Callovian (Jurassic) Ammonites from the United States and Alaska

Part 2. Alaska Peninsula and Cook Inlet Regions

GEOLOGICAL SURVEY PROFESSIONAL PAPER 249-B

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By RALPH W. IMLAY

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Descriptions and illustrations of cephalopods of Late Jurassic age

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1953

UNITED STATES DEPARTMENT OF THE INTERIOR

Douglas McKay, *Secretary*

GEOLOGICAL SURVEY

W. E. Wrather, *Director*

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CALLOVIAN (JURASSIC) AMMONITES FROM THE UNITED STATES AND ALASKA

PART 2. ALASKA PENINSULA AND COOK INLET REGIONS

By Ralph W. Imlay

ABSTRACT

The ammonites from the Chinitna formation of the Cook Inlet region and the Shelikof formation of the Alaska Peninsula show that these formations are of early Late Jurassic age, represent most of the Callovian stage, and correspond with the northwest European zones of *Proplanulites koenigi* to *Erymnoceras coronatum*. The basal Callovian zone of *Macrocephalites macrocephalus* is possibly represented locally by some basal shelly sandstones. The highest zones of the Callovian are probably represented by an unconformity at the base of the Naknek formation. The ammonites from the lower third of the Chinitna formation and from the lower siltstone member of the Shelikof formation are similar to species in the lower Callovian beds of the western interior of the United States and of East Greenland. The ammonites from the higher parts of the Chinitna and Shelikof formations are younger than the marine Callovian of the western interior region, or of East Greenland, and greatly resemble the ammonites from the middle part of the Callovian of England and central Russia.

Studies of the vertical ranges of the ammonites from the Chinitna and Shelikof formations show that ammonite collections can be localized within the lower, middle or upper third of the formations, some collections containing certain associations of ammonites can be localized within much smaller intervals, and some estimate of the amount of pre-Naknek erosion can be obtained. Such data should be valuable to the field men in their attempts to divide the formations into mappable members, which, considering the thousands of feet of sedimentary rocks involved, is desirable economically.

Most probably the Callovian marine sediments were deposited along a steep slope fronting a major ocean and were derived from mountains that lay immediately to the north. A fairly shallow water origin for the basal shelly sandstone of the Chinitna formation is indicated by the presence of *Meleagrinella* and *Ostrea*. Other sandstones higher in the Chinitna, or in the Shelikof, contain benthonic forms characteristic of the neritic zone. The siltstones were mostly deposited below wave base as they contain few benthonic mollusks and show persistent, thin, even-bedding. The presence of *Phylloceras* and the absence of nautiloids is probably related to depth of water rather than to temperature, as the opposite faunal condition exists in the Callovian deposits of the western interior of the United States, where the associated mollusks indicate an environment representing the littoral zone or the shallow part of the neritic zone. The association of the thin-shelled *Phylloceras* with the thicker-shelled cardioceratids suggests that fairly deep waters approached the shore so that the shells of these ammonites became mingled easily after death. A cooling of the boreal sea of Late Jurassic time as compared with seas farther south is suggested by the absence of corals, the rarity of gryphaeas and exogyras, the provincial character of the ammonites, the poverty in molluscan genera and species, and the scarcity of calcium carbonate other than as concretions.

INTRODUCTION

This study of the early Late Jurassic ammonites of the Alaska Peninsula and Cook Inlet regions is based almost entirely on collections made by field parties from the Geological Survey since 1903. The principal collectors were T. W. Stanton and G. C. Martin in 1904, A. A. Baker and F. H. Moffit in 1921, S. R. Capps in 1921, W. R. Smith in 1922 to 1924, L. B. Kellum in 1944 and 1945, C. E. Kerschner in 1946, Don J. Miller in 1948, and John K. Hartsock and Arthur Grantz in 1948 to 1950. The writer spent the summer of 1948 with Don J. Miller examining typical Jurassic sections and collecting fossils at or near Tuxedni Bay, Chinitna Bay, Iniskin Peninsula, Puale Bay, and Wide Bay. This provided first hand field information that has been very useful in subsequent paleontologic studies requested by field men and in the preparation and analysis of the present report. In its preparation the objectives have been to describe and interpret both biologic and stratigraphic data in such a manner as to be immediately useful to field men, to suggest problems for future field consideration, and to show the relationships of the Jurassic sedimentary rocks and faunas involved to those of the Jurassic of the entire North American continent and the boreal region. It is believed that the results of broad objectives frequently have useful local implications.

BIOLOGIC ANALYSIS

The Callovian ammonites from Alaska now in the Geological Survey's collections include about 795 specimens of ammonites that are specifically identifiable. Among these the Phylloceratidae is represented by 29 specimens, the Oppelidae by 24 specimens, the Macrocephalitidae by 84 specimens, the Cardioceratidae by 621 specimens, the Cosmoceratidae by 36 specimens, the Morphoceratidae by 1 specimen, and the Perisphinctidae by 5 specimens. The Cardioceratidae numerically comprise 78 percent of the ammonites. Within this family the genus *Cadoceras* comprises 61 percent and the genus *Pseudocadoceras* 17 percent of the total number of ammonites. Considering the number of species, the Phylloceratidae is represented by 5, the Oppelidae by 2, the Macrocephalitidae by 14, the Cardioceratidae by 24, the Cosmoceratidae by 13, the Morphoceratidae by 1, and the Perisphinctidae by 4. The ammonites are distributed among 19 genera and subgenera and 62 species. Of these 1 subgenus and 38 species are described as new, 8 species have been described previously from Alaskan collections, 9 have been described previously from collections from British Columbia, 1 is identified with a species from Greenland, 1 is compared with a European species, and 5 are not named because they are inadequately preserved.

The Phylloceratidae is represented in the Callovian deposits of Alaska by *Phylloceras*, *Calliphylloceras*, *Macrophylloceras*, and *Partschiceras*. The Oppelidae is represented by 2 species of *Oxycerites* that are similar to species described from Europe. *Oxycerites* has been obtained in Alaska, only from the lower two-thirds of the Chinitna formation and from the lower member of the Shelikof formation.

The Macrocephalitidae in Alaska includes *Lilloettia*, *Xenocephalites* and *Kheraiceras*. *Lilloettia*, known only from Alaska and British Columbia, differs from *Macrocephalites*, sensu strictu, by being more involute and generally more inflated, by having broader and more closely-spaced ribbing on the venter of its inner whorls, and by becoming smoother at an earlier growth stage. *Lilloettia* was suspected by Spath (1932, p. 156) as being identical with *Arctocephalites* of the Boreal region. However, on *Lilloettia* the umbilicus is consistently more narrow, the body shape generally more rotund, and the body chamber a little longer. Its ribbing is much more flexuous on the flanks, generally arches forward on the venter, and tends to disappear from the flanks earlier than in *Arctocephalites*. In the young individuals of *Lilloettia* the ribs are low on the flanks, thick, rounded, and closely-spaced on the venter and have sloping sides. This contrasts with the thin, high ribs of *Arctocephalites* at comparable growth stages. Another closely comparable form is *Eurycephalites* (Spath, 1928, p. 175), from South America and southern Mexico. It resembles *Arctocephalites* more than *Lilloettia* in width of umbilicus and sharpness of ribbing, but its ribbing is flexuous as in *Lilloettia*. It is distinguished from both by a much simpler suture line. It is questionable whether any of these forms are worthy of more than subgeneric rank under *Macrocephalites*. Their differences may be in part provincial and in part stratigraphic. *Eurycephalites* in South America occurs at several levels, associated with ammonites that indicate both late Bathonian and early Callovian ages (Burckhardt, 1903, p. 21; 1930, p. 26, 27; Stehn, 1924, pp. 143–151). *Arctocephalites* is probably restricted to the upper Bathonian, as it is found in Montana, in the Richardson Mountains of northern Canada, and in east Greenland immediately below beds containing *Arcticoceras*, which genus marks the basal Callovian, as discussed elsewhere (Imlay, 1948, p. 14, 15). *Lilloettia* has been found in southwestern Alaska in the upper part of the lower member of the Shelikof formation and in most of the lower two-thirds of the Chinitna formation except the lowermost 500 to 600 ft. This occurrence probably corresponds to the *calloviense* and *jason* zones of northwest Europe. Unfortunately, *Arctocephalites* has not been found in southwestern Alaska, although a similar macrocephalitid, *Cranocephalites*, which immediately underlies *Arctocephalites* in Greenland, has been found at many places a few hundred feet below the lowest occurrence of *Lilloettia*. Regardless of the explanation for the absence of *Arctocephalites*, the ammonite genera associated with *Lilloettia* show that it occurs in beds younger than those with *Arctocephalites*. The speculation by Spath (1932, p. 156) that *Eurycephalites* spread to the boreal set via Alaska implies that *Lilloettia* and *Arctocephalites* were probably derived from *Eurycephalites*. This may be true, but the characteristics of *Lilloettia* and its stratigraphic position suggest that descent from *Arctocephalites* is just as probable.

The occurrence of several species of *Xenocephalites* in southwestern Alaska is very interesting because the genus appears to be fairly distinctive of the lower Callovian of the Pacific Province. One species is known from southern Mexico (Burckhardt, 1927, p. 33, pl. 16, figs. 4–9); five species and varieties from South America (Stehn, 1924, pp. 86–92, pl. 1, figs. 3–6), one species from east Greenland (Spath, 1932, p. 44, pl. 14, figs. 4 a–d), and two undescribed species from Montana. In Alaska *Xenocephalites* ranges through the lower two-fifths of the Chinitna formation, but occurs also in underlying beds containing *Cranocephalites*. The species from Alaska and Montana were at first referred to *Kamptokephalites* but their generic position in *Xenocephalites* is indicated by their extremely narrow umbilicus, depressed whorl section, small size, and the early appearance of prominent, very flexuous ribs, that become very widely-spaced on the body chamber. The immature forms of *Xenocephalites* differ from comparable forms of *Kheraiceras* by having much coarser, higher, more widely-spaced ribs and from comparable forms of *Cranocephalites* by having much thicker, more flexuous ribs.

Kheraiceras has been found in lower and middle Callovian deposits in many parts of the world, but is probably nowhere represented by such variety as in Alaska. The adult is more or less inflated and has a very small umbilicus, a hook-like body chamber, and generally a pronounced apertural constriction. The suture line is finely divided and has broad saddles and lobes. The immature forms differ from similar forms of *Pleurocephalites* by being sphaeroceratid in lateral view. They differ from immature forms of *Cadoceras* by their smaller umbilicus, broader whorl section, and flexuous ribs. They differ from immature forms of *Cranocephalites*, or *Arctocephalites* by being more inflated and by having weaker, denser, more flexuous ribbing. The adult whorls of some of the least inflated species of *Kheraiceras* resemble the adult whorls of *Cranocephalites*, but *Kheraiceras* can generally be distinguished by the sudden coarsening of the ribbing on the body chamber. The suture line, if preserved, is a certain means of distinction, as the highly frilled, broad saddles and lobes of *Kheraiceras* contrast greatly with the rather simple sutural elements of *Cranocephalites*. In southwestern Alaska *Kheraiceras* occurs in the lower two-thirds of the Chinitna formation and near the base of the Shelikof formation.

The Cardioceratidae in the Callovian deposits of southwestern Alaska include the genera *Cadoceras* and *Pseudocadoceras*, but not *Arcticoceras*. The absence of the *Arcticoceras* is probably significant, as the genus is abundant in the western interior of the United States and Canada and along the Arctic coast of Canada and Alaska. Spath (1932, pp. 50–52) has noted the great resemblance of *Arcticoceras* to the slightly older *Arctocephalites* and to the slightly younger *Pseudocadoceras* and *Longaeviceras*. He also notes (1932, p. 53) the resemblance of the young *Arcticoceras* to the early whorls of *Cadoceras* such as *C. stenolobum* (Keyserling). Thus, *Arcticoceras* occupies a position biologically and stratigraphically between the Macrocephalitidae and the Cardioceratidae. Its inner and intermediate whorls resemble the Cardioceratids by their lateral compression, narrowed venter, and forwardly inclined ribbing. Its adult whorls resemble the Macrocephalitids by their high degree of involution and absence of an umbilical edge.

Cadoceras was defined by Fischer (1882, p. 394) as a subgenus of *Stephanoceras* in the following words (translation):

Shell very swollen; umbilicus narrow, carinate; last whorl entirely smooth. Preceding whorls with the ribs forming an angle directed forward on the ventral region. Ex. *C. modiolare* Luid.

Spath (1932, p. 58) notes that the name *modiolare* is pre-Linnean and selects *Ammonites sublaevis* J. Sowerby (1814, vol. 1, p. 117, pl. 54, large figure) as the genotype because he considers it identical with the form described by Lhuyd.

Since *Cadoceras* was first defined, the name has been applied by most geologists to a genus and usually in a broader sense than that specified by Fischer in order to include forms that are closely allied (Nikitin, 1884, pp. 142, 143; 1885, pp. 51, 52; Douville, 1912, pp. 14–19; Spath, 1932, pp. 58–64). Thus a definition of *Cadoceras*, sensu latu, as currently employed, may be phrased as follows:

Shell compressed to swollen, generally stout to globose in the adult; umbilicus narrow to fairly wide, wall steep to nearly vertical, edge sharp to rounded; ribbing weak to strong, gently to strongly inclined forward on flanks, faintly to strongly arched forward on venter, never sickle-shaped or angulate; umbilical tubercles present or absent in intermediate and adult whorls, when present forming a characteristic festoon on umbilical edge; body whorl generally smooth but ribbed in some species and there may be rejuvenescence of ribbing near the aperture after a smooth stage; aperture slightly sinuous, inclined forward, without rostrum or lateral lappets, preceded by a weak constriction; suture line fairly complex, first lateral lobe trifid and generally longer than external lobe, second lateral lobe generally much shorter than external lobe, external saddle asymmetrically divided.

The features that especially characterize *Cadoceras* are the smooth, or nearly smooth adult body chamber, the steep, smooth umbilical wall of the adult body whorl, the rounded, depressed adult venter and the regular arching of the ribs on the venter. These features exclude *Pseudocadoceras*, which has a strongly ribbed body chamber, a rounded umbilical wall, and a sharpened adult venter, although *Pseudocadoceras* greatly recembles the intermediate-sized whorls of some species of *Cadoceras*, such as *C. stenolobum* (Keyserling) (1846, p. 329, pl. 20, fig. 7, pl. 22, figs. 13, 14; Sokolov, 1912, pl. 1, fig. 4) or *C. nikitini* Sokolov (1912, p. 53, pl. 1, figs. 3 a–d), and might conceivably be the ancestor of some species included in *Cadoceras*. These features also exclude *Longaeviceras* because the latter has keeled inner whorls, sicklelike ribs that are angulate on the venter, and a low umbilical wall at all growth stages. *Longaeviceras* is generally considered a subgenus of *Quenstedtoceras* (Spath, 1932, pp. 47, 48), but its features are transitional between those of *Quenstedtoceras* and *Pseudocadoceras* and its range from the *calloviense* to the *athleta* zone fits that of a transitional form. *Quenstedtoceras* itself is distinguished from *Cadoceras* essentially by a sharpened venter and angulate ventral ribbing but may develop a cadoceratid adult body whorl as in the subgenus *Eboraciceras*.

The genus *Cadoceras* as defined herein is divisible into seven groups, of which two are characterized sufficiently biologically and stratigraphically to merit recognition as subgenera. Probably some of the other five groups will be considered subgenera when they are better known. These groups are distinguished primarily on the characteristics of the umbilicus and on the changes in the shape of the whorl section during growth. Useful secondary distinctions include the presence or absence of tubercles, the shape of the tubercles, and the amount of forward inclination of the ribbing. The last seems to vary directly with the degree of compression of the shells and is strongest on the species with the most narrow venters. The characteristics, relationships, and occurrences of these seven groups will now be discussed.

GROUP 1

Group 1 includes forms with evolute whorls that are compressed in the young and stout in the adult. The umbilicus is fairly wide for the genus (umbilical ratio about 23 to 33). The umbilical edge is rounded on the inner whorls but generally abrupt on the adult body whorl. The ribbing is weak to strong, is inclined forward considerably on the flanks, arched forward on the venter, and may disappear on the body chamber. Bifurcation of the ribs occurs at one-fourth to one-half of the height of the flanks, but single ribs are common in some species. Tubercles are weak or absent.

This group constitutes an easily recognized subgenus for which the name *Paracadoceras* Crickmay (1930, p. 55, pl. 16, figs. 1, 2) is available. The type, *P. harveyi* Crickmay, does not have a well-defined umbilical edge, but it is probably an immature specimen. Its primary ribs bifurcate near the middle of the flanks on the body whorl (see pl. 43, fig. 12) instead of being single as suggested by the original illustrations. *Paracadoceras* is not accorded more than subgeneric rank because most species develop a typical *Cadoceras*-like wall on the body chamber and because there is a close resemblance with the species of *Cadoceras* in group 2.

The following species belong to *Paracadoceras:*

- *C. elatmae* (Nikitin) 1881b, p. 116, pl. 11 (IV), figs 20, 21, 23; 1885, p. 54, pl. 10 (VIII), fig. 47.
- *C. breve* Blake 1905, p. 48, pl. 5, fig. 1.
- *C. harveyi* (Crickmay) 1930, p. 55, pl. 16, figs. 1, 2.
- *C. ammon* (Spath) 1932, p. 78, pl. 21, figs. 5a, b.
- *C. chisikense* Imlay.
- *C. tonniense* Imlay.
- *C. multiforme* Imlay.
- *C. moffiti* Imlay.

The following species may belong to *Paracadoceras:*

- *C. frearsi* (D'Orbigny) 1845, p. 444, pl. 37, figs. 1, 2; Nikitin, 1881b, pl. 11, figs. 22a, b; Nikitin, 1885, pl. 12, fig. 52.
- *C. schumarowi* Nikitin, 1884, p. 68, pl. 3, fig. 16.
- *C. pseudoishmae* Spath, 1932, p. 77, pl. 8, figs. 6a, b.

Among these species, *C. harveyi*, *C. schumarowi* and *C. ammon* do not have a well-defined umbilical edge. However, the first two species are probably based on imature specimens that had not developed an umbilical edge and the last is a crushed specimen. *C. schumarowi* bears considerable resemblance to the inner whorls of *C. moffiti* Imlay. *C. harveyi* resembles the immature forms of *C. multiforme* Imlay. *C. pseudoishmae* has a narrower umbilicus than the other species of *Paracadoceras* but agrees well in whorl shape and character of ribbing. Spath (1932, p. 59) considered it transitional between *Arcticoceras* and *Cadoceras*. *C. frearsi* has a trigonal venter in the adult. It is interesting that the inner whorls of *Paracadoceras* at diameters less than 36 mm greatly resemble the adults of *Pseudocadoceras*, which in Alaska occurs a little higher stratigraphically than *Paracadoceras*.

Paracadoceras is characteristic of the lower part of the Callovian in the boreal region. In Alaska five species have been found in the lower two-fifths of the Chinitna formation. In British Columbia *P. harveyi* is associated with forms of *Cadoceras* which are identified (Crickmay, 1930, pp. 56, 57) with species in the lower third of the Chinitna formation. In Russia *C. elatmae* (Nikitin) and *C. frearsi* (D'Orbigny) occur in beds that Arkell (1946, p. 25) correlates with the zones of *Macrocephalites macrocephalus* and *Proplanulites koenigi* in northwest Europe. *C. schumarowi* Nikitin (1884, pp. 68, 143, pl. 3, fig. 16), however, occurs in the Russian zone of *Cadoceras milaschevici* and must represent some part of the middle Callovian. *C. ammon* Spath from Greenland occurs with other ammonites that indicate a correlation with the zone of *Sigaloceras calloviense*. In England *C. breve* Blake occurs in the upper part of the Cornbrash. Judging from these occurrences *Paracadoceras* first appears in the zone of *Macrocephalites macrocephalus*, ranges through at least the zone of *Sigaloceras calloviense*, and is not common above the zone of *Proplanulites koenigi.*

GROUP 2

Group 2 includes forms with evolute, ovate to compressed inner whorls and broadly rounded, depressed outer whorls. The umbilicus is fairly wide for the genus (umbilical ratio about 27 to 37) and is fairly deep in the adult. The umbilical edge is rounded on the inner whorls but sharp on the outer whorls. The ribbing ranges from weak to moderately strong, is moderately to strongly inclined forward on the flanks, and may disappear on the body whorl. Bifurcation of the ribs occurs at one-third to one-half of the height of the flanks. Single ribs are fairly common. Comma-shaped umbilical swellings are moderate to strong and persist to a later growth stage than the ribbing.

The inner whorls of the species of this group greatly resemble the intermediate and adult whorls of *Paracadoceras*. The outer whorls in contrast are broadly rounded and depressed, have a sharp umbilical edge, persistent comma-shaped umbilical swelling, and the ribs, where present, do not incline forward as strongly on the flanks or on the venter.

The following species represent group 2:

- *C. tschernyschewi* Sokolov, 1912, pp. 19, 51, pl. 1, fig. 2, pl. 2, fig. 1
- *C. quenstedti* Spath, 1932, p. 59; Quenstedt, 1887, p. 672, pl. 79, fig. 7
- *C. simulans* Spath, 1932, p. 61; Nikitin, 1885, p. 52, pl. 11
- *C. victor* Spath 1932, p. 67, pl. 16, figs. 6 a–c
- *C. calyx* Spath 1932, p. 69, pl. 20, figs. 1 a, b
- *C. brooksi* Crickmay 1930, p. 57, pl. 16, figs. 3–5
- *C. catostoma* Pompeckj 1900, p. 263, pl. 5, figs. 1 a–e, 2 a. b.
- *C. comma* Imlay
- *C. glabrum* Imlay

Among these species *C. calyx* has the coarsest ribbing and *C. glabrum* the finest. *C. brooksi* is based on a fragmentary specimen and may be identical specifically with one of the Alaskan forms.

Group 2 in Alaska is abundant in the lower two-thirds of the Chinitna formation except for the basal few hundred feet. It occurs also in the upper part of the lower member of the Shelikof formation. The Greenland species occur in beds that probably represent the zone of *Sigaloceras calloviense*. The Russian species, *C. tschernyschewi* Sokolov and *C. simulans* Spath occur in the Russian zone of *Cadoceras elatmae*. The *Arcticoceras* beds in Montana and Wyoming have not furnished any species of this group. Judging from these occurrences, the species of *Cadoceras* in Group 2 occur in the lower part of the Callovian and do not range above the zone of *Cosmoceras jason*.

GROUP 3

Group 3 includes forms similar to group 2 in their evolute inner whorls and broadly rounded outer whorls, but differ essentially by having an evenly rounded umbilical edge and by lacking tubercles. The following species are included:

C. crassum {Madsen, 1904, p. 193, pl. 9, figs. 1–3, pl. 10, fig. 1, Spath, 1932, p. 64, pl. 16, figs. 3a, b.}
C. variabile Spath, 1932, p. 75, pls. 18, fig. 1a, b, pl. 19, figs. 1a–c, 2a, b.
C. variabile var. *occlusum* Spath, 1932, p. 76, pl. 19, fig. 2.

These forms are all from Greenland from beds that are correlated with the *Sigaloceras calloviense* zone.

GROUP 4

Group 4 includes forms that are characterized by a fairly narrow, step-like umbilicus (umbilical ratio about 20 to 26). The venter is evenly arched. The umbilical edge is abrupt to sharp. The ribbing is fine to strong and nearly disappears on the body chamber. Weak comma-shaped swellings are present on the umbilical edge. The body chamber is stout but not globose.

The group is represented by the following species:

C. wosnessenskii (Grewingk), 1850, p. 344, pl. 4, figs. 1 a–d; Pompeckj, 1900, p. 251, pl. 5, fig. 5 a–c.
C. doroschini (Eichwald), 1871, p. 138, pl. 7, fig. 6, pl. 8, figs. 1, 2.
C. tenuicostatum Imlay
C. kialagvikense Imlay

These species have a considerable vertical range in southwestern Alaska in the middle two-thirds of the Chinitna formation and in the lower and middle members of the Shelikof formation. They are absent from the basal few hundred feet of both formations.

GROUP 5

Group 5 includes forms that are characterized by a narrow umbilicus (umbilical ratio about 18 to 26) having a tubular or corkscrew-like shape. The whorls are moderately to broadly rounded. The umbilical edge is generally evenly rounded and is never sharp. The ribbing ranges from fine to strong and is inclined moderately forward. Weak conical tubercles may be present in the inner whorls. The body chamber is globose and smooth.

The following species represent group 5.

C. franciscus Spath, 1932, p. 74, pl. 20, figs. 2 a–c.
C. freboldi Spath, 1932, p. 65, pl. 18, figs. 2a, b.
C. shoshonense Imlay, 1948, p. 22, pl. 7, figs. 13, 16, 17.
C. surense Nikitin, 1885, p. 57, pl. 12, figs. 53–55, text fig. 4 on p. 58.
?*C. subpatruum* Nikitin, 1885, p. 58, pl. 13, fig. 58, text fig. 5 on p. 59.

C. franciscus Spath and *C. freboldi* Spath appear to be less depressed than the other species in this group. The group is represented in the lower Callovian of Montana by several species that show variation in shape from a globose form, such as *C. shoshonense* Imlay, to a moderately compressed form similar to *C. franciscus*. The inner whorls of *C. surense* Nikitin resemble the intermediate-sized whorls of *Paracadoceras*, but the deep, corkscrew-shaped umbilicus of the adult is quite different.

C. subpatruum Nikitin is provisionally placed in this group because of its narrow, corkscrew-like umbilicus and because the ribbing of its inner whorls is described as similar to that of *C. surense*, but its venter is narrowed more than the other species in the group. The adult whorl bears considerable resemblance to *Arcticoceras henryi* (Meek and Hayden), but has a wider umbilicus.

Species of group 5 occur in the Western Interior of the United States at three levels associated respectively with *Arcticoceras*, *Gowericeras*, and *Kepplerites tychonis* Ravn. This association indicates a lower Callovian age corresponding to the European zones of *Macrocephalites macrocephalus*, *Proplanulites koenigi*, and *Sigaloceras calloviense*. The described species from Greenland and Russia are from beds that probably represent the *Sigaloceras calloviense* zone.

GROUP 6

Group 6 includes forms that are characterized by a moderately narrow, deep, crater-like umbilicus (umbilical ratio about 24 to 30). The venter is broadly rounded. The umbilical edge is sharp, or abruptly rounded. The ribbing ranges in strength from moderate to strong and is gently inclined forward. Conical tubercles may be present. The body chamber is globose and smooth or nearly smooth. This group differs from group 5 by having a sharp or more abrupt umbilical edge in the outer two adult whorls, a somewhat wider umbilicus, and generally a more depressed whorl section.

The group is represented by the following species:

- *C. sublaeve* (J. Sowerby), 1814, Mineral conchology, vol. 1, p. 117, pl. 54 (large figure)
- *C. sublaeve* var. *commune* Spath, 1932, p. 60
- *C. sublaeve* var. *rugosum* Spath, 1932, p. 60, Buckman, 1922, pl. 275
- *C. orbis* Spath, 1932, p. 61; D'Orbigny, Pal. Française; Terr. Jur. vol. 1, 1847, p. 468, pl. 170
- *C. tolype* Buckman, 1922, pl. 406
- ?*C durum* (Buckman), 1922, Yorkshire Ammonites, vol. 4, pl. 283; 1929, pl. 3
- *C. bathyomphalum* Imlay
- *C. tchefkini* (D'Orbigny), 1845, p. 439, pl. 35, figs. 10–15; Nikitin, 1884, pl. 3, fig. 15
- *C. sysolae* Khudyaev, 1927, p. 506, pl. 27, figs. 1, 2.

