1,600 ft below Chinitna formation.
19	20744	46AKr154	Kirschner, C. E., 1946. Iniskin Peninsula on Bowser Creek 2.6 miles west of Front Mountain. Sandy siltstone in lower middle part of Bowser member of Tuxedni formation at about same stratigraphic position as loc. 20743.

TABLE 4.—*Localities at which ammonites of Bathonian or early Callovian age have been collected in the upper member of the Sawtooth formation in western Montana*

Locality on figs. 5 and 6	Geol. Survey Mesozoic locality	Collector's field No.	Collector, year of collection, description of locality, and stratigraphic assignment
20	19183		Imlay, R. W., Reeside, J. B., Jr., and Cobban, W. A., 1944. Swift Reservoir, north side, sec. 27, T. 28 N., R. 10 W., Pondera County. From 3 ft of siliceous limestone about 6½ ft above base of Sawtooth formation in the lower member.
20	19185		Imlay, R. W., Reeside, J. B., and Cobban, W. A., 1944. Swift Reservoir, north side, sec. 27, T. 28 N., R. 10 W., Pondera County. From sandy limestone near top of Sawtooth formation.
20	19186		Imlay, R. W., and Yingling, H. C., 1944. Same location as Mesozoic loc. 19183. From lower part of the upper siltstone member of the Sawtooth formation.
20	19192		Imlay, R. W., and Yingling, H. C., 1944. Same location as Mesozoic loc. 19183. Near base of middle member of Sawtooth formation and 20 ft above base of formation.
21	19195		Imlay, R. W., and Yingling, H. C., 1944. Same location as Mesozoic loc. 19183, but on south side of Swift Reservoir. From basal 2 ft of sandstone of Sawtooth formation.
22	19609	I45-8-12B	Imlay, R. W., and Saalfrank, William, 1945. Between Middle Fork and North Fork of Teton River in sec. 21, T. 25 N., R 9 W., Teton County. From upper 2 ft of siltstone member at top of Sawtooth formation.
23	18718	6	Bridge, Josiah, and Deiss, C. F., 1941. Lonesome Ridge, west side of sec. 34, T. 25 N., R. 9 W., Saypo quad., Teton County. Upper member of Sawtooth formation. (Note: Most of collection 18718 was obtained from the Rierdon formation.)
23	19601	I45-8-11A	Imlay, R. W., and Saalfrank, William, 1945. Lonesome Ridge on line of secs. 33 and 34, T. 25 N., R. 9 W., Saypo quad., Teton County. Upper 2 ft of upper member of Sawtooth formation.
23	19604	I45-8-11D	Imlay, R. W., and Saalfrank, William, 1945. Lonesome Ridge on line of secs. 33 and 34, T. 25 N., R. 9 W., Saypo quad., Teton County. From lower part of upper member of Sawtooth formation.
23	20355	I46-7-28C	Cobban, W. A., and Imlay, R. W., 1946. Lonesome Ridge on line of secs. 33 and 34, T. 25 N., R. 9 W., Saypo quad., Teton County. From upper silty member of the Sawtooth formation.

TABLE 4.—*Localities at which ammonites of Bathonian or early Callovian age have been collected in the upper member of the Sawtooth formation in western Montana*—Continued

Locality on figs. 2–4	Geol. Survey Mesozoic locality	Collector's field No.	Collector, year of collection, description of locality, and stratigraphic assignment
23	20357	I46–7–28D	Imlay, R. W., 1946. Lonesome Ridge on line of secs. 33 and 34, T. 25 N., R. 9 W., Saypo quad., Teton County. From lower foot of upper silty member of the Sawtooth formation.
24	18711	Deiss 5/1	Deiss, C. F., 1941. Head of Rierdon Gulch at altitude of about 7,550 ft, S½ sec. 23, T. 24 N., R. 9 W., Saypo quad., Teton County. Zone 1 from lower part of middle shale member of Sawtooth formation, 12 ft above base of formation.
24	18712	Deiss 5/2	Deiss, C. F., 1941. Head of Rierdon Gulch at altitude of 7,560 ft, S½ sec. 23, T. 24 N., R. 9 W., Saypo quad., Teton County. Zone 2 from lower part of middle shale member of the Sawtooth formation, about 17 ft above base of formation.
24	18713	Deiss 5/3	Deiss, C. F., 1941. Same location as Mesozoic loc. 18711. Zone 3, from 36–107 ft above base of Sawtooth formation in middle shale member.
24	18714	5/4	Deiss, C. F., 1941. Head of Rierdon Gulch, S½ sec. 23, T. 24 N., R. 9 W., Saypo quad., Teton County. Zone 4 from basal 13 ft of upper member of the Sawtooth formation, or 107–120 ft above base of Ellis group.
24	18715	Deiss 5/5	Deiss, C. F., 1941. Same location as Mesozoic loc. 18711. Zone 5 from about 10 ft below the top of the Sawtooth formation in upper siltstone member.
24	19184		Imlay, R. W., and Yingling, H. C., Jr., 1944. Head of Rierdon Gulch, S½ sec. 23, T. 24 N., R. 9 W., Saypo quad., Teton County. From sandy limestone in upper 20 ft of upper member of Sawtooth formation.
24	22652	I51–8–17A	Imlay, R. W., 1951. About a quarter of a mile north of head of Rierdon Gulch, north-central part of sec. 23, T. 24 N., R. 9 W., Saypo quad., Teton County. From 6 to 10 ft above base of upper silty member of Sawtooth formation.
24	22653	I51–8–17B	Imlay, R. W., 1951. One mile north of head of Rierdon Gulch in north-central part of sec. 23, T. 24 N., R. 9 W., Teton County. From 15 to 22 ft above base of upper siltstone member of the Sawtooth formation.
24	22654	I51–8–17C	Imlay, R. W., 1951. About half a mile north of head of Rierdon Gulch in north-central part of sec. 23, T. 24 N., R. 9 W., Saypo quad., Teton County. From 6 ft below top of upper silty member of Sawtooth formation.
24	22655	I51–8–17D	Imlay, R. W., 1951. Half a mile north of head of Rierdon Gulch in central part of sec. 23, T. 24 N., R. 9 W., Teton County. From upper foot of upper siltstone member of the Sawtooth formation.
25	27040	F224	Imlay, R. W., 1959. Head of Hannan Gulch, NW¼ sec. 35, T. 23 N., R. 9 W., lat 47°43′ N., long 112°43′ W., Saypo quad., Teton County. 29 ft below top of upper siltstone member of the Sawtooth formation.
25	27043	F223	Mudge, M. R., 1958. From head of Hannan Gulch in NW¼ sec. 35, T. 23 N., R. 9 W., Saypo quad., Tenton County. From middle shale member of the Sawtooth formation.
25	27046	F225	Mudge, M. R., 1958. Head of Hannan Gulch, NW¼ sec. 35, T. 23 N., R. 9 W., Teton County. From upper siltstone member of the Sawtooth formation.
26	27506	F291	Imlay, R. W., 1959. Head of Green Timber Gulch, lat 47°42′05″ W., long 112°42′00″ W., south-central part of sec. 36, T. 23 N., R. 9 W., Saypo quad., Teton County. Upper siltstone member of the Sawtooth formation.
27	19606	I45–8–14B	Imlay, R. W., and Saalfrank, William, 1945. Wagner basin, north-central part of sec. 25, T. 21 N., R. 9 W., Saypo quad., Teton County. From lower sandstone member of the Sawtooth formation about 3 ft above base of formation.
27	19608	I45–8–14A	Imlay, R. W., and Saalfrank, William, 1945. Same location as Mesozoic loc. 19606. Upper siltstone member of the Sawtooth formation.
27	27037	F55	Imlay, R. W., Mudge, M. R., and Reynolds, M. W., 1958. Wagner basin, in draw at contact of Paleozoic limestone and Jurassic beds, north-central part of sec. 25, T. 21 N., R. 9 W., Saypo quad., Teton County. From lower sandstone member of the Sawtooth formation.
27	27042	F57	Imlay, R. W., Mudge, M. R., and Reynolds, M. W., 1958. Wagner basin, north-central part of sec. 25, T. 21 N., R. 9 W., lat 47°38′ N., long 112°42′20″ W., Saypo quad., Teton County. From upper 12 ft of upper silty member of the Sawtooth formation.
28	27039	F231	Imlay, R. W., Mudge, M. R., and Reynolds, M. W., 1958. West side of Mortimer Gulch on north side of Gibson Reservoir, near center of sec. 4, T. 21 N., R. 9 W., lat 47°37′ N., long 112°46′ W., Saypo quad., Teton County. From upper silty member of the Sawtooth formation.
28	27502	F278	Mudge, M. R, and Reynolds, M. W., 1959. West side of Mortimer Gulch on north shore of Gibson Reservoir, near center sec. 4, T. 21 N., R. 9 W., lat 47°36′03″ N., long 112°45′ W., Saypo quad. Teton County. From upper member of the Sawtooth formation.
29	27045	F228	Mudge, M. R., 1958. North shore of Gibson Reservoir on east side of Big George Gulch, NE¼ sec. 5, T. 21 N., R. 9 W., Teton County. From upper siltstone member of the Sawtooth formation 3 ft below Mesozoic loc. 27047.

TABLE 4.—*Localities at which ammonites of Bathonian or early Callovian age have been collected in the upper member of the Sawtooth formation in western Montana*—Continued

Locality on figs. 2-4	Geol. Survey Mesozoic locality	Collector's field No.	Collector, year of collection, description of locality, and stratigraphic assignment
29	27047	F227	Mudge, M. R., 1958. East side of Big George Gulch on north side of Gibson Reservoir, NE. cor. of sec. 5, T. 21 N., R. 9 W., lat 47°36′19″ N., long 112°47′15″ W., Saypo quad., Teton County. From lower part of upper member of the Sawtooth formation.
29	27501	F227	Mudge, M. R., 1959. Same as Mesozoic loc. 27047.
30	27044	F221	Imlay, R. W., Mudge, M. R., and Reynolds, M. W., 1958. Home Gulch, SW. cor. sec. 36, T. 22 N., R. 9 W., lat 47°31′ N., long 112°42′ W., Lewis and Clark County. Middle shale member of the Sawtooth formation.
31	27503	F286	Mudge, M. R., and Reynolds, M. W., 1959. Same location as Mesozoic loc. 27504, but about 15 ft lower in upper siltstone member of the Sawtooth formation.
31	27504	F286	Mudge, M. R., and Reynolds, M. W., 1959. Saddle at north end of Sheep Sheds basin, lat 47°31′45″ N., long 112°47′40″ W., Lewis and Clark County. From upper member of the Sawtooth formation.
31	27505	F287	Mudge, M. R., 1959. Saddle NNW. of north saddle in Sheep Sheds basin, lat 47°32′ N., long 112°47′47″ W., Lewis and Clark County. Float in lower part of upper siltstone member of the Sawtooth formation.
32	18324	2/1	Deiss, C. F., and Garrells, R. M., 1940. Head of Lime Gulch, SW¼ sec. 1, T. 20 S., R. 9 W., Saypo quad., Lewis and Clark County. From 10 ft of sandy shale and limestone near base of measured section, upper member of Sawtooth formation.
32	27041	F237	Imlay, R. W., 1958. Head of Lime Gulch, SW¼ of sec. 1, T. 20 S., R. 9 W., Saypo quad., lat 47°31′ N., long 112°41′30″ W., Lewis and Clark County. From upper silty member of the Sawtooth formation.
33	19623	I45–7–17B	Imlay, R. W., and Saalfrank, William, 1945. About 8 miles northwest of Drummond just north of highway in sec. 12, T. 11 N., R. 14 W., Granite County. From yellowish-gray shale and silty nodular limestone in lower 29 ft of upper siltstone member of the Sawtooth formation. Base of siltstone member is 166 ft above base of Ellis group.
33	19625	I45–7–17C	Imlay, R. W., and Saalfrank, William, 1945. Same location as Mesozoic loc 19623. From 44 ft of gray calcareous shale and shaly limestone whose base is about 73 ft above base of Sawtooth formation and whose top is about 113 ft below top of formation.

SUMMARY OF RESULTS

1. The ammonites from Alaska and Montana described herein include 10 genera and 18 species. Of these, 2 genera, *Parareineckeia* and *Cobbanites*, and 5 species are described as new. *Arctocephalites* (*Cranocephalites*) comprises 54 percent, *Cobbanites* 17 percent, and *Holcophylloceras* 5 percent of the total number of ammonite specimens found. Some specimens are referred questionably to *Oecotraustes*, *Xenocephalites*, *Arctocephalites*, and *Siemiradzkia*.
2. Comparable faunules, represented mostly by *Arctocephalites* and *Cranocephalites*, have been found beneath beds of Callovian age at many places in the Arctic region. They have not been found elsewhere in the world, except in Montana and the Cook Inlet region, Alaska.
3. An ammonite faunule characterized by *Arctocephalites* (*Cranocephalites*) occurs on the northwest side of Cook Inlet, Alaska, in the middle part of the Bowser member of the Tuxedni formation. The lower few hundred feet of this member contains ammonites of late Bajocian age, and the upper 700 to 1,150 feet contains ammonites of early Callovian age. The *Cranocephalites* beds grade upward into the early Callovian beds, rest abruptly on the late Bajocian beds, and in the Iniskin Peninsula truncate the late Bajocian beds from north to south. The presence of an unconformity at such a position suggests that the *Cranocephalites* beds correspond in position with the late Bathonian, or earliest Callovian, or both.
4. Another *Arctocephalites* (*Cranocephalites*) faunule occurs in northern Montana in the upper silty member of the Sawtooth formation. This member grades downward into dark-gray shales that, near their base at the Swift Reservoir, have furnished the middle Bajocian ammonite *Chondroceras* and that rests near Drummond, with apparent conformity on buff to red siltstone that contains the middle Bajocian ammonites *Stemmatoceras* and *Normannites*. The upper member is overlain rather sharply by the Rierdon formation, which contains a succession of ammonite faunules of early Callovian age. Locally, the top of the Sawtooth formation in northwestern Montana contains pebbles and rounded belemnite fragments suggestive of a minor disconformity. Similarly a sedimentary break is indicated by the abrupt change from the yellowish gray siltstone and

TABLE 5.—*Geographic distribution of fossils from the* Arctocephalites (Cranocephalites) *beds in the Cook Inlet region, Alaska*

[Numbers 1–19 refer to numbers on figures 2–4. Higher numbers are Geological Survey locality numbers]

	Talkeetna Mountains								Peninsula south of Tuxedni Bay				Iniskin Peninsula														
	Tuxedni formation																										
	Unnamed unit								Middle part of Bowser member																		
	1	2	3	4				5	6	7	8		9	10			11		12	13	14	15	16	17		18	19
	27515	24822	24115	24116	24117	24118	24825	8573	21284	21283	22711	22712	22698	21308	21309	21310	20005	27100	20011	11038	20746	20745	20754	20751	20752	20743	20744
Holcophylloceras sp.					X							X	X														
Oecotraustes (*Paroecotraustes*)? sp.				X																							
Arctocephalites? *alticostus* Imlay, n. sp.				X										X					X						X		
cf. *A.*? *alticostus* Imlay, n. sp.																											X
sp.																	X								X		
Arctocephalites (*Cranocephalites*) *pompeckji* (Madsen)									X	X			X														
cf. *A. pompeckji* (Madsen)											X	X										X					
costidensus Imlay, n. sp.	X		X	X	X					X		X	X										X				
cf. *A. costidensus* Imlay, n. sp.								X																			
sp.							X							X													
? sp.		X													X			X		X	X			X		X	
Parareineckeia hickersonensis Imlay, n. sp.													X														
cf. P. *shelikofana* Imlay					X																	X					
Cobbanites talkeetnanus Imlay, n. sp.				X																							
Siemiradzkia? cf. *S. aurigera* (Oppel)													X														
Belemnite fragments					X								X			X				X	X	X		X			
Gastropods undet.										X						X				X							
Grammatodon? sp.																X				X	X				X	X	
Parallelodon cumshewaensis Whiteaves																					X						
simillimus (Whiteaves)																X											
Trigonarca? cf. *T. tumida* Whiteaves								X											X								
Modiolus sp.																								X			
Meleagrinella sp.		X														X		X	X		X				X		
Oxytoma sp.																			X		X						
Inoceramus eximius Eichwald				X																X							
cf. *I. porrectus* Eichwald				X	X																						
sp.													X									X		X	X		
Camptonectes sp.			X	X		X														X					X		
Ostrea sp.			X	X	X														X								
Gryphaea impressimarginata McLearn						X		X																			
sp.		X			X																						
Trigonia spp.		X			X	X										X									X		
Tancredia sp.																			X								
Astarte carlottensis Whiteaves				X	X																				X		
sp.																				X							
Lucina sp.																X											
Protocardia sp.																			X								
Isocyprina ?																X											
Pleuromya carlottensis Whiteaves				X																X							
sp.		X			X			X						X							X						
Pholadomya sp.																					X						
Thracia semiplanata Whiteaves					X															X							
sp.																					X						
Cercomya? sp.																X											

sandstone at the top of the Sawtooth formation to a massive oolitic limestone at the base of the Rierdon formation as exposed near Drummond and generally throughout southwestern Montana. Such a disconformity would be at the same stratigraphic position as a well-marked unconformity in south-central Montana, northern Wyoming, and western South Dakota. As the *Arcticoceras* zone at the base of the Rierdon formation corresponds at least in part with the earliest Callovian *Macrocephalites macrocephalus* zone of Europe, the presence of a disconformity between the Rierdon and Sawtooth formations would favor an age older than Callovian for the upper silty member of the Sawtooth formation. Stratigraphically the upper member could be of any age between late Bajocian and earliest Callovian, but the evidence favors a Bathonian age.

5. Faunally, the exact age of the *Arctocephalites* (*Cranocephalites*) beds has not been determined. However, they cannot be older than the Bathonian stage, or younger than the earliest Callovian zone of *Macrocephalites macrocephalus*, and that zone is at least partly represented by the *Arcticoceras* beds in Greenland and in the western interior of North America. They do not contain any ammonite genera typical of the Callovian of Europe and only two ammonites that probably belong to the Bathonian genus *Siemiradzkia*. A Callovian age is favored slightly by the presence of the ammonite family Reineckeiidae, by the fact that the new genera *Parareineckeia* and *Cobbanites* range upward into beds containing typical Callovia ammonites, and by the apparent close biological relations of the dominant ammonite *Cranocephalites* with such Callovian genera as *Arcticoceras* and

TABLE 6.—*Geographic distribution of fossils from the Sawtooth formation in northwestern Montana*

[Numbers 20–33 refer to numbers on figures 5 and 6. Higher numbers are Geological Survey Mesozoic locality numbers]

	Sawtooth formation																																									
	Lower sandstone member				Middle shale member							Upper siltstone member																														
	20	21	27		20	24			25	30	33	20		22	23					24							25		26	27		28		29			31			32		33
	19183	19195	19606	27037	19192	18711	18712	18713	27043	27044	19625	19185	19186	19609	18718	19601	19604	20355	20357	18714	18715	19184	22652	22653	22654	22655	27040	27046	27506	19608	27042	27039	27502	27045	27047	27501	27503	27504	27505	18324	27041	19623
Chondroceras oblatum (Whiteaves)					X																																					
Xenocephalites? sp																				X																						
Arctocephalites? *saypoensis* Imlay																																								X		
(*Cranocephalites*) *sawtoothensis* Imlay															X	X		X				X			X		X				X		X									
cf. *A. gracilis* (Spath)																X																				X						
cf. *A. maculatus* (Spath)																						X	X				X					X										
cf. *A. platynotus* Spath																X																										
sp												X		X										X		X		X							X			X				
(*Cranocephalites*)? sp																														X												
Articoceras? sp																									X																	
Cobbanites spp												X			X	X	X	X	X			X	X		X										X	X					X	X
Belemnite fragments		X				X			X																								X	X								
Gastropods undet									X											X																	X					
Procerithium (*Rhabdocolpus*) sp									X																																	
Dentalium sp						X																																				
Nucula sp						X																																				
Grammatodon sp				X																X															X							
Idonearca? cf. *I. rockymontana* (Warren)	X																																									
haguei Stanton																							X																			
Modiolus rosii McLearn								X																					X		X									X		
sp																																										X
Pinna kingi Meek																				X			X		X		X		X		X	X									X	
Oxytoma mclearni Warren	X																																									
sp		X																																								
Meleagrinella curta (Hall)	X			X												X				X	X										X								X	X		
Gervillia sp																																					X					
Inoceramus sp		X																																					X			
Chlamys sp														X																												
Camptonectes stygius White				X						X										X	X			X			X					X								X	X	
platessiformis White																				X																						X
sp			X													X														X							X					
Lopha sp																																										X
Ostrea strigilecula White																				X																						
sp		X		X		X			X												X																			X		
Gryphaea impressimarginata McLearn												X	X												X																	X
sp. juv. cf. *G. impressimarginata* McLearn								X																													X					
Placunopsis sp	X																																									
Trigonia montanaensis Meek						X					X									X				X	X																	
cf. *T. trafalgarensis* Warren	X	X	X																																							
cf. *T. conradi* Meek				X																																						
Astarte meeki Stanton						X														X																						
cf. *A. packardi* Meek						X															X																			X		
(*Coelastarte*) *morion* Crickmay									X																																	
sp		X																																								
Lucina sp	X	X						X																																		
Isocyprina? cf. *I.*? *iddingsi* (Stanton)																				X																						
Protocardia schucherti McLearn								X												X																				X		
sp																					X														X							
Pleuromya subcompressa Meek								X	X	X	X									X			X	X	X		X		X	X					X	X				X		X
cf. *P. oblongata* Warren				X																																						
Pholadomya kingi Meek												X								X																						
inaequiplicatus Stanton																							X		X									X	X							
Cercomya punctata (Stanton)																									X		X								X							
Quenstedtia? sp			X																																							
Tancredia cf. *T. inornata* Meek							X	X																																		
sp						X																																				
Brachiopods undet																																							X			
Pentacrinus asteriscus Meek and Hayden																					X																					
Crinoid fragments																																					X					
Echinoid spines				X																																						

Cadoceras. This evidence is not conclusive, but it does indicate that the ammonites in the *Cranocephalites* beds are biologically closer to those in the Callovian than in the Bajocian and are not likely to be older than late Bathonian.

6. The *Arctocephalites* (*Cranocephalites*) beds in Alaska and Montana are herein tentatively correlated with the Bathonian rather than the Callovian stage. This correlation is based on the following: (a) in Montana geologists cannot find evidence of an important unconformity that might acccount for the absence of Bathonian ammonites typical of Europe and the Tethyan region, (b) the lower Callovian is well represented by a succession of ammonites in both Alaska and the western interior region, and (c) the ammonites in the *Arctocephalites* (*Cranocephalites*) beds, although biologically related to those in the overlying Callovian beds, do not include any typical Callovian genera. If this correlation is valid, the ammonites of Bathonian time occupied two distinct realms of which one included parts of Europe and the Tethyan region from Mexico to Indonesia and the other included the Arctic

region and some of the North Pacific Ocean. This concept differs somewhat from that of Arkell (1956, p. 608-610), who correlated the *Arctocephalites* (*Cranocephalites*) beds with the earliest Callovian and inferred that the Arctic Ocean during Bathonian time was completely isolated from the other oceans and that the Bathonian faunas of the Arctic Ocean are now buried beneath the present Arctic Ocean. Emergence of the continents during Bathonian time, discussed by Arkell, fits either concept.

SYSTEMATIC DESCRIPTIONS

Genus HOLCOPHYLLOCERAS Spath, 1927

Holcophylloceras sp.

Plate 1, figure 1

Seven internal molds of a single species are present in the *Cranocephalites* beds. These show the deep strongly sigmoidal constrictions that are characteristic of the genus. Traces of fine ribbing are present on the venter of one specimen. The largest mold is a fragment of a large body chamber belonging to an ammonite that was at least 200 mm in diameter. The suture line has only diphyllic saddles.

Figured specimen: USNM 130754.

Occurrence: Bowser member of the Tuxedni formation at USGS Mesozoic locs. 22698 and 22712; equivalent beds in the Talkeetna Mountains at Mesozoic loc. 24117.

Genus OECOTRAUSTES, Waagen, 1869

Subgenus PAROECOTRAUSTES Spath, 1928

Oecotraustes (Paroecotraustes)? sp.

Plate 1, figures 2–4

One small septate compressed ammonite is characterized by having a tiny umbilicus, a low vertical umbilical wall, a median raised spiral groove, and low backwardly arched ribs on the upper parts of the flanks. The venter is so worn that its characteristics cannot be determined. There is a suggestion of low broad forwardly inclined ribbing on the lower part of the flanks. The suture line cannot be traced accurately.

The features of this specimen suggest an assignment to the Oppeliidae, but do not fit those of any described genus. The umbilicus is smaller than in *Oecotraustes* or *Paroecotraustes*. The spiral groove is much deeper than in *Oppelia* or in *Oxycerites*. The absence of secondary ribs likewise excludes *Oppelia*. The ribs appear to be broader than on any described species of *Oxycerites*, but this appearance is due partly to weathering. The specimen may represent a new genus, but lack of knowledge of the venter precludes any certain generic assignment.

Figured specimen: USNM 130747.

Occurrence: Unnamed beds in the Talkeetna Mountains at Mesozoic loc. 24116.

Genus XENOCEPHALITES Spath, 1928

Xenocephalites? sp.

Plate 6, figures 4, 5, 9.

One small specimen bears ribbing similar to that on the much larger holotype of *Arctocephalites*? *sayposensis* Imlay, n. sp. (pl. 6, figs. 1, 2), but its body chamber is terminated by a constriction and a rib pattern suggestive of an adult shell. If so, it probably is a different species as it is considerably smaller. Also, the venter of the penultimate whorl bears low broad ribs separated by narrow interspaces, which feature is suggestive of *Xenocephalites*, but not of *Arctocephalites*

Figured specimen: USNM 130775.

Occurrence: Sawtooth formation, upper member, at USGS Mesozoic loc. 18714.

Genus ARCTOCEPHALITES Spath, 1928

Arctocephalites? alticostus Imlay, n. sp.

Plate 2, figures 1–8

The species is represented by five specimens. The whorls are moderately stout and are wider than high. The umbilicus is small and has a steep umbilical wall that rounds rather abruptly into the flanks. The body chamber on the largest specimen represents three-fourths of a whorl and is terminated by a constriction that is present only on the lower part of the flanks.

The ribbing is very high and sharp. The primary ribs curve backward on the umbilical wall, curve forward on the flanks, and become very high on the lower fourth of the flanks. Most primary ribs pass into slightly weaker secondary ribs between the lower fourth and the lower third of the flanks, but some primary ribs do not branch and others are indistinctly connected with secondary ribs. A few secondary ribs arise freely on the lower part of the flanks. The secondary ribs cross the venter transversely and become slightly higher ventrally.

The suture line is not well preserved and cannot be traced. The holotype has been compressed laterally, but at a diameter of 36 mm has a whorl height of 18 mm, a whorl thickness of 18 mm, and an umbilical width of 6.5 mm. On the small paratype, shown on plate 2, figure 3, the same dimensions are 15, 8, 11.5, and 3.5 mm respectively.

This species has much higher and sparser ribbing than any of the small specimens from Greenland that have been assigned to *Arctocephalites* or to the subgenus *Cranocephalites*, but it shows some resemblances to the immature whorls of *Arctocephalites sphaericus* Spath (1932, p. 40, pl. 6, fig. 3, pl. 19, fig. 4) and A. (Cranocephalites) cf. *C. pompeckji* (Madsen) (Spath, 1932, pl. 3, fig. 3). It shows more resemblance to *A.? saypoensis* Imlay, n. sp., described here, but has higher and more flexuous primary ribs.

The holotype of *A.? alticostus* Imlay, n. sp., shows some resemblance to *Xenocephalites vicarius* Imlay (1953b, p. 78, pl. 28, figs. 1–8), from the Chinitna formation, Alaska, but differs from this and all other species of that genus by being less narrowly umbilicate, by its adult body whorl not contracting from the inner whorls, by its ribs being much higher and thinner on the inner whorls, by its ribs remaining thin on its outer whorl instead of becoming broad and widely spaced, and by the presence of an apertural constriction.