The species from England represent the Zones of *Proplanulites koenigi* and *Sigaloceras calloviense*. The Greenland species probably represents the *calloviense* zone. *C. tchefkini* occurs in the Russian zone of *Cadoceras milaschevici*, which Arkell (1946, p. 25) correlates with the *calloviense* to *coronatum* zones of northwest Europe. It is interesting that only one species of group 6 has been found in Alaska and none in the western interior of the United States, whereas the group is fairly common in northwest Europe and includes the genotype species, *C. sublaeve*.

GROUP 7

Group 7 includes moderately large, compressed forms with narrow umbilicus (umbilical ratio about 14 to 23) and narrowly to evenly rounded venter. The umbilical edge is rounded on the inner whorls and abrupt on the body whorl. The ribbing varies from fine to coarse, is gently inclined on the flanks, arches forward slightly on the venter, and may nearly disappear on the body chamber. Rib-branching generally occurs between the lower third and the middle of the flanks. Tubercles are weak or absent.

As group 7 has certain distinctive characters that distinguish it clearly from the somewhat similar *Pseudocadoceras* Buckman (1918, p. XIV; 1919, pl. 121c) and *Longaeviceras* Buckman (1918, p. XIV; 1919, pl. 121a), it is herein defined as a new subgenus, *Stenocadoceras*, and *C. multicostatum* Imlay (see p. 90) is designated the type. The inner whorls of *Stenocadoceras* greatly resemble the adult whorls of *Pseudocadoceras*, but the umbilicus is somewhat narrower and does not widen during growth and the venter is not sharpened. The adult whorls of *Stenocadoceras* are distinguished from those of *Pseudocadoceras* by a rounded venter, an abrupt umbilical edge, and by weakening of the ribbing on the body chamber. The adult *Stenocadoceras* is similar in general appearance and size to *Longaeviceras* (compare *L. funiferum* (Phillips) in D'Orbigny, 1847, pl. 156, fig. 3; Douville, 1912, pl. 3 (IX), fig. 6, text-figs. 16, 17; Nikitin, 1885, pl. (X) XII, figs. 56, 57; also compare *L. placenta* (Simpson) in Buckman, 1920, pl. 148, and Sokolov, 1912, pl. 2, fig. 2), but the latter has much more strongly inclined secondary ribs, does not develop an abrupt umbilical edge, and its inner whorls are keeled.

The following species are included in *Stenocadoceras*:

- *C. stenolobum* (Keyserling) 1846, p. 329, pl. 20, fig. 7, pl. 22, figs. 13, 14; Sokolov, 1912, p. 52, pl. 1, fig. 4.
- *C. stenolobum* var. *densicostatum* Spath 1932, p. 62; *Nikitin* 1881b, p. 121, pl. 12, figs. 28–30.
- *C. milaschevici* Nikitin 1881a, p. 66, pl. 3, fig. 25; 1881b, p. 121, pl. 12, figs. 26, 27.
- *C. compressum* Nikitin, 1881a, p. 67, pl. 3, figs. 26, 27.
- *C. dubium* Spath 1932, p. 73, pl. 22, figs. 2a, b.
- *C. multicostatum* Imlay.
- *C. striatum* Imlay.
- *C. iniskinense* Imlay.
- *C. bowserense* Imlay.
- *C. pomeroyense* Imlay.
- *C. stenoloboide* Pompeckj 1900, p. 255, pl. 7, figs. 2, 3.
- *C. nikitini* Sokolov, 1912, p. 53, pl. 1, figs. 3a–d.

The body whorl of some of these species is comparable in stoutness with that of group 4 although the umbilicus is narrower and the shape of the inner whorls is quite different. Such species include *C. stenolobum* var. *densicostatum* Spath, *C. milaschevici* Nikitin, *C. nikitini* Sokolov, *C. stenoloboide* Pompeckj, and *C. pomeroyense* Imlay.

The Russian species listed under group 7 are from the Russian zone of *Cadoceras milaschevici* which Arkell (1946, p. 25) correlates with the northwest European zones of *Sigaloceras calloviense*, *Cosmoceras jason* and *Erymnoceras coronatum*. *C. dubium* from Greenland probably represents the *Sigaloceras calloviense* zone. The Alaskan species range through the upper five-sixths of the Chinitna formation, but are common only in the upper two-fifths.

Pseudocadoceras was named by Buckman (1918, p. XIV; 1919, pl. 121c; 1929, p. 22), who designated *P. boreale* Buckman (1919, pl. 121B) as the type. The genus includes small, compressed forms characterized by a narrow to moderately narrow, shallow, umbilicus and a sharpened to narrowly rounded venter. The umbilical ratio ranges from about 20 to 30 and the umbilicus generally enlarges during growth. The ribbing varies from fine to coarse, is gently to moderately inclined forward on the flanks, is arched gently to strongly on the venter, and does not weaken on the body chamber. Bifurcation of the ribs occurs a little below the middle of the flanks. Single ribs and intercalated ribs are common. Tubercles are not present. The suture line is somewhat simpler than in *Cadoceras* but has the same general pattern.

The species belonging to *Pseudocadoceras* were placed in *Cadoceras* by Pompeckj (1899, p. 86; 1900, pp. 258–267), but since its definition by Buckman the genus has been considered distinct. It differs from *Cadoceras* essentially by having a strongly ribbed body chamber in the adult and by its umbilical wall remaining rounded and ribbed instead of becoming steep and

Table 1.—*Morphological comparisons of groups of* Cadoceras

Group or subgenus	Whorl shape	Umbilicus (Adult)			Rib inclination		Tubercles	Body chamber
		Shape	Width	Edge	Flanks	Venter		
1. *Paracadoceras. C. (P.) harveyi* Crickmay.	Compressed, then evenly arched.	Shallow, open	Fairly wide Ratio=22:33.	Generally abrupt.	Strong	Moderately arched.	Weak or absent	Fairly stout.
2. Group of *C. comma* Imlay.	Ovate, then depressed.	Fairly deep, open.	Fairly wide Ratio=27:37.	Sharp	Moderate to strong.	Gently arched	Comma-shaped, persistent.	Stout.
3. Group of *C. crassum* (Madsen).	Depressed	Fairly deep and open.	Fairly wide Ratio=24:30.	Evenly rounded	Moderate	Gently arched	None	Stout.
4. Group of *C. doroschini* (Eichwald).	Evenly arched	Step-like	Fairly narrow Ratio=20:26.	Abrupt to sharp	Gentle	Slightly arched	Weak, comma-shaped.	Stout.
5. Group of *C. shoshonense* Imlay.	Moderately to broadly arched.	Tubular or corkscrew-like.	Narrow Ratio=18:26.	Evenly rounded to abrupt.	Moderate to gentle.	Slightly arched	Weak, conical, or absent.	Globose.
6. Group of *C. sublaeve* (J. Sowerby).	Broadly arched	Deep, crater-like.	Moderately wide. Ratio=24:30.	Sharp	Gentle	Slightly arched	Conical or absent.	Globose.
7. *Stenocadoceras. C. (S.) multicostatum* Imlay.	Narrowly to evenly arched.	Shallow to moderately shallow.	Narrow Ratio=14:23.	Abrupt	Gentle to moderate.	Slightly arched	Absent, or weak swellings.	Compressed to moderately stout.

smooth. It bears some resemblance to the innermost whorls of *Paracadoceras* (see plate 42, figures 1, 2, 5, 7) and to the intermediate-sized whorls of *Stenocadoceras* (see pl. 20, figs. 1–12), both of which develop a *Cadoceras*-like body chamber. It greatly resembles *Longaeviceras*, but its ribbing is less arched ventrally and does not weaken on the body chamber. Maire (1938, p. 12) considers that *Pseudocadoceras* is intermediate between *Cadoceras* and the species of *Quenstedtoceras* in which the ribs form a V on the venter, such as in the subgenus *Bourkelamberticeras*. It is conceivable that *Pseudocadoceras* arose from *Paracadoceras*, which immediately preceded it in Alaska, but morphologically an origin from some strongly-ribbed species of *Arcticoceras* seems much more probable. It probably did not develop into *Longaeviceras*, as the latter occurs as low as the *Sigaloceras calloviense* zone. Rather, the characteristics and stratigraphic ranges of *Pseudocadoceras*, *Stenocadoceras*, and *Longaeviceras* indicate that they arose independently of each other from lower Callovian forms similar to *Arcticoceras*.

The following species belong to *Pseudocadoceras:*

- *P. boreale* Buckman, 1919, pl. 121B; Maire, 1938, p. 12, pl. 1, figs. 1, 1a.
- *P. concinnum* Buckman, 1927, pl. 735.
- *P. laminatum* Buckman, 1927, p. 727.
- *P. nanseni* (Pompeckj), 1899, p. 86, pl. 2, figs. 1–3, 5, 6, text figs. 16, 17; Spath, 1932, pl. 9, fig. 2, pl. 11, fig. 4.
- *P. orbignyi* Maire, 1932, p. 197; 1938, pl. 1, fig. 3; D'Orbigny, 1848, pl. 179, figs. 7, 8.
- *P. grewingki* (Pompeckj), 1900, p. 258, pl. 6, figs. 1a-d only.
- *P. petelini* (Pompeckj), 1900, p. 267, pl. 6, figs. 4–6.
- *P. crassicostatum* Imlay.
- *P. chinitnense* Imlay.
- *P. schmidti* (Pompeckj), 1900, p. 265, pl. 5, figs. 3a–d, 4a, b.

Pseudocadoceras in northwest Europe ranges from the *Sigaloceras calloviense* zone through the *Erymnoceras coronatum* zone but is most common in the *calloviense* and *jason* zones. In southwest Alaska *Pseudocadoceras* ranges through the upper two-thirds of the Chinitna formation and from the upper beds of the lower member of the Shelikof formation through the middle member. *Pseudocadoceras grewingki* shows this entire range. *P. petelini* has been found only in the middle member of the Shelikof formation. *P. crassicostatum* has been found in the upper third of the Chinitna formation and in the middle member of the Shelikof. *P. chinitnense* occurs throughout the upper third of the Chinitna formation.

The Cosmoceratidae are represented mostly by *Kepplerites*, of which genus eight species have been found in southwestern Alaska in the lower two-thirds of the Chinitna formation and near the base of the Shelikof formation. *Gowericeras* includes three species, each represented by single specimens. Two species were found near the base of the Chinitna formation and one in the lower part of the middle third. One specimen of *Cosmoceras*, comparable to *C. spinosum* (J. de C. Sowerby), was found as float near the top of the middle third of the Chinitna formation. Several fragments belonging to *Gulielmiceras* were obtained near the base of the Chinitna formation. All the species of *Kepplerites* in Alaska are referred to the subgenus *Seymourites*, which differs from the typical *Kepplerites* in central Europe according to Spath (1932, p. 83) by its

> . . . large size, the tendency of the peristome to become flared, with a preceding shallow constriction, the loss of runcination at an earlier stage than in the Wurtemberg examples, and especially the finer ribbing in the young. . . .

Spath suggests that these differences reflect differences in habitat, but notes that the typical *Kepplerites* in Europe occurs in the *Macrocephalites macrocephalus* zone, whereas the known species of *Seymourites* appear to be from slightly younger beds. In this regard it may be significant that *Kepplerites* has not yet been found associated with *Arcticoceras* in North America.

The Morphoceratidae is represented in the Callovian of Alaska by two specimens of *Reineckeia*. One of these, found near the base of the Shelikof formation at Wide Bay, is assigned to the subgenus *Kellawaysites* rather than to *Reineckeites* because of the presence of long, closely spaced primary ribs, weak tuberculation, and restriction of tubercles to the inner whorls. The other specimen, found near the base of the Chinitna formation on the Iniskin Peninsula (Mes. loc. 21320), bears prominent tubercles at a size that suggests assignment to typical *Reineckeia*. One other specimen of *Reineckeia* is known from the Iniskin Peninsula, from the middle part of the Bowser member of the Tuxedni formation (Mes. loc. 20745), which on the basis of the presence of *Cranocephalites* is considered to be of early or middle Bathonian age. The occurrence of *Reineckeia* in southwestern Alaska is especially interesting, as the genus is characteristic of the Mediterranean province, is uncommon in northwest Europe, and has not been recorded as far north as Yorkshire, England, or northern Germany (Spath, 1932, pp. 148, 149; Arkell, 1946, p. 16).

The Perisphinctidae are represented in the basal beds of the Chinitna formation of southwestern Alaska by a few specimens of *Procerites* and a single specimen of *Grossouvria*. Fragments probably belonging to *Procerites* occur also in the underlying beds characterized by *Cranocephalites*. The occurrence of *Procerites* and *Grossouvria* in the Chinitna formation is not surprising, as both genera occur in lower Callovian beds in Montana.

STRATIGRAPHIC SUMMARY

ALASKAN PENINSULA REGION

SHELIKOF FORMATION

Three lithologic members have been recognized within the Shelikof formation in the Wide Bay and Puale

Bay (formerly Cold Bay) areas. These include a lower siltstone member ranging from 800 to 1,800 ft thick; a middle sandstone member ranging from 1,000 (or less) to 3,500 ft thick; and an upper siltstone member ranging from 900 to 1,500 ft thick (Capps, 1922, pp. 97–101; Smith and Baker, 1925, pp. 169, 176–178; Smith, 1925, pp. 196–197; Smith, 1926, pp. 71–85; Kellum, Daviess, and Swinney, 1945, p. 8, fig. 2).[1]

The lower member in the Wide Bay area consists mainly of gray siltstone and sandy siltstone that is generally soft and brown weathering in the lower part of the member but becomes harder and darker gray upward on both fresh and weathered surfaces. It, also, contains many sandy interbeds from a few inches to as much as 200 ft thick. Thin beds of white to yellowish-brown, fine-grained material, probably volcanic ash, are fairly common in the lower part of the member and serve to distinguish the basal siltstones of the Shelikof formation from similar soft siltstones in the underlying Kialagvik formation. Limestone concretions that weather brown and gray are abundant at many levels. Faunally the member is characterized throughout by the ammonite *Cadoceras*, and its middle and upper parts contain many specimens of *Pseudocadoceras* and *Lilloettia*.

The lower member at Puale Bay is represented by about 800 ft of brown-weathering siltstone that includes many concretions. The brown appearance of the outcrops is due to the presence of ashy beds resembling those in the lowest beds of the Shelikof formation in the Wide Bay area. The siltstone is underlain by about 100 ft of coarse conglomerate that rests on Lower Jurassic siltstone. One fossil collection (Mesozoic loc. 3106), obtained near the top of the member, contains *Cadoceras* and *Pseudocadoceras*.

The middle member of the Shelikof formation consists dominantly of massive gray sandstone but contains interbeds of siltstone and lenses of conglomerate. The conglomerate consists of granitic and dioritic rocks, is generally fine, but in places contains boulders as much as 2 ft in diameter. Locally, the sandstones in the upper part appear to pass laterally into siltstones of the upper member. From the middle member have been obtained a considerable number of pelecypods, and some gastropods, belemnites, ammonites and brachiopods. *Pseudocadoceras* is more abundant than *Cadoceras*.

The upper member of the Shelikof formation consists mostly of hard, dark gray, gray weathering siltstone. Near Wide Bay the siltstone contains thin interbeds of sandstone and limestone. Near Puale Bay the siltstone contains lenses of yellowish-weathering limestone that greatly resemble limestone lenses in the upper part of the Chinitna formation on the Iniskin Peninsula. The known fossils from the upper member of the Shelikof formation consist only of pelecypods, gastropods, and belemnites. *Pseudocadoceras* has been found near the top of the middle member at several localities and possibly occurs in the upper member at Mesozoic locality 10813, southwest of Wide Bay.

[1] The following description of the Shelikof formation is condensed from an unpublished memorandum by D. J. Miller and R. W. Imlay based on field work in the Wide Bay and Puale Bay areas in 1948. It also takes into account unpublished information obtained by L. R. Kellum and Jacob Freedman in 1945.

COOK INLET REGION

CHINITA FORMATION

The Chinitna formation occurs in the area extending from Iniskin Bay to Tuxedni Bay (Moffit, 1927, pp. 23–31, 66; Kirschner and Minard, 1949). The name has likewise been used in the Matanuska Valley (Chapin, 1918, pp. 33, 34; Paige and Knopf, 1907, pp. 20–24) for several thousand feet of beds that contain *Cadoceras* and are reported to differ from the typical Chinitna formation of the Chinitna Bay area by containing some conglomerate and massive sandstone. Actually the Chinitna formation of the Matanuska Valley as mapped may include beds older than the typical Chinitna, because one lot (Mesozoic loc. 8573) from the Matanuska Valley contains *Cranocephalites* and *Gryphaea impressimarginata* McLearn, of Middle Jurassic Age.

The Chinitna formation west of Cook Inlet consists dominantly of medium- to dark-gray siltstone that weathers reddish brown, contains local lenses of gray sandstone at various levels, generally is marked basally by several hundred feet of shelly sandstone, and ranges in thickness from about 3,200 to 4,500 ft. It likewise contains many gray to brown calcareous concretions that may be as much as 2 ft in diameter and are commonly fossiliferous. The concretions occur singly and in layers parallel to the bedding. Most of the concretions are rounded, but the upper third of the formation contains many elongate concretions.

Attempts have been made in the field during the past few years to subdivide the Chinitna formation into mappable members on the basis of certain thick sandstone units, but careful traversing of all the creeks has shown that the sandstone units are not persistent enough for mapping. One example of this is the series of strata defined by Kirschner and Minard (1949) as the Tonnie member of the Tuxedni formation, primarily on the basis of the section at the head of Tonnie Creek in the central part of the Iniskin Peninsula. The section exposed at this place consists, from bottom to top, of (1) 440 ft of massive, rather soft gray siltstone containing interbeds of fine-grained greenish-gray sandstone and a few brown to gray concretions, (2) 580 ft of massive, dark-gray siltstone that contains many yellowish-brown-weathering concretions, and (3) 410 ft of fine-grained gray or greenish-gray sandstone that is interbedded with some sandy siltstone and

Genus and species	Chinitna formation			Shelikof formation		
	Lower third	Middle third	Upper third	Lower member	Middle member	Upper member
Phylloceras (Phylloceras) bakeri Imlay, n. sp.			—			
P. (Calliphylloceras) freibrocki Imlay, n. sp.	—	—	—		—	
P. (Partschiceras) subobtusiforme Pompeckj	—	—	—			
P. (Partschiceras) grantzi Imlay, n. sp.		—				
P. (Macrophylloceras) grossicostatum Imlay, n. sp.	—	—				
Oppelia (Oxycerites) chinitnana Imlay, n. sp.		—				
O. (Oxycerites) sp.	—	—		—		
Lilloettia buckmani (Crickmay)	—	—		—		
L. milleri Imlay n. sp.	—			—		
L. mertonyarwoodi Crickmay	—	—		—		
L. lilloetensis Crickmay		—		—		
L. stantoni Imlay n. sp.		—		—		
Xenocephalites hebetus Imlay, n. sp.	—					
X. vicarius Imlay, n. sp.	—	—				
X. hartsocki Imlay, n. sp.	—	—				
Kheraiceras magniforme Imlay, n. sp.	—	—				
K. martini Imlay, n. sp.	—					
K. abruptum Imlay, n. sp.	—			—		
K. varicostatum Imlay, n. sp.		—				
K. intermedium Imlay, n. sp.	—					
K. ? parviforme Imlay, n. sp.	—					
Cadoceras catostoma Pompeckj	—	—		—		
C. comma Imlay, n. sp.	—	—		—		
C. glabrum Imlay, n. sp.		—		—		
C. bathomphalum Imlay, n. sp.				—		
C. tenuicostatum Imlay, n. sp.		—	—	—	—	
C. doroschini (Eichwald)		—	—		—	
C. wosnessenskii (Grewingk)		—	—	—		
C. kialagvikense Imlay, n. sp.		—		—		
C. (Paracadoceras) moffiti Imlay, n. sp.	—					
C. (Paracadoceras) multiforme Imlay, n. sp.		—				
C. (Paracadoceras) tonniense Imlay, n. sp.	—	—				
C. (Paracadoceras) aff. *C. tonniense* Imlay		—				
C. (Paracadoceras) chisikense Imlay n. sp.	—					
C. (Stenocadoceras) multicostatum Imlay n. sp.		—	—		—	
C. (Stenocadoceras) striatum Imlay, n. sp.		—				
C. (Stenocadoceras) iniskinense Imlay, n. sp.	—	—		—	—	
C. (Stenocadoceras) bowserense Imlay, n. sp.	—					
C. (Stenocadoceras) stenoloboide Pompeckj		—	—	—	—	
C. (Stenocadoceras) pomeroyense Imlay, n. sp.			—			
Pseudocadoceras petelini (Pompeckj)					—	
P. grewingki (Pompeckj)	—	—	—	—	—	—
P. crassicostatum Imlay, n. sp.			—		—	
P. chinitnense Imlay, n. sp.		—	—			
P. schmidti (Pompeckj)					—	
Kepplerites (Seymourites) alticostatus Imlay, n. sp.	—					
K. (Seymourites) multus (McLearn)	—	—				
K. (Seymourites) tychonis Ravn	—					
K. (Seymoutites) ingrahami (McLearn)	—	—		—		
K. (Seymourites) mcevoyi (McLearn)		—				
K. (Seymourites) gitinsi (McLearn)		—				
K. (Seymourites) abruptus (McLearn)	—					
K. (Seymourites) plenus (McLearn)				—		
Gowericeras snugharborense Imlay, n. sp.	—					
G. spinosum Imlay, n. sp.		—				
G. sp.	—					
Cosmoceras cf. *C. spinosum* (J. de C. Sowerby)		—				
Cosmoceras (Gulielmiceras) alaskanum Imlay, n. sp.	—					
Reineckeia (Kellawaysites) shelikofana Imlay, n. sp.				—		
Procerites spp.	—					
P. ? irregularis Imlay, n. sp.	—					
Grossouvria sp.	—					

Table 2.—Stratigraphic distribution of Callovian ammonite species from Alaska Peninsula and Cook Inlet regions

grades into the underlying massive siltstone. This sandstone unit at the top seems to disappear southward across the Iniskin Peninsula, and has not been recognized as a persistent unit south of Fitz Creek. In addition, recent fossil collections have disclosed that the fauna of the Tonnie member, as mapped on Tonnie Peak by Kirschner and Minard, and the fauna of the lower third of the Chinitna formation, wherever it has been examined, are identical. For this reason, and because of the lack of a persistent sandstone unit at the top, the Tonnie member has been placed in the Chinitna, forming roughly the lower third of the formation.

Similarly, it was attempted to subdivide the upper two-thirds of the Chinitna formation on the basis of a massive sandstone about 30 ft thick that lies about 1,000 ft below the top of the formation on the south shore of Chinitna Bay. This sandstone seemed to be similar lithologically and stratigraphically to about 80 ft of massive gray sandstone that lies 950 ft below the top of the Chinitna formation at Tuxedni Bay. Mapping of the intervening area as well as the area southwest of Chinitna Bay, however, suggests that the sandstones in question pass laterally into siltstone and that similar sandstone lenses appear at the same or at other levels.

The boundaries of the Chinitna formation are rather sharp. The basal siltstones or shelly sandstones rest on massive ridge-forming sandstone or sandy siltstone at the top of the Bowser member of the Tuxedni formation. In places the highest beds of the Chinitna formation are overlain by conglomerate or sandstone at the base of the Naknek formation. In other places, as on Chinitna Bay, the formations appear to grade into each other through about 100 ft of interbedded sandstone and siltstone. The boundary with the Tuxedni formation may mark a minor sedimentary break, as the highest beds of the Bowser member contain *Cranocephalites* and there is no record of *Arctocephalites* in the basal Chinitna, although that genus immediately succeeds *Cranocephalites* in East Greenland and is widespread in boreal Jurassic deposits. The boundary of the Chinitna with the Naknek formation affords convincing physical evidence of a marked change in conditions of sedimentation and faunally marks a disconformity equivalent to the late Callovian, as the abundance of *Pseudocadoceras* and *Cadoceras* in the upper 100 ft of the Chinitna indicates an age not younger than the *Erymnoceras coronatum* zone and the abundance of *Quenstedtoceras* (*Scarburgiceras*) near the base of the Naknek indicates an age not older than that of the *Quenstedtoceras mariae* zone.

Discussion of the stratigraphic distribution of the fossils would have been facilitated by division of the Chinitna formation into members. As this has not yet been done, in the present paper the Chinitna formation is arbitrarily divided into three parts which will be called thirds. Of course, the locality descriptions (pp. 65–71) furnish as exact stratigraphic data as are known.

In the lower third of the Chinitna formation, formerly called the Tonnie member, the ammonites consist mostly of *Cadoceras*, *Paracadoceras*, *Kepplerites*, *Lilloettia*, *Kheraiceras*, and *Xenocephalites* (see table 3). *Kheraiceras* and *Xenocephalites* occur throughout the lower third. *Lilloettia* has not been found in the lowermost 500 to 600 ft of the Chinitna formation. *Procerites* and *Grossouvria* are uncommon and occur only in the basal beds. *Kepplerites* and *Paracadoceras* have been found within 70 ft of the base. *Gulielmiceras* has been found within several hundred feet of the base. On Chisik Island *Gowericeras* was obtained within a zone 30 to 80 ft above the base of the formation.

In the middle third of the Chinitna formation the common ammonites are *Phylloceras*, *Oxycerites*, *Lilloettia*, *Cadoceras*, *Pseudocadoceras*, and *Kepplerites*. One specimen of *Gowericeras* was found in the lower part of the middle third, associated with *Pseudocadoceras*, *Cadoceras*, *Paracadoceras*, *Xenocephalites*, and *Kheraiceras*. In the upper third of the Chinitna formation the only ammonites found are *Phylloceras*, *Lilloettia* (rare), *Cadoceras*, and *Pseudocadoceras*. Most of the species of *Cadoceras* in the upper third are compressed and are included under a new subgenus, *Stenocadoceras*. *Pseudocadoceras* is common only in the lower part of the upper third.