This species is not assigned to *Cranocephalites* because the body chamber does not contract from the inner whorls. It differs from *Arctocephalites* by its ribs remaining high and sharp on the body chamber instead of weakening or disappearing. It probably represents a new genus or subgenus, but the preservation of the specimens in hand does not justify making such an assignment.

Types: Holotype USNM 130757; paratypes USNM 130758–130760.

Occurrence: Bowser member of the Tuxedni formation at USGS Mesozoic locs. 20011, 20752, and 21308; from equivalent beds in the Talkeetna Mountains at Mesozoic loc. 24116.

Arctocephalites? saypoensis Imlay, n. sp.

Plate 6, figures 1, 2

Arctocephalites sp. juv. cf. *A. sawtoothensis* Imlay, 1948, U.S. Geol. Survey Prof. Paper 214–B, p. 19, pl. 6, figs. 2, 5.

The holotype has been crushed laterally, but its whorl section originally was probably wider than high. The umbilicus is moderate in width, and the umbilical wall is low and vertical. The body chamber occupies about three-fourths of a whorl, is probably nearly complete, and is not contracted adorally.

The ornamentation of the inner whorls is not known. On the outer whorl of the holotype, the primary ribs are strong and high. They curve backward on the umbilical wall and curve forward on the lower fourth of the flanks. On the septate part of the whorl, all primary ribs bifurcate at the top of the lower fourth of the flank. Toward the aperture the rib branch nearest the aperture becomes indistinctly connected with the primary rib, and on the last fourth of the body whorl, there is regular alternation of long radial primary ribs and shorter secondary ribs. All ribs are high and narrow on the venter on which they arch forward gently.

The suture line cannot be traced, and dimensions cannot be measured accurately.

The presence of many single ribs near the adoral end of the body chamber suggests that the specimen is an adult. If so, it is smaller than any described species of *Arctocephalites* or *Cranocephalites* from Greenland. It, also, has much stronger ribbing than any species of *Arctocephalites* or *Cranocephalites* at a comparable size. The most similar species is *A? alticostus* Imlay, n. sp., described herein, from which it differs by having lower less flexuous primary ribs, by having stouter secondary ribs, and by being larger. Its umbilicus appears to be wider than in *Arctocephalites*, but this appearance may be deceptive considering that the inner whorls are not preserved and that the specimen has been deformed.

Type: Holotype USNM 104149.

Occurrence: Sawtooth formation, upper member at USGS Mesozoic loc. 18324. A small specimen of this species in the Princeton University collections was obtained 4 miles west of Drummond, Mont., in a railroad cut in the NE¼ of sec. 21, T. 11 N., R. 13 W.

Subgenus CRANOCEPHALITES Spath, 1932

Arctocephalites (Cranocephalites) pompeckji (Madsen)

Plate 1, figures 5–13

Macrocephalites pompeckji Madsen, 1904, Meddelelser om Grönland, v. 29, p. 189, pl. 8, figs. 5, 6a, b.

Cranocephalites pompeckji (Madsen). Spath, 1932, Meddelelser om Grönland, v. 87, p. 16, pl. 3, fig. 3, pl. 4, figs. 8–10. pl. 5, figs. 3, 6–8, pl. 9, fig. 4, pl. 13, figs. 1a, b.

Arctocephalites (*Cranocephalites*) *pompeckji* (Madsen) aff. var, *costata* Spath. Donovan, 1953, Meddeleslser om Grönland, v. 111, p. 83, pl. 17, figs. 2a, b.

Arctocephalites (*Cranocephalites*) *pompeckji* (Madsen) var. *intermedia* Spath, Donovan, 1953, Meddelelser om Grönland v. 111, p. 83, pl. 17, figs. 3a, b.

Six specimens from Alaska are within the range of variation of *C. pompeckji* (Madsen) as described by Spath (1932, p. 16–20). They are characterized by a compressed whorl section, a highly arched venter, and by high sharp widely spaced ribs that cross the venter without reduction in strength. The primary ribs curve backward on the unbilical slope, curve forward on the flanks, and pass into pairs of slightly weaker secondary ribs between the lower fourth and the middle of the flanks. Many of the pairs of the secondary ribs are separated by single ribs that begin freely on the lower third of the flanks. The secondary ribs incline forward slightly on the upper part of the flanks but cross the venter nearly transversely. The body chamber includes about three-fifths of a whorl. It is terminated adorally by a constriction that is followed by a swelling and then by a smooth area.

The suture line shown on plate 1, figure 9, occurs at the beginning of the body chamber and is considerably worn. Traces of the suture preserved on the opposite side of the same specimen show that it is nearly as complex as the suture on *Cranocephalites vulgaris* Spath (1932, pl. 3, fig. 5), differing mainly by having a slightly longer ventral lobe. The suture is characterized by having broad saddles and fairly short lobes and by its auxiliaries ascending toward the umbilical seam.

The largest specimen (pl. 1, figs. 11–13), which is slightly compressed, at a maximum diameter of 96 mm has a whorl height of 42 mm, a whorl thickness of 38(?) mm, and an umbilical width of 16 mm. On a smaller specimen (pl. 1, fig. 6) the comparable dimensions are 62, 27, 26, and 15 mm.

Among the Alaskan specimens, the smallest are similar to a small specimen illustrated by Spath (1932, pl. 3, fig. 3). The specimen shown on plate 1, figure 10, resembles *C. pompeckji* var. *intermedia* Spath (1932, pl. 5, fig. 7). The specimen shown on plate 1, figure 6, resembles other variants illustrated by Spath (1932, pl. 4, figs. 9a, b, pl. 13, figs. 1a, b). The largest specimen from Alaska (pl. 1, figs. 11–13) differs from the holotype of *C. pompeckji* (Madsen) (1904, pl. 8, figs. 6a, b) mainly by having slightly finer and denser ribbing.

The species *C. pompeckji* (Madsen) is more similar to *C. vulgaris* Spath (1932, p. 20, pl. 1, figs. 2–4, 6; pl. 2, figs. 1a, b; pl. 3, fig. 5; pl. 4, figs. 1, 3a, b; pl. 5, figs. 1a, b; pl. 8, figs. 1a, b; pl. 10, figs. 3a, b) than to any other described species. It differs by being more compressed and by having higher sharper more widely spaced ribs that remain fairly strong on the venter of the adult body whorl.

Type: Plesiotypes USNM 130751–130753.

Occurrence: Bowser member of the Tuxedni formation at 21283, 21284, 22698. The species is possibly represented at Mesozoic locs. 20745 and 22711 in the Bowser member.

Arctocephalites (Cranocephalites) costidensus Imlay, n. sp.

Plate 2, figures 11–19

The species is represented by 35 specimens. The whorls are ovate in section, slightly wider than high. The flanks are gently convex and round evenly into a moderately broad venter. The body chamber occupies about three-fifths of a whorl. The aperture is terminated by a pronounced constriction that is followed by a swelling.

The ornamentation consists of fine dense ribbing. The primary ribs curve backward on the umbilical wall, curve forward on the flanks, and give rise to 2 or 3 somewhat weaker secondary ribs between the lower third and the middle of the flanks. Many other secondary ribs arise freely on the lower third of the flanks. The secondary ribs cross the venter transversely, or with a slight forward arching, and are slightly reduced in strength along the venter on some of the largest body chambers.

The suture line is characterized by having fairly broad saddles and by its auxiliaries ascending to the umbilical seam. All the specimens are deformed so much that measurements are meaningless.

This species has finer denser ribbing than any described species of *Arctocephalites* or *Cranocephalites* from Greenland, but approaches most closely to *C. gracilis* Spath (1932, p. 22, pl. 2, figs. 6 a, b, pl. 3, figs. 1 a, b) which it resembles also, in stoutness. However, even the most coarsely ribbed variants of the Alaskan species (pl. 2, figs. 19) have finer ribs and more closely spaced secondary ribs. *Arctocephalites orientalis* Krimholz (1939, p. 59, pl. 2, figs. 5, 6) from northern Asia has as fine and dense ribbing as *A.* (*Cranocephalites*) *costidensus* Imlay, n. sp., but is much more inflated and appears to have a smaller umbilicus.

Types: Holotype USNM 130745; paratypes USNM 130746, 130748, 130749.

Occurrence: Bowser member of the Tuxedni formation at Mesozoic. locs. 20754, 21283, 22698, 22712; equivalent beds in the Talkeetna Mountains at Mesozoic locs. 24115, 24116, and 24117.

Arctocephalites (Cranocephalites) sawtoothensis Imlay

Plate 3, figures 1–10, plate 4, figures 2, 4, 6

Arctocephalites sawtoothensis Imlay, 1948, U.S. Geol. Survey Prof Paper 214–B, p. 19, pl. 6, fig. 7.

Arctocephalites metastatus (Buckman) var. *sweetgrassensis* Imlay, 1948, U.S. Geol. Survey Prof. Paper 214–B, p. 20, pl. 6, figs. 1, 3.

This species is represented by 14 specimens of various sizes and growth stages. These show that the specimen described as *Arctocephalites metastatus* (Buckman) var. *sweetgrassensis* Imlay is merely a finely ribbed variant of *A. sawtoothensis* Imlay. The holotype of *Metacephalites metastatus* Buckman (1929, p. 11, pl. 3, figs. 1–4) has much lower blunter primary ribs than immature individuals of *A. sawtoothensis* Imlay and probably is not generically related. Assignment of *A. sawtoothensis* Imlay to the subgenus *Cranocephalites* is based on the presence of a contracted body chamber. One small laterally crushed specimen shown on pl. 3, fig 3, is shown for comparison with the holotype of *Macrocephalites laminatus* Buckman (1929, p. 14, pl. 1, figs. 4, 4a, 5).

Types: Holotype USNM 104148; plesiotypes USNM 104150, 130766–130770.

Occurrence: Sawtooth formation, upper member, USGS Mesozoic locs. 18718, 19184, 19601, 20355, 22654, 27040, 27042, and 27502.

Arctocephalites (Cranocephalites) cf. A. gracilis (Spath)

Plate 5, figures 1–3

Three specimens from the Sawtooth formation are distinguished from *A. sawtoothensis* Imlay by having considerably finer ribbing. They are comparable in ribbing with the holotype of *Cranocephalites gracilis*

Spath (1932, p. 22, pl. 3, figs. 1 a, b) from east Greenland but are possibly a little stouter.

Figured specimens: USNM 130771.
Occurrence: Sawtooth formation, upper member at USGS Mesozoic locs. 19601, 27501.

Arctocephalites (Cranocephalites) cf. A. maculatus (Spath)

Plate 4, figures 1, 3, 5

The septate specimen, illustrated on plate 4, figure 5, is the best preserved of four, although it has been crushed laterally and the details of its ribbing are not preserved. The specimens are characterized by having a stout whorl section, very coarse, thick ribbing, and a smooth contracted body chamber. They are comparable in stoutness and in coarseness of ribbing with *Cranocephalites maculatus* Spath (1932, p. 24, pl. 1, figs. 1 a, b, pl. 2, figs. 3 a, b, pl. 3, figs. 6 a, b, pl. 4, fig. 2), from east Greenland, but differ by developing a smooth body chamber. Immature individuals of the species from Montana have not been identified definitely, but are possibly represented by the specimens shown on plate 4, figures 1, 3.

Figured specimens: USNM 130773, 130774.
Occurrence: Sawtooth formation, upper member at USGS Mesozoic locs. 19184, 22652, 27039, and 27040.

Arctocephalites (Cranocephalites) cf. A.? platynotus (Spath)

Plate 5, figures 4–6, 8

Two specimens from Montana are as broadly depressed as *A.? platynotus* Spath (1932, p. 43, pl. 11, figs. 6 a, b) from east Greenland but differ by having much stronger primary ribs and more distinct rib branching low on the flanks. The larger specimen represents the adoral part of a scaphitoid body chamber and is marked by two constrictions.

Figured specimens: USNM 130772.
Occurrence: Sawtooth formation, upper member at USGS Mesozoic loc. 19601

Genus ARCTICOCERAS Spath, 1924

Arcticoceras? sp.

Plate 5, figure 7

One adult body whorl is similar in shape to the adult of *Arctiococeras rierdonense* Imlay (1953a, p. 19, pl. 2), differing mainly by being much smaller and by having a prolonged ventral lappet. The aperture is terminated by a constriction near the dorsum. The umbilicus is extremely small. The body chamber occupies about four-fifths of a whorl. Only traces of the suture line are preserved.

This specimen, by comparisons with ammonite specimens from the western interior, probably belongs to the genus *Arcticoceras* rather than to *Arctocephalites.* However, without knowledge of the ribbing of its internal whorls a definite generic assignment cannot be made. Nevertheless, the resemblance to *Arcticoceras* suggests that the upper part of the Sawtooth formation is not much older than the *Arcticoceras* zone at the base of the Rierdon formation.

Figured specimen: USNM 130776.
Occurrence: Sawtooth formation, upper member at USGS Mesozoic loc. 22654.

Genus PARAREINECKEIA Imlay, n. gen.

This genus is distinguished from other genera and subgenera of the Reineckeiidae (Arkell, 1957, p. L311–L313) by having larger primary ribs, a single row of tubercles high on the flanks, and an exceedingly weak ventral sinus that does not interrupt the ribbing. The inner whorls are coronate and bear prominent tubercles at the umbilical seam. During growth the whorls become ovate, the tubercles become weaker, and the ribs become broader and more widely spaced. *P. hickersonensis* Imlay, n. sp., is designated as the type species. The genus likewise includes *Reineckeia (Kellawaysites) shelikofana* Imlay (1953b, p. 101, pl. 55, figs. 1, 2, 5–8).