AGE OF THE FAUNAS

The lower third of the Chinitna formation contains the Callovian ammonites *Kepplerites*, *Cosmoceras* (*Gulielmiceras*), *Gowericeras*, *Cadoceras*, *C.* (*Paracadoceras*), *Lilloettia* and *Grossouvria*. Longer-ranging ammonites include *Phylloceras*, *Oppelia* (*Oxycerites*), *Xenocephalites*, *Kheraiceras*, and *Procerites*. This assemblage differs from that in the middle third of the Chinitna formation by the absence of *Pseudocadoceras*, except possibly at the very top, by the presence of abundant *Paracadoceras*, *Kheraiceras*, and *Xenocephalites*, and by the presence of rare *Gulielmiceras*, *Grossouvria* and *Procerites*. An early Callovian age is clearly shown by the abundance of *Paracadoceras*, which includes such European forms as *C. elatmae* (Nikitin) and *C. breve* Blake. The presence of *Gulielmiceras* only a few hundred feet above the base of the Chinitna formation indicates an age not older than the *Sigaloceras calloviense* zone of northwest Europe for most of the lower third. The presence of *Gowericeras* near the base of the Chinitna formation on Chisik Island suggests that the basal 200 to 300 ft represent the *Proplanulites koenigi* zone. This is supported by the presence of *Procerites* in these basal beds and by the similarity of the species of *Gowericeras* and *Xeno-*

Genera, subgenera, and groups	Chinitna formation			Shelikof formation		
	Lower third	Middle third	Upper third	Lower member	Middle member	Upper member
Phylloceras (Phylloceras)			—			
P. (Calliphylloceras)	—	—	—		—	
P. (Partschiceras)	—	—	—			
P. (Macrophylloceras)	—	—				
Oppelia (Oxycerites)	—	—		—		
Lilloettia	—	—		—		
Xenocephalites	—	—				
Kheraiceras	—	—		—		
Cadoceras (Paracadoceras)	—	—				
Group of *C. comma* Imlay	—	—		—		
Group of *C. sublaeve* (J. Sowerby)				—		
Group of *C. doroschini* (Eichwald)	—	—	—	—	—	
Cadoceras (Stenocadoceras)	—	—	—	—	—	
Pseudocadoceras	—	—	—	—	—	—
Kepplerites	—	—		—		
Gowericeras	—	—				
Cosmoceras (Cosmoceras)		? —				
C. (Gulielmiceras)	—					
Reineckeia (Kellawaysites)				—		
Procerites	—					
Grossouvria	—					

TABLE 3.—*Stratigraphic ranges of Callovian ammonites in Alaska*

cephalites to species in the *Gowericeras subitum* beds in Montana (Imlay, 1948, pp. 15, 16). It is supported too by the presence of *Kepplerites tychonis* Ravn on Chisik Island about 80 ft above the lowest exposure and apparently from a slightly higher bed than that which furnished *Gowericeras*. This species characterizes the *Kepplerites tychonis* beds of East Greenland (Spath, 1932, pp. 145, 146) and of Montana (Imlay, 1948, p. 16), which beds probably correspond to the lower part of the *Sigaloceras calloviense* zone. The correlation is supported by the presence of a fragment of *Kepplerites*, probably belonging to *K. tychonis* Ravn, associated with *Gulielmiceras* at U.S.G.S. Mes. loc. 20755 on Iniskin Bay. The evidence seems rather strong, therefore, that the basal beds of the Chinitna formation correlate with the *Proplanulites koenigi* zone and the remainder of the lower third with at least the lower part of the *Sigaloceras calloviense* zone of northwest Europe. It is interesting that evidence has not been found in southwestern Alaska for the presence of beds of the *Macrocephalites macrocephalus* zone. It is possibly represented locally at the base of the Chinitna formation by shelly sandstone that has furnished such ammonites as *Phylloceras*, *Lytoceras*, *Xenocephalites*, *Kheraiceras*, and some small undeterminable macrocephalitids. However, not a single specimen of *Arcticoceras* has been found in these beds, in marked contrast to the abundance of *Arcticoceras* at the base of the Callovian in the boreal region, including northern Alaska and the western interior of North America. Failure to find *Arcticoceras* implies (1) an unconformity, (2) some kind of barrier between the Jurassic seas of southern and northern Alaska, (3) unfavorable ecological conditions, or (4) collecting failure.

The middle third of the Chinitna formation has furnished many ammonites belonging to *Cadoceras*, *Pseudocadoceras*, *Kepplerites*, *Lilloettia*, *Oxycerites* and *Phylloceras*. *Paracadoceras*, *Kheraiceras*, *Xenocephalites*, and *Gowericeras* occur rarely in the lower part of the middle third. This assemblage represents the middle of the Callovian, as shown long ago by Pompeckj (1900). It probably corresponds with the zone of *Cosmoceras jason*, as indicated by stratigraphic position and by the ranges of the ammonites. In Europe *Pseudocadoceras* ranges from the *Sigaloceras calloviense* to the *Erymnoceras coronatum* zone; *Cadoceras* ranges from the *Macrocephalites macrocephalus* into the *E. coronatum* zone; *Kepplerites* ranges from the *M. macrocephalus* to the *S. calloviense* zone in England and apparently into the *E. coronatum* zone in northern Russia. *Paracadoceras* is most common in the zones of *M. macrocephalus* and *Proplanulites koenigi* but ranges at least as high as the *S. calloviense* zone. *Gowericeras* is characteristic of the *P. koenigi* zone but occurs rarely in the *S. calloviense* zone. These ranges show that the middle third of the Chinitna cannot be older than the *S. calloviense* zone and part of it may be younger. The basal part of the middle third correlates with the *S. calloviense* zone because of the association of *Gowericeras* and *Paracadoceras* with *Pseudocadoceras*. Its stratigraphic position above beds containing *Kepplerites tychonis* Ravn and *Gulielmiceras* shows that it represents only the upper part of the *S. calloviense* zone. An age slightly younger than that of the *S. calloviense* zone for most of the middle third is indicated by comparisons of the species of *Cadoceras* and *Kepplerites* with those in the lower Callovian beds of Montana. The common species of *Cadoceras* differ from those found in Montana by having an angular instead of a rounded umbilical edge and persistent comma-shaped tubercles instead of nonpersistent conical tubercles and by tending to lose the ribbing on the lower part of the flanks before losing the ribbing on the venter. The species of *Kepplerites* in the middle third of the Chinitna differ from those in Montana by nearly complete absence of ventral flattening in the young forms.

Possible additional evidence of age is furnished by one specimen of *Cosmoceras*, similar to *C. spinosum* (J. de C. Sowerby), obtained as float on the east shore of Iniskin Bay. This specimen shows little evidence of weathering or rounding, and probably was derived from nearby beds in the upper part of the middle third of the Chinitna formation. As forms similar to *Cosmoceras spinosum* range from the *Erymnoceras coronatum* to the *Quenstedtoceras mariae* zone, it may be that the specimen was derived from the lower part of the Naknek formation, which corresponds to the *Q. mariae* zone.

The siltstone of the upper third of the Chinitna formation contains abundant *Pseudocadoceras* and *Cadoceras* and some *Phylloceras*. Most of the forms of *Cadoceras* are compressed and resemble *C. milaschevici* (Nikitin) and *C. stenolobum* (Keyserling). This assemblage probably corresponds with the European zone of *Erymnoceras coronatum* because *Pseudocadoceras* is not known to range higher. The absence of such ammonites as *Paracadoceras*, *Kepplerites*, *Lilloettia*, *Kheraiceras* and *Xenocephalites*, that occur in the siltstone of the middle third of the Chinitna, cannot be explained by ecological differences, and implies a fairly high position in the Callovian. The presence of *Pseudocadoceras* in the upper 100 ft of the siltstone of the Chinitna shows that no part of the formation is as young as the Oxfordian.

The Shelikof formation is considered to be the equivalent of the Chinitna formation as it contains the same species of ammonites. As discussed under the stratigraphic summary, the Shelikof formation consists of a lower siltstone member 1,500 ft or less in thickness, a middle sandstone member at least several thousand feet thick, and an upper siltstone member from 700 to 1,000 ft thick. At Wide Bay the lower member has

Genera or subgenera	Bajocian	Bathonian	Callovian							Oxfordian					
			macrocephalus	*koenigi*	*calloviense*	*jason*	*coronatum*	*athleta*	*lamberti*	*mariae*	*cordatus*	*plicatilis*	*cautisnigrae*	*decipiens*	*pseudocordata*
Kheraiceras		—	—	—	—	—	—								
Cadoceras, s. s.			—	—	—	—	—								
Paracadoceras			—	—	—										
Pseudocadoceras					—	—	—								
Kepplerites			—	—	—	—?									
Gowericeras				—	—										
Cosmoceras, s. s.						—	—	—	—	—	—	—			
Gulielmiceras					—	—	—								
Kellawaysites				—	—	—	—	—	—						
Reineckeia, s. s.		—	—	—	—	—	—	—							
Procerites	—	—	—	—											
Grossouvria			—	—	—	—	—	—	—						

TABLE 4.—*European ranges of certain ammonites present in Alaska*

furnished *Oxycerites*, *Reineckeia*, *Cadoceras*, *Kepplerites*, *Pseudocadoceras*, and *Lilloettia*. The last two genera were found only in the upper part of the lower member. At Wide Bay and Puale Bay (formerly Cold Bay) the middle member has furnished *Cadoceras* and *Pseudocadoceras*. The presence of *Reineckeia* (*Kellawaysites*) about 350 ft above the base of the Shelikof formation at one locality on Wide Bay shows that the basal part of the formation is not older than Callovian.

COMPARISONS WITH OTHER FAUNAS

WESTERN INTERIOR OF THE UNITED STATES AND CANADA

The ammonite assemblage in the Callovian of southwestern Alaska has the appearance of being quite distinct from that in the western interior of North America, because nearly all the species are distinct, a number of genera and subgenera found in one area are not found in the other, and the relative abundance of certain genera seems to be different in the two areas. For example, *Phylloceras*, *Ovycerites*, *Kheraiceras*, *Paracadoceras* and *Reineckeia* have been found in southwestern Alaska and not in the western interior. *Arcticoceras* has been found in the Callovian of the western interior but not in southwestern Alaska. The abundance of *Gowericeras* in the western interior contrasts with its scarcity in southwestern Alaska. The genus *Cadoceras* is represented by different subgenera or groups in the two areas. However, much of this apparent distinctness is due to the fact that most of the Callovian ammonites from southwestern Alaska have been obtained from beds that are younger than any Callovian beds yet identified in the western interior. The faunal differences are not nearly as great if beds of the same age are compared. Thus, the lower third of the Chinitna formation has furnished a few specimens of *Gowericeras*, *Kepplerites*, *Cosmoceras* (*Gulielmiceras*), and *Xenocephalites* that are either closely comparable or identical specifically with ammonites in the lower Callovian of the western interior. Contrast is furnished by the presence in the lower third of the Chinitna of *Phylloceras*, and certain groups of *Cadoceras*, such as *Paracadoceras*, that are not found in the western interior. These differences are probably ecologic, as *Phylloceras* is rare in deposits of the ably ecologic, as *Phylloceras* is rare in deposits of the of *Cadoceras* varies considerably from place to place within the boreal region.

ARCTIC REGION OF CANADA

In the Richardson Mountains of northwestern Canada near the Arctic Ocean the upper Bathonian is represented by the *Arctocephalites* beds and the lower Callovian by the *Arcticoceras* beds, just as in the western interior of North America and in East Greenland, and similarly *Cadoceras* is associated with *Arcticoceras* but not with *Arctocephalites*. Close affinities with the lower Callovian of East Greenland is shown by the presence of a *Cadoceras*, probably identical with *C. calyx* Spath (1932, pp. 69–70, pl. 20, figs. 1a, b) and an *Arcticoceras* similar to *A. kochi* Spath (1932, pp. 53–56, pl. 12, fig. 1, pl. 13, figs. 4–5, pl. 14, figs. 1–3, pl. 15, figs. 1, 4, 6), but having coarser ribbing on the small specimens than on the immature forms that Spath places in *A. kochi.*

ARCTIC REGION OF ALASKA

The Callovian ammonites found in the Kingak shale along the west bank of the Canning River at the mouths of Eagle and Cache creeks show both boreal and central European affinities. *Arcticoceras* occurs a little above the middle of the formation and about 1,000 ft above shales containing *Pseudolioceras* and *Erycites*, of lower Bajocian age. Another 1,850 ft higher at the same locality the shale has furnished many specimens of *Cosmoceras castor* (Reinecke), a species which in northwest Europe occurs in the zone of *Erymnoceras coronatum.* This zone is much younger than any Callovian yet found in Greenland or in the western interior of the United States, but is probably represented in southwestern Alaska.

EAST GREENLAND AND BARENTS SEA

The history of the Callovian Sea and the composition and distribution of its faunas for the area comprising East Greenland and the present Barents Sea (including mainly King Karl Land, Franz Josef Land, Petchora Land, Novaja Zembla and Spitzbergen) have been discussed in considerable detail by Rosenkrantz (1929), Frebold (1929, 1930, 1935), and Spath (1932). From their discussions it is apparent that the major movements of the Callovian boreal sea and the succession of its molluscan faunas were essentially the same as in the western interior of North America and somewhat different from those in southwestern Alaska. Thus, both the boreal sea and the western interior sea underwent a major transgression during the early Callovian (zones of *Macrocephalites macrocephalus* to *Sigaloceras calloviense*) and a major regression during the late Callovian. In contrast, in southwestern Alaska marine waters persisted throughout most of the Callovian. Faunally the lower Callovian of the East Greenland-Barents Sea area differs from the lower Callovian of Alaska by an abundance of *Arcticoceras*, a scarcity of *Xenocephalites* and *Paracadoceras* and an absence of *Phylloceras*, *Lilloettia*, and *Kheraiceras.* It seems probable that the differences noted reflect different environmental conditions, as the Callovian seas of the western interior and of the Greenland-Barents Sea area represent extensive, very shallow floodings of continental masses, whereas the Callovian sea of southwestern Alaska bordered highlands or mountains comparable with those of the present day.

NORTHWEST EUROPE AND CENTRAL RUSSIA

The striking similarities of the Callovian ammanite assemblages from England through northwest Europe into central Russia have been discussed recently by Arkell (1939, pp. 196–214; 1945, pp. 340–345, 355; 1946, pp. 23–25). Comparisons of these assemblages with those from east Greenland and the Barents Sea area have been made by Spath (1932, pp. 138–157), who notes the greater diversity of the cardioceratids in England than farther north and the absence of certain groups, such as *Chamoussetia*, from the Arctic areas north of central Russia. He also notes that in Europe *Kepplerites* is replaced southward by *Reineckeia* and is typical of the zone of *Macrocephalites macrocephalus*, whereas in east Greenland it is abundant in higher beds that are probably equivalent to the zone of *Sigaloceras calloviense.* He shows that the groups of *Cadoceras* and *Kepplerites* present in the Arctic areas are in general distinct from those in northwest Europe. He ascribes the rarity of cosmoceratids in the Arctic areas to the scarcity or absence of deposits of late Callovian age (1932, p. 80). Spath considers that the Arctic seas were freely connected with the seas in northwest Europe and that the northward changes in the ammonite assemblages favors the existence of climatic zones.

Many of these distinctions between the Callovian ammonite assemblages of northwest Europe and those in the Greenland-Barents Sea area apply equally in comparisons between northwest Europe and southwestern Alaska, although some of the apparently greater diversity of cardioceratids in England than elsewhere may be a matter of description rather than reality. Completely missing from the Alaskan Callovian are such common European genera as *Chamoussetia* and *Proplanulites* in the lower Callovian and *Erymnoceras* in the upper Callovian. *Xenocephalites* is the one distinctive Pacific element in the Alaskan fauna unknown from Europe. *Lilloettia* is probably only a local race of *Macrocephalites*. *Kheraiceras* is interesting because of its abundance in Alaska and because it has not been recorded before from Arctic areas, but it has a nearly world-wide distribution and is represented in Europe by similar forms. The Alaskan Callovian is particularly characterized by a greater abundance and diversity of *Cadoceras* and *Pseudocadoceras* than exists in northwest Europe, according to published records. Thus the subgenus *Paracadoceras* seems to be much more abundant than in Europe. The group represented by *C. doroschini* (Eichwald) does not appear to be present in Europe. On the other hand the group represented by *C. sublaeve* (J. Sowerby) is very scarce in Alaska. The rarity of *Cosmoceras* in southwestern Alaska cannot be explained by the absence of upper Callovian deposits, because the Chinitna formation includes at least the European zones of *Cosmoceras jason* and *Erymnoceras coronatum*. The rarity more likely has an ecologic explanation, especially considering that the genus is locally abundant in Montana and on the Canning River in northeastern Alaska.

PACIFIC COAST REGION OF CANADA AND UNITED STATES

The Jurassic rocks of the Pacific coast region of North America have certain features in common that distinguish them from the Jurassic of the western interior of the continent and of the Barents Sea area. They were laid down in fairly narrow troughs that received thousands of feet of clastic sediments and volcanics derived from nearby uplifts. Thicknesses of 15,000 to 20,000 ft occur in southwestern Alaska, of 10,000 to 15,000 ft in western British Columbia, over 16,000 ft in central Oregon (Lupher, 1941, p. 227), and well over 30,000 ft in northern California (Taliaferro, 1942; Anderson, 1945, p. 917). Limestones are rare in the Jurassic in Alaska and western British Columbia, are much subordinate to coarse clastic sedimentary rocks in Oregon and California, and occur mainly in the Lower Jurassic and the Bajocian. This occurrence may be partly of climatic significance, as the ammonites of the Lower Jurassic and Bajocian belong mostly to cosmopolitan genera whereas the ammonites of the Bathonian and Upper Jurassic north of California belong mostly to genera that are either distinctly boreal or related to those in northwestern Europe. These include *Cadoceras*, *Paracadoceras*, *Pseudocadoceras*, *Lilloettia*, *Kepplerites*, and *Cosmosceras* in the Callovian, *Cardioceras* in the lower Oxfordian, and *Amoeboceras* in the upper Oxfordian. Perisphinctid ammonites are as rare as in the Boreal province. In the Upper Jurassic of northern California some of the ammonites characteristic of the Boreal province occur in the same formation with perisphinctids such as characterized the Upper Jurassic of Mexico and the Mediterranean province. Thus the Mariposa slate, of Kimmeridgian age, contains *Amoeboceras* (*Amoebites*) of boreal affinities (Reeside, 1919, p. 38, pl. 24, figs. 5–8) and perisphinctids of Mediterranean affinities (Crickmay, 1933, pp. 56–58). The Knoxville formation, of Portlandian age, contains ammonites that are entirely of Mediterranean aspect. It appears, therefore, that during the Late Jurassic northern California occupied a position between the faunal provinces comparable to that occupied by central Europe and southern England (Spath, 1932, pp. 146–150).

Concerning diastrophism in the Pacific coast region south of Alaska, it may be significant that to date ammonites of latest Callovian and middle and late Kimmeridgian ages have not been identified. This is consistent with the absence in the western interior of marine upper Callovian, Kimmeridgian and Portlandian, and perhaps even upper Oxfordian. Also, in East Greenland and the Barents Sea areas, there is no faunal evidence of the upper Callovian, representing the zones of *Cosmoceras jason*, *Erymnoceras coronatum* and *Peltoceras athleta*, or of the middle Kimmeridgian (Spath, 1932, pp. 146–157; 1935, pp. 66, 70, 80). The evidence is sufficiently strong to show that there were two major marine regressions, culminating in the upper Callovian and the middle Kimmeridgian.

MEXICO

This region has been discussed in considerable detail elsewhere (Burckhardt, 1930; Imlay, 1943). The Callovian has been identified faunally only in southern Mexico, where it is represented by more than 2,000 ft of dark marine shale and limestone (Burckhardt, 1927). The lower part of the Callovian grades downward into the Bathonian and contains the ammonites *Reineckeia*, *Reineckeites*, *Xenocephalites*, *Eurycephalites*, *Pleurocephalites*, *Choffatia*, and *Subgrossouvria* of early Callovian age. The upper 275 ft of the Callovian contains the ammonites *Reineckeia*, *Erymnoceras*, *Kellawaysites*, and *Peltoceras*, of later Callovian age. Spath (1933, p. 769) considers these highest beds upper Callovian but not as high as the *Peltoceras athleta* zone of northwest Europe, probably because of the abundance of reineckeiids and the scarcity of perisphinctids. Faunally, the affinities are mainly with the Mediterranean province, as shown by the abundance of reineckeiids and peltoceratids. Among the ammonites only *Kellawaysites* and *Xenocephalites* have been found in southwestern Alaska. Of these, *Kellawaysites* is known only from one specimen and *Xenocephalites* seems to be a Pacific element common to the Callovian of both North and South America. The close resemblances of *Eurycephalites* to *Lilloettia* suggests that the two are only geographical variants of the same genus. Contrasts with the Alaskan Callovian among the other invertebrates include an abundance of gastropods and brachiopods and a scarcity of belemnites.

ECOLOGIC CONSIDERATIONS

CONDITIONS OF DEPOSITION

The Callovian sedimentary rocks now exposed in the Matanuska Valley, the northwest side of Cook Inlet, and the southeast side of the Alaskan Peninsula were derived from mountainous highlands that lay immediately to the north or northwest. This is shown by the southward thinning of thick masses of sandstone in the Shelikof formation of the Alaskan Peninsula and by a southeastward decrease in sandy material in the lower part of the Chinitna formation on the Iniskin Peninsula. Nearness to land is shown by the pebbly character of some of the Callovian beds on the Alaskan Peninsula and in the Matanuska Valley, by the presence locally of granitic boulders as much as 2 ft in diameter, and by the thick lenses of massive sandstone in the Chinitna formation northwest of Cook Inlet. The considerable thickness of Callovian sedimentary rocks (4,000 to 6,000 ft), implies rapid subsidence of the sea bottom and an ample source of sediment. The many thin seams of tuffaceous material in the siltstone suggest deposition below wave base. However, the presence of some massive sandstone beds and the local reworking of fossiliferous Callovian concretions into conglomeratic zones within the Callovian sequence indicates that at least locally the sea bottom was subjected to strong wave and current action. That the Callovian sediments of southwestern Alaska were deposited along a steep slope fronting a major ocean rather than in a shallow arm of the sea comparable to the present Cook Inlet is suggested by the abundance of the thin-shelled ammonite, *Phylloceras*, by the persistent thin banding in most of the siltstones, and by the rapid lithologic change southward from conglomerates to siltstone within the Shelikof formation. Probably the sea shore was indented by many small bays similar to those existing today.

Vulcanism in the area of southwestern Alaska during Callovian time is attested by the occurrence in the siltstones of many thin beds of ashy material that weathers reddish brown. Such ashy material is not evident in the sandstones although possibly it causes the greenish color of most sandstone beds. Also, the general composition of the sandstones and conglomerates within the Shelikof formation indicates that their source rocks were mostly granitic and dioritic.

Possibly related to vulcanism is the occurrence of numerous calcareous concretions in the Callovian siltstones associated with ashy beds. The concretions may crop out singly or in rows. In many places the conditions of collecting do not permit close observation of the bedding relationships of the concretions, but on some steep banks the concretions crop out in rows that appear to coincide with thin tuffaceous beds.

The Callovian beds are bounded by disconformities that are determinable faunally (as discussed under the stratigraphic summary), and also include minor sedimentary breaks or diastems without faunal significance. One example of such is present at the northwest end of Chisik Island in Tuxedni Bay, according to observations by Don J. Miller and R. W. Imlay. At this place about 200 ft of interbedded concretionary sandstone and siltstone are truncated abrubtly by a channel-like coarse conglomerate that consists mostly of concretions containing Callovian ammonites and *Inoceramus*. The base of the conglomerate rests in beds that contain *Kheraiceras* and *Procerites* and represent the basal part of the Chinitna formation. The upper part of the conglomerate passes laterally into a pebbly sandstone from the top of which issue many springs and which lies with apparent conformity between Callovian siltstones. The conglomerate and associated pebbly sandstone appear to be isolated on Chisik Island as they have not been found in the Callovian beds several miles to the southwest on the south side of Tuxedni Bay. From these relationships it seems evident that the sea bottom in the area of Chisik Island was scoured during early Callovian time by a river or by a shore current that removed a considerable amount of sediment locally and concentrated the concretions in the resulting submarine channel.

Another example of local scouring during Callovian time was observed by Don J. Miller and R. W. Imlay on the southwestern side of Wide Bay on the Alaskan Peninsula. Along the shore of Wide Bay from 3 to 4 miles southwest of Hartman Island, the middle sandstone member of the Shelikof formation rests sharply on the lower siltstone member. A bed of coarse conglomerate ranging from 5 to 45 ft above the base of the sandstone consists mostly of volcanic and granitic rocks but, also, consists partly of limestone concretions that contain *Pseudocadoceras grewingki* (Pompeckj), *Cadoceras stenoloboide* Pompeckj, and *Lilloettia buckmani* (Crickmay). As these same species were collected from concretions in the lower siltstone member at the same locality it seems evident that the concretions in the conglomerate were eroded from the siltstone member.

A similar coarse conglomerate consisting mostly of quartz diorite and granite but containing some fossiliferous concretions of Callovian age was noted by Smith (1926, pp. 73–75) about 5,000 ft below the top of the Shelikof formation near the head of Salmon Creek about half way between Wide Bay and Puale Bay. It seems likely that the stratigraphic position of this conglomerate is near the base of the middle sandstone member of the Shelikof formation.

These examples afford positive proof of local interruptions in sedimentation during Callovian time as a result of current action or a change in base level. It is inferred that many other similar breaks, or pauses in deposition, exist throughout the Callovian sequence, particularly in places where there is a sharp boundary between siltstone and sandstone beds. Local thick masses of sandstone may reasonably be interpreted as channel deposits filling in depressions from which siltstone has been scoured. The ammonites occurring in concretions in such massive sandstone may have originally been embedded in siltstone and subsequently washed into the depressions.

FAUNAL ASSEMBLAGES

The ammonites in the Callovian beds of southwestern Alaska are the most conspicuous faunal element. They are dominated by the fairly thick-shelled Cardioceratidae, belonging to the genera *Cadoceras* and *Pseudocadoceras*, that comprise more than 80 percent of the ammonite specimens. The Macrocephalitidae are second in abundance and are represented by *Lilloettia*, *Xenocephalites*, and *Kheraiceras*. Much less common are the Cosmoceratidae, represented mainly by *Kepplerites* but including rare specimens of *Gowericeras* and *Cosmoceras*. The Oppeliidae is represented only by *Oppelia* (*Oxycerites*). The Phylloceratidae are represented by *Phylloceras*, *Calliphylloceras*, *Macrophylloceras*, and *Partschiceras*. Two specimens of *Reineckeia* represent the Morphoceratidae.

Among these ammonites only *Phylloceras*, *Cadoceras* and *Pseudocadoceras* occur in the highest Callovian

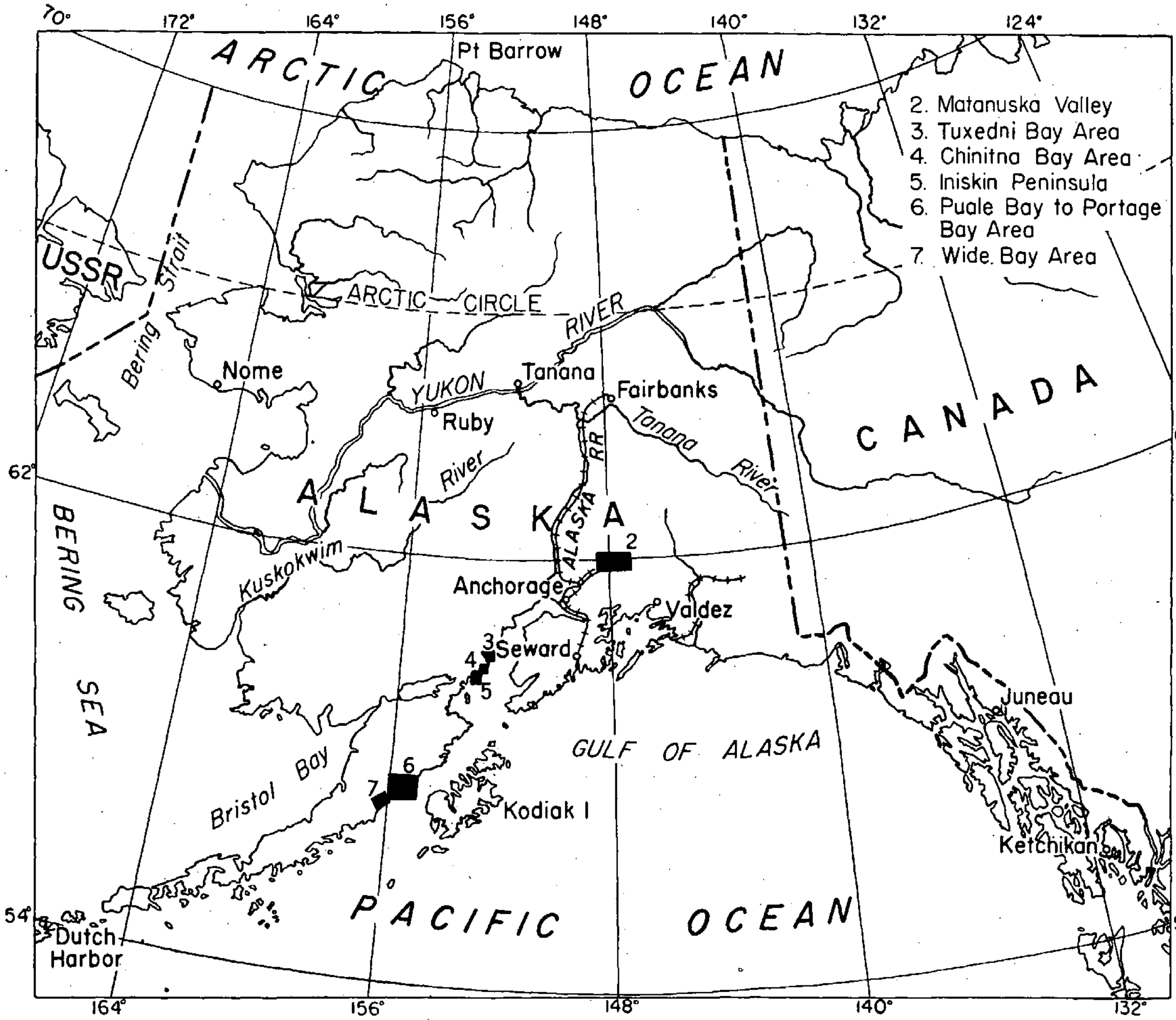

FIGURE 3.—Index map of the principal areas of Jurassic rocks in the Alaska Peninsula and Cook Inlet regions, Alaska. (See figures 4–9).

beds. *Pseudocadoceras* has not been found in the lowest beds. *Gowericeras* and *Reineckeia* have been found only fairly low stratigraphically. *Paracadoceras*, a subgenus of *Cadoceras*, has not been found above the lower two-fifths of the Callovian.