The tuberculate coronate inner whorls of *Parareineckeia* may be distinguished from those of *Reineckeia* by the position of the tubercles much higher on the flanks. The weakening of tuberculation during growth contrasts markedly with the condition in *Reineckeia.* The adult of *Parareineckeia* shows some resemblance to *Kellawaysites*, but is readily distinguished by its coronate inner whorls, much longer primary ribs, and absence of rib branching on the flanks below the tubercles. The genus *Collotia* bears tubercles high on the flanks as in *Parareineckeia*, but it, also, bears rows of tubercles near the umbilicus and on the venter and it has a well-defined ventral groove. The outer septate whorls of *Kellawaysites oxyptychoides* Spath (1928, p. 266, pl. 41, figs. 5 a, b; 1933, pl. 126, fig. 1) bear tubercles high on the flanks as in *Parareineckeia*, but the primary ribs bifurcate below the middle of the flanks as well as higher. The genus *Epimorphoceras* Spath (1928, p. 252–254) differs from *Parareineckeia* by developing compressed instead of ovate whorls, by loosing its tubercles at an earlier growth stage, by developing fasiculate ribbing, and by having a well-developed ventral sulcus.

Parareineckeia hickersonensis Imlay, n. sp.

Plate 7, figures 1–5

Only one specimen of this species is known. It is moderately compressed and evolute. Its whorls are much depressed, but become less depressed during growth. The flanks on the inner whorls are divergent.

but on the outer whorls become evenly rounded. The venter on the inner whorls is very broad and depressed and makes a sharp angle with the flanks, but during growth the venter becomes gently convex and rounds less abruptly into the flanks. The umbilicus is very wide; the wall is steep and rounds evenly into flanks. The body chamber is incomplete, but includes at least half a whorl.

The primary ribs are high, narrow, fairly widely spaced, incline forward on the flanks and terminate at the top of the flanks in tubercles of variable strength. From most tubercles pass pairs of weaker secondary ribs that arch forward slightly on the venter and may, or may not unite in a single tubercle on the opposite side of the venter. Some tubercles are connected across the venter by single ribs or by three ribs. A weak median sinus is present along the midline of the venter on the outer whorl. There are 3 or 4 constrictions on each whorl.

The suture line has broad saddles. The external lobe is slightly shorter than the first lateral lobe. The second lateral lobe is nearly as large as the first lateral lobe. The auxiliaries ascend toward the umbilical seam.

The holotype at a diameter of 43 mm has a whorl height of 14.5 mm, a whorl thickness of 19.5 mm, and an umbilical width of 22 mm. At a diameter of 65 mm the other dimensions are 20, 24, and 29 mm, respectively.

This species is distinguished from *Parareineckeia shelikofana* (Imlay) (1953b, p. 101, pl. 55, figs. 1, 2, 5–8) by its much coarser ribbing, stronger tuberculation, and more depressed whorl section.

Type: Holotype USNM 130756.
Occurrence: Bowser member of the Tuxendi formation at USGS Mesozoic loc. 22698.

Parareineckeia cf. P. shelikofana (Imlay)

Plate 7, figures 6, 7

Two fragments resemble the inner whorls of *P. shelikofana* (Imlay) (1953b, p. 101, pl. 55, figs. 1, 8) from the Chinitna formation of Alaska. They differ by having slightly sparser and sharper ribs at a comarable size. As in that species the zone of tuberculation is situated high on the flanks and a weak median sinus is present on the venter.

Figured specimen: USNM 130750.
Occurrence: Bowser member of the Tuxedni formation at USGS Mesozoic loc. 20745; equivalent beds in the Talkeetna Mountains at Mesozoic loc. 24117.

Genus COBBANITES Imlay, n. gen.

Cobbanites is characterized by having compressed whorls that become more compressed during growth, by bearing prorsiradiate ribbing and deeply impressed forwardly inclined constrictions, by developing a smooth body chamber, and by the venter on its inner whorls bearing strongly arched ribs that in some species are slightly weakened along the midline. The primary ribs on the small innermost whorls are prominent, are radial, or inclined slightly forward, most of them bifurcate near the middle of the flanks, and along the zone of furcation they become strongly swollen. Tiny tubercles are present at the furcation points on the innermost whorls of a species from Montana. The suture line has a strongly retracted suspensive lobe. The aperture terminates simply. *Cobbanites talkeetnanus* Imlay, n. sp., is designated as the type species.

Cobbanites shows a general resemblance to some finely ribbed species of *Choffatia,* such as figured by Neumayr (1871, pl. 14, figs. la, b, 2a, b, pl. 15, figs. la, b, 2a, b), and particularly to the subgenus *Homoeoplanulites* Buckman (1922, pl. 328; 1924, pl. 515; Westermann, 1958, p. 85; Arkell, 1958, p. 211, 225–227), but its primary ribs become much weaker and more closely spaced on the adult body whorl, and its secondary ribs are inclined forward much more strongly, especially on the inner whorls. Also, its peristone does not bear lateral lappets as in *Homoeoplanulites.*

An assignment of *Cobbanites* to the subfamily Zigzagiceratinae (see Arkell, 1957, p. L314–L316) is favored by such features as its prorsiradiate ribbing, the swollen primary ribs on its inner whorls, the tiny lateral tubercles on one species, and perhaps the reduction of ribbing along the midventral line on immature specimens. Its ribbing in particular suggests a relationship with the genus *Procerites.* It differs from *Procerites,* however, by having deeply impressed constrictions on its septate whorls and by being more evolute and compressed than most species that have been assigned to *Procerites.* The subgenus *Gracilisphinctes* Buckman (1920, pl. 193; Arkell, 1958, p. 174), has constrictions, but only on its inner whorls. Furthermore it differs from *Cobbanites* by having more evolute inner whorls and more involute outer whorls, and on the adult body whorl the ribbing fades first on the lower part of the flanks instead of on the venter.

Cobbanites also shows resemblances to *Gonolkites* Buckman (1925, pl. 546a, b; Arkell, 1956, p. 145, 153–160) from the lower Bathonian—but it is much more evolute; the ribbing on the adult whorl fades earliest on the venter instead of on the flanks; and it does not have a distinct ventral groove.

Other species of *Cobbanites* include the specimens from Montana and Alaska assigned to *Procerites* spp. by Imlay (1953a, p. 33, pl. 23, figs. 13, 17, pl. 24, figs. 9–11; 1953b, p. 102, pl. 53, figs. 1–3), *Procerites engleri*

Frebold (1957a, p. 65, pl. 39, fig. 1, pl. 40, figs. 1a, b) from Canada and probably *Procerites*? sp. described by Frebold (1957a, p. 66, pl. 40, figs. 2a, b; pl. 41) from Canada. Another species of *Cobbanites* occurs in the Sawtooth formation of Montana and is described herein.

Cobbanites is named in honor of William A. Cobban, of the U.S. Geological Survey at Denver, Colo.

Cobbanites occurs in the Cook Inlet area, Alaska, in the basal part of the Chinitna formation of early Callovian age and in the directly underlying beds whose age is in question. In Alberta it is associated with other ammonites of early Callovian age (Frebold, 1957a, p. 65, 66, 76, 80) in the Fernie formation. In Montana it occurs in the lower part of the Rierdon formation of early Callovian age and in the directly underlying upper member of the Sawtooth formation.

Cobbanites talkeetnanus Imlay, n. sp.

Plate 7, figures 8–13, plate 8, figure 1

This species is represented by 1 large adult specimen that includes the body chamber and by 1 fragment that shows 5 septate inner whorls. The shell is compressed. The whorls are elliptical in section, much higher than wide, and each whorl embraces about two-fifths of the preceding whorl. The flanks are flattened and rounded evenly into the highly arched venter which becomes narrower during growth. The umbilicus is very wide and shallow; the umbilical wall is low and steeply inclined. The body chamber occupies about four-fifths of a whorl. The aperture on the internal mold is terminated by a pronounced forwardly inclined constriction.

On the inner whorls the primary ribs are fairly high and sharp, are regularly spaced, and are separated by moderately wide interspaces. They begin near the umbilical seam, incline forward gently on the flanks, and bifurcate regularly near the middle of the flanks. The secondary ribs are a little weaker than the primary ribs, curve forward strongly on the flanks, arch forward considerably on the venter, and are slightly weakened along the midventral line. Each whorl bears from 3 to 4 deep constrictions that are inclined forward more strongly than the ribs and are generally bounded by 1 or 2 swollen ribs.

During growth the ribs become weaker and less strongly projected. On the penultimate whorl the ribbing is weak, is only slightly arched on the venter, and gradually fades adorally. The body chamber is marked only by faint moderately spaced primary ribs on the lower third of the flanks.

The suture line, partly exposed at several places on the largest septate whorl, is fairly complex and has long, slender lobes and a strongly retracted suspensive lobe.

The holotype at a diameter of 190 mm has a whorl height of 59 mm, a whorl thickness of 39 mm, and an umbilical width of 82 mm. Near the aperture the same dimensions are 260(?), 68, 52, and 124 mm, respectively.

This species is characterized by its compressed whorl section, its deep strongly inclined constrictions, the moderate spacing of its primary ribs, and strong forward inclination of its secondary ribs. It differs from most species of *Choffatia* by not developing widely spaced primary ribs on its outer whorls, and in that respect resembles the subgenus *Homoeoplanulites* (Buckman, 1922, pl. 328; 1924, pl. 515) from the Lower Cornbrash formation of England. *Homoeoplanulites* is characterized, however, by the presence of lateral lappets, and its secondary ribs are not inclined forward.

Cobbanites talkeetnanus Imlay, n. sp., has weaker ribbing than on *C. engleri* (Frebold) (1957a, p. 65, pl. 39, pl. 40, figs. 1a, b), its secondary ribs are more strongly projected on the flanks, and it appears to be a much smaller species.

Types: Holotype USNM 130743; paratype USNM 130744.
Occurrence: Unnamed beds in the Talkeetna Mountains at Mesozoic loc. 24116.

Cobbanites spp.

Plate 6, figures 3, 6–8, 10–15

The genus is represented in the Sawtooth formation by 20 fragments, of which most belong to a species similar to *Cobbanites talkeetnanus* Imlay, n. sp., from Alaska. The inner whorls are depressed ovate in section and probably a little wider than high. During growth the whorl section becomes more compressed and on the adult body chamber is about twice as high as wide.

The smallest whorls bear prominent moderately spaced primary ribs that incline forward slightly on the lower parts of the flanks and bifurcate fairly regularly near the middle of the flanks. A few primary ribs remain simple. The furcation points on the smallest whorls are marked by tiny conical tubercles. The secondary ribs are slightly weaker than the primary ribs, are inclined forward on the flanks, and are arched forward strongly on the venter.

During growth the ribbing gradually becomes weaker and less strongly arched, but persists on all septate whorls. The adult body chamber is smooth, or bears only faint traces of ribbing low on the flanks. Strong forwardly inclined constrictions are present on all septate whorls and are most deeply impressed on the inner whorls.

The suture line has long, slender lobes and a strongly retracted suspensive lobe. All the specimens are too imperfect for measurements to be made.

The ornamentation of the inner whorls of the specimens of *Cobbanites* from the Sawtooth formation greatly resemble the Middle Jurassic genus *Parkinsonia* except for the absence of a ventral groove. They likewise resemble the small specimen from Alberta that Frebold (1957a, p. 65, 66, pl. 40, figs. 2 a, b, pl. 41) referred questionably to *Procerites*. The larger septate whorls are comparable with the paratype of *Cobbanites engleri* (Frebold) (1957a, pl. 40, figs. 1 a, b) but appear to have more widely spaced ribbing and a more compressed ovate whorl section. They differ from *C. talkeetnanus* Imlay, n. sp., from Alaska by attaining a much larger size, by having stronger ribbing on the larger septate whorls, and by developing a higher whorl section. The suture line, partially exposed on one specimen, has a more strongly retracted suspensive lobe than that on the holotype of *Cobbanites engleri* (Frebold) (1957a, pl. 39).

Figured specimen: USNM 130761–130765.

Occurrence: Sawtooth formation upper member at USGS, Mesozonic locs. 18718, 19184, 19185, 19601, 19604, 19623, 20355, 20357, 22652, 22654, 27041, 27047.

Genus SIEMIRADZKIA Hyatt, 1900

Siemiradzkia? cf. S. aurigera (Oppel)

Plate 2, figures 9, 10

Two laterally crushed ammonites have highly evolute coiling and elliptical whorl sections that become more compressed during growth. The body chamber is represented by half a whorl and is terminated by lateral lappets.

Both specimens on their inner whorls have sharp evenly spaced forwardly inclined ribbing, but on one specimen the ribbing is much sharper and more widely spaced than on the other. On the outer two whorls of both specimens, the ribbing is sharp, inclined forward, variably spaced, and mostly simple. On the body whorl a few ribs fork high on the flanks or are indistinctly connected with secondary ribs. The suture line, partly exposed on one specimen, is fairly simple.

These specimens have the fine sharp irregular ribbing that is characteristic of the genera *Siemiradzkia* and *Grossouiria*. They are tentatively assigned to *Siemiradzkia* rather than to *Grossouvria* because single ribs are much more common than forked ribs, the ribs do not recurve backward on the venter, constrictions are not prominent, and the sides of the adult whorl tend to flatten. The more finely ribbed specimen is similar to finely ribbed specimens of *S. aurigera* (Oppel) from Europe (Grossouvre, 1919, pl. 15, fig. 5; Westermann, 1958, pl. 36, fig. 2). The more coarsely ribbed specimen develops ribbing on its body whorl similar to that of the more coarsely ribbed specimen of *S. aurigera* (Oppel) (D'Orbigny, 1843, pl. 149, fig. 1; Grossouvre, 1919, pl. 15, figs. 6, 7). The lappets on the Alaskan specimens are much simpler than in *S. aurigera* (Oppel) but resemble those of *S. matisconensis* (Lissajous) (1923, pl. 5, fig. 3) or *S. berthae* (Lissajous) (1923, pl. 5, fig. 1).

The Alaskan specimens were once referred by the writer to *Planisphinctes* (Imlay, 1952, p. 980), which Arkell (1958, p. 212, 213) considers a subgenus of *Siemiradzkia*. They differ from *Planisphinctes* however, by their whorl sections becoming elliptical instead of circular or depressed and by the body chamber bearing irregular variably spaced ribbing.

Figured specimens: USNM 130755.

Occurrence: Bowser member of the Tuxedni formation at USGS Mesozoic loc. 22698.

LITERATURE CITED

Arkell, W. J., 1950–58, English Bathonian ammonites: Palaeont. Soc. Pub., 264 p., 33 pls., 83 text figs.