The ammonites occur mostly in concretions in siltstones but some occur in concretions in sandstone. Some of the larger concretions contain many ammonites, others have a single ammonite in the center. Many of the concretions barely encompass a single ammonite, and commonly the ammonite protrudes much beyond the concretion. In addition, many undeformed ammonites not associated with concretions occur in siltstone or in massive sandstone. As these ammonites consist of calcium carbonate and as many are lined internally with crystals of calcite, they were probably preserved and hardened by the chemical process that formed the concretions. Crushed ammonites are most common in the thin-bedded sandstones, generally not associated with concretions. Possibly some of the ammonites that occur in the massive sandstones have been winnowed out of siltstones by submarine erosion. This may be true of the ammonites in the massive sandstone at the top of the siltstone of the Chinitna on the north slope of Mount Pomeroy at the southern end of the Iniskin Peninsula, as these ammonites are conspecific with those in the middle part of the siltstone of the Chinitna at the north end of the Iniskin Peninsula.

The faunal elements other than ammonites in the Callovian beds consist of belemnites, pelecypods, gastropods, brachiopods, crustaceans, worm tubes, plant leaves, and wood fragments. These have been examined only casually. Belemnites are common in the Shelikof formation and rather uncommon in the siltstone of the Chinitna. They appear to be generically distinct from the belemnites in the Callovian beds of the western interior of the United States, in agreement with the generic assignments made by Spath (1932, p. 154). Pelecypods are fairly common throughout the Callovian beds of southwestern Alaska, but not nearly as conspicuous as the ammonites. They are more common in sandy or silty beds than in concretions where most of the ammonites occur. Some of the pelecypod genera have been listed by Stanton in Martin (1926, pp. 164, 200, 228). Other genera represented include *Tancredia* and *Quenstedtia.* It is interesting that such shallow-water forms as *Meleagrinella* and *Ostrea* are rare in Alaska except in the shelly sandstone at the base of the Chinitna formation on the Iniskin Peninsula. The listing of *Gryphaea* from the siltstone of the Chinitna of the Matanuska Valley probably represents a misidentification of the formation, as the specimens in question are associated with *Cranocephalites* and are identical with *Gryphaea impressimarginata* (McLearn), which occurs in the Bathonian beds in the western interior. Of the other classes of organisms, the gastropods and brachiopods are rather uncommon but occur more frequently in the Shelikof formation than in the siltstone of the Chinitna. The crustaceans, plant leaves, and wood fragments are all rare and occur in concretions.

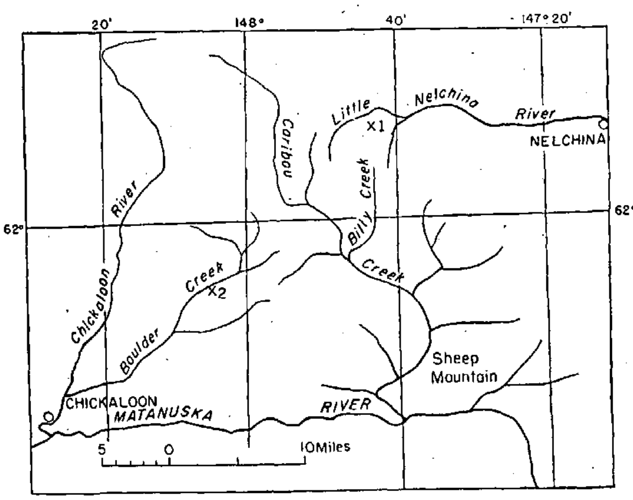

FIGURE 4.—Index map showing Callovian localities at the head of Matanuska Valley, Cook Inlet region. Numbers on map refer to those given in the locality list (p. 65) and in the distribution table.

ECOLOGIC IMPLICATIONS

DEPTH OF WATER

The probability that much of the siltstone in the Callovian sequence was deposited below wave base as indicated by the persistence of thin bands of ashy material has already been discussed. Further evidence are the fair abundance of *Phylloceras*, the absence of *Gryphaea* and nautiloid cephlapods, and the scarcity of *Meleagrinella* and *Ostrea.* This condition contrasts with the Callovian deposits of the western interior of the United States in which *Ostrea*, *Gryphaea*, and *Meleagrinella* are very abundant, nautiloids are fairly common, and *Phylloceras* is absent. This condition likewise contrasts with that in the Middle Jurassic beds of southwestern Alaska in which *Meleagrinella* is common and the other forms mentioned are represented. Of course, the absence of *Gryphaea* and the rarity of *Meleagrinella* and *Ostrea* in the Callovian beds of southwestern Alaska might be explained on the basis of temperature rather than depth of water, or may reflect changes in both temperature and depth. Whatever the explanation, pelecypods are much less common in numbers, species and genera in the Callovian beds than in the underlying Middle Jurassic and do not contain certain genera that are abundant elsewhere in the shallow-water deposits of the Jurassic. The presence of *Phylloceras* and the absence of nautiloids in the Callovian of southwestern Alaska is more clearly related to depth of water than to temperature, as the opposite faunal condition exists in the shallow-water Callovian deposits of the western interior of the United States, and *Phylloceras* is now known from the Canning River area of

Arctic Alaska in association with such boreal forms as *Aucella* and *Amoeboceras*. Also, the scarcity of the thin-shelled ammonites *Phylloceras* and *Lytoceras* in the Jurassic of East Greenland (1932, pp. 151, 152) contrasts with their abundance there during the Lower Cretaceous (Spath, 1946, pp. 6, 7) and may be more easily explained by changes in depth of water rather than in temperature. This does not necessarily mean that *Phylloceras* and *Lytoceras* lived exclusively in deep water, as postulated by Haug (1907, p. 1119), but that because of their thin shells they avoided the shallowest waters of the epeiric and shelf seas. In some places,

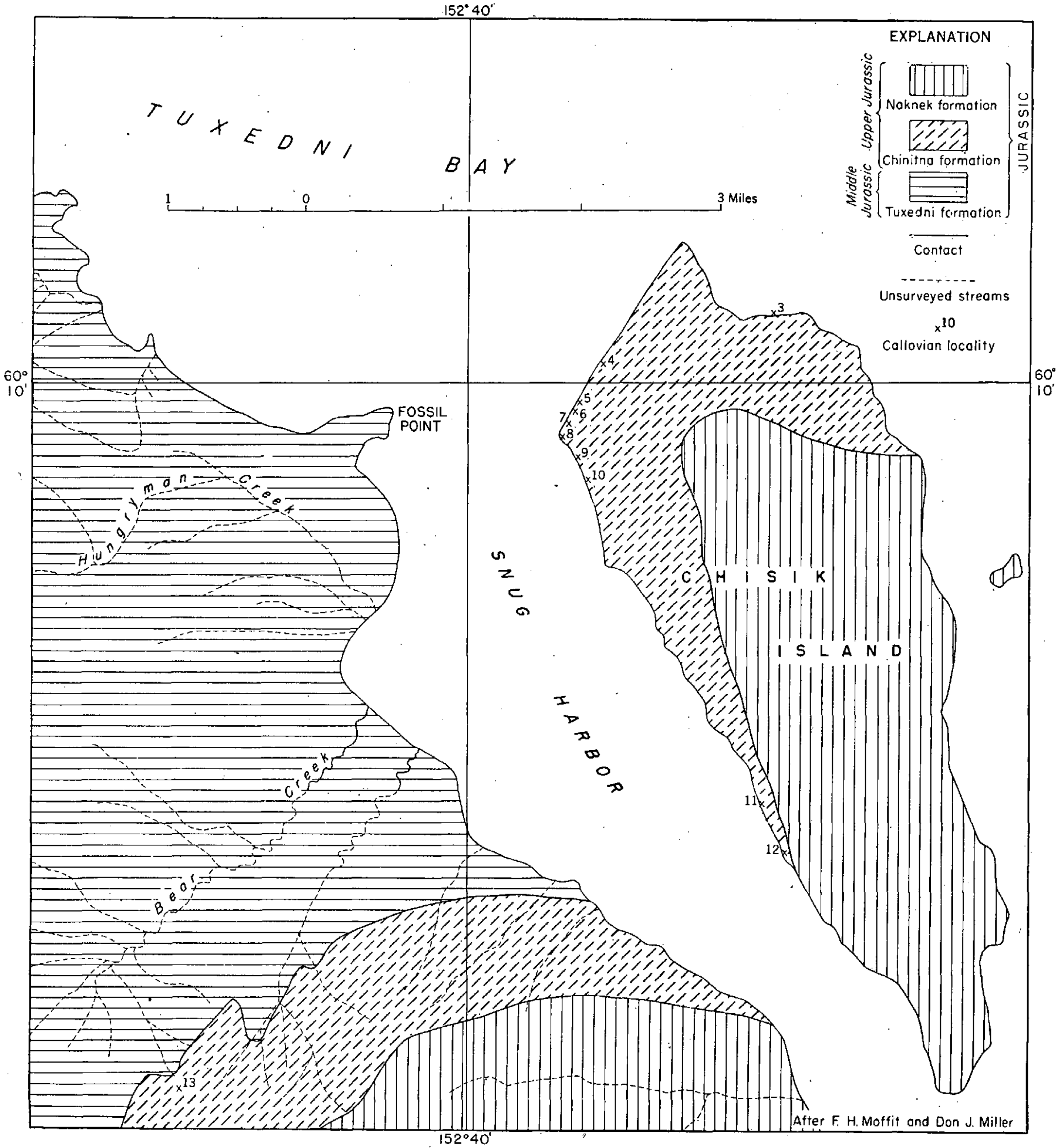

FIGURE 5.—Index map showing Callovian localities in the Tuxedni Bay area, Cook Inlet region. Numbers on map refer to those given in the locality list (p. 65) and in the distribution table.

	European stages (Arkell, 1946)	English formations (After Arkell, 1933)	Northwest Europe standard zones (Arkell, 1946, 1951)	Characteristic fossils in the Western Interior region		Characteristic fossils in East Greenland, modified after Spath (1932, 1935, 1936)	Characteristic fossils in the Alaska Peninsula and Cook Inlet regions	Alaska — Alaska Peninsula — Wide Bay	Alaska — Alaska Peninsula — Puale Bay	Alaska — Cook Inlet — Seldovia to Port Graham area	Alaska — Cook Inlet — Iniskin Peninsula	Alaska — Cook Inlet — Tuxedni Bay area	Alaska — Cook Inlet — Matanuska Valley and Talkeetna Mountains	United States — Western Interior — West-central and north-central Montana	United States — Western Interior — Southeastern Idaho	United States — Western Interior — Black Hills, western South Dakota and northeastern Wyoming
											Tertiary	Tertiary	Lower Cretaceous	Lower Cretaceous	Lower Cretaceous	Lower Cretaceous
		Purbeck beds				*Titanites*?, *Craspedites*, and *Laugeites*										
	Portlandian		*Titanites giganteus*													
		Portland beds	*Kerberites okusensis*													
			Glaucolithites gorei			*Crendonites* beds							?	?		?
			Zaraiskites albani			*Epipallasiceras* beds		Not identified	Not identified	Not identified	Not identified	Not identified				
			Pavlovia pallasiodes				?									
			Pavlovia rotunda			*Pallasiceras* beds										
			Pectinatites pectinatus			*Pectinatites* beds							Black gypsiferous beds			
			Subplanites wheatleyensis	*Vetulonaia* spp. and *Gyraulus veternus*			*Vetulonaia* sp.							Morrison formation		Morrison formation
			Subplanites sp.													
	Kimmeridgian	Kimmeridge clay	*Gravesia gigas*													
			Gravesia gravesiana													
			Aulacostephanus pseudomutabilis													
			Rasenia mutabilis			*Hoplocardioceras decipiens*	?	?	?		?	?	?			
Upper Jurassic			*Rasenia cymodoce*			*Amoebites*: *Euprionoceras kochi* *Rasenia borealis*										
			Pictonia baylei			*Rasenia orbignyi*	*Amoeboceras* and *Aucella bronni*									
			Ringsteadia pseudocordata													
		Corallian beds	*Decipia decipiens*			*Amoeboceras (Prionodoceras)* and *Ringsteadia*		Naknek formation	Naknek formation		Naknek formation	Naknek formation	Naknek formation		?	
	Oxfordian		*Perisphinctes cautisnigrae*													
			Perisphinctes plicatilis			*Cardioceras* aff. *C. zenaidae*								Swift formation	Stump sandstone	Redwater shale member
			Cardioceras cordatum	*Cardioceras* spp.		*Cardioceras* beds	*Cardioceras distans*									
			Quenstedtoceras mariae	*Cardioceras cordiforme*												
		Oxford clay	*Quenstedtoceras lamberti*	*Quenstedtoceras collieri*			*Cardioceras martini*									
			Peltoceras athleta													Sundance formation
			Erymnoceras coronatum		*Gryphaea nebrascensis*		*Pseudocadoceras*								Preuss sandstone	Lak member
	Callovian		*Kosmoceras jason*				*Kepplerites, Lilloettia, Oxycerites* (*Cadoceras*)	Shelikof formation	Shelikof formation		Chinitna formation	Chinitna formation	Chinitna formation			
		Kellaways beds	*Sigaloceras calloviense*	*Kepplerites mclearni* *Kepplerites tychonis*		*Kepplerites tychonis* beds	*Paracadoceras, Kheraiceras, Xenocephalites, Gowericeras*							Ellis group	Sandy limestone	Hulett ss. member
			Proplanulites koenigi	*Gowericeras subitum*			*Gulielmiceras*							Rierdon formation	Shaly limestone	Stockade Beaver shale member
		Cornbrash beds	*Macrocephalites macrocephalus*	*Arcticoceras*		*Arcticoceras* beds		?	?		?	?	?		Oolitic limestone	Canyon Springs sandstone member
			Clydoniceras discus								Not identified	Not identified	Not identified			
			Clydoniceras hollandi	*Arctocephalites*		*Arctocephalites* beds										
	Bathonian	Great oolite	*Oppelia aspidoides*		*Gryphaea impressimarginata*									Marine yellowish siltstone and silty sandstone	Redbeds and yellowish silty limestone	
			Tulites subcontractus	?		?	?				?	?	?			
			Procerites progracilis			*Cranocephalites* beds	*Cranocephalites*				Bowser member	Bowser member		Sawtooth formation	Twin Creek limestone	
			Zigzagiceras zigzag													
Middle Jurassic			*Parkinsonia parkinsoni*	? *Stemmatoceras*		?	*Sphaeroceras*							Dark gray shale and limestone	Medium gray shaly limestone	
			Stephanoceras humphriesianum		*Gryphaea planoconvexa*		*Chondroceras*				? Cynthia Falls sandstone member	? Cynthia Falls sandstone member	Tuxedni formation	Gray sandstone		
	Bajocian	Inferior oolite	*Otoites sauzei*	*Chondroceras* and *Stemmatoceras*			*Normannites, Teloceras* *Stemmatoceras* (Sonniniidae, *Leptosphinctes*, *Lissoceras*, *Stephanoceras*)	?			Tuxedni formation: ? Siltstone member Gaikema sandstone member Siltstone member	Tuxedni formation: ? Siltstone member Sandstone and siltstone		?	Dark gray medium-bedded limestone	
			Sonninia sowerbyi				*Emileia*					Siltstone reddish-brown weathering			Brecciated redbeds	Gypsum Spring formation
			Ludwigia murchisonae				*Tmetoceras* (*Pseudolioceras*, *Erycites*)	Kialagvik formation			Present in subsurface	Sandstone and siltstone				
			Lioceras opalinum													?
			Lytoceras jurense			*Pseudolioceras*		?					?		?	
	Toarcian	Upper Lias	*Hildoceras bifrons*			*Dactylioceras*	*Pseudogrammoceras*									
			Harpoceras serpentinum													
			Dactylioceras tenuicostatum													
		Middle Lias	*Paltopleuroceras spinatum*			Present			?				?			
			Amaltheus margaritatus													
	Pliensbachian		*Prodactylioceras davoei*				*Amaltheus*(?), *Deroceras* and *Xipheroceras*						Talkeetna formation			
			Tragophylloceras ibex			*Beaniceras*					Probably present in subsurface and in Marsh Creek area	Probably represented by tuffs, lavas, and agglomerates			Nugget sandstone	
Lower Jurassic			*Uptonia jamesoni*			*Uptonia jamesoni*		Not exposed								
			Echioceras raricostatum							?			?			
			Oxynoticeras oxynotum						Present							
	Sinemurian	Lower Lias	*Asteroceras obtusum*				*Coroniceras* and *Arnioceras*			Present						
			Arietites turneri			Absent										
			Arnioceras semicostatum													
			Coroniceras bucklandi													
	Hettangian		*Scamnoceras angulatum*							?					?	
			Psiloceras planorbis			Plant beds	*Wahneroceras*(?)									
									Upper Triassic	Upper Triassic	Upper Triassic			Pennsylvanian to Mississippian	Triassic	Triassic

Designation of the Kialagvik formation on the Alaska Peninsula as Middle Jurassic, instead of Lower Jurassic as previously published, and extension downward of the Tuxedni formation on Cook Inlet to include the Gaikema sandstone member and all underlying strata of Middle Jurassic age, instead of assigning them to the Kialagvik formation as previously published, is based on hitherto unpublished field work done by the author and Don J. Miller, also of the U.S. Geological Survey, in 1948

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CORRELATION OF THE JURASSIC FORMATIONS OF THE ALASKA PENINSULA AND COOK INLET REGIONS such as Alaska, where fairly deep waters approached the shores, the shells of such ammonites might easily become intermingled after death with those of thicker-shelled ammonites that lived in shallow waters.

TEMPERATURE AND CLIMATE

Cooling of the boreal sea and the development of climatic zones during late Middle Jurassic time and Late Jurassic time is suggested by the absence of corals and the rarity of gryphaeas and exogyras in the boreal Jurassic after early Bajocian time, by the change in the character of the ammonites and belemnites from cosmopolitan to provincial during Middle Jurassic time, and by the scarcity of deposits of calcium carbonate other than as concretions in the Middle and Upper Jurassic sediments. The existence of climatic zones in the Jurassic much less distinct than today has been upheld by Neumayr (1883, 1885), Haug (1907, p. 117), Stanton (1910), Uhlig (1911, pp. 435–448), Burckhardt (1930, p. 123), and Spath (1932, pp. 146–

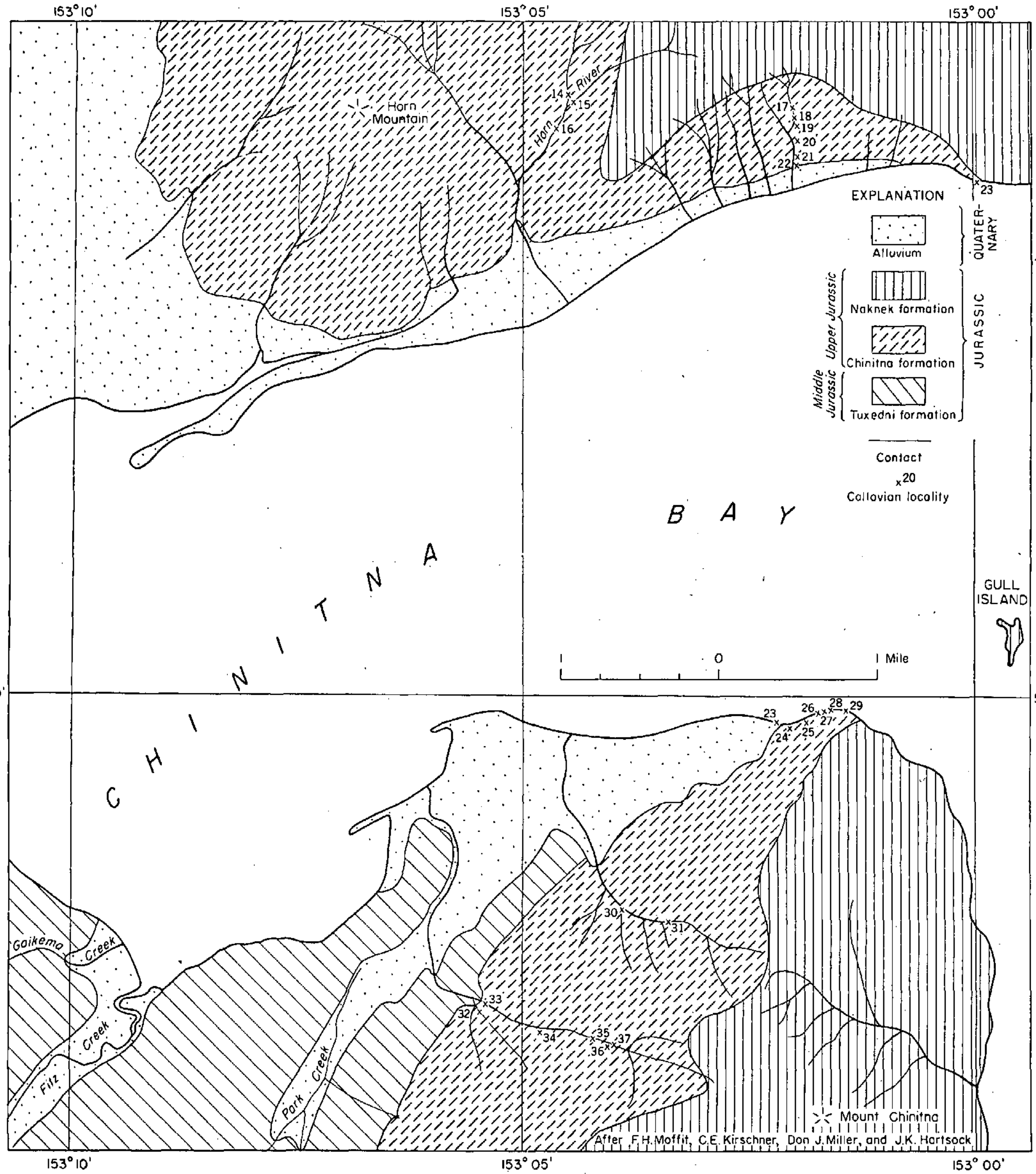

FIGURE 6.—Index map showing Callovian localities near Chinitna Bay, Cook Inlet region. Numbers on map refer to those given in the locality list (pp. 66, 67) and in the distribution table.

153) because of the dissimilarity of the ammonite faunas of the Mediterranean and Boreal Provinces. Also, Gothan (1908) and Antevs (1925) consider that the marked rings in the Jurassic woods from Spitzbergen and the absence of rings in Jurassic woods from East Africa indicate marked climatic zones. Some

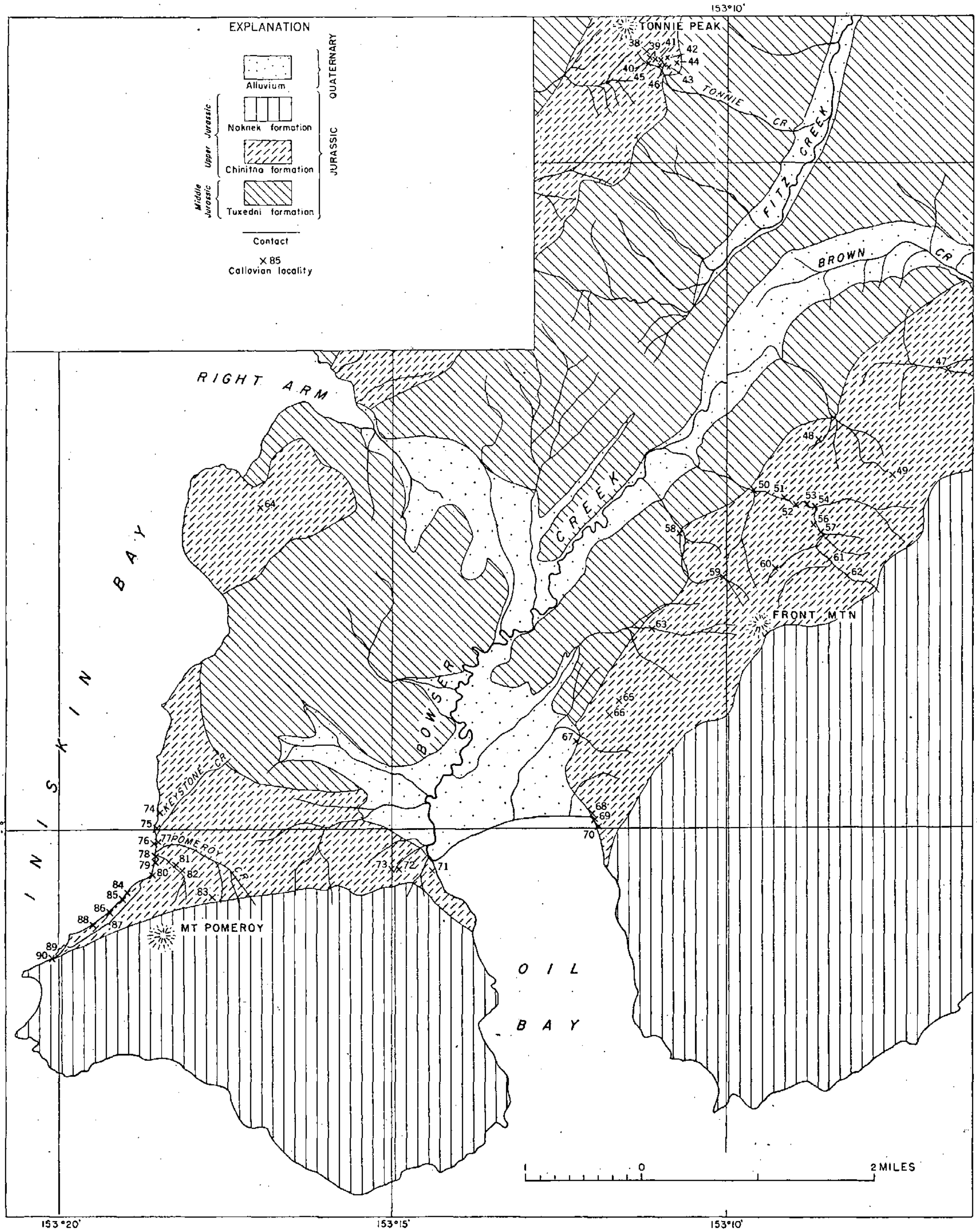

FIGURE 7.—Index map showing Callovian localities in the central and southern parts of the Iniskin Peninsula, Cook Inlet region. Numbers on map refer to those given in the locality list (pp. 67–69) and in the distribution table.