——— 1956, Jurassic Geology of the World: Oliver and Boyd Ltd., London, 806 p., 46 pls., 28 tables, 102 figs.

——— 1957, *in* Arkell, W. J., Kummel, Bernhard, and Wright, C. W., Mesozoic Ammonoidea: Treatise on Invertebrate Paleontology, Part L, Mollusca 4, 490 p., illus.

Buckman, S. S., 1909–30, [Yorkshire] Type Ammonites: Weldon and Wesley Ltd., London, 7 v.

——— 1929, Jurassic Ammonoidea: Canada Natl. Mus. Bull. 58, p. 1–27, 3 pls., 1 fig.

Burckhardt, Carlos, 1927, Cefalopodes del Jurasico medio de Oaxaca y Guerrero: Inst. geol. Mexico Bol., no. 47, 108 p., 34 pls.

Callomon, J. H., 1955, The ammonite succession in the Lower Oxford clay and Kellaways beds at Kidlington, Oxfordshire, and the zones of the Callovian stage: Royal Soc. London Philos. Trans., v. 239, p. 215–264, pls. 2, 3, 5 figs., 4 tables.

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

Capps, S. R., 1927, Geology of the upper Matanuska Valley, Alaska: U.S. Geol. Survey Bull. 791, 92 p., 16 pls., 5 figs.

Cobban, W. A., 1945, Marine Jurassic formations of Sweetgrass Arch, Montana: Am. Assoc. Petroleum Geologists Bull., v. 29, p. 1262–1303, 6 figs.

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

——— 1957, The Jurassic and Cretaceous systems in East Greenland: Meddelelser om Grönland, v. 155, no. 4, 214 p., 4 pls., 25 figs.

Frebold, Hans, 1930, Verbreitung und Ausbildung des Mesozoikums in Spitzbergen: Skrifter om Svalbard og Ishavet [Oslo], no. 19, p. 183–201, pls. 1–33.

——— 1951, Geologie des Barentsschelfes: Deutsche Akad. Wiss. Berlin Abh., Kl. Math. u. allg. Naturw. Jahrg. 1950, no. 5, 151 p., 82 figs.

——— 1953, Correlation of the Jurassic formations of Canada: Geol. Soc. America Bull., v. 64, p. 1229–1246, 1 correlation chart.

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

——— 1957b, Fauna, age, and correlation of the Jurassic rocks of Prince Patrick Island: Canada Geol. Survey Bull. 41, 32 p., pls. 1–18 [issued January 1958].

Grossouvre, Albert de, 1919, Bajocien-Bathonien dans la Nièvre: Soc. géol. France, Bull., 4 ser., v. 18, p. 337–459, pls. 13–16.

Imlay, R. W., 1948, Characteristic marine Jurassic fossils from the western interior of the United States: U.S. Geol. Survey Prof. Paper 214–B, p. 13–33, pls. 5–9.

——— 1952, Correlation of the Jurassic formations of North America, exclusive of Canada: Geol. Soc. America Bull., v. 63, p. 953–992, 2 correlation charts.

——— 1953a, Callovian (Jurassic) ammonites from the United States and Alaska, Part 1. Western interior United States: U.S. Geol. Survey Prof. Paper 249–A, p. 1–39, 24 pls., figs. 1, 2, 3 tables.

——— 1953b, Callovian (Jurassic) ammonites from the United States and Alaska. Part 2. Alaska Peninsula and Cook Inlet regions: U.S. Geol. Survey Prof. Paper 249–B, p. 41–108, pls. 25–55, figs. 2–9, 6 tables.

——— 1956a, Marine Jurassic exposed in Bighorn Basin, Pryor Mountains, and northern Bighorn Mountains, Wyoming and Montana: Am. Assoc. Petroleum Geologists Bull., v. 40, p. 562–599, 7 figs.

——— 1956b, Interpretations of the marine Jurassic fossil record at Lower Slide Lake, Teton County, Wyoming: Wyoming Geol. Assoc. Guidebook 11th Ann. Field Conf., p. 70–71.

——— 1957, Paleoecology of Jurassic seas in the western interior of the United States: Treatise on Marine Ecology and Paleoecology, v. 2, Geol. Soc. America, Mem. 67, p. 469–504.

Imlay, R. W., Gardner, L. S., Rogers, C. P., Jr., and Hadley, H. D., 1948, Marine Jurassic formations of Montana: U.S. Geol. Survey Oil and Gas Inv. (Prelim.) Chart 32.

Krimholz, G. Y., 1939, Materials on the geology of the Bureya coal basin, 4; Contribution to the stratigraphy of the Jurassic marine strata on the Bureya river [East Siberia]: United Central Geol. Prosp. Inst. Russia Trans., v. 117, 60 p., 3 pls.

Kirschner, C. E. and Minard, D. L., 1949, Geology of the Iniskin Peninsula, Alaska: U.S. Geol. Survey Oil and Gas Inv. (Prelim.) Map 95.

Lupher, R. L., 1941, Jurassic stratigraphy of Central Oregon: Geol. Soc. America Bull., v. 52, p. 219–270.

McLearn, F. H., 1924, New pelecypods from the Fernie formation of the Alberta Jurassic: Royal Soc. Canada Proc. and Trans., 3d ser., sec. 4, v. 18, p. 39–61, pls. 1–9.

——— 1928, New Jurassic ammonoidea from the Fernie formation Alberta: Canada Geol. Survey Bull. 49, Geol. Ser. no. 48, p. 19–22; pls. 4–8.

——— 1929, Stratigraphic paleontology, Blairmore region, Alberta: Canada Natl. Mus. Bull. 58, Geol Ser., no. 50, p. 80–107.

——— 1932, Three Fernie Jurassic ammonoids: Royal Soc. Canada Proc. and Trans., 3d ser., sec. 4, v. 26, p. 111–115, 5 pls.

Madsen, V., 1904, On Jurassic fossils from East Greenland: Meddelelser om Grönland, v. 29, p. 157–210, pls. 6–10.

Martin, G. C., 1926, The Mesozoic stratigraphy of Alaska: U.S. Geol. Survey Bull. 776, 493 p., 13 figs.

Mapel, W. J., and Bergendahl, M. H., 1956, Gypsum Spring formation, northwestern Black Hills, Wyoming, and South Dakota: Am. Assoc. Petroleum Geologists Bull., v. 40, p. 84–93, 2 figs.

Moor, G. G., 1937, Explanatory note geologic map northern USSR: Arctic Inst. Trans., v. 87, p. 207–290.

Neumayr, M., 1871, Die Cephalopoden-Fauna der Oolithe von Balin bei Krakau: K. K. Geol. Reichsanstalt Abh., v. 5, p. 19–54, pls. 9–15.

Newton, E. T. and Teall, J. J. H., 1897, Notes on a collection of rocks and fossils from Franz Josef land, made by the Jackson-Harmsworth expedition, 1894–96: Geol. Soc. London Quart. Jour., v. 53, p. 477–519, pls. 37–41.

Nikolaev, I. G., 1938, Data on geology and mineral deposits of the Kharaulakh range *in* Geology and mineral deposits of the Lena-Kolyma district; part 1: Arctic Inst. Trans., v. 99, 193 p., 41 figs., 5 pls.

Orbigny, Alcide d', 1842–51, Paleontologie francaise: Terrains Jurassiques, v. 1.

Pompeckj, J. F., 1899, The Jurassic fauna of Cape Flora, Franz Josef Land, *in* Nansen, F., The Norwegian North Polar Expedition, 1893–96: Sci. Results, v. 1, no. 2, 147 pp., 3 pls.

Salfeld, Hans, and Frebold, Hans, 1924, Jura-und Kreidefossilien von Nowaja Semlja: Rep. Sci. Results Norwegian Exped. Novaya Zemlya for 1921 (Kristiania), no. 23, p. 1–12, pls. 1–4.

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

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

Stehn, E., 1924, Beitrage zur Kenntnis des Bathonien und Callovien in Sudamerika: Neues Jahrb., Beilage-Band 49 for 1923, p. 52–58, 8 pls.

Warren, P. S., 1932, A new pelecypod fauna from the Fernie formation, Alberta: Royal Soc. Canada Proc. and Trans., 3d ser., sec. 4, v. 26, p. 1–36, 5 pls.

——— 1934, Present status of the Fernie shale: Am. Jour. Sci., 5th ser., v. 27, p. 56–70.

——— 1947, Description of Jurassic ammonites from the Fernie formation, Alberta: Research Council, Alberta, Rept. 49, p. 67–76, 7 pls.

Weir, J. D., 1949, Marine Jurassic formations of southern Alberta Plains: Am. Assoc. Petroleum Geologists Bull., v. 33, p. 547–563, 3 figs.

Westermann, Gerd, 1958, Ammoniten-Fauna und Stratigraphie des Bathonien NW-Deutschlands: Beihefte Geol. Jahrb., no. 32, p. 1–103, pls. 1–49.

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

INDEX

[Italic numbers indicate descriptions]

Page

A

Abstract C-1
Alaska and Montana, Callovian versus Bathonian in 13
Alaska, Cook Inlet region 2-3
Alaska, evidence from 10-12
alticostus, Arctocephalites .... 20, *22*, 23; pl. 2
Ammonites 1, 2, 3, 10, 12, 14
analysis, biologic 2
Arctic region 15
Arcticoceras 2, 5, 10, 12, 13, 14, 15, 20, 25
kochi 15
rierdonense 25
sp .... 21, *25*; pl. 5
Arctocephalites 2, 4, 12, 13, 14, 15, 19, 22, 23, 24, 25
alticostus .... 20, *22*, 23; pl. 2
costidensus 20
(*Cranocephalites*) 2, 3, 5, 9, 10, 15, 16, 17, 19, 20, 21, 22, 24,
costidensus .... *24*; pl. 2
gracilis .... *24*; pl. 5
maculatus .... *25*; pl. 4
platynotus .... *25*; pl. 5
pompeckji .... 20, 22, *23*; pl. 1
intermedia 23
sawtoothensis .... 21, *24*; pl. 3
sp 21
gracilis 21
maculatus 21
metastatus sweetgrassensis 24
platynotus 21
pompeckji 20
sawtoothensis 23, 24
saypoensis .... 10, 21, 22, *23*; pl. 6
sphaericus 22
sp 20, 21
sp. juv 23
Astarte carlottensis 20
(*Coelastarte*) *morion* 21
meeki 21
packardi 21
sp 20, 21
asteriscus, Pentacrinus 21
aurigera, Siemiradzkia .... 20, *28*; pl. 2

B

bakeri, Phylloceras 3
Bathonian versus Callovian in Alaska and Montana 13
Bathonian versus Callovian in Greenland 12-13
Belemnites 20, 21
berthae, Siemiradzkia 28
Biologic analysis 2
Bowser member, Tuxedni formation 2, 3, 10, 12, 19, 20, 22, 23, 24, 26, 28
Brachiopods 21

C

Cadoceras 4, 10, 12, 13, 14, 15, 21
Cadoceratinae 2
Calliphylloceras freibrocki 3
Calliphylloceratinae 2
Callovian versus Bathonian in Alaska and Montana 13
Callovian versus Bathonian in Greenland 12-13
calloviense, Sigaloceras 10, 13
Camptonectes platessiformis 10, 21
stygius 21
sp 20
Canada, western interior of 14-15
Cardioceratidae 2, 14
carlottensis, Astarte 20
Pleuromya 20
Cercomya punctata 21
sp 20
Channel conglomerate 3
Chinitna Bay, peninsula north of 3
Chinitna formation 2, 4, 10, 16, 17, 23, 26
Chlamys sp 21
Choffatia 15, 26, 27
Chondroceras 12, 19
oblatum 21
Clydoniceras discus 12
Cobbanites 2, 12, 13, 14, 19, 20, 26, 27, 28
talkeetnanus .... 20, 26, *27*, 28; pls. 7, 8
spp .... 21, *27*; pl. 6
(*Coelastarte*) *morion, Astarte* 21
Collotia 25
Comparisons with other faunas 14-15
Cook Inlet region, Alaska 2-5
conradi, Trigonia 21
Corbula munda 9
Cosmoceras 4, 10
costidensus, Arctocephalites 20
Arctocephalites (*Cranocephalites*) .... *24*; pl. 2
Cranocephalites 2, 3, 4, 5, 10, 12, 13, 14, 15, 19, 20, 21, 22, 23, 24
gracilis 24
maculatus 25
pompeckji 15, 22, 23, 24
intermedia 24
vulgaris 23, 24
(*Cranocephalites*), *Arctocephalites* 2, 3, 5, 9, 10, 15, 16, 17, 19, 20, 21, 22, 24,
Arctocephalites sp 21
costidensus, Arctocephalites .... *24*; pl. 2
gracilis, Arctocephalites .... *24*; pl. 5
maculatus, Arctocephalites .... *25*; pl. 4
platynotus, Arctocephalites .... *25*; pl. 5
pompeckji, Arctocephalites .... 20, 22, *23*; pl. 1
pompeckji intermedia, Arctocephalites 23
sawtoothensis, Arctocephalites .... 21, *24*; pl. 3
Crinoid fragments 21
cumshewaensis, Parallelodon 20
curta, Meleagrinella 21
Cynthia Falls sandstone member, Tuxedni formation 2

D

Dentalium sp 21
descriptions, systematic 22-28
discus, Clydoniceras 12
distribution, geographic 15-19
Donovan, quoted 13
Drummond area 10

E

Echinoid spines 21
Ellis group 18, 19
engleri, Procerites 26, 28
Epimorphoceras 25
era, Sphaeroceras 15
Evidence from Alaska 10-12
from Montana 12
summation of 14
eximius Inoceramus 20

F

Faunas, age of the 10-14
comparisons with other 14-15
Fernie formation 14, 27
Rock Creek member 9, 12
freibrocki, Calliphylloceras 3

G

Gastropods 20
Geographic distribution 15-19
Gervillia sp 21
Gonolkites 26
Gowericeras 10, 13
gracilis, Arctocephalites 21
Arctocephalites (*Cranocephalites*) .... *24*; pl. 5
Cranocephalites 24
Gracilisphinctes 26
Grammatodon sp 21, 20
Greenland, Callovian versus Bathonian in 12-13
grossicostatum, Macrophylloceras 3
Grossouvria 10, 13, 28
sp 2, 3
Gryphaea 9
impressimarginata 5, 9, 10, 20, 21
Gypsum Spring formation 6