workers have believed that the faunal dissimilarities are due to physical barriers or isolation (Salfeld, 1921; Nikitin, 1886) or have suggested that the faunas compared are possibly not of the same age (Frebold, 1929, p. 18). The evidence has been summarized recently by Spath (1932, pp. 146–153; 1935, pp. 75–78), who shows that the Late Jurassic ammonite faunas change gradually from north to south across Europe and that in central Europe and southern England occur an admixture of boreal and Mediterranean genera that would not have been possible if the boreal sea had been isolated. Likewise, among the belemnites in central Europe occurs an association of genera of the Mediterranean Province with genera of the Boreal Province. He presents rather convincing evidence that the boreal sea was connected with the Mediterranean sea through several straits, including at least the Shetland Straits, Mackenzie Straits, and a strait in eastern European Russia. It is conceivable that constriction of these straits might lead to cooling of the boreal sea, but against this idea

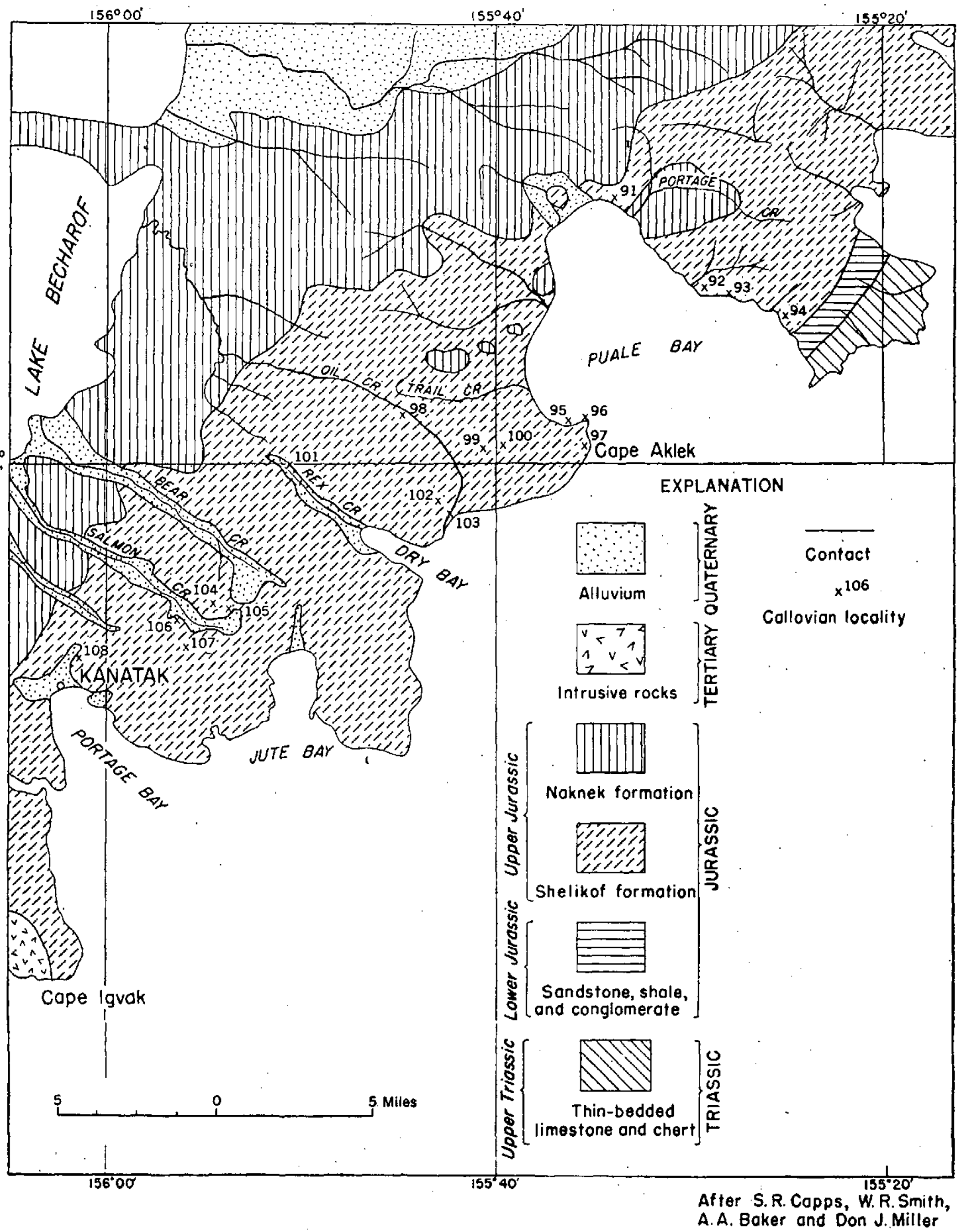

FIGURE 8.—Index map showing Callovian localities in the Puale Bay to Portage Bay area, Alaska Peninsula region. Numbers on map refer to those given in the locality list (pp. 69–70) and in the distribution table.

is the fact that the boreal sea was much more widespread in the Late Jurassic than in the Early Jurassic, when the waters were apparently warmest, as indicated by the gryphaeas, corals, and ammonites, although some writers have presented contrary evidence (Schuchert, 1914, pp. 280, 281) based on dwarfing of insects and the abundance of black shale and coal in the Lias. Another fact suggesting that the Boreal Province was cooler than the Mediterranean Province is the poverty of the northern faunas in molluscan genera and species, and the abundance of individuals of the species, which relationship is reversed in the Mediterranean Province. A similar relationship is reported to exist today between the Arctic or Antarctic and the equatorial seas (Twenhofel, 1939, pp. 159, 160; Russell and Yonge, 1936, p. 58).

More direct evidence that the Callovian seas of southwestern Alaska were cooler than marine waters farther south is furnished by the absence of Exogyras, Gryphaeas, and corals. The absence of *Exogyra* is not surprising, as the genus is typically Mediterranean and is absent even from the Jurassic deposits of the western interior of the United States. However, the absence of *Gryphaea* contrasts with the abundance of the genus in the Callovian in the western interior region, in central Europe, and locally in the Mediterranean Province, such as in southern Mexico. Its absence in southwestern Alaska cannot be ascribed to the lack of a suitable substratum, although the genus occurs in greatest abundance in soft calcareous shales, or to the lack of shallow water as, at least locally, some of the sandstone units show evidence of scouring. Rather, the absence of *Gryphaea* can readily be explained by a temperature too low for its growth, by rapid subsidence of the sea bottom, and by the scarcity of readily available calcium carbonate in the sea water. The absence of limestone beds in the Callovian might itself reflect low temperature of the sea water, or be due to dissemination of the calcareous material throughout the thousands of feet of Callovian siltstone and sandstone. However, such dissemination has not occurred as the Callovian siltstones are mostly noncalcareous and many of the sandstones are noncalcareous. It appears, in fact, that most of the calcareous material present is in the concretions and fossils and that the origin of many of the concretions is related to deposition of volcanic ash.

The absence of corals above the lower Bajocian in southwestern Alaska may likewise be explained by an unfavorable temperature of the seawater, by lack of calcareous material, or by unsuitable bottom conditions. Certainly the absence of corals in the Jurassic throughout the entire Boreal province north of Yorkshire, England, and southwestern Alaska is more likely to be related to an unfavorable temperature than to bottom conditions, which vary from place to place and would probably be suitable for coralline growth in some parts of the province.

HABITATS

Most of the Callovian fossils from southwestern Alaska represent free-swimming organisms, such as ammonites, belemnites, pectens, pterias, and oxytomas. These are found both in the sandstones and siltstones,

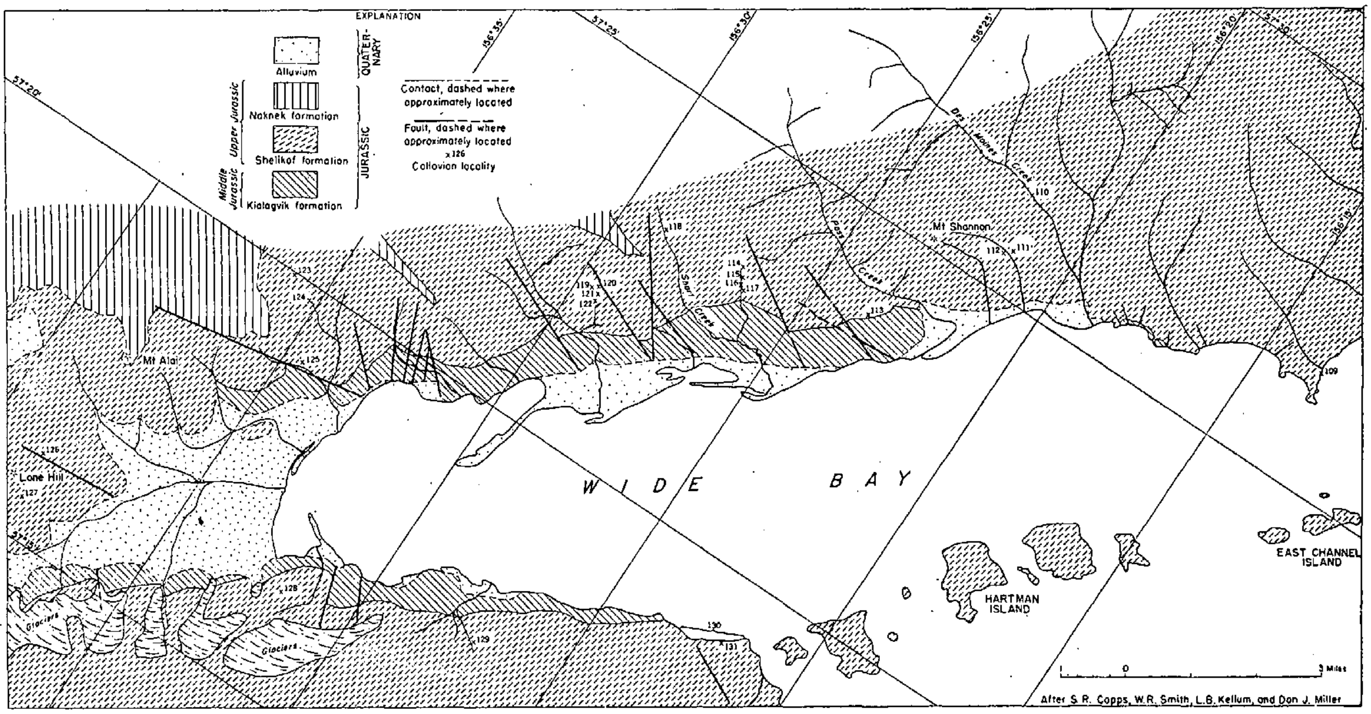

FIGURE 9.—Index map showing Callovian localities in the Wide Bay area, Alaska Peninsula region. Numbers on map refer to those given in the locality list (pp. 70, 71) and in the distribution table.

and are best preserved in the concretions. On the soft mud bottoms, now preserved as dark gray siltstone, lived such organisms as *Nucula*, *Nuculana*, *Grammatodon*, *Astarte*, *Thracia*, *Goniomya*, *Pleuromya*, *Pholadomya*, *Pinna*, *Trigonia*, *Inoceramus*, *Tancredia*, *Quenstedtia*, and some gastropods and brachiopods. The last two classes were much more common on the sandy bottoms associated with *Trigonia* and *Inoceramus* but were not common in the thick sand lenses. None of these molluscan genera is indicative of the littoral zone and they could represent the deeper part of the neritic zone. The basal shelly sandstones of the Chinitna formation were probably deposited in the shallow part of the neritic zone as they contain a few *Meleagrinella* and *Ostrea*. Microfossils are singularly uncommon in the siltstones. It seems unlikely that the cephalopods could have derived any appreciable part of their food supply from the other organisms now preserved as fossils.

GEOGRAPHIC DISTRIBUTION

The occurrence by area and locality of the 62 species described in this report is indicated in the table facing p. 72. The position of the various areas of Callovian sedimentary rocks is shown in figure 3, and the general position of each locality is shown in figures 4 to 9. Detailed descriptions of the individual localities are given in the following list.

Localities at which ammonites were collected from the Callovian strata of southwestern Alaska

No. on figs. 4–9	Geological Survey Mesozoic locality	Collector's field numbers	Collector, year of collection, description of locality, and stratigraphic assignment
1	3700	6AK156	Adolph Knopf, 1906. Talkeetna Mountains, near headwaters of Nelchina River, about 10 miles N. 10° E. of mouth of Billy Creek at altitude of 5000 ft. Float from Chinitna formation.
2	8571	20	G. C. Martin, 1913. Talkeetna Mountains, tributary to Boulder Creek from north, 3 miles above East Fork. Float from Chinitna formation.
3	3016	920	T. W. Stanton, 1904. Tuxedni Bay, northeast shore of Chisik Island. Chinitna formation, near top of middle third.
3	21291	48AI72	R. W. Imlay and D. J. Miller, 1948. Tuxedni Bay area, north shore of Chisik Island, 2.86 miles N. 76° E. of Fossil Point. Chinitna formation, middle third, from 75 to 100 ft below the sandstone unit at base of upper third.
4	21287	48AI71	R. W. Imlay and D. J. Miller, 1948. Tuxedni Bay area, northwest shore of Chisik Island, 1.57 miles N. 77° E. of Fossil Point, about 80 ft above base of Chinitna formation.
5	3015	919	T. W. Stanton, 1904. Tuxedni Bay, north end of Chisik Island about ¼ mile northeast of point formed by massive conglomerate, Chinitna formation, lower third.
5	21286	48AI70	R. W. Imlay and D. J. Miller, 1948. Tuxedni Bay area, northwest shore of Chisik Island 1.35 miles N. 88° E. of Fossil Point, about 30 ft above base of Chinitna formation.
6	21273	48AI69	D. J. Miller and R. W. Imlay, 1948. Tuxedni Bay area, northwest shore of Chisik Island, 1.3 miles N. 90° E. of Fossil Point, from 50 to 100 ft above lowest exposure, Chinitna formation, near base.
7	10250	G	C. N. Fenner, 1919. Tuxedni Bay, Chisik Island, northwest end from beds above massive conglomerate, Chinitna formation, lower third.
8	3014	918	T. W. Stanton, 1904. Tuxedni Bay area, north end of Chisik Island, 1.25 miles S. 81° E. of Fossil Point, 1 ft below base of channel conglomerate, Chinitna formation, near base.
8	12074	A	W. R. Smith, 1923. Tuxedni Bay area, Chisik Island, 5 miles north of cannery and across bay from Fossil Point. Chinitna formation, lower third.
8	21272	48AI68	D. J. Miller and R. W. Imlay, 1948. Tuxedni Bay area, northwest shore of Chisik Island, 1.25 miles S. 81° E. of Fossil Point, 1 ft below base of channel conglomerate, Chinitna formation, near base.
9	2992	913	T. W. Stanton, 1904. Tuxedni Bay, west shore of Chisik Island, near northwest end. Chinitna formation, lower third, from shale overlying a massive conglomerate.
10	21285	48AI67	R. W. Imlay and D. J. Miller, 1948. Tuxedni Bay area, west shore of Chisik Island, 1.5 miles S. 70° E. of Fossil Point, about 20 ft below top of sandstone unit from which issue many springs. Chinitna formation, near top of lower third.
11	2991	912b	T. W. Stanton, 1904. Tuxedni Bay, west shore of Chisik Island. Chinitna formation, upper third, several hundred feet below top.
11	21290	48AI55	R. W. Imlay and D. J. Miller, 1948. Tuxedni Bay area, west shore of Chisik Island, 3.94 miles S. 43° E. of Fossil Point. Chinitna formation, upper third, from 300 to 375 ft below top.
12	2990	912a	T. W. Stanton, 1904. Tuxedni Bay, west shore of Chisik Island near entrance to Snug Harbor. Chinitna formation near top of upper third.
12	22554	50AHa69	Arthur Grantz, 1950. Chisik Island, west shore, near top of Chinitna formation.
13	21288	48AI83	R. W. Imlay and D. J. Miller, 1948. Tuxedni Bay area, head of stream entering Bear Creek from the southeast at first outcrop above mouth, 5.2 miles S. 17° W. of Fossil Point. Chinitna formation, lower third, about 600 ft above base.

Localities at which ammonites were collected from the Callovian strata of southwestern Alaska—Continued

No. on figs. 4–9	Geological Survey Mesozoic locality	Collector's field numbers	Collector, year of collection, description of locality, and stratigraphic assignment
14	21338	48AMr142	D. J. Miller, 1948. North side of Chinitna Bay. East branch of large stream east of Horn Mountain at point 1.36 miles N. 87° E. of Horn Mountain, Chinitna formation, probably near middle of middle third.
15	21781	49AHa67	J. K. Hartsock, 1949. North side of Chinitna Bay, tributary to large canyon east of Horn Mountain, from face of Cascade about 50 yd east of loc. 21338, Chinitna formation, near middle of middle third.
16	21337	48AMr141	D. J. Miller, 1948. North side of Chinitna Bay, east branch of large stream east of Horn Mountain at point 1.3 miles S. 83° E. of Horn Mountain, Chinitna formation probably near middle of middle third.
17	3018	923a	T. W. Stanton, 1904. On small creek entering Chinitna Bay from north about 4 miles west of East Glacier Creek at elevation of 410 ft. Chinitna formation, near top of middle third.
18	21345	48AI21	R. W. Imlay and D. J. Miller, 1948. Gulch entering Chinitna Bay from north, 2.8 miles S. 89° E. of Horn Mountain, about 200 ft below the top of the middle third of the Chinitna formation.
19	21344	48AI20	R. W. Imlay and D. J. Miller, 1948. Gulch entering Chinitna Bay from north 2.8 miles S. 88° E. of Horn Mountain, about 500 ft below the top of the middle third of the Chinitna formation.
20	3019	923b	T. W. Stanton, 1904. On same creek as loc. 3018 at elevation of 270 ft. Chinitna formation, middle third, about 500 ft above base of section. (See Martin, 1926, p. 160.)
21	3020	923c	T. W. Stanton, 1904. On same creek as loc. 3018 at elevation of 125 ft. Chinitna formation, near base of middle third.
22	21343	48AI19	R. W. Imlay and D. J. Miller, 1948. Gulch entering Chinitna Bay from north, 2.81 miles S. 84° E. of Horn Mountain, about 1,200 ft below top of middle third of the Chinitna formation.
23	21342	48AI18	R. W. Imlay and D. J. Miller, 1948. Cliff on north shore of Chinitna Bay 4.0 miles S. 83° E. of Horn Mountain, about 70 ft below top of the upper third of the Chinitna formation
23	21774	49AHa62	J. K. Hartsock, 1949. Iniskin Peninsula, south side of Chinitna Bay opposite Gull Island in south trending gully, Chinitna formation, near top of middle third.
24	10978	F 1	F. J. Moffit, 1921. Iniskin Peninsula, south shore of Chinitna Bay, 700 ft west of point near the entrance to bay. Chinitna formation, near base of upper third.
25	21777	49AGz33	A. Grantz, 1949. Iniskin Peninsula, south shore of Chinitna Bay from 1.2 to 1.3 miles west of Gull Island from siltstone and thin limestones in the lower part of the upper third of the Chinitna formation.
26	21347	48AI23	R. W. Imlay and D. J. Miller, 1948. Iniskin Peninsula, talus at base of cliff on south shore of Chinitna Bay, 4.73 miles N. 68° E. of dock at mouth of Fitz Creek, probably derived from same beds in same cliff as lot 21346, Chinitna formation, upper third.
27	21776	49AG19	A. Grantz, 1949. Iniskin Peninsula, south shore of Chinitna Bay 1.1 miles west of Gull Island. Float from thick siltstone of the upper third of the Chinitna formation.
28	21778	49AG34	A. Grantz, 1949. Iniskin Peninsula, south shore of Chinitna Bay from 1.0 to 1.1 miles west of Gull Island, lower half of the massive siltstone forming the upper half of the upper third of the Chinitna formation.
29	10997	ABF4	A. A. Baker, 1921. Iniskin Peninsula, south shore of Chinitna Bay at point near entrance to bay, Chinitna formation, near top of upper third.
29	11011	ABF19	A. A. Baker, 1921. Iniskin Peninsula, south shore of Chinitna Bay at point near entrance to bay, Chinitna formation, near top of upper third.
29	21346	48AI22	R. W. Imlay and D. J. Miller, 1948. Iniskin Peninsula, cliff on south shore of Chinitna Bay 4.88 miles N. 69° E. of dock at mouth of Fitz Creek, near top of upper third of the Chinitna formation.
30	22421	50AHa30	D. M. Hill and A. Grantz, 1950. Iniskin Peninsula, first creek entering Chinitna Bay east of Park Creek, 3.08 miles N. 80° E. of dock at mouth of Fitz Creek. Chinitna formation, top of lower third.
31	21348	48AI25	R. W. Imlay and D. J. Miller, 1948. Iniskin Peninsula, first stream entering Chinitna Bay east of Park Creek, 3.42 miles N. 83° E. of dock at mouth of Fitz Creek, a little below middle of the middle third of the Chinitna formation.
32	22438	50AHa36	J. K. Hartsock, 1950. Iniskin Peninsula, 2.15 miles S. 86° E. of dock at mouth of Fitz Creek. Massive sandstone at base of Chinitna formation.
33	22437	50AHa34	J. K. Hartsock, 1950. Iniskin Peninsula, 2.15 miles S. 88° E. of dock at mouth of Fitz Creek. Chinitna formation, basal sandstone.
34	21341	40AI15	R. W. Imlay and D. J. Miller, 1948. Iniskin Peninsula, first tributary entering Park Creek from the southeast above the mouth, 2.62 miles S. 86° E. of dock at mouth of Fitz Creek, about 200 ft above base of middle third of the Chinitna formation.

Localities at which ammonites were collected from the Callovian strata of southwestern Alaska—Continued

No. on figs. 4-9	Geological Survey Mesozoic locality	Collector's field numbers	Collector, year of collection, description of locality, and stratigraphic assignment
35	21340	48AI14	R. W. Imlay and D. J. Miller, 1948. Iniskin Peninsula, first tributary entering Park Creek from the southeast above the mouth, 2.95 miles S. 86° E. of dock at mouth of Fitz Creek, about 900 ft above base of middle third of Chinitna formation.
36	22556	46AKr192	C. E. Kirschner, 1946. Iniskin Peninsula, 4 miles S. 84° E. of dock at mouth of Fitz Creek, Chinitna formation, upper part of middle third.
37	21339	48AI13	R. W. Imlay and D. J. Miller, 1948. Iniskin Peninsula, first tributary entering Park Creek from the southeast above mouth, 3.1 miles S. 84° E. of dock at mouth of Fitz Creek, about 1,200 ft above base of middle third of Chinitna formation.
38	21322	48AI38	R. W. Imlay and D. J. Miller, 1948. Iniskin Peninsula, northeast side of Tonnie Creek valley near head, 1,750 ft S. 35° E. of Tonnie Peak, from limestone concretions 565 to 585 ft above base of the Chinitna formation.
39	21324	48AI40	R. W. Imlay and D. J. Miller, 1948. Iniskin Peninsula, northeast side of Tonnie Creek valley near head, 2,000 ft S. 37° E. of Tonnie Peak, float obtained about 400 ft above base of the Chinitna formation.
40	21331	48AI47	R. W. Imlay and D. J. Miller, 1948. Iniskin Peninsula, near head of Tonnie Creek, 2,000 ft S. 30° E. of Tonnie Peak, 425 ft above base of the Chinitna formation.
41	21321	48AI37	R. W. Imlay and D. J. Miller, 1948. Iniskin Peninsula, northeast side of Tonnie Creek Valley near head, 2,100 ft S. 45° E. of Tonnie Peak. From 350 ft above base of Chinitna formation.
42	21325	48AI41	R. W. Imlay and D. J. Miller, 1948. Iniskin Peninsula, northeast side of Tonnie Creek Valley near head, 2,400 ft S. 50° E. of Tonnie Peak, from siltstone about 350 ft above base of Chinitna formation.
43	21327	48AI43	R. W. Imlay and D. J. Miller, 1948. Iniskin Peninsula, near head of Tonnie Creek, 2,600 ft S. 43° E. of Tonnie Peak, 70 ft above base of the Chinitna formation.
43	21330	48AI46	R. W. Imlay and D. J. Miller, 1948. Iniskin Peninsula, same as loc. 21327 but nearer Tonnie Creek, about 70 ft above base of the Chinitna formation.
44	21326	48AI42	R. W. Imlay and D. J. Miller, 1949. Iniskin Peninsula, divide between Tonnie Creek and Forky Creek, 2,850 ft S. 55° E. of Tonnie Peak, about 100 ft above base of Chinitna formation.
45	21329	48AI45	R. W. Imlay and D. J. Miller, 1948. Iniskin Peninsula, near head of Tonnie Creek, 2,400 ft S. 39° E. of Tonnie Peak, from 130 to 155 ft above base of the Chinitna formation.
46	21328	48AI44	R. W. Imlay and D. J. Miller, 1948. Iniskin Peninsula, near head of Tonnie Creek, 2,500 ft S. 43° E. of Tonnie Peak, from 90 to 100 ft above base of the Chinitna formation.
46	21332	48AI48	R. W. Imlay and D. J. Miller, 1948. Iniskin Peninsula, near head of Tonnie Creek, float from same locality as 21328, about 90 to 100 ft above base of the Chinitna formation.
47	22442	50AHi13	D. M. Hill, 1950. Iniskin Peninsula, 2.8 miles N. 35° E. of Front Mountain. Chinitna formation, near base of middle third.
48	11041	ABF50	A. A. Baker, 1921. Iniskin Peninsula, near head of Bowser Creek about 1.7 miles N. 17° E. of Front Mountain. Chinitna formation, a little below middle of lower third.
49	10982	F4a	F. H. Moffit, 1921. Iniskin Peninsula, head of Bowser Creek, south side of valley, 1.7 miles N. 42° E. of Front Mountain. Chinitna formation, upper part of middle third.
50	21320	48AI49	D. J. Miller and R. W. Imlay, 1948. Iniskin Peninsula, 4.7 miles S. 15° E. of Tonnie Peak, Chinitna formation, near base.
51	21333	48AI50	R. W. Imlay and D. J. Miller, 1948. Iniskin Peninsula, on stream entering Bowser Creek from southeast, 4.32 miles S. 19° E. of Tonnie Peak, a little below middle of the lower third of the Chinitna formation.
52	21334	48AI51	R. W. Imlay and D. J. Miller, 1948. Iniskin Peninsula, on stream entering Bowser Creek from southeast, 4.42 miles S. 20° E. of Tonnie Peak, a little above middle of the lower third of the Chinitna formation.
53	11047	ABF56	A. A. Baker, 1921. Iniskin Peninsula, on tributary to Bowser Creek about 1.1 miles N. 20° E. of Front Mountain. Chinitna formation, near top of lower third.
54	10986	F8	F. H. Moffit, 1921. Iniskin Peninsula, tributary to Bowser Creek from south, next below head branch of creek, about 1 mile N. 26° E. of Front Mountain. Chinitna formation, near top of lower third.
55	21335	48AI52	R. W. Imlay and D. J. Miller, 1948. Iniskin Peninsula, on stream entering Bowser Creek from southeast, 4.52 miles S. 21° E. of Tonnie Peak, near top of the lower third of the Chinitna formation.
56	21349	48AI53	R. W. Imlay and D. J. Miller, 1948. Iniskin Peninsula, on stream entering Bowser Creek from the southeast, 4.62 miles S. 21° E. of Tonnie Peak, about 100 ft above base of the Chinitna formation.
57	20761	46AKr163	C. E. Kirschner, 1946. Iniskin Peninsula, 0.8 mile N. 20° E. of Front Mountain. Chinitna formation, middle third.