H

haguei, Idonearca 21
hebetus, Xenocephalites 3
hickersonensis, Parareineckeia .... 20, *25*; pl. 7
Holcophylloceras 2, 19, 22
sp .... 20, *22*; pl. 1
Homoeoplanulites 26, 27

I

iddingsi, Isocyprina 21
Idonearca 21
haguei 21
rockymontana 21
impressimarginata, Gryphaea 5, 9, 10, 20, 21
inaequiplicatus, Pholadomya 21
Iniskin Peninsula 2-3
Inoceramus eximius 20
porrectus 20
sp 20, 21
inornata, Tancredia 21
intermedia, Arctocephalites (*Cranocephalites*) *pompeckji* 23
intermedia, Cranocephalites pompeckji 24
intermedium, Kheraiceras 2, 3
Isocyprina 20, 21
iddingsi 21

K

Kellawaysites 25
oxyptychoides 25
(*Kellawaysites*) *shelikofana, Reineckeia* 25
Kepplerites 10, 13
(*Seymourites*) 13, 14
tychonis 3, 13
sp 3
Kheraiceras 4, 10
intermedium 2, 3
parviforme 2, 3
sp 3
kingi, Pholadomya 21
Pinna 21
kochi, Articoceras 15

Page

koenigi, Proplanulites 12
Kosmoceras 13
Kosmoceratidae 14

L

laminatus, Macrocephalites 24
Leptosphinctes 2
Lilloettia 10, 51
Lissoceras 2, 3
Literature cited 28-29
Lopha sp 10, 21
Lower Cornbrash formation, England 27
Lucina sp 20, 21

M

Macrocephalitidae 2
Macrocephalites laminatus 24
macrocephalus 10, 12, 13, 20
pompeckji 23
Macrocephalus 13
macrocephalus, Macrocephalites 10, 12, 13, 20
Macrophylloceras grossicostatum 3
maculatus, Arctocephalites 21
Arctocephalites (*Cranocephalites*) *25*; pl. 4
Cranocephalites 25
matisconensis, Siemiradzkia 28
mclearni, Oxytoma 21
meeki, Astarte 21
Meleagrinella curta 21
sp 20
Metacephalites 14
metastatus 24
metastatus, Metacephalites 24
metastatus sweetgrassensis, Arctocephalites 24
Miccocephalites 14
Modiolus rosii 21
sp 10, 20, 21
Montana and Alaska, Callovian versus Bathonian in 13
Montana, evidence from 12
Montana, western 5-10
montanaensis, Trigonia 10, 21
morion, Astarte (Coelastarte) 21
Morphoceratidae 13
munda, Corbula 9

N

Normannites 12, 19
sp 10
Nucula sp 21

O

oblatum, Chondroceras 21
oblongata, Pleuromya 21
Oecotraustes 2, 22
(*Paroecotraustes*) sp 20, *22*; pl. 1
Oppeliidae 2
Oppeliinae 2
Oppelia 22
(*Oxycerites*) 2, 3
Ostrea strigilecula 21
sp 10, 20, 21
Oxycerites 22
(*Oxycerites*), *Oppelia* 2, 3
oxyptychoides, Kellawaysites 25
Oxytoma mclearni 21
sp 20, 21

P

packardi, Astarte 21
Paleogeographic considerations 13-14
palliseri, Stemmatoceras 10
Paraacdoceras 10, 15

Page

tonniense 4
Parallelodon cumshewaensis 20
simillimus 20
Parareineckeia 2, 3, 4, 12, 13, 14, 19, 20, 25
hickersonensis 20, *25*; pl. 7
shelikofana 20, *26*; pl. 7
sp 3
Paroecotraustes 22
(*Paroecotraustes*) sp., *Oecotraustes* 20, *22*; pl. 1
Parkinsonia 28
Parkinsonidae 13
parviforme, Kheraiceras 2, 3
Pelecypods 2, 12
Peninsula north of Chinita Bay 3
Pentacrinus asteriscus 21
Perisphinctidae 2
Pholadomya inaequiplicatus 21
kingi 21
sp 20
Phylloceras bakeri 3
Phylloceratidae 2
Pinna kingi 21
Piper formation 9
Placunopsis sp 21
Planisphinctes 28
Platessiformis, Camptonectes 10, 21
platynotus, Arctocephalites 21
Arctocephalites (*Cranocephalites*) *25*; pl. 4
Pleuromya carlottensis 20
oblongata 21
subcompressa 10, 21
sp 20
Polyplectites 2
pompeckji, Arctocephalites 20
Arctocephalites (*Cranocephalites*) 20, 22, *23*; pl. 1
Cranocephalites 15, 22, 23, 24
Macrocephalites 23
pompeckji intermedia, Arctocephalites (*Cranocephalites*) 23
Cranocephalites 24
Porrectus, Inoceramus 20
procerites 26, 28
engleri 26, 28
sp 27
spp 26
Procerithium (*Rhabdocolpus*) sp 21
Proplanulites 13
koenigi 12
Protocardia schucherti 21
sp 20, 21
Pseudocadoceras 13, 15
Pseudoperisphinctinae 2
punctata, Cercomya 21

Q

Quenstedtia sp 21

R

Reineckeia (*Kellawaysites*) *shelikofana* 25
Reinckeia 12, 15, 25
Reineckeiidae 2, 13, 20
Results, summary of 19-22
(*Rhabdocolpus*), *Procerithium* sp 21
Rierdon formation 9, 10, 12, 17, 20, 25
rierdonense, Arcticoceras 25
Rock Creek member, Fernie formation 9, 12
rockymontana, Idonearca 21
Rocky Mountain front north of the Sun River 5-10
rosii, Modiolus 21

S

Sawtooth formation 5, 9, 10, 12, 13, 15, 17, 18, 19, 20, 21, 22, 23, 24, 25, 27, 28

Page

sawtoothensis, Arctocephalites 23, 24
Arctocephalites (*Cranocephalites*) 21, *24*; pl. 24
saypoensis, Arctocephalites 10, 21, 22, *23*; pl 6
schucherti, Protocardia 21
semiplanata, Thracia 20
(*Seymourites*), *Kepplerites* 13, 14
shelikofana, Parareineckeia 20, *26*; pl. 7
Reineckeia (*Kellawaysites*) 25
Siemiradzkia 2, 3, 13, 19, 20, 28
aurigera 20, *28*; pl. 28
berthae 28
matisconensis 28
Sigaloceras calloviense 10, 13
simillimus, Parallelodon 20
Snowshoe formation 15
sphaericus, Arctocephalites 22
Sphaeroceras 2, 3
era 15
Stemmatoceras 10, 12, 19
palliseri 10
Stratigraphic summary 2-10
strigilecula, Ostrea 21
stygius, Camptonectes 21
subcompressa, Pleuromya 10, 21
Summary, stratigraphic 2-10
Sundance formation 9
Sun River, Rocky Mountain front north of 5-10
sweetgrassensis, Arctocephalites metastatus 24
Systematic descriptions 22-28

T

Talkeetna formation 4
Talkeetna Mountains 3-5
talkeetnanus, Cobbanites 20, 26, *27*, 28; pls. 7, 8
Tancredia 21
inornata 21
sp 20, 21
Thracia semiplanata 20
sp 20
tonniense, Paracadoceras 4
trafalgarensis, Trigonia 21
Trigonarca 20
tumida 20
Trigonia conradi 21
montanaensis 10, 21
trafalgarensis 21
sp 20
tumida, Trigonarca 20
Tuxedni formation 16, 20
Bowser member 2, 3, 10, 16, 17, 19, 20, 22, 23, 24, 26, 28
Cynthia Falls sandstone member 2
tychonis, Kepplerites 3, 13

V

vicarius, Xenocephalites 3, 23
vulgaris, Cranocephalites 23, 24

W

Western interior of Canada 14-15
Western Montana 5-10

X

Xenocephalites 2, 4, 13, 15, 19, 22
hebetus 3
vicarius 3, 23
sp 3, 21, *22*; pl. 6

Z

Zigzagiceratinae 2, 26

PLATES 1–8

PLATE 1

[All figures natural size]

FIGURE 1. *Holcophylloceras* sp. (p. C-22).
USNM 130754 from USGS Mesozoic loc. 22698.

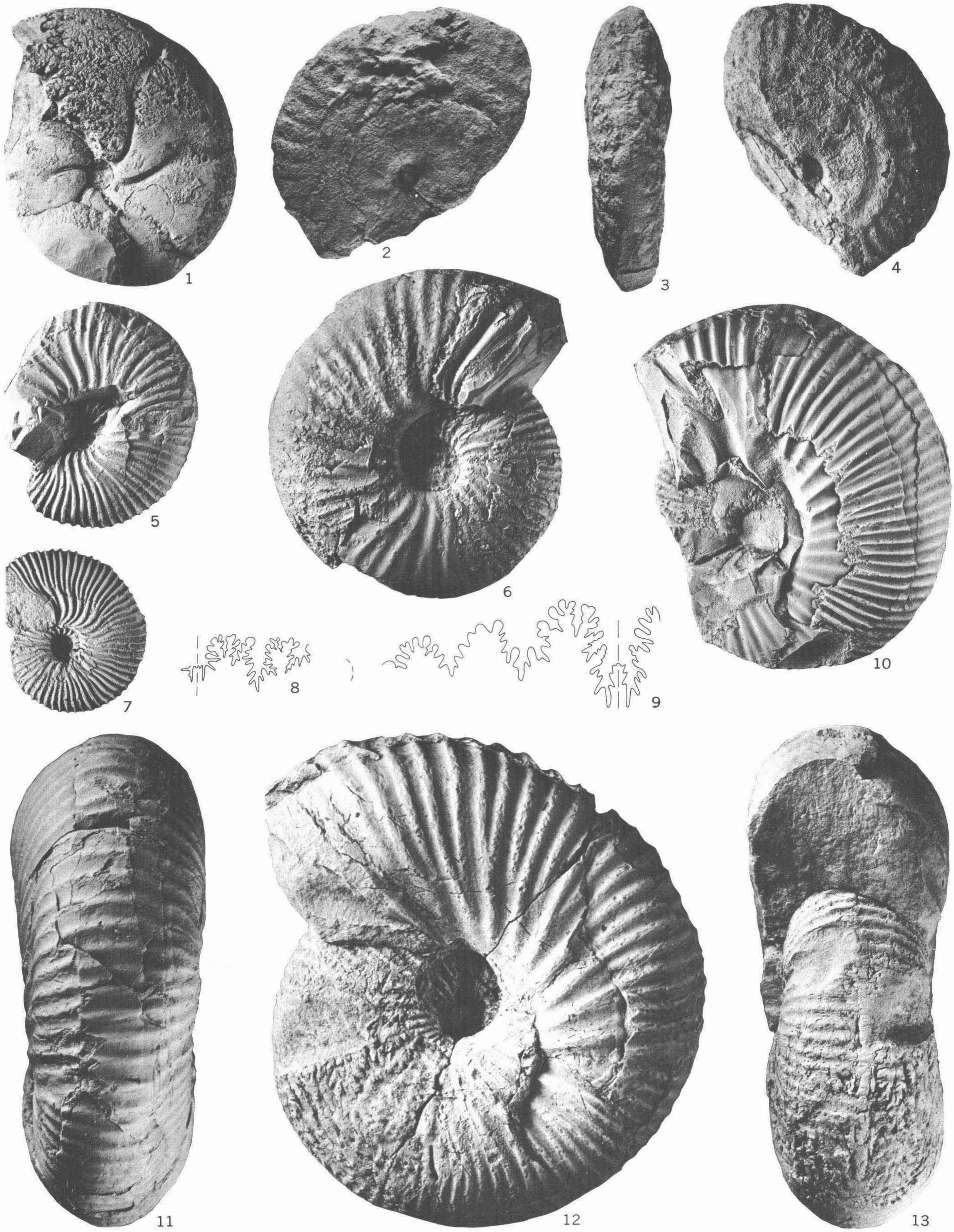
2–4. *Oecotraustes* (*Paroecotraustes*)? sp. (p. C-22).
Lateral and ventral views, USNM 130747 from USGS Mesozoic loc. 24116.

5–13. *Arctocephalites* (*Cranocephalites*) *pompeckji* (Madsen) (p. C–23).

5–8. Plesiotypes, USNM 130753 from USGS Mesozoic loc. 22698. Fig. 8 shows suture line drawn at beginning of complete body chamber of specimen shown on fig. 6.

9, 11–13. Plesiotype, USNM 130751 from USGS Mesozoic loc. 21284. Fig. 9 shows suture line drawn near beginning of complete body chamber.

10. Plesiotype, USNM 130752 from USGS Mesozoic loc. 21283. Shows nearly complete body chamber.



HOLCOPHYLLOCERAS, OECOTRAUSTES (PAROECOTRAUSTES)?, AND *ARCTOCEPHALITES (CRANOCEPHALITES)*

PLATE 2

[All figures natural size]

FIGURES 1–8. *Arctocephalites*? *alticostatus* Imlay, n. sp. (p. C–22).

1, 2. Paratype, USNM 130758 from USGS Mesozoic loc. 20752.

3. Paratype, USNM 130760 from USGS Mesozoic loc. 21308.

4–6. Paratype, USNM 130759 from USGS Mesozoic loc. 20011.

7, 8. Holotype, USNM 130757 from USGS Mesozoic loc. 20752.

9, 10. *Siemiradzkia*? cf. *S. aurigera* (Oppel) (p. C–28).

Specimens USNM 130755 from USGS Mesozoic loc. 22698. Note lateral lappets.