Localities at which ammonites were collected from the Callovian strata of southwestern Alaska—Continued

No. on figs. 4–9	Geological Survey Mesozoic locality	Collector's field numbers	Collector, year of collection, description of locality, and stratigraphic assignment
58	20753	46AKr168	C. E. Kirschner, 1946. Iniskin Peninsula, 0.75 mile N. 52° W. of Front Mountain. Chinitna formation, at base.
59	20762	46AKr169	C. E. Kirschner, 1946. Iniskin Peninsula, 0.55 mile N. 57° W. of Front Mountain. Chinitna formation, top of lower third.
60	11052	ABF63	A. A. Baker, 1921. Iniskin Peninsula, about 0.5 mile N. 14° E. of Front Mountain. Chinitna formation, middle third.
61	11049	ABF58	A. A. Baker, 1921. Iniskin Peninsula, about 0.8 mile N. 46° E. of Front Mountain. Chinitna formation, middle third.
62	11050	ABF59 to 61	A. A. Baker, 1921. Iniskin Peninsula, about 0.8 mile N. 61° E. of Front Mountain. Chinitna formation, probably near top of middle third.
63	22427	50AHa25	R. W. Juhle and J. K. Hartsock, 1950. Iniskin Peninsula, east side of valley of Bowser Creek 0.9 mile S. 87° W. of Front Mountain. Chinitna formation, basal sandstone.
64	22559	50AHi10	David Hill, 1950. Iniskin Peninsula, 4.4 miles N. 63° W. of Front Mountain. Float near base of Chinitna formation.
65	22425	50AHa22	R. W. Juhle, 1950. Iniskin Peninsula, east side of valley of Bowser Creek 1.4 miles S. 61° W. of Front Mountain. Chinitna formation, base of middle third.
66	22430	50AHa23	R. W. Juhle and J. K. Hartsock, 1950. Iniskin Peninsula, 1.5 miles S. 59° W. of Front Mountain. Chinitna formation, base of middle third.
67	20760	46AKr109	C. E. Kirschner, 1946. Iniskin Peninsula, 1.7 miles S. 50° W. of Front Mountain. Chinitna formation, middle third.
68	11052a	ABF68	A. A. Baker, 1921. Iniskin Peninsula, northeast corner of Oil Bay. Chinitna formation, probably near top of middle third.
69	3042	934b	T. W. Stanton, 1904. Iniskin Peninsula, northeast shore of Oil Bay. Chinitna formation, upper part of middle third.
69	20759	46AKr105	C. E. Kirschner, 1946. Iniskin Peninsula, northeast corner of Oil Bay, 2.3 miles S. 44° W. of Front Mountain. Chinitna formation, near top of middle third.
70	2941		G. C. Martin, 1903. Iniskin Peninsula, northeast shore of Oil Bay. From 72½ ft above base of measured section (See Martin, 1926, p. 162). Chinitna formation, near base of upper third.
71	20757	46AKr91	C. E. Kirschner, 1946. Iniskin Peninsula, 3.5 miles S. 53° W. of Front Mountain on southwest side of Oil Bay. Chinitna formation, near base of upper third.
71	22429	50AHa20	R. Hoare, R. W. Juhle, J. K. Hartsock, 1950. Iniskin Peninsula, west side of Oil Bay 3.6 miles S. 53° W. of Front Mountain, Chinitna formation, near base of upper third.
72	22451	50AGz18	A. Grantz, 1950. Iniskin Peninsula, west of head of Oil Bay, 3.75 miles S. 55° W. of Front Mountain, Chinitna formation, near base of upper third.
73	22452	50AGz19	A. Grantz, 1950. Iniskin Peninsula, 3.8 miles S. 56° W. of Front Mountain. Chinitna formation, near base of upper third.
74	22446	50AGz10	A. Grantz, 1950. Iniskin Peninsula, 250 yd north of mouth of Keystone Creek, 5.45 miles S. 72° W. of Front Mountain. Chinitna formation, basal beds.
75	2920		G. C. Martin, 1903. Iniskin Peninsula, east shore of Iniskin Bay. Same locality as 20755. Chinitna formation, near base.
75	20755	46AKr189	C. E. Kirschner, 1946. Iniskin Peninsula, 5.6 miles S. 72° W. of Front Mountain. Same as loc. 11057. Chinitna formation, near base.
75	22448	50AGz12	A. Grantz, 1950. Iniskin Peninsula, from mouth of Keystone Creek northward 175 yd, 5.5 miles S. 70° W. of Front Mountain. Chinitna formation, near base.
76	22428	50AHa13	J. K. Hartsock, 1950. Iniskin Peninsula, reef between mouths of Keystone Creek and Pomeroy Creek, 5.6 miles S. 70° W. of Front Mountain. Chinitna formation, near middle of lower third.
77	22431	50AHa1	J. K. Hartsock, 1950. Iniskin Peninsula, from 10 ft of siltstone on beach between mouths of Keystone and Pomeroy Creeks 5.7 miles S. 69° W. of Front Mountain. Chinitna formation, middle of lower third.
78	10989	F11	F. H. Moffit, 1921. Iniskin Peninsula, east shore of Iniskin Bay, south of trail to Oil Bay. Chinitna formation, middle third.
78	22433	50AHa7	J. K. Hartsock, 1950. Iniskin Peninsula, at mouth of first creek south of Pomeroy Creek, 5.5 miles S. 69° W. of Front Mountain. Chinitna formation, middle of lower third.
79	3028	929	T. W. Stanton, 1904. Iniskin Peninsula, east shore of Iniskin Bay about 0.65 miles N. 5° W. of Mt. Pomeroy. Chinitna formation, near base of middle third.
80	22422	50AHa11	J. K. Hartsock, 1950. Iniskin Peninsula, talus from sea cliff 5.62 miles S. 67° W. of Front Mountain. Chinitna formation, lower part of middle third.
80	22432	50AHa2	R. W. Juhle and R. D. Hoare, 1950. Iniskin Peninsula, sea cliff from 30 to 150 yd southward from Mes. loc. 22422 on east shore of Iniskin Bay. Chinitna formation, lower part of middle third.

Localities at which ammonites were collected from the Callovian strata of southwestern Alaska—Continued

No. on figs. 4–9	Geological Survey Mesozoic locality	Collector's field numbers	Collector, year of collection, description of locality, and stratigraphic assignment
81	22419	50AHa3	R. W. Juhle, 1950. Iniskin Peninsula, ¼ mile up the stream just south of Pomeroy Creek, 5.42 miles S. 67° W. of Front Mountain. Chinitna formation, lower third.
82	22411	50AHa8	J. K. Hartsock, 1950. Iniskin Peninsula, float in first stream south of Pomeroy Creek, 5.4 miles S. 67° W. of Front Mountain. Chinitna formation, lower third.
83	22415	50AHa17	A. Grantz, 1950. Iniskin Peninsula, north slope of Mt. Pomeroy, 5 miles S. 63° W. of Front Mountain, Chinitna formation, 300 ft below top.
84	22434	50AHa14	A. Grantz and J. K. Hartsock, 1950. Iniskin Peninsula, 5.9 miles S. 67° W. of Front Mountain on east shore of Iniskin Bay. Chinitna formation, from 100 ft of siltstone lying 200 ft below top.
85	20763	46AKr190	C. E. Kirschner, 1946. Iniskin Peninsula, east shore of Iniskin Bay, 6 miles S. 67° W. of Front Mountain. Chinitna formation, near top of middle third.
86	3029	929a	T. W. Stanton, 1904. Iniskin Peninsula, east shore of Iniskin Bay, about 0.5 miles N. 65° W. of Mt. Pomeroy. Chinitna formation, upper part of middle third.
86	10990	F12	F. H. Moffit, 1921. Iniskin Peninsula, east shore of Iniskin Bay 1 mile south of trail to Oil Bay, about 0.5 mile N. 65° W. of Mt. Pomeroy Chinitna formation, probably top of middle third.
86	10991	F13	F. H. Moffit, 1921. Iniskin Peninsula, Float at same general location as loc. 10990. Chinitna formation.
86	10992	F14	F. H. Moffit, 1921. Iniskin Peninsula, same location as 10990. Chinitna formation, probably top of middle third.
87	2921		G. C. Martin, 1903. Iniskin Peninsula, east shore of Iniskin Bay. Chinitna formation, upper 1200 ft.
88	22435	50AHa15	A. Grantz and J. K. Hartsock, 1950. Iniskin Peninsula, 6.25 miles S. 66° W. of Front Mountain on east shore of Iniskin Bay. Chinitna formation, upper 200 ft.
89	3030	929b	T. W. Stanton, 1904. Iniskin Peninsula, east shore of Iniskin Bay about 0.9 mile S. 70° W. of Mt. Pomeroy. Chinitna formation, upper 100 ft of upper third.
90	11060	ABF76	A. A. Baker, 1921. Iniskin Peninsula, on east shore of Iniskin Bay about 750 ft south of Mushroom Rocks, 1 mile S. 78° W. of Mt. Pomeroy. Chinitna formation, upper third, at very top.
91	21354	48AI113	R. W. Imlay and D. J. Miller, 1948. Puale Bay, sea cliff on northeast shore, 2,400 to 2,600 ft northwest of mouth of Portage Creek, interbeds of hard gray siltstone near top of sandstone member and about 2,200 ft below the top of the Shelikof formation.
92	10818	1–126	S. R. Capps, 1921. Puale Bay, northeast shore, 4 miles northwest of mouth of bay. Shelikof formation, middle member.
93	3105	946	T. W. Stanton and R. W. Stone, 1904. Puale Bay, northeast shore about 4 miles northwest of Cape Kekurnoi. From thin bed at top of 200 ft of dark shale in Shelikof formation, middle member.
94	3106	947	T. W. Stanton and R. W. Stone, 1904. Puale Bay, northeast shore about 3 miles northwest of Cape Kekurnoi. Shelikof formation, lower member.
95	3103	944	T. W. Stanton, 1904. Puale Bay, west shore about ½ mile within entrance to bay. Shelikof formation, middle member.
96	10824	C	S. R. Capps, 1921. Puale Bay, southwest shore. Shelikof formation.
96	12386	F8	W. R. Smith, 1924. Alaskan Peninsula, southwest side of Puale Bay. Same locality as 10824. Shelikof formation.
97	3104	945	T. W. Stanton, 1904. Puale Bay, west shore near Cape Aklek. Shelikof formation, middle member, from conglomerate 100 ft above base of section (See Martin, 1926, p. 198).
98	12385	F7	W. R. Smith, 1924. Alaskan Peninsula, head of Oil Creek. Shelikof formation, upper member.
99	12387	F9	W. R. Smith, 1924. Alaskan Peninsula, Puale Bay area, near summit of hill 1½ miles southwest of head of bay. Shelikof formation.
100	3117		R. W. Stone, 1904. Puale Bay, southwest side, near head of small creek near Cape Aklek. Shelikof formation, middle member.
100	10822	3	S. R. Capps, 1921. Puale Bay, southwest side, head of small creek near Cape Aklek. Shelikof formation, middle member.
101	10790	1–57	S. R. Capps, 1921. Puale Bay area, about 3½ miles above mouth of Rex Creek, Alaskan Peninsula. Shelikof formation.
102	3113	954	T. W. Stanton, 1904. Four miles west of Puale Bay on west side of Oil Creek, ½ mile above its mouth and at an elevation of 500 ft above the creek. Shelikof formation, middle member.
103	2943		G. C. Martin, 1903. Kanatak area, Dry Bay, near mouth of Oil Creek, Alaskan Peninsula. Shelikof formation, middle member.

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Localities at which ammonites were collected from the Callovian strata of southwestern Alaska—Continued

No. on figs. 4-9	Geological Survey Mesozoic locality	Collector's field numbers	Collector, year of collection, description of locality, and stratigraphic assignment
104	12382	F4	W. R. Smith, 1924. Alaskan Peninsula, Salmon Creek in draw east of large seepage, Kanatak area. Shelikof formation.
105	12384	F6	W. R. Smith, 1924. Alaskan Peninsula, Salmon Creek in draw east of large seepage, Kanatak area. Shelikof formation from beds lower than loc. 12382.
106	12381	F3	W. R. Smith, 1924. Alaskan Peninsula, Salmon Creek just above large oil seepage, Kanatak area. Shelikof formation.
107	12411	F33	W. R. Smith, 1924. Alaskan Peninsula, large draw near crest of dome on Salmon Creek in Kanatak area. Shelikof formation.
108	12380	F2	W. R. Smith, 1924. Alaskan Peninsula, East branch of Kanatak Creek, 1 mile north of Kanatak. Shelikof formation.
109	10803	1-101	S. R. Capps, 1921. Wide Bay near point 1½ miles south of mouth of Big Creek. Shelikof formation, lower member.
110	12398	F20	W. R. Smith, 1924. Alaskan Peninsula, Wide Bay area, 1½ miles up west branch of Des Moines (Lee) Creek. Shelikof formation, lower member.
111	19902	45AKmF92	L. B. Kellum, 1945. Alaskan Peninsula, Wide Bay area, 5.2 miles N. 32° W. of west end of Hartman Island, Float near elevation of 478 ft in Shelikof formation.
112	19911	45AKmF101	L. B. Kellum, 1945, Alaskan Peninsula, Wide Bay area, 1.0 mile N. 64½° E. of Mt. Shannon at elevation of 412 ft in Shelikof formation.
113	10805	1-105	S. R. Capps, 1921. Wide Bay, about 1 mile west of mouth of Pass Creek. Shelikof formation, lower member.
114	21357	48AI94	R. W. Imlay and D. J. Miller, 1948. Wide Bay area, on divide at head of stream entering Short Creek about 1 mile northwest of beach, 5.37 miles N. 68½° W. of west end of Hartman Island. Siltstone about 40 ft below base of sandstone sequence and about 1,140 ft above the base of the Shelikof formation.
115	21356	48AI93	R. W. Imlay and D. J. Miller, 1948. Wide Bay area, near head of tributary entering Short Creek about 1 mile northwest of beach, 5.2 miles N. 70° W. of west end of Hartman Island about 1,100 ft above the base of the Shelikof formation.
116	19744	44AKmF5	L. B. Kellum, 1944. Alaskan Peninsula, Wide Bay area, first gully that enters Short Creek from north about ⅝ mile above junction at elevation of 950 ft. Float about 660 ft above base of Shelikof formation.
117	21355	48AI92	R. W. Imlay and D. J. Miller, 1948. Wide Bay area, tributary entering Short Creek about 1 mile northwest of beach, 5.05 miles N. 72° W. of west end of Hartman Island. From base of abundant limestone concretions in gray siltstone about 350 ft above base of Shelikof formation.
118	11072	M5	Ernest Marquardt, 1921. Wide Bay, about 3 miles northwest of shore on creek that empties into bay 4 miles southwest of mouth of Des Moines (Lee) Creek. Shelikof formation, probably base of middle member.
119	19781	44AKmF51	L. B. Kellum, 1944. Alaskan Peninsula, Wide Bay area, 7.2 miles N. 82½° W. of west end of Hartman Island, 1500 ft above base of Shelikof formation.
120	21360	48AI99	R. W. Imlay and D. J. Miller, 1948. Wide Bay area, southwest face of mountain front on northwest side of bay, 6.70 miles N. 96° W. of west end of Hartman Island, limestone concretions in siltstone about 1,600 ft above base of the Shelikof formation.
121	21359	48AI98	R. W. Imlay and D. J. Miller, 1948. Wide Bay area, southwest face of mountain front on northwest side of bay, 6.61 miles N. 97° W. of west end of Hartman Island, limestone concretions in siltstone about 1,400 ft above the base of the Shelikof formation.
122	21358	48AI97	R. W. Imlay and D. J. Miller, 1948. Wide Bay area, southwest face of mountain front 6.60 miles N. 97½° W. of west end of Hartman Island, Gray siltstone 20 to 40 ft below the first prominent sandstone bed at this place and about 1,000 ft above the base of the Shelikof formation.
123	10813	1-117	S. R. Capps, 1921. Same locality as 10812 but higher in the section. Shelikof formation.
124	10812	1-116	S. R. Capps, 1921. Wide Bay area, near head of creek that enters Wide Bay from northwest at southwest end of bay. Shelikof formation, probably base of middle member.
125	19793	44AKmF63	S. N. Daviess, 1944. Alaskan Peninsula, Wide Bay area, 2.6 miles N. 59° E. of Mt. Alai, 500 ft above base of Shelikof formation.
126	12407	F29	W. R. Smith, 1924. Alaskan Peninsula, Wide Bay, southwest side, near summit of Lone Hill. Shelikof formation, lower member.
127	12408	F30	W. R. Smith, 1924. Alaskan Peninsula, southwest side of Wide Bay on south side of Lone Hill. Shelikof formation, lower member.
128	19873	F66	L. B. Kellum, 1945. Alaskan Peninsula, Wide Bay area, 4.4 miles S. 67½° E. of Mt. Alai at elevation of 985 ft. Shelikof formation, 1,080 ft above base.

Localities at which ammonites were collected from the Callovian strata of southwestern Alaska—Continued

No. on figs. 4–9	Geological Survey Mesozoic locality	Collector's field numbers	Collector, year of collection, description of locality, and stratigraphic assignment
129	19896	45AKmF86	J. Friedman and L. B. Kellum, 1945, Alaskan Peninsula, Wide Bay area, 7.4 miles S. 54° W. of west end of Hartman Island at elevation of 289 ft, and 330 ft above base of Shelikof formation.
130	21362	48AI102	R. W. Imlay and D. J. Miller, 1948. Wide Bay area, Talus blocks and outcrops along sea cliff on southeast side of Wide Bay from a point 4.20 miles S. 39° W. of west end of Hartman Island northeastward along beach to end of peninsula. Fossils occur in limestone concretions forming part of a coarse conglomerate from 5 to 45 ft above the top of the lower siltstone member of the Shelikof formation.
131	21361	48AI101	R. W. Imlay and D. J. Miller, 1948. Wide Bay area, sea cliff on southeast shore, 3.60 to 3.70 miles S. 34° W. of west end of Hartman Island. Hard, gray, siltstone 15 to 25 ft below base of massive sandstone and conglomerate and in top of lower siltstone member of Shelikof formation.
none	1496		D. F. Becker and W. H. Dall, 1895. Northeast side of Puale Bay, Alaskan Peninsula, Shelikof formation.
none	1497		C. W. Purington, 1895. Puale Bay from first bench on high ridge west of stream that drains into northeast end of Puale Bay. Shelikof formation, upper member.
none	2707		A. H. Brooks, 1901. Iniskin Bay, near entrance to Cook Inlet. Chinitna formation.
none	10814	1–118	S. R. Capps, 1921. Wide Bay, north shore, about 4 miles from its southwest end. Loose boulder derived from the Shelikof formation.
none	22132	81	Wm. J. Fisher, about 1900. From Wide Bay area of Alaskan Peninsula. Shelikof formation.

SUMMARY OF RESULTS

1. The described Callovian ammonites from the Alaskan Peninsula and Cook Inlet regions include 19 genera and 62 species. Of these, 1 subgenus, *Stenocadoceras*, and 38 species are new. The genus *Cadoceras* comprises 61 percent and the genus *Pseudocadoceras* 17 percent of the total number of ammonite specimens found. *Paracadoceras* and *Stenocadoceras* are considered subgenera of *Cadoceras*. Of especial interest are the occurrences in the lower part of the Callovian sequence of such ammonites as *Kheraiceras*, *Xenocephalites*, *Lilloettia*, *Paracadoceras*, *Gulielmiceras*, *Gowericeras*, *Procerites*, and *Reineckeia* (*Kellawaysites*).
2. The exact stratigraphic positions of the fossil collections have been difficult to ascertain because of the thousands of feet of Callovian sedimentary rocks that are present, the lack of distinctive, persistent marker beds, and the probability that locally considerable thicknesses have been removed during late Callovian time prior to the deposition of the Naknek formation. The presence of a middle sandstone member within the Shelikof formation is of some aid stratigraphically, although this member appears to grade laterally as well as vertically into the adjoining siltstone members. As for the Chinitna formation, the fossil collections can readily be localized within the lower, middle, or upper thirds and some collections can be localized within a certain number of feet of the boundaries of the formation.
3. The lower third of the Chinitna formation is characterized by *Cadoceras*, *Paracadoceras*, *Kepplerites*, *Lilloettia*, *Xenocephalites*, *Kheraiceras*, *Gowericeras*, *Gulielmiceras*, *Procerites* and *Grossouvria*. The last three have been found only within a few hundred feet of the base of the formation. *Kepplerites tychonis* Ravn was found near the base on Chisik Island.

   The middle third of the Chinitna formation contains commonly *Phylloceras*, *Oppelia* (*Oxycerites*), *Lilloettia*, *Cadoceras*, *Pseudocadoceras*, and *Kepplerites*. Near the lower part of the middle third these may be associated with *Kheraiceras*, *Xenocephalites*, *Paracadoceras*, and *Gowericeras*. *Pseudocadoceras grewingki* (Pompeckj) is the most common fossil in the middle third, although it ranges higher.

   The upper third of the Chinitna formation contains the ammonites *Phylloceras*, *Cadoceras*, *C.* (*Stenocadoceras*), *Pseudocadoceras*, and *Lilloettia*. The latter occurs rarely. *Stenocadoceras* and *Pseudocadoceras* are the most common ammonites.
4. Faunally the lower siltstone member of the Shelikof formation is correlated with approximately the lower third of the Chinitna formation and the middle sandstone member is correlated with the middle third of the Chinitna. The upper siltstone member of the Shelikof has not furnished ammonites, except possibly at one locality.

5. The Chinitna and Shelikof formations are correlated with the lower and middle parts of the Callovian stage, corresponding to the northwest European zones of *Proplanulites koenigi* to *Erymnoceras coronatum*. This correlation is based on comparisons of the ammonites of these formations with the Callovian ammonites from the western interior of the United States, from East Greenland, from the Barents Sea area, and from northern Europe. The basal Callovian zone of *Macrocephalites macrocephalus* has not been identified faunally, although possibly represented locally by a basal shelly sandstone. Likewise, the highest European zones of the Callovian have not been identified faunally but are probably represented by an unconformity at the base of the Naknek formation.
6. The lower siltstone member of the Shelikof formation and the lower third of the Chinitna formation are correlated with the zones of *Proplanulites koenigi* and the lower part of the zone of *Sigaloceras calloviense* on the basis of the presence of such ammonites as *Gowericeras*, *Paracadoceras*, *Gulielmiceras*, and *Kepplerites tychonis* Ravn. Similar or identical species occur in the upper part of the lower Callovian sequence in Montana and East Greenland.
7. The middle sandstone member of the Shelikof formation and the middle third of the Chinitna formation are correlated with the upper part of the zone of *Sigaloceras calloviense* and with the zone of *Cosmoceras jason* (1) on the basis of superposition, (2) because of the association of *Gowericeras*, *Paracadoceras*, and *Pseudocadoceras* in the lower part of the middle third of the Chinitna, (3) because of the abundance of *Pseudocadoceras* throughout, and (4) because the species of *Cadoceras* and *Kepplerites* are quite distinct from those in Montana and in East Greenland.
8. The upper third of the Chinitna formation is correlated with the European zone of *Erymnoceras coronatum* because of the abundance of compressed *Cadoceras* (*Stenocadoceras*) similar to forms in central Russia, because *Pseudocadoceras* is not known to range higher, and because the absence of many genera that are common lower in the Chinitna formation implies a fairly high position in the Callovian.
9. It seems likely that the Callovian sediments of the Alaska Peninsula and Cook Inlet areas were deposited along a steep slope fronting a major ocean and were derived from mountains that lay immediately to the north or northwest. An ample source of sedimentary material and rapid subsidence is implied by thicknesses ranging from 4,000 to 6,000 ft. Locally the sea bottom was subjected to strong wave and current action, although most of the siltstones appear to have been deposited below wave base. Such distinctive shallow water forms as *Meleagrinella* and *Ostrea* are lacking, except in the basal shelly sandstone of the Chinitna formation. The association of the thin-shelled *Phylloceras* with the thicker-shelled cardioceratids suggests fairly deep waters near shore. The presence of *Phylloceras* and the absence of nautiloids is probably related to depth of water rather than to temperature, as the opposite faunal condition exists in the Callovian deposits of the western interior of the United States. A cooling of the boreal sea of Late Jurassic time, as compared to seas farther south is suggested by the absence of corals, the rarity of gryphaeas and exogyras, the provincial character of the ammonites, the poverty in molluscan genera and species as compared with the Mediterranean seas, and by the scarcity of calcium carbonate other than as concretions.

SYSTEMATIC DESCRIPTIONS

Genus Phylloceras Suess 1865

Subgenus Phylloceras, sensu stricto

Phylloceras bakeri Imlay, n. sp.

Plate 25, figures 10, 14

The species is represented by six specimens. Form discoidal, compressed; whorls elliptical, much higher than wide, widest near the middle of the flanks; flanks slightly convex; venter highly arched. Umbilicus very narrow; wall low, vertical at base, rounding rapidly into flanks. Body chamber incomplete; represents one-fourth of outer whorl of holotype.

The ornamentation consists of slightly flexuous ribs that incline forward moderately on the flanks and arch forward on the venter. They are fine and threadlike near the umbilicus, but widen considerably ventrally. On the upper parts of the flanks and on the venter they are broad, nearly flat-topped, have steep anterior and posterior margins, and are separated by much narrower interspaces. On the middle parts of the flanks are many low, broad radial folds that include from three to five ribs.

The suture line is imperfectly preserved.

Measurements cannot be made as all the specimens are partly crushed, but the proportions are probably about the same as on *Calliphylloceras freibrocki* Imlay.

This species is characterized by broad, nearly flat-topped ribs on the venter and upper part of the flanks. Otherwise its ornamentation agrees with that of the group of species related to *Phylloceras heterophyllum* (J. Sowerby), as discussed by Neumayr (1871, pp. 308–321).

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

Holotype, U.S.N.M. 108004; paratype, U.S.N.M. 108005.

Table 6.—Geographic Distribution of Callovian Ammonites From Alaska Peninsula and Cook Inlet Regions

[Numbers from 1-131 refer to numbers on figs. 4-9. Higher numbers are Geological Survey Mesozoic locality numbers]

	Cook Inlet region																																																					
	Mata-nuska		Tuxedni Bay																													Chinitna Bay																						
	Chinitna formation																																																					
	1	2	3		4	5		6	7	8			9	10	11		12		13	14	15	16	17	18	19	20	21	22	23		24	25	26	27	28	29			30	31	32	33	34	35	36	37	38	39	40	41	42	43		44	45
	3700	8571	3016	21291	21287	3015	21286	21273	10250	3014	12074	21272	2992	21285	2991	21290	2990	22554	21288	21338	21781	21337	3018	21345	21344	3019	3020	21343	21342	21774	10978	21777	21347	21776	21778	10997	11011	21346	22421	21348	22438	22437	21341	21340	22556	21339	21322	21324	21331	21321	21325	21327	21330	21326	21329
Phylloceras (Phylloceras) bakeri Imlay, n. sp.																	X	X														X	X		X	X																			
P. (Calliphylloceras) freibrocki Imlay, n. sp.						X	X																																																
P.? (Partschiceras) subobtusiforme Pompeckj																																								X															
P.? (Partschiceras) grantzi Imlay, n. sp.																																																							
P.? (Macrophylloceras) grossicostatum Imlay, n. sp.						X																																																	
Oppelia (Oxycerites) chinitnana Imlay, n. sp.																																																							
O. (Oxycerites) sp.																						X					X																												
Lilloettia buckmani (Crickmay)																																													X		X								
L. milleri Imlay, n. sp.																																															X								
L. mertonyarwoodi Crickmay																																															X								
L. lilloetensis Crickmay																																												X											
L.? stantoni Imlay, n. sp.																																													X										
Xenocephalites hebetus Imlay, n. sp.																																																							X
X. vicarius Imlay, n. sp.																																									X	X			X					X					X
X. hartsocki Imlay, n. sp.																																											X												
Kheraiceras magniforme Imlay, n. sp.																																																							
K. martini Imlay, n. sp.																																																							
K. abruptum Imlay, n. sp.																																																							
K. varicostatum Imlay, n. sp.																																																							
K. intermedium Imlay, n. sp.								X				X																																											
K.? parviforme Imlay, n. sp.																																																							
Cadoceras catostoma Pompeckj																			X																					X		X													
C. comma Imlay, n. sp.																				X	X				X		X													X	X					X									
C. glabrum Imlay, n. sp.		X																												X																									
C. bathomphalum Imlay, n. sp.																																																							
C. tenuicostatum Imlay, n. sp.																																																							
C. doroschini (Eichwald)	X																								X																														
C. wosnessenskii (Grewingk)																							X		X														X	X															
C. kialagvikense Imlay, n. sp.																								X																															
C. (Paracadoceras) moffiti Imlay, n. sp.																																																							
C. (Paracadoceras) multiforme Imlay, n. sp.																										X														X															
C. (Paracadoceras) tonniense Imlay, n. sp.																																																X	X					X	
C. (Paracadoceras) aff. *C. tonniense* Imlay																										X																													
C. (Paracadoceras) chisikense Imlay, n. sp.									X																																														
C. (Stenocadoceras) multicostatum Imlay, n. sp.			X												X	X													X		X	X	X	X	X			X																	
C.? (Stenocadoceras) striatum Imlay, n. sp.				X																																																			
C. (Stenocadoceras) iniskinense Imlay, n. sp.																							X																																
C. (Stenocadoceras) bowserense Imlay, n. sp.																																																							
C.? (Stenocadoceras) stenoloboide Pompeckj																													X			X																							
C.? (Stenocadoceras) pomeroyense Imlay, n. sp.																																																							
Pseudocadoceras petelini (Pompeckj)																																																							
P. grewingki (Pompeckj)																							X		X															X															
P. crassicostatum Imlay, n. sp.																																																							
P. chinitnense Imlay, n. sp.															X																X	X			X																				
P. schmidti (Pompeckj)																																																							
Kepplerites (Seymourites) alticostatus Imlay, n. sp.													X																																										
K. (Seymourites) multus (McLearn)																																																							
K. (Seymourites) tychonis Ravn					X																																																		
K. (Seymourites) ingrahami (McLearn)											X																																												
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K. (Seymourites) plenus (McLearn)																																																							
Gowericeras snugharborense Imlay, n. sp.						X																																																	
G. spinosum Imlay, n. sp.																																																							
G. sp.						X																																																	
Cosmoceras cf. *C. spinosum* (J. de C. Sowerby)																																																							
C. (Gulielmiceras) alaskanum Imlay, n. sp.																																																							
Reineckeia (Kellawaysites) shelikofana Imlay, n. sp.																																																							
Procerites spp.																																																							
P.? irregularis Imlay, n. sp.								X																																															
Grossouvria sp.																																																							

																						Central and southwestern parts of Iniskin Peninsula																																
	46		47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69		70	71		72	73	74	75			76	77	78		79	80		81	82	83	84	85	86				87	88	89	90
	21328	21332	22442	11041	10982	21320	21333	21334	11047	10986	21335	21349	20761	20753	20762	11052	11049	11050	22427	22559	22425	22430	20760	11052a	3042	20759	2941	20757	22429	22451	22452	22446	2920	20755	22448	22428	22431	10989	22433	3028	22422	22432	22419	22411	22415	22434	20763	3020	10990	10991	10992	2921	22435	3030	11060
Phylloceras (Phylloceras) bakeri Imlay, n. sp.																																																							
P. (Calliphylloceras) freibrocki Imlay, n. sp.									X										X								X																				X								
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P.? (Partschiceras) grantzi Imlay, n. sp.																																										X													
P.? (Macrophylloceras) grossicostatum Imlay, n. sp.			X						X																										X													X				X			
Oppelia (Oxycerites) chinitnana Imlay, n. sp.																																																X							
O. (Oxycerites) sp.												X											X																	X															
Lilloettia buckmani (Crickmay)		X					X																																									X				X			
L. milleri Imlay, n. sp.																																																							
L. mertonyarwoodi Crickmay																																								X															
L. lilloetensis Crickmay			X																																																				
L.? stantoni Imlay, n. sp.																	X																							X						X									
Xenocephalites hebetus Imlay, n. sp.																																														X									
X. vicarius Imlay, n. sp.				X																																				X															
X. hartsocki Imlay, n. sp.												X																																											
Kheraiceras magniforme Imlay, n. sp.																			X																X					X															
K. martini Imlay, n. sp.																																X																							
K. abruptum Imlay, n. sp.																																				X	X		X																
K. varicostatum Imlay, n. sp.																							X																																
K. intermedium Imlay, n. sp.								X																																															
K.? parviforme Imlay, n. sp.								X											X																																				
Cadoceras catostoma Pompeckj												X										X		X																X		X	X					X				X			
C. comma Imlay, n. sp.												X				X					X				X	X					X							X		X		X						X					X		
C. glabrum Imlay, n. sp.													X																											X	X	X						X				X			
C. bathomphalum Imlay, n. sp.																																																							
C. tenuicostatum Imlay, n. sp.																																															X	X				X		X	
C. doroschini (Eichwald)																																								X							X	X					X	X	
C. wosnessenskii (Grewingk)					X																				X																			X		X	X	X				X	X		
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C.? (Stenocadoceras) stenoloboide Pompeckj																								X				X																					X			X		X	
C.? (Stenocadoceras) pomeroyense Imlay, n. sp.																																													X										
Pseudocadoceras petelini (Pompeckj)																																																							
P. grewingki (Pompeckj)																												X	X	X	X									X		X					X	X				X	X		
P. crassicostatum Imlay, n. sp.																																																							X
P. chinitnense Imlay, n. sp.																																																							
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Kepplerites (Seymourites) alticostatus Imlay, n. sp.																																					X		X																
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P.? irregularis Imlay, n. sp.																																																							
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	Alaska Peninsula region																																															
	Puale Bay to Portage Bay																				Wide Bay																											
	Shelikof formation																																															
	91	92	93	94	95	96		97	98	99	100		101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131					
	21354	10818	3105	3106	3103	10824	12886	3104	12385	12387	3117	10822	10790	3113	2943	12382	12384	12381	12411	12380	10803	12398	19002	19911	10805	21357	21356	10744	21355	11072	19781	21360	21359	21358	10813	10812	19793	12407	12408	19873	19896	21362	21361	1496	1497	2707	10814	22132
Phylloceras (Phylloceras) bakeri Imlay, n. sp.																																																
P. (Calliphylloceras) freibrocki Imlay, n. sp.								X																																								
P.? (Partschiceras) subobtusiforme Pompeckj																																																
P.? (Partschiceras) grantzi Imlay, n. sp.																																																
P.? (Macrophylloceras) grossicostatum Imlay, n. sp.																																																
Oppelia (Oxycerites) chinitnana Imlay, n. sp.																																																
O. (Oxycerites) sp.																																		X														
Lilloettia buckmani (Crickmay)																							X								X	X	X								X	X						
L. milleri Imlay, n. sp.																																																
L. mertonyarwoodi Crickmay																																										X						
L. lilloetensis Crickmay																																X															X	
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X. hartsocki Imlay, n. sp.																																																
Kheraiceras magniforme Imlay, n. sp.																																																
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C. comma Imlay, n. sp.																								X							X																	
C. glabrum Imlay, n. sp.																															X																	
C. bathomphalum Imlay, n. sp.																																							X									
C. tenuicostatum Imlay, n. sp.		X		X	X									X													X																					
C. doroschini (Eichwald)										X				X																																		
C. wosnessenskii (Grewingk)																															X	X	X							X								
C. kialagvikense Imlay, n. sp.																												X											X									
C. (Paracadoceras) moffiti Imlay, n. sp.																																																
C. (Paracadoceras) multiforme Imlay, n. sp.																																																
C. (Paracadoceras) tonniense Imlay, n. sp.																																																
C. (Paracadoceras) aff. *C. tonniense* Imlay																																																
C. (Paracadoceras) chisikense Imlay, n. sp.																																																
C. (Stenocadoceras) multicostatum Imlay, n. sp.			X				X													X															X													
C.? (Stenocadoceras) striatum Imlay, n. sp.																																																
C. (Stenocadoceras) iniskinense Imlay, n. sp.			X	X							X																									X												
C. (Stenocadoceras) bowserense Imlay, n. sp.																																																
C.? (Stenocadoceras) stenoloboide Pompeckj	X					X	X			X	X	X			X											X	X												X			X						
C.? (Stenocadoceras) pomeroyense Imlay, n. sp.																																																
Pseudocadoceras petelini (Pompeckj)							X		X	X		X		X																																		
P. grewingki (Pompeckj)			X				X																											X	X							X						
P. crassicostatum Imlay, n. sp.			X							X																																						
P. chinitnense Imlay, n. sp.																																																
P. schmidti (Pompeckj)						X																																										
Kepplerites (Seymourites) alticostatus Imlay, n. sp.																																																
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Gowericeras snugharborense Imlay, n. sp.																																																
G. spinosum Imlay, n. sp.																																																
G. sp.																																																
Cosmoceras cf. *C. spinosum* (J. de C. Sowerby)																																																
C. (Gulielmiceras) alaskanum Imlay, n. sp.																																																
Reineckeia (Kellawaysites) shelikofana Imlay, n. sp.																													X																			
Procerites spp.																																																
P.? irregularis Imlay, n. sp.																																																
Grossouvria sp.																																																

Chinitna formation, upper part of upper third, U.S.G.S. Mes. locs. 2990, 10997, 21347, 21777, 21778, and 22554.

Subgenus Calliphylloceras Spath 1927

Phylloceras (Calliphylloceras) freibrocki Imlay, n. sp.

Plate 26, figures 7–11

The species is represented by 10 specimens. Form discoidal, compressed; whorls elliptical, much higher than wide, widest near middle of flanks; flanks slightly convex; venter highly arched. Umbilicus extremely narrow; wall low, vertical, rounding rather abruptly into flanks. Body chamber unknown.

The ornamentation consists of pronounced flexuous constrictions and fine ribbing. Both constrictions and ribbing incline forward moderately on the lower part of the flanks, recurve slightly on the upper part of the flanks, and then arch forward strongly on the venter. There are 7 constrictions on the small specimens and 8 or 9 constrictions on the largest specimens. Constrictions are not visible where the shell is preserved. The ribs have a short, steep anterior slope, a long, gentle posterior slope, and a sharp crest. They are scarcely stronger than striae near the umbilicus but become a little stronger ventrally.

The suture line is typical of *Calliphylloceras*. The saddles and lobes are about equal in width. The external saddle is bifid and the first and second lateral saddles tend to be trifid.

The dimensions in millimeters and ratios of whorl height and thickness to the diameter are as follows: [2]

Specimen	Diameter	Whorl height	Whorl thickness	Umbilical width
Paratype (pl. 26, figs. 8, 9)	51	26(0.51)	20 (0.39)	?
Do	66	36(.54)	28 (.42)	7(0.10)
Holotype (pl. 26, fig. 10)	166	94(.57)	58?(.34)	?

[2] In the following pages this statement will be abbreviated to "Dimensions in millimeters and ratios are as follows":

This species resembles *Calliphylloceras demidoffi* (Rousseau) (see Loczy, 1915, p. 291, pl. 1, fig. 2, pl. 2, figs. 3–5, pl. 3, fig. 1; Arkell, 1939, p. 141) in number of constrictions and in ornamentation. It appears to have flatter flanks, a broader venter, and wider saddles. This species is named in honor of Mr. Eric Freibrock, owner of the Snug Harbor Cannery, who has kindly helped members of the Geological Survey on many occasions.

Holotype, U.S.N.M. 108006; paratypes, U.S.N.M. 108007, 108008.

Chinitna formation, lower two-thirds, U.S.G.S. Mes. locs. 2941, 3015, 11047, 20763, 21286, 21287, 22427, and 22456. Shelikof formation, base of middle member, Mes. loc. 3104.

Subgenus Partschiceras Fucini 1923

Phylloceras (Partschiceras) subobtusiforme Pompeckj

Plate 25, figures 1–3, 8

Phylloceras subobtusiforme Pompeckj, Russ. K. Min. Gesell. St. Petersburg Verh., ser. 2, Band 38, p. 247, pl. 7, figs. 1a–d, 1900.

Four specimens of this species are available. Form small, discoidal, moderately stout; whorls subovate, higher than wide, widest at about two-thirds of the height of the flanks; flanks flattened in lower part and diverging slightly, rounding rapidly above into rather broad venter. Umbilicus very narrow; wall steeply inclined, rounding evenly into flanks. Body chamber represented by at least three-fifths of a whorl. Aperture unknown.

The ornamentation of the outer whorls consist of fine growth lines or striae on the lower parts of the flanks that pass into low, rounded ribs on the upper parts of the flanks. The growth lines are radial near the umbilicus and strongly inclined forward on the flanks. The ribs incline forward slightly on the upper parts of the flanks and arch forward gently on the venter. They are about as wide as the interspaces.

The suture line as illustrated herein has a longer external lobe than on the type of the species and the saddles are a little wider.

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

Specimen	Diameter	Whorl height	Whorl thickness
Holotype	17	11.5(0.68)	8(0.47)
Plesiotype (pl. 25, figs. 2, 3)	30	18 (.60)	14(.47)

Pompeckj (1900, p. 249) notes that this species is distinguished from *Phylloceras subobtusum* Kudernatsch (1852, p. 7, pl. 2, figs. 1–3), from the Bathonian of Europe, by the forward arching of the ribs on the venter and by a simpler suture line. It is also much stouter. *P. chantrei* Munier-Chalmas (see Sayn and Roman, 1930, p. 216, pl. 21, figs. 11, 11a, text fig. 33), from the Callovian and Oxfordian of Europe, is even more compressed than *P. subobtusum*.

Plesiotypes, U.S.N.M. 108009–108011.

Chinitna formation, middle two-thirds, U.S.G.S. Mes. locs. 3029, 21348, 22411, and 22434.

Phylloceras (Partschiceras) grantzi Imlay, n. sp.

Plate 25, figures 4–7, 9

The species is represented by two specimens. Form small, discoidal, fairly stout; whorls subquadrate, higher than wide, widest near the middle of the flanks; flanks flattened and nearly parallel, rounding rapidly into rather broad venter. Umbilicus very narrow, wall steeply inclined, rounding evenly into flanks. Body chamber represented by about two-thirds of a whorl. Aperture sigmoid, strongly inclined forward, bordered on internal mold by a constriction which is followed by a weak swelling.

The ornamentation of the body whorl consists of fine, flexuous, forwardly inclined growth lines on the flanks and of low, broad, forwardly arched ribs on the venter. The ventral ribs are a little narrower than the interspaces, are variable in strength, and become broader and stronger anteriorly.

The suture line is essentially the same as in *P. subobtusiforme* Pompeckj.

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

Specimen	Diameter	Whorl height	Whorl thickness
Holotype (pl. 25, figs. 4, 5)	27	16(0.59)	12.5(0.46)
Do	39	23(.59)	16 (.41)
Paratype (pl. 25, figs. 6, 7)	47	29(.61)	20 (.42)

This species differs from *P. subobtusiforme* Pompeckj by its ribbing, which appears at a later growth stage, is confined to the venter, and is much coarser.

This species is named in honor of Arthur Grantz, geologist with the Geological Survey, who has studied the Jurassic rocks of the Cook Inlet region.

Holotype, U.S.N.M. 108012; paratype, U.S.N.M. 108013.

Chinitna formation, middle third, U.S.G.S. Mes. loc. 22432.

Subgenus Macrophylloceras Spath 1927

Phylloceras (Macrophylloceras) grossicostatum Imlay, n. sp.

Plate 25, figures 11–13, 15, 16

Six specimens of this species are known. Form discoidal, compressed; whorls elliptical, much higher than wide, widest near the middle of the flanks; flanks gently convex; venter highly arched. Umbilicus extremely narrow; wall very low, vertical at base, rounding evenly into flanks. Body chamber unknown.

Fine, gently flexuous ribbing is barely visible at a diameter of 26 mm. This ribbing is scarcely stronger than striae near the umbilicus, becomes a little stronger ventrally and persists to a diameter of about 60 mm. In addition, at a diameter of about 30 mm some broad, low, widely spaced fold-like ribs appear on the upper two-thirds of the flanks. These ribs curve forward near the middle of the flanks, but recurve higher on the flanks and cross the venter transversely. They tend to fade out on the venter at diameters less than about 60 mm but at greater diameters are as strong on the venter as on the flanks. Anteriorly these ribs become fairly prominent and are separated by broad flat interspaces. Most of these ribs are separated at diameters greater than 60 mm by short ribs that do not extend below the upper fifth of the flanks but are as strong on the venter as the long ribs.

The suture line shows the high external lobe characteristic of *Macrophylloceras*. The saddles are a little stouter than the lobes. The external saddle is bifid and the first lateral saddle is nearly trifid.

Accurate measurements of the holotype cannot be made owing to crushing. The paratype shown on plate 25, figures 12 and 13, at a diameter of 59 mm has a whorl height of 36 mm and a whorl thickness of 23 mm.

The ribbing of this species resembles that of the Cretaceous *Phyllopachyceras* Spath (1927, p. 36; D'Orbigny, 1842, pl. 39, figs. 4, 5) more than that of the Jurassic *Macrophylloceras* Spath (1927, p. 36; Zittel, 1868, p. 68, pl. 7, figs. 3, 4), but the high external lobe is quite different from that of *Phyllopachyceras*.

Holotype, U.S.N.M. 108014; paratypes, U.S.N.M. 108015–108017.

Chinitna formation, lower two-thirds, U.S.G.S. Mes. locs. 2921, 3015, 3029, 11047, 22442, and 22448.

Genus Oppelia Waagen 1869

Subgenus Oxycerites Rollier 1909

Oppelia (Oxycerites) chinitnana Imlay, n. sp.

Plate 26, figures 3–6

This species is represented for certain only by the holotype. Shell flattened, discoidal; outer whorl wedge-shaped in section, much higher than wide almost completely embracing preceding whorl, thickest a little below middle of flanks; flanks nearly flat in lower half, gently convex in upper half; venter bearing blunt keel. Umbilicus very narrow; wall low and vertical, rounding abruptly into flanks. Body chamber represented by half a whorl. Aperture imperfectly preserved, but the character of the ribbing suggests the presence of long lateral lappets.

The ornamentation consists of striae on the lower part of the flanks, of low, broad ribs on the upper part of the flanks, and of a faint spiral groove slightly above the middle of the flanks. The striae and ribs together form sickles that are strongly inflected forward along the spiral groove and become increasingly more inflected anteriorly. The ribs are barely visible on the septate posterior part of the body whorl but become stronger rapidly on the body chamber. They curve forward sharply on the venter and then disappear, resulting in a smooth area between their terminations and the keel. There are about 20 ribs on the body chamber.

The suture line has rather broad lobes and saddles. The first lateral lobe is shorter than the external lobe. The second lateral lobe is nearly as wide as the first lateral lobe but much shorter.

The holotype at a diameter of 63 mm has a whorl height of 35 mm, a whorl thickness of 11.5 mm, and an umbilical width of 5 mm.

The species is characterized by the sickle-like ribbing on its body chamber and by its very narrow umbilicus. None of the described European species of *Oxycerites* bears a close resemblance.

Holotype, U.S.N.M. 108018.

Chinitna formation, middle third, U.S.G.S. Mes. loc. 3029.

Oppelia (Oxycerites) sp.

Plate 26, figures 1, 2

Most of the Callovian oppelids in the Alaskan collections are fairly smooth, or exhibit feeble striae and ribs only under oblique lighting. The smooth forms are possibly comparable to *O. calloviensis* Parona and Bonarelli (1897, p. 127, pl. 2, fig. 5; Corroy, 1932, p. 94, pl. 6, fig. 10). Some small, feebly ribbed forms possibly represent the inner whorls of *O. chinitnana* just described. However, six specimens at diameters greater than 45 mm differ from *O. chinitnana* by having feebler and more widely spaced ribbing on the upper part of the flanks. Their general appearance is similar to that of *Oppelia* (*Oxycerites*) *aspidoides* (Oppel) (1862, p. 147, pl. 47, figs. 4a, b), and particularly to the forms figured by J. Roemer (1911, pl. 4, figs. 1–6, pl. 6, figs. 1–4, pl. 10, figs. 6–9). The latter appear to be a little more inflated and to have a slightly wider umbilicus. *O. tilli* Loczy (1915, p. 342, pl. 16, (4), figs. 2–4) is likewise very similar except for a slightly wider umbilicus. The suture line of one of the Alaskan specimens is similar to that of *O. aspidoides* (Oppel) except that it is less frilled and the second lateral lobe is much shorter.

Figured specimens, U.S.N.M. 108019.

Chinitna formation, lower two-thirds, U.S.G.S. Mes. locs. 3020, 3028, 20760, 21337, and 21349. Shelikof formation, lower member, Mes. loc. 21358.

Genus Lilloettia Crickmay 1930

Lilloettia buckmani (Crickmay)

Plate 27, figures 1–9

Buckmaniceras buckmani Crickmay, Canada Nat. Mus. Bull. 63, p. 62, pl. 20, figs. 1–4, text fig. 7, 1930.

This species is represented by 21 specimens. Form stout; whorls depressed, wider than high, widest at top of lower third of flanks except at anterior end of body chamber where the greatest width is near the umbilicus, embracing almost completely; flanks and venter evenly convex. Umbilicus extremely small; wall fairly low, vertical at base, rounding evenly into flanks except near aperture. Body chamber represented by about five-sixths of a whorl, aperture curved strongly forward.

The ornamentation consists of prominent, flexuous ribs that are particularly strong and wide on the venter. On the internal whorls at diameters less than about 60 mm the primary ribs are narrow, prominent, and divide near the middle of the flank into two stronger secondary ribs. Between most successive pairs of forked ribs is an intercalated rib. At diameters greater than 60 mm effacement of the ribs begins near the umbilicus and during growth gradually spreads ventrally. On the anterior part of the penultimate whorl the lower half of the flanks is quite smooth but the ventral ribs are still fairly strong and persist onto the posterior third of the body whorl. The anterior two-thirds of the body whorl is fairly smooth, bearing faint striae on the flanks and broad indistinct ribs on the venter.

The suture line is not well exposed on the larger Alaskan specimens. On one immature specimen the first lateral lobe is about the same length as the external lobe. The saddles are nearly symmetrical and a little wider than the lobes.

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

Specimen	Diameter	Whorl height	Whorl thickness	Umbilical width
Holotype	102	47(0.46)	70(0.68)	6?(0.06)
Plesiotype (pl. 27, figs. 7, 9)	86	46(.53)	59(.68)	4 (.04)
Do	106	56(.53)	62(.58)	5 (.05)
Plesiotype (pl. 27, fig. 1)	98	52(.53)	62(.63)	4 (.04)

This species has the coarsest ribbing of any described form of *Lilloettia* and is second only to *L. milleri* Imlay in amount of inflation. It is easily distinguished from the latter by its much coarser ribbing. Comparison of the Alaskan specimens of *L. buckmani* with the holotype shows that the latter is about average for the species as regards strength of ribbing and inflation.

Comparison of the inner whorls of *L. buckmani* with similarly coarsely ribbed inner whorls of *Arctocephalites* (Spath, 1932, pl. 6, figs. 3, 4, pl. 8, fig. 2, pl. 12, fig. 2, pl. 15, figs. 2a, b, pl. 16, figs. 1a, b; Newton and Teall, 1897, pl. 40, figs. 2a, b) shows that the latter may be distinguished from *Lilloettia* by less flexuous ribbing, by fewer secondary ribs that do not become thickened ventrally until a much larger size is attained, and by a consistently larger umbilicus.

Plesiotypes, U.S.N.M. 108021–108025, 108026a, b.

Chinitna formation, U.S.G.S. Mes. locs. 2921, 3029, 21322, 21332, 21333, and 22556. Shelikof formation, middle member at Mes. locs. 19781, 19896, 19902, 21359, 21360, and 21362.

Lilloettia milleri Imlay, n. sp.

Plate 28, figures 11, 13–15; plate 29, figures 14, 15

This species is based mainly on two complete specimens, of which one has been broken down in order to study the inner whorls. Form globose; whorls depressed, much wider than high, widest at the top of the lower fourth of the flanks, becoming a little higher during growth, embracing nearly completely; flanks and venter evenly convex except at extreme anterior end of body chamber where the venter tends to flatten. Umbilicus extremely small, wall fairly low, vertical at base, rounding evenly into flanks on inner whorls, rounding abruptly into flanks on outer whorls. Body chamber represented by about three-fourths of a whorl. Aperture curved strongly forward, anterior extremity truncated on flanks, bent down on the venter; internal mold marked by a broad constriction followed by a weak swelling that is not apparent where the shell is preserved.

The ornamentation of the broken paratype at a diameter of about 50 mm consists of low, broadly rounded ribs that begin low on the flanks and are separated by narrower interspaces. During growth the ribs become lower, irregular in strength, bifurcate indistinctly at about the top of the lower third of the flanks, and tend to become effaced on the flanks. The adult body chamber is nearly smooth, but under oblique lighting shows faint forwardly curved riblets that are a little stronger on the venter than on the flanks.

One small specimen from the Chinitna formation, shown on plate 28, figures 11, 14, probably represents the inner whorls of *L. milleri* because it agrees closely as regards ornamentation and inflation with the innermost exposed whorls of the paratype just described. The ornamentation of this small specimen presents an interesting contrast with that of similar small inner whorls of *Arctocephalites* from the western interior of Canada (Buckman, 1929, pl. 1, figs. 4–7, pl. 3) and from east Greenland (Spath, 1932, pl. 4, figs. 7a–c, pl. 6, fig. 3, pl. 9, figs. 3a, b, pl. 15, figs. 2a, b) in which the ribs are high and thin even on the venter and have nearly vertical sides. In contrast, on the inner whorls of *Lilloettia* the ribs are generally low on the flanks, are thick and rounded on the venter, and have sloping sides.

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

Specimen	Diameter	Whorl height	Whorl thickness	Umbilical width
Paratype (pl. 29, figs. 14, 15)	85	50(0.59)	74(0.87)	8(0.09)
Do	112	61(.54)	89(.79)	8(.07)
Do	145	77(.53)	95(.65)	9(.06)
Holotype (pl. 28, figs. 13, 15)	120	66(.55)	91(.76)	5(.04)
Do	135	70(.52)	96(.71)	4(.03)

This species is by far the most globose in the genus *Lilloettia*. It is named in honor of Don J. Miller who collected the specimens.

Holotype, U.S.N.M. 108027; paratypes, U.S.N.M. 108028, 108029.

Chinitna formation, middle of lower third, U.S.G.S. Mes. loc. 21322.

Lilloettia mertonyarwoodi Crickmay

Plate 30, figures 3, 5–7, 9–11

Lilloettia mertonyarwoodi Crickmay, Canada Nat. Mus. Bull. 63, p. 62, pl. 19, figs. 1, 2, text fig. 7, 1930

Three specimens from Alaska represent this species. Form fairly stout; whorls subovate, a little wider than high on outer two whorls, widest near the middle of the flanks in the inner whorls but widest at the top of the lower fourth of the flanks on the body whorl, embracing nearly completely; flanks on inner whorls flattened below, evenly convex above; flanks on outer two whorls gently convex, upper three-fourths converging to a moderately narrow venter; venter changing from evenly arched on inner whorls to rather narrowly arched on body whorl. Umbilicus extremely narrow, helicoid; wall low, vertical, rounding rather abruptly into flanks. Body chamber represented by at least five-sixths of a whorl. Aperture not preserved.