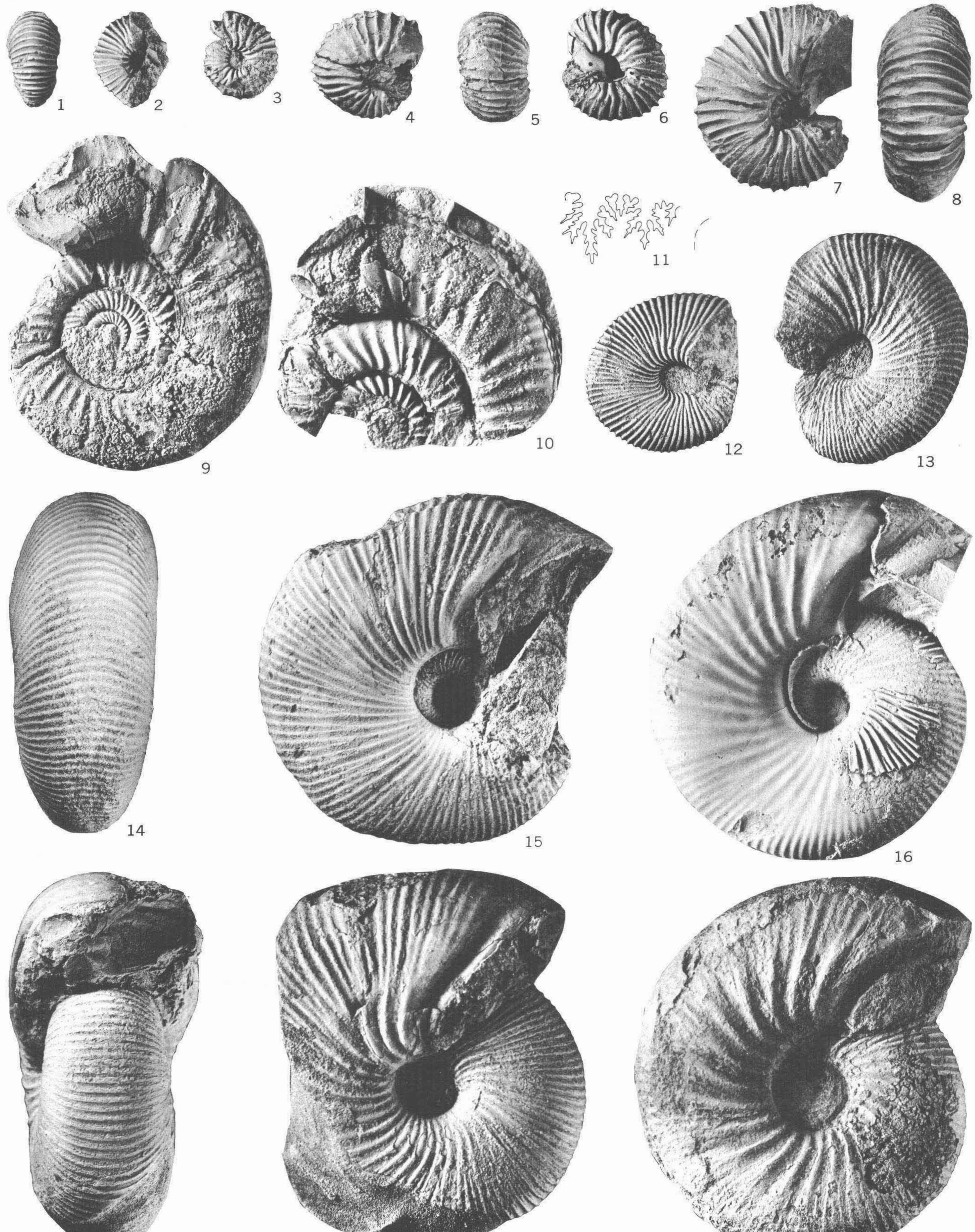
11–19. *Arctocephalites* (*Cranocephalites*) *costidensus* Imlay, n. sp. (p. C–24).

11–13, 19. Paratypes, USNM 130749 from USGS Mesozoic loc. 24117. Suture line drawn from specimen shown on fig. 19.

14, 15. Holotype, USNM 130745 from USGS Mesozoic loc. 24116.

16. Paratype, USNM 130748 from USGS Mesozoic loc. 22712.

17, 18. Paratype, USNM 130746 from USGS Mesozoic loc. 24116.



ARCTOCEPHALITES?, *SIEMIRADZKIA*?, AND *ARCTOCEPHALITES* (*CRANOCEPHALITES*)

PLATE 3

[All figures natural size]

FIGURES 1–10. *Arctocephalites* (*Cranocephalites*) *sawtoothensis* Imlay (p. C–24).

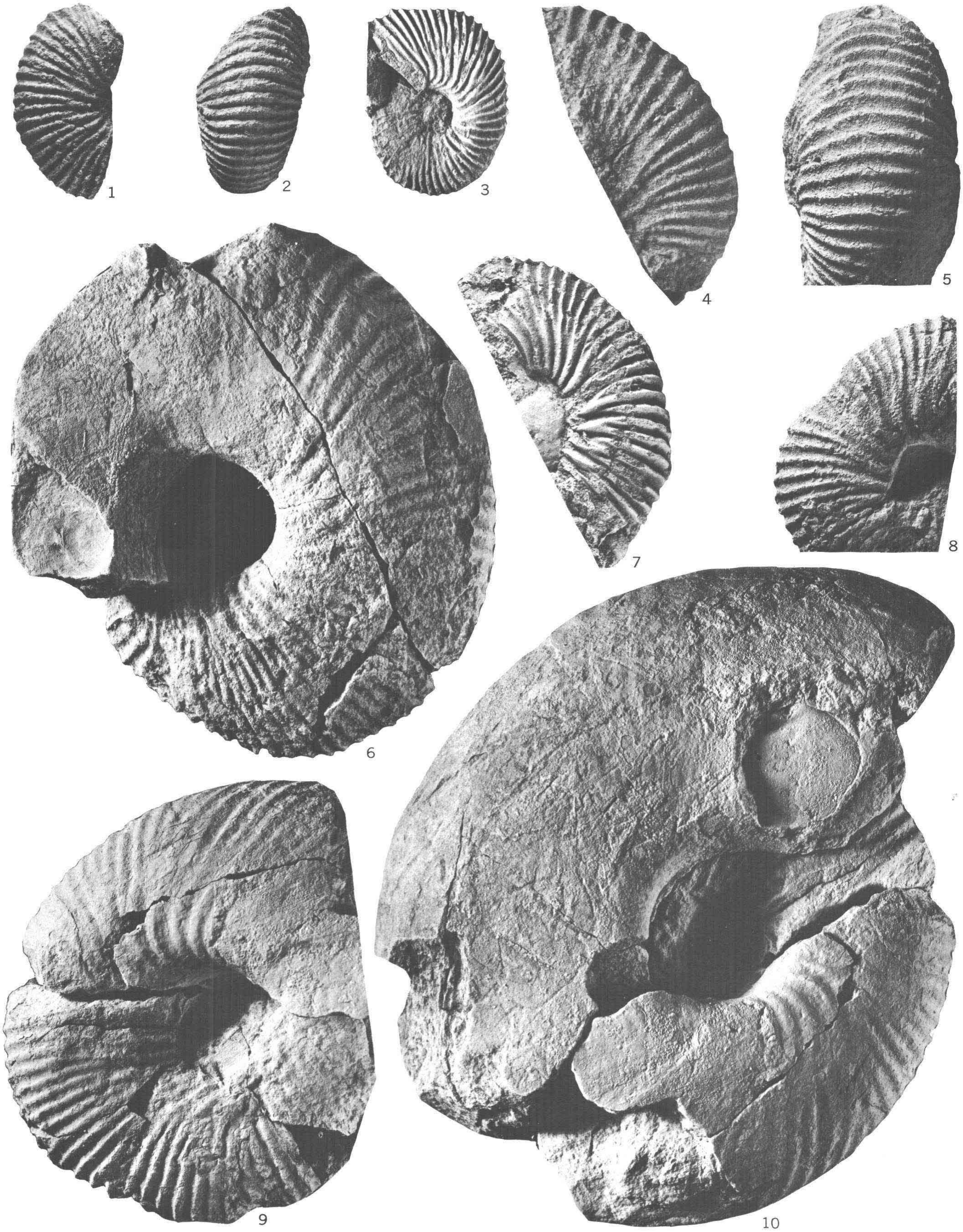
1, 2, 4, 5. Lateral and ventral views of plesiotypes, USNM 130766 from USGS Mesozoic loc. 18718.

3. Plesiotype, USNM 130769 from USGS Mesozoic loc. 27047 showing sharp ribbing.

6, 9, 10. Plesiotype, USNM 130767 from USGS Mesozoic loc. 27040 showing disappearance of ribbing on the body chamber.

7. Plesiotype, USNM 130768 from USGS Mesozoic loc. 27042.

8. Plesiotype, USNM 130770 from USGS Mesozoic loc. 19601.



ARCTOCEPHALITES (CRANOCEPHALITES)

PLATE 4

[All figures natural size]

FIGURES 1, 3, 5. *Arctocephalites (Cranocephalites)* cf. *A. maculatus* (Spath) (p. C–25).

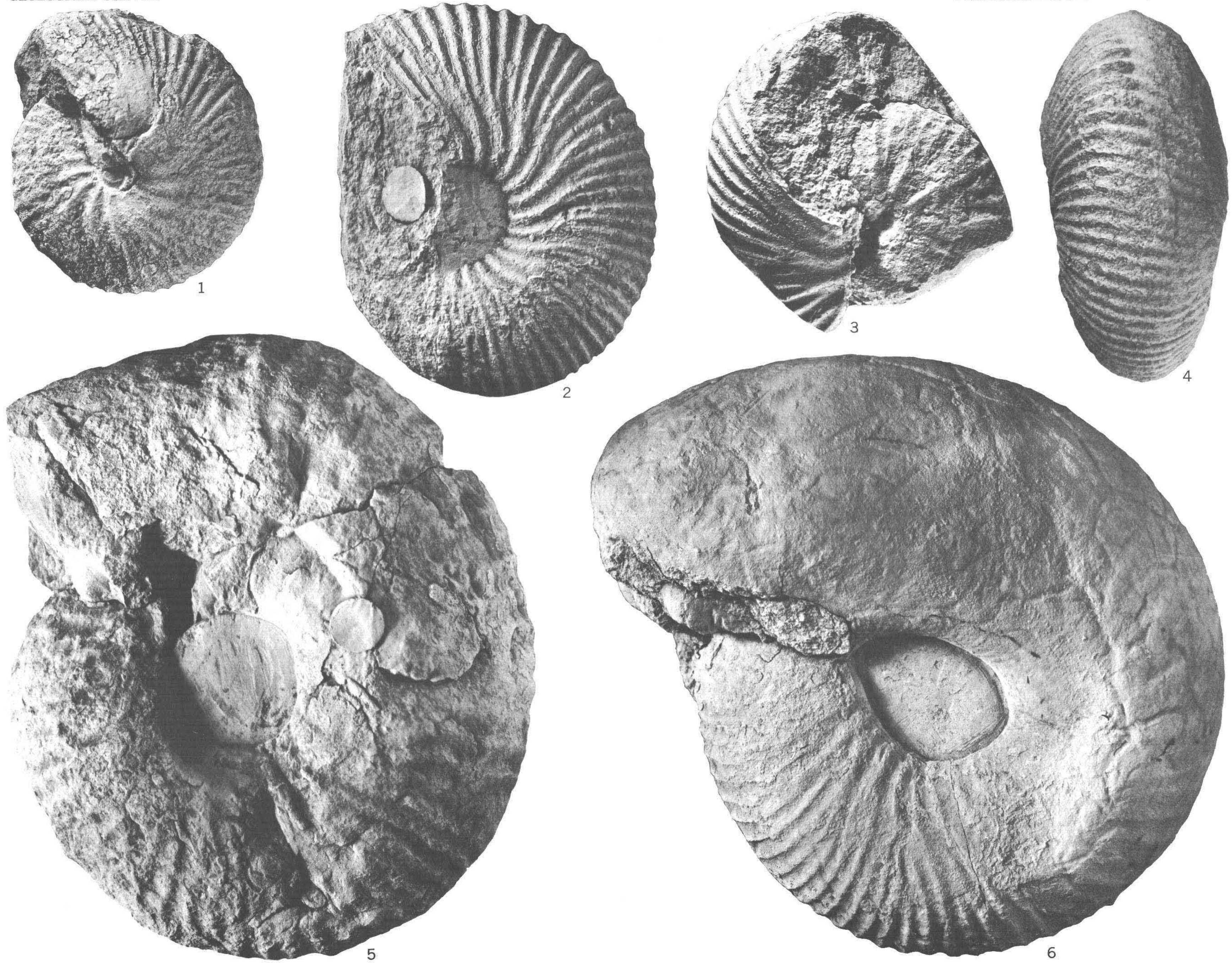
1, 3. Lateral views of two specimens, USNM 130744 from USGS Mesozoic loc. 22652.

5. Adult specimen, USNM 130733 from USGS Mesozoic loc. 19184 showing half a whorl of body chamber.

2, 4, 6. *Arctocephalites (Cranocephalites) sawtoothensis* Imlay (p. C–24).

2, 4. Plesiotype, USNM 104150 from USGS Mesozoic loc. 19601. This specimen was originally described as *Arctocephalites metastatus* (Buckman) var. *sweetgrassense* Imlay

6. Holotype, USNM 104148 from USGS Mesozoic loc. 19184.



ARCTOCEPHALITES (CRANOCEPHALITES)

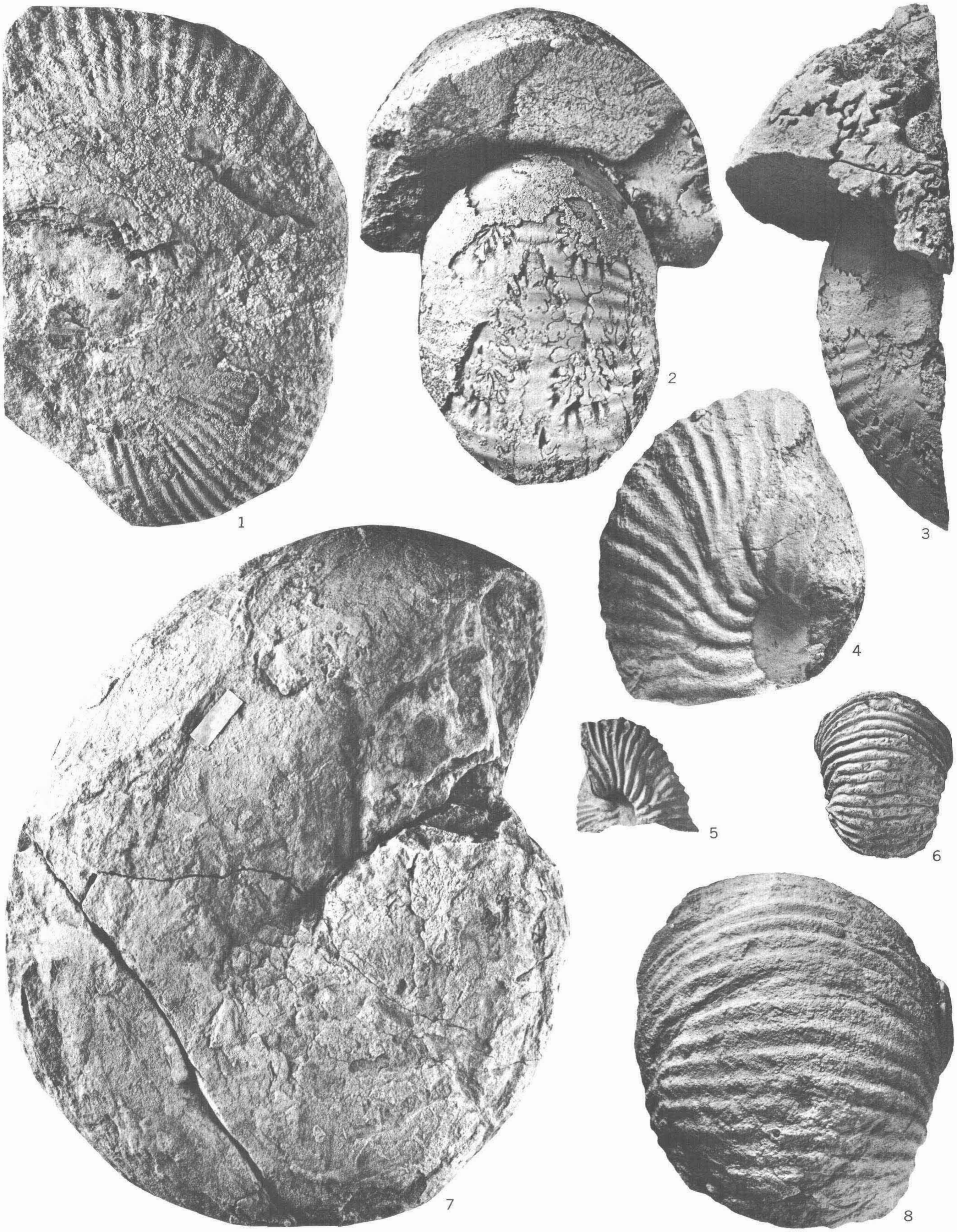
PLATE 5

[All figures natural size]

FIGURES 1–3. *Arctocephalites* (*Cranocephalites*) cf. *A. gracilis* (Spath) (p. C–24).
Specimens, USNM 130771 from USGS Mesozoic loc. 19601 showing weak ribbing. Figs. 2 and 3 are ventral and lateral views of a single specimen.

4–6, 8. *Arctocephalites* (*Cranocephalites*) cf. *A. platynotus* (Spath) (p. C–25).
4, 8. Lateral and ventral views of an adult specimen, USNM 130772 from USGS Mesozoic loc. 19601 showing globose body whorl.
5, 6. Lateral and ventral views of an immature specimen USNM 130772 from same locality as specimens shown on figs. 4 and 8.

7. *Arcticoceras*? sp. (p. C–25).
Lateral view of adult specimen showing apertural constriction, USNM 130776 from USGS Mesozoic loc. 22654.



ARCTOCEPHALITES (CRANOCEPHALITES) AND *ARCTICOCERAS*?

PLATE 6

[All figures natural size]

FIGURES 1, 2. *Arctocephalites*? *saypoensis* Imlay, n. sp. (p. C–23).
Holotype, USNM 104149 from USGS Mesozoic loc. 18324.

3, 6–8, 10–15. *Cobbanites* spp. (p. C–27).

3, 14. Suture line and cross section of a specimen, USNM 130765a from USGS Mesozoic loc. 18718.

6. Lateral view of a rubber cast showing tiny tubercles at ends of primary ribs, USNM 130763 from USGS Mesozoic loc. 22654.

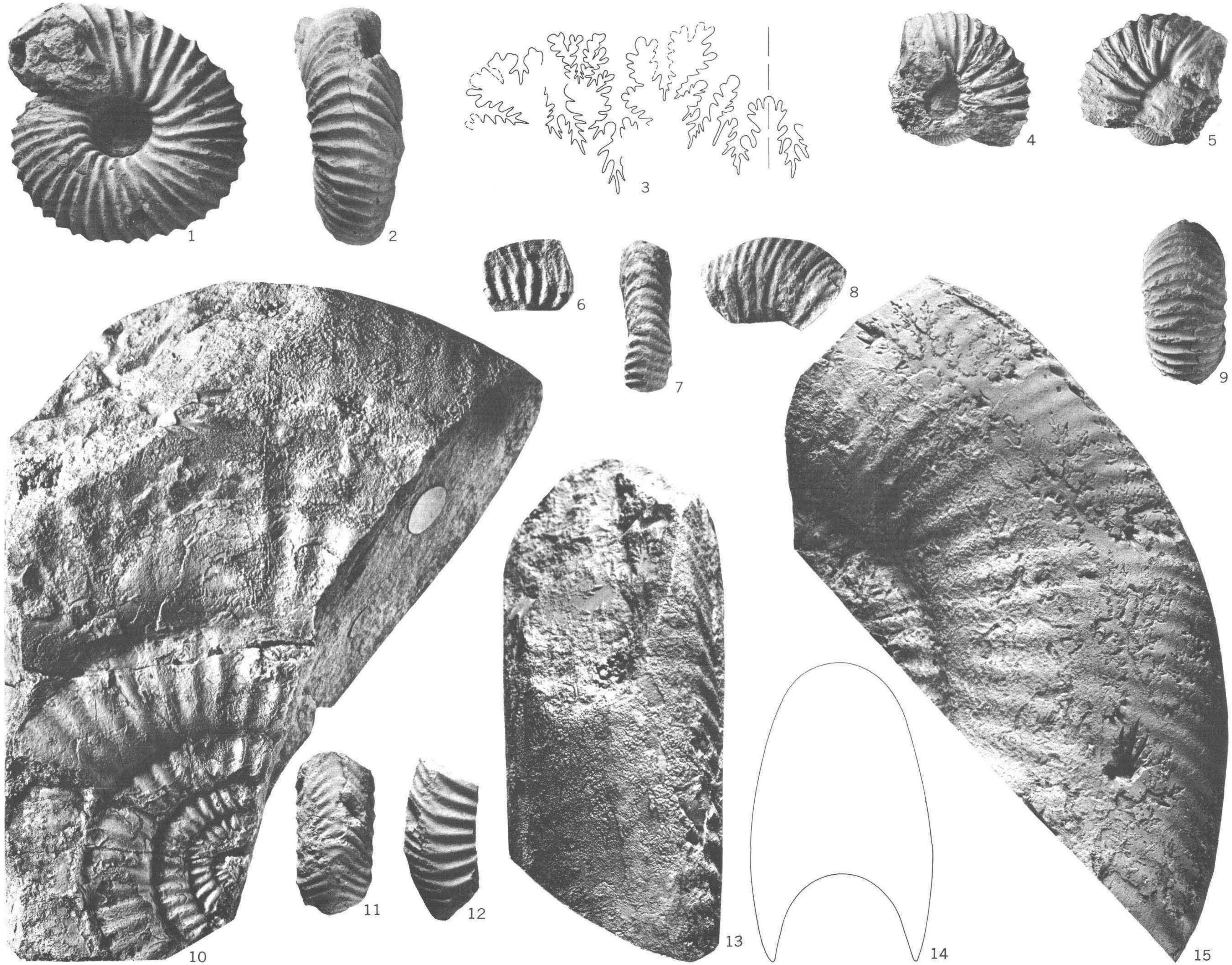
7, 8. Ventral and lateral views of an immature specimen, USNM 130765b from USGS Mesozoic loc. 18718.

10, 13. Lateral and ventral views of a septate specimen, USNM 130765c from USGS Mesozoic loc. 18718. On fig. 13 the adoral end is pointed downward.

11, 12. Ventral and lateral views of an immature specimen, USNM 130762 from USGS Mesozoic loc. 19184.

15. Specimen, USNM 130761 from USGS Mesozoic loc. 20357. Adoral end is pointed downward.

4, 5, 9. *Xenocephalites*? sp. (p. C–22).
Lateral and ventral views of adult whorl, USNM 130775 from USGS Mesozoic loc. 18714. Note apertural constriction.



ARCTOCEPHALITES?, *COBBANITES*, AND *XENOCEPHALITES*?

PLATE 7

[All figures natural size]

FIGURES 1–5. *Parareinckeia hickersonensis* Imlay, n. sp. (p. C–25).

Ventral lateral cross-sectional and apertural views of holotype, USNM 130756 from USGS Mesozoic loc. 22698. Cross section drawn at diameter of 36 mm. Suture line drawn at diameter of 42 mm and whorl height of 11.5 mm.

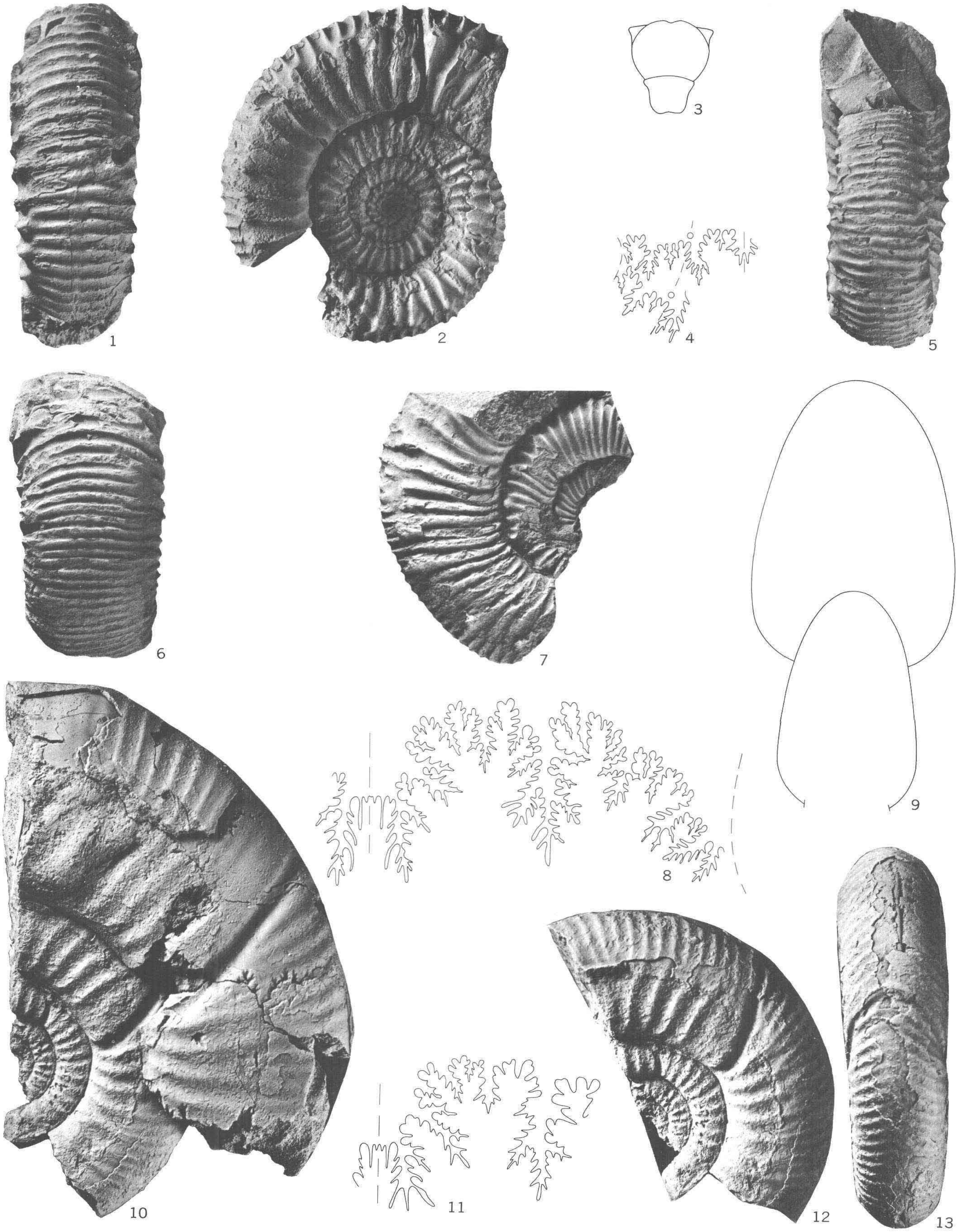
6, 7. *Parareineckeia* cf. *P. shelikofana* Imlay (p. C–26).

Ventral and lateral views, USNM 130750 from USGS Mesozoic loc. 24117.

8–13. *Cobbanites talkeetnanus* Imlay, n. sp. (p. C–27).

8, 9, 11. Suture lines and cross section of holotype, USNM 130743 from USGS Mesozoic loc. 24116. Suture line shown on fig. 8 drawn about 2 in. from adoral end of last septate whorl. Suture line shown on fig. 11 drawn about 5 in. from doaral end of last septate whorl. Cross section drawn at beginning of body chamber.

10, 12, 13. Lateral and ventral views of paratype USNM 130744 from USGS Mesozoic loc. 24116. Note figs. 12 and 13 represent inner whorls of specimen shown in fig. 10.



PARAREINECKEIA AND *COBBANITES*

PLATE 8

[Figure about nine-tenths natural size]

FIGURE 1. *Cobbanites talkeetnanus* Imlay, n. sp. (p. C–27).
Lateral view of holotype, USNM 130743 from USGS Mesozoic loc. 24116. Beginning of body chamber indicated by an arrow. Note apertural constriction. Other views of holotype shown on pl. 7, figs. 8, 9, 11.

1

COBBANITES

U.S. GOVERNMENT PRINTING OFFICE: 1961 O - 582600