The ribbing of the whorl preceding the penultimate is shown on plate 30, figures 3, 7, 10. On this whorl the ribs curve forward strongly on the lower part of the flanks, recurve slightly on the upper part of the flanks, and arch forward gently on the venter. The primary ribs are sharp-topped, triangular in section, and bifurcate again a little above the middle of the flanks. Some of the sets of branched ribs are separated by short intercalated ribs. The secondary ribs are triangular in section near the furcation points but become broadly rounded on the venter. At a diameter of 51 mm there are 22 primary ribs and 71 secondary ribs.

The ribbing on the penultimate whorl, shown on plate 30, figures 9, 11, is strongly inclined but less flexuous than on the preceding whorl and becomes effaced anteriorly on the lower part of the flanks. Wherever the shell is preserved the ribs are much more conspicuous than on the internal mold. At a diameter of 72 mm there are 92 secondary ribs. Anteriorly on the body whorl (plate 30, figure 9) effacement of the ribbing from the flanks spreads more and more ventrally. Concomitantly the ventral ribs become broader and fainter but are still visible at the anterior end of the shell.

The suture line as detailed on one of the Alaskan specimens has a longer external lobe than on the holotype. This is possibly explained by the rather eroded and fragmentary condition of the holotype. Otherwise the sutures compare very well. The lobes and saddles are of about equal width and the saddles are nearly symmetrically divided by secondary lobules.

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

Specimen	Diameter	Whorl height	Whorl thickness	Umbilical width
Plesiotype (pl. 30, figs. 3, 7, 10)	51	28(0.55)	30 (0.60)	3(0.06)
Plesiotype (pl. 30, fig. 11)	80	45(.56)	52 (.65)	3(.04)
Holotype	80	46(.57)	49 (.61)	3(.04)
Plesiotype (pl. 30, figs. 6, 9)	98	54(.55)	65?(.66)	3(.03)

This species differs from *L. lilloetensis* Crickmay by its thicker whorl section, more strongly converging flanks, and finer, sharper ribs. *L. milleri* is much more inflated and has lower, broader ribs. The distinction between *Lilloettia* and *Arctocephalites* may be illustrated by comparing the inner whorls of *L. mertonyarwoodi* on pl. 30, figs. 3, 7, 10 with *Arctocephalites ellipticus* Spath (1932, p. 33, pl. 13, figs. 6a, b). It may be noted that the former has a smaller umbilicus, much more flexuous ribbing, and that the ventral ribs are wider and more closely-spaced.

Pleosiotypes, U.S.N.M. 108030–108032.

Chinitna formation, lower third, U.S.G.S. Mes. loc. 3028 and 21322; Shelikof formation, top of lower member at Mes. loc. 21362.

Lilloettia lilloetensis Crickmay

Plate 30, figures 1, 2, 4, 8

Lilloettia lilloetensis Crickmay, Canada Nat. Mus. Bull. 63, p. 62, pl. 18, figs 1–4, text fig. 7, 1930.

The Alaskan collections contain 4 specimens of this species. Form discoidal, compressed; whorls ovate, a little higher than wide, thickest at top of lower fourth of flanks, embracing nearly completely; flanks gently convex, upper three-fourths converging slowly to highly arched venter. Umbilicus extremely narrow, wall low, vertical, rounding rather abruptly into flanks. Body chamber represented by five-sixths of a whorl. Aperture marked on internal mold by a broad, forwardly curved constriction that is followed by a low swelling.

The ribbing of the inner whorls of the holotype at a diameter of 28 mm is flexuous, strongly inclined forward, and of moderate strength and density for the genus. The primary ribs bifurcate near the middle of the flanks. Most pairs of forked ribs are separated by single intercalated ribs that begin near the middle of the flanks. All secondary ribs become fairly thick on the venter where they are separated by interspaces about as wide as the ribs.

On the penultimate whorl (plate 30, figures 1, 4) the ribs are fairly distinct at the posterior end. The primary ribs are low, broad and divide near the middle of the flank into narrower secondary ribs. Single ribs are intercalated between the paired ribs. On the venter all secondaries are moderately broad, low and are separated by interspaces of similar width. Anteriorly on the penultimate whorl effacement of the ribs takes place rapidly until the anterior end has ribs only on the venter. The body whorl appears quite smooth except for a few faint ribs on the venter at the posterior end.

The suture line is essentially the same as that on *L. mertonyarwoodi* and both agree in pattern with the sutures of *Arctocephalites* and *Cranocephalites* figured by Spath (1932, pl. 3, figs. 5, 7, pl. 5, fig. 7b, pl. 11, fig. 7b).

The holotype at a diameter of 100 mm has a whorl height of 57 mm and an estimated whorl thickness of 50 mm.

This species is characterized by its compressed form and its rather low, fairly dense ribs. *L. stantoni* Imlay is similarly compressed but has much coarser, more persistent ribbing. *L. mertonyarwoodi* Crickmay (1930, p. 62, pl. 19, figs. 1, 2, text-figure 7) has a thicker whorl section, more convergent flanks, and sharper ribs.

Plesiotypes, U.S.N.M. 108033, 108034.

Chinitna formation, middle third, U.S.G.S. Mes. locs. 21340 and 22442; Shelikof formation, lower member at Mes. locs. 10814 and 21360.

Lilloettia stantoni Imlay, n. sp.

Plate 29, figures 1–5, 9, 10

The species is represented by 10 specimens. Form discoidal, compressed; whorls higher than wide, widest a little below the middle of the flanks, embracing nearly completely; flanks nearly flat in lower half, gently convex in upper half, passing evenly into highly arched venter. Umbilicus extremely narrow; wall low, vertical at base, passing rather abruptly into flanks. Body chamber represented by at least five-sixths of a whorl. The aperture is not preserved but probably very little of the shell is missing.

The ribbing on the septate part of the shell is vigorous, flexuous, and rather strongly inclined forward. The primary ribs are sharp, triangular in section, and bifurcate near the top of the lower third of the flanks. Many of the furcation points are indistinct. Most pairs of forked ribs are separated by short, intercalated ribs. The secondary ribs are stronger and rounder than the primary ribs and attain their greatest strength on the venter. The ribs curve backward on the umbilical shoulder, curve forward strongly on the lower part of the flanks, recurve slightly on the upper part of the flanks, and arch forward on the venter. At the posterior end of the body chamber the ribbing disappears abruptly on the lower half of the flanks, and is replaced by weak, flexuous striae, but the ventral ribbing remains strong. Anteriorly effacement of the ribbing extends farther and farther ventrally so that the anterior third of the body chamber is marked only by striae that curved strongly forward.

The suture line is imperfectly preserved.

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

Specimen	Diameter	Whorl height	Whorl thickness	Umbilical width
Paratype (pl. 29, fig. 5)	32	18(0.56)	15?(0.47)	1.5 (0.05)
Holotype (pl. 29, figs. 9, 10)	43	23(.53)	21 (.48)	3 ?(.07)
Paratype (pl. 29, fig. 1)	53	28(.53)	?	3 (.06)
Holotype (pl. 29, figs. 2, 3)	79	46(.58)	40 (.50)	?

This species is characterized by vigorous ribbing that does not disappear on the lower part of the flanks on the septate portion of the shell. Among the Alaskan species of *Lilloettia* only *L. buckmani* (Crickmay) exceeds it in coarseness of ribbing. It is otherwise distinguished from *L. buckmani* by its compressed whorl section, flatter flanks, more persistent primary ribs, and somewhat weaker secondary ribs. It is distinguished from *L. lilloetensis* Crickmay (1930, p. 62, pl. 18, figs. 1–4) by having much coarser ribbing, more persistent primary ribs, and by attaining its greatest thickness higher on the flanks. The ribbing on the inner whorls of *L. stantoni* compares in sharpness with that on the inner whorls of *Arctocephalites arcticus* (Newton and Teall, 1897, p. 500, pl. 40, figs. 1, 1a; Whitfield, 1906, p. 131, pl. 18, fig. 2; Spath, 1932, p. 32, pl. 12, fig. 2). However, on *L. stantoni* the ribbing is more flexuous, the primary ribs are more widely spaced, the secondary ribs are thicker and more closely spaced, and the umbilicus is smaller.

Holotype, U.S.N.M. 108035; paratypes, U.S.N.M. 108036, 108037a, b.

Chinitna formation, middle third and lower part of upper third, U.S.G.S. Mes. locs. 3028, 11049, 22434, and 22556; Shelikof formation, lower member at Mes. loc. 21359.

Genus Xenocephalites Spath 1928

Xenocephalites hebetus Imlay, n. sp.

Plate 29, figures 6–8, 11

This species is definitely represented in the Survey collections by only two specimens, although the immature form shown on plate 29, figures 12, 13 possibly belongs to the species. Shell small, globose; whorls depressed ovate, wider than high, widest a little below middle of flanks, embracing nearly completely except on body whorl; flanks evenly convex, merging evenly into broadly rounded venter. Umbilicus extremely narrow, widening at anterior end of body chamber; wall low and rounding evenly into flanks. Body chamber represented by a little more than half a whorl. Aperture abruptly truncated.

The ribs on the penultimate whorl are broadly rounded and a little wider than the interspaces. On the last whorl the ribs become progressively higher and narrower than the interspaces and on the body chamber are prominent and widely separated. They bend backward on the umbilical wall, strongly forward on the lower half of the flank, then backward toward the venter but cross the venter transversely. Most of the ribs bifurcate at the top of the lower third of the flanks. In addition there are some intercalary ribs that begin along the zone of furcation.

The suture line is poorly preserved on the type specimens. On a small specimen (plate 29, figures 12, 13), which may be a young form of *X. hebetus*, the suture has very broad saddles and its first lateral lobe is much shorter than the external lobe.

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

Specimen	Diameter	Whorl height	Whorl thickness	Umbilical width
Paratype (pl. 29, figs. 6, 7)	46	23(0.50)	28 (0.60)	8 (0.17)
Holotype (pl. 29, figs. 8, 11)	33	20(.60)	25 (.76)	2 (.06)
Xenocephalites sp. juv. (pl. 29, figs. 12, 13)	17	9(.53)	12.5(.73)	1.5(.08)

This species is characterized by its globose form and by the ribbing of the body chamber becoming strongly flexuous, widely spaced, and prominent ventrally. It differs from *X. vicarius* Imlay by being more globose and more densely ribbed. *X. hebetus* compares closely in form and sculpture with *Xenocephalites neuquensis* (Stehn) (1924, p. 86, pl. 1, fig. 3, text fig. 11) from Argentina. The latter has slightly weaker ribbing and its umbilicus enlarges rapidly at the anterior end of the body whorl. This last feature cannot be proven for *X. hebetus* with the material in hand. *X. borealis* Spath (1932, p. 44, pl. 14, figs. 4a–d), from east Greenland, has much coarser ribbing than *X. hebetus* at a comparable size.

The small specimen, plate 29, figures 12, 13, differs from the immature forms of any species of *Cadoceras* known from Alaska by its smaller umbilicus, broader whorl section, and flexuous ribs that branch by twos and threes on the lower third of the flanks. Its lateral aspect is sphaeroceratid and thus quite different than that of the immature forms of *Pleurocephalites* figured by Spath (1928, p. 171, pl. 36, figs. 4–6). Its aspect is similar to some immature *Cranocephalites* from Alaska except that the latter have high, thin ribs.

Holotype, U.S.N.M. 108038; paratype, U.S.N.M. 108039.

Chinitna formation, near base, U.S.G.S. Mes. locs. 21329 and 22434.

Xenocephalites vicarius Imlay, n. sp.

Plate 28, figures 1–8

The Survey collections contain eight specimens of this species. Shell small, compressed in young, moderately inflated in adult; whorls ovate, wider than high, becoming depressed during growth, widest a little below the middle of the flanks, embracing nearly completely; flanks gently convex, venter evenly arched in young, becoming broadly arched on body whorl. Umbilicus extremely narrow, enlarging slightly at anterior end of body whorl; wall very low, vertical, and rounding evenly into flanks. Body chamber represented by three-fourths of a whorl. The aperture is inclined strongly forward and abruptly truncated.

The ribs on the inner whorls are fine, dense, and nearly radial. On the body whorl they become high and thick ventrally, widely spaced, strongly flexuous on the flanks, and arched forward gently on the venter. The thick ribs on the venter have longer posterior than anterior slopes. Some ribs remain simple, but most ribs branch slightly below the middle of the flanks. Some of the branch ribs are indistinctly connected with the primary ribs and, in places, unbranched ribs alternate with short ribs that begin near the middle of the flank.

The suture line is not preserved.

The holotype at a diameter of 33 mm has a whorl height of 17 mm, a whorl thickness of 19 mm, and an umbilical width of 3 mm.

This species is distinguished by the high, blunt, widely spaced ribs on its body whorl. *X. hebetus* Imlay has a more robust form and a more rapid change from fine to coarse ribbing. *X. nikitini* (Burckhardt, 1927, p. 33, pl. 16, figs. 4–9) has less dense ribbing and a more rounded whorl section. Reference to *Xenocephalites* rather than *Kamptocephalites* is indicated by the extremely narrow umbilicus, the depressed whorl section, the small size, and the early appearance of prominent, strongly flexuous ribs.

Holotype, U.S.N.M. 108041; paratypes, U.S.N.M. 108042–108044.

Chinitna formation, lower third, U.S.G.S. Mes. locs. 3028, 11041, 21321, 21329, 22437, 22438, and 22556.

Xenocephalites hartsocki Imlay, n. sp.

Plate 28, figures 9, 10, 12

The species is represented by three specimens. Form small, moderately inflated; whorls subquadrate, a little wider than high, widest slightly below the middle of the flanks, embracing nearly completely; flanks somewhat flattened on lower part, rounding evenly into broadly rounded venter. Umbilicus extremely narrow; wall low, rounding rapidly into flanks. Body chamber incomplete but represented by at least five-sixths of a whorl.

The ribs on the penultimate and body whorls are sharp and strongly flexuous. On the penultimate whorl they are closely spaced and have uniform steep slopes, but anteriorly on the body whorl they become widely spaced and develop vertical or overhanging posterior slopes. Most of the primary ribs branch a little below the middle of the flanks and many of the pairs of forked ribs are separated by single, short, intercalated ribs.

The suture line is poorly preserved.

The holotype at a diameter of 30 mm has a whorl height of 16 mm and a whorl thickness of 18 mm.

Compared with *Xenocephalites vicarius* Imlay this species is a little more inflated and has less prominent, less widely spaced ribbing on its body whorl. *X. parvus* var. *angustiumbilicatus* (Stehn) (1924, p. 92, pl. 1, fig. 6, text-fig. 13) from the Callovian of Argentina is very similar. It appears to have a stouter form and higher points of rib branching.

This species is named in honor of John K. Hartsock, of the Geological Survey, who has spent several summers studying the Jurassic in the Cook Inlet area.

Holotype, U.S.N.M. 108045; paratype, U.S.N.M. 108046.

Chinitna formation, lower two-fifths, U.S.G.S. Mes. locs. 21341 and 21349.

Genus Kheraiceras Spath 1924

Kheraiceras magniforme Imlay, n. sp.

Plate 31, figures 5–8

This species is based on five specimens including two adults. Shell globose; whorls depressed, much wider than high, widest at the top of the lower fourth of the flanks, embracing nearly completely except for body chamber; flanks evenly convex, merging gradually into broadly rounded venter. Umbilicus extremely small, but enlarging rapidly on anterior fourth of body whorl; wall fairly low and rounding evenly into flanks. Body chamber represented by about three-fifths of a whorl, hook-shaped in lateral view, depressed anteriorly but not constricted transversely. Aperture not perfectly preserved, but marked by an abrupt inward bending of the shell which probably was not followed by a swelling.

The ribs on the septate posterior part of the last whorl are low, rounded, a little narrower than the interspaces, and indistinct near the umbilicus. Anteriorly on the body chamber the ribs become progressively broader and more widely spaced and are rather prominent at the anterior end of the shell. The primary ribs begin on the upper part of the umbilical wall, incline forward slightly on the lower third of the flanks and then pass into two or three secondary ribs that curve forward gently near the middle of the flanks, but cross the venter transversely. Single intercalary ribs occur between most rib pairs.

The suture line is finely divided and shows the broad saddles and lobes characteristic of the genus. The general sutural pattern is similar to that of *Kheraiceras cosmopolita* (Parona and Bonarelli) figured by Spath (1928, pl. 47, fig. 6), although more complex and having a shorter first lateral lobe.

The holotype at a diameter of 79 mm has a whorl height of 47 mm and a whorl thickness of 66 mm. At the anterior end of the holotype the diameter is 95 mm, the whorl height 40 mm, and the whorl thickness 70 mm.

The septate portion of *K. magniforme* compares closely in size and shape with the septate holotype of *K.? globulatum* (Quenstedt) (1887, p. 661, pl. 78, fig. 2), but its ribbing appears to be much finer. *K. stansfieldi* Spath (1925, p. 15, pl. 1, figs. 2a, b) has a similar shape, but its ribs appear to be weaker and more inclined forward. *K. cosmopolita* (Parona and Bonarelli) (1897, p. 146; Waagen, 1875, p. 129, pl. 32, figs. 1a, b) has weaker ribbing and a narrowed body chamber.

Holotype, U.S.N.M. 108047.

The holotype was obtained from the Iliamna Bay area, but its exact location is unknown. It most likely came from the lower part of the Chinitna formation because all the other species assigned to *Kheraiceras* are from the lower two-thirds. Other specimens of *K. magniforme* are from the Chinitna formation at U.S.G.S. Mes. locs. 3028, 22427, and 22448.

Kheraiceras martini Imlay, n. sp.

Plate 32, figures 1, 4, 6

The species is represented for certain only by the holotype. Shell stout; whorls depressed, higher than wide, widest a little below the middle of the flanks, embracing nearly completely except for the body chamber; flanks evenly convex on penultimate whorl, becoming flattened on body chamber, merging evenly into broadly rounded venter. Umbilicus extremely small but enlarging rapidly on the anterior third of the body chamber; wall low, steep and rounding evenly into flanks. Body chamber represented by three-fourths of a whorl, hook-shaped in lateral view, depressed anteriorly but not constricted transversely. Aperture marked on flanks by a pronounced, forwardly inclined constriction that is followed by a slight swelling which terminates in a sharp edge.

The ribs on the septate posterior part of the last whorl are low, rounded, much narrower than the interspaces, and become stronger ventrally. Anteriorly on the body chamber the ribs become broader, more widely spaced, stronger on the flanks, but remain rather low on the venter. The primary ribs begin low on the umbilical wall, are nearly radial on the lower third of the flanks and pass into three or four secondary ribs that are likewise nearly radial. There are some intercalated ribs between the bundles of ribs.

The suture line is very complicated and not very well preserved. It appears to be very similar to that of *Kheraiceras magniforme* Imlay except that it is more frilled.

The holotype at a diameter of 108 mm has a whorl height of 57 mm, and a whorl thickness of 70 mm. A quarter of a whorl anteriorly the corresponding dimensions are 122, 61, and 72 mm. Near the end of the shell the corresponding dimensions are 121, 54, and 75 mm.

This species is distinguished from *K. magniforme* Imlay by its higher whorl section, longer body chamber, and finer ribbing on the body chamber.

This species is named in honor of George C. Martin, who spent many years studying the geology of Alaska.

Holotype, U.S.N.M. 108048.

Chinitna formation, basal beds, U.S.G.S. Mes. loc. 22446.

Kheraiceras abruptum Imlay, n. sp.

Plate 33, figures 1, 7, 11, 13

The species is represented by five adult specimens, of which the holotype has the most prominent ribbing. Shell stout; whorls depressed, wider than high, widest at the top of the lower fourth of the flank, embracing nearly completely except for the body chamber; flanks somewhat flattened in their lower parts, gently convex above and rounding evenly into broadly rounded venter. Umbilicus extremely small, but enlarging rapidly on anterior half of body chamber; wall very low, rounding evenly into flanks. Body chamber represented by about three-fourths of a whorl, depressed anteriorly but not constricted transversely. Aperture marked by a pronounced forwardly inclined constriction that is followed by a weak swelling.

The ribs on the penultimate whorl are moderately high, rounded, and are a little narrower than the interspaces. The primary ribs incline forward on the lower third of the flanks and pass into two, or three slightly weaker secondary ribs that curve forward strongly but cross the venter transversely. There are many intercalated ribs.

At the beginning of the body chamber the ribbing suddenly becomes much coarser and more widely spaced and the coarsening increases greatly anteriorly. Most of the primary ribs branch on the lower third of the flanks into two sharper secondary ribs, but some primary ribs do not branch. In addition single short ribs occur between most pairs of branched ribs.

The suture line is poorly preserved but the elements appear to be broad and shallow as in other species of *Kheraiceras*.

The holotype at a diameter of 120 mm has a whorl height of 61 mm. At the anterior end of the holotype the diameter is 139 mm and the whorl height is 53 mm.

This species is characterized by the coarse ribbing of its body chamber and by the abrupt change from fine to coarse ribbing at the beginning of the body chamber.

Holotype, U.S.N.M. 108049.

Chinitna formation, lower third, U.S.G.S. Mes. locs. 22433, 22428, and 22431; Shelikof formation, lower member, Mes. loc. 19793.

Kheraiceras varicostatum Imlay, n. sp.

Plate 33, figures 2, 4, 5

The species is represented by one specimen whose body whorl is much eroded on one side and on the venter. Shell globose; whorls depressed, much wider than high, widest at the top of the lower third of the flanks, embracing nearly completely except for body chamber; flanks evenly convex, merging gradually into broadly rounded venter. Umbilicus extremely small, but enlarging rapidly on anterior fourth of body whorl; wall moderate in height and rounding evenly into flanks. Body chamber represented by about three-fifths of a whorl, anterior half becoming rapidly evolute, depressed anteriorly but only slightly narrowed transversely. Aperture marked by a pronounced forwardly inclined constriction that is followed by a slight swelling.

The ribs on the septate posterior part of the last whorl are fine, rather widely spaced, and flexuous. The ribs curve backward on the umbilical wall, curve forward on the middle of the flanks, and then recurve slightly and cross the venter with only a gentle forward arching. The primary ribs divide into two slightly weaker secondaries at the top of the lower third of the flanks. Generally one of the secondaries is indistinctly connected. In addition most pairs of branched ribs are separated by intercalary ribs that begin along the zone of furcation. This results in about 3 secondary ribs for every primary. Anteriorly on the body chamber the ribs become progressively stronger and more widely spaced and are moderately prominent at the anterior end of the shell. Also, they become inclined more strongly forward.

The highly frilled suture line has even broader saddles than that of *K. magniforme* Imlay. The first lateral lobe is also more slender and longer. The general pattern greatly resembles that of the suture of a specimen of *Ammonites platystomus* Quenstedt (1887, pl. 78, fig. 25).

The holotype at a diameter of 65 mm has a whorl height of 32 mm and an estimated whorl thickness of 42 mm.

This species differs from *K. magniforme* by its much smaller size, its more widely spaced ribbing, and by its body chamber being less hook-like in lateral view. *K. cosmopolita* (Parona and Bonarelli) (Waagen, 1875, p. 129, pl. 32, fig. 1) has a more narrowed body chamber and weaker ribbing.

Holotype, U.S.N.M. 108050.

Chinitna formation, base of middle third, U.S.G.S. Mes. loc. 20760.

Kheraiceras intermedium Imlay, n. sp.

Plate 31, figures 1–4; plate 32, figures 2, 3, 5, 7, 8

The species is based on four specimens, including three adults. Shell medium stout; whorls ovate depressed, wider than high, widest on the lower fourth of the flanks, embracing considerably; flanks gently convex, merging into evenly rounded venter. Umbilicus small; wall low and rounding evenly into flanks. Body chamber represented by three-fifths of a whorl, not depressed anteriorly. Aperture on internal mold marked by a deep, forwardly inclined constriction followed by a gentle swelling.

The ribs on the penultimate whorl are narrow, are separated by somewhat wider interspaces, incline forward gently on the flanks, and arch forward slightly on the venter. Most of the primary ribs bifurcate below the middle of the flanks, but some remain simple and some are indistinctly connected with secondary ribs. Other ribs arise along the zone of furcation resulting in nearly three secondary ribs for every primary. On the body chamber the ribs are low, narrow, and fairly widely spaced. They incline backward on the umbilical wall and incline forward gently on the flanks and venter. Most of the primary ribs bifurcate at the top of the lower two-fifths of the flanks and about half of the rib pairs are separated by intercalary ribs.

The suture line, fairly well-preserved on the holotype, is similar to that on *K. magniforme* Imlay, but has broader saddles and is somewhat less frilled.

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

Specimens	Diameter	Whorl height	Whorl thickness	Umbilical width
Holotype (pl. 31, figs. 3, 4)	73	41(0.56)	44(0.60)	3(0.04)
Holotype (pl. 31, figs. 3, 4)	86	43(.50)	50(.58)	12(.14)
Paratype (pl. 31, figs. 1, 2)	69	37(.53)	39(.56)	?
Paratype (pl. 32, figs. 7, 8)	62?	26(.39)	31(.46)	?

This species is distinguished from most of the species of *Kheraiceras* described herein by its much less inflated form and its weaker ribbing. *K.? parviforme* Imlay is more compressed. Inclusion of *K. intermedium* in the genus *Kheraiceras* is indicated by its small umbilicus, contracting body whorl, and pronounced apertural constriction. Furthermore, similarly compressed forms have been referred to *K. quenstedti* (J. Roemer) (1911, p. 42; Spath, 1925, p. 16; Quenstedt, 1887, pl. 77, figs. 7, 8) and *K. microstoma* (Quenstedt) (1887, pl. 78, fig. 5) (non d'Orbigny). The latter appears to differ from *K. intermedium* mainly in its smaller size and narrowed body chamber.

Holotype, U.S.N.M. 108223; paratypes, U.S.N.M. 108051, 108224, 108225.

Chinitna formation, lower third, U.S.G.S. Mes. locs. 21272, 21273, and 21334.

Kheraiceras? parviforme Imlay, n. sp.

Plate 33, figures 3, 6, 8–10, 12

This species is represented by 17 specimens, of which 3 have complete body chambers. Shell small, compressed; whorls subquadrate, height and thickness nearly equal, widest a little below the middle of the flanks, embracing about five-sixths except for the body whorl which gradually becomes less involute and at the end of the shell embraces only about three-fifths of the preceding whorl; flanks flattened, passing rather abruptly into the umbilical wall and into the nearly flat venter. Umbilicus very small, but enlarging appreciably on the body whorl; wall low and vertical; edge fairly abrupt. Body chamber represented by about five-sixths of a whorl that is not depressed or constricted anteriorly. Aperture marked by a forwardly inclined constriction that is pronounced on the flanks and faint on the venter. This is followed on the flanks by a sharp rib that is prolonged dorsally (plate 33, figures 6, 8). On the venter the faint constriction is followed by one or two ribs that are slightly weaker than the preceding ribs on the venter.

The ribs are narrow, fairly prominent, flexuous, and are separated by somewhat wider interspaces. They curve backward on the umbilical wall, curve forward rather strongly on the lower part of the flanks, recurve slightly on the upper part of the flanks, and arch forward gently on the venter. During growth they become gradually more prominent and more widely spaced. Part of the primary ribs bifurcate at about the top of the lower two-fifths of the flanks. Other primary ribs remain simple, or are indistinctly connected with secondary ribs. In places there appears regular alternation of simple ribs with short intercalary ribs that arise along the zone of furcation. Secondary ribs outnumber the primary ribs by 2½ times on the body whorl.

The suture line is not well preserved.

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

Specimen	Diameter	Whorl height	Whorl thickness	Umbilical width
Paratype (pl. 33, fig. 3)	14	7 (0.50)	7 (0.50)	2 (0.14)
Paratype (pl. 33, fig. 12)	19.5	9.5(.48)	9 (.46)	2.5(.12)
Holotype (pl. 33, figs. 8-10)	22	10.5(.48)	11 (.50)	4 (.18)
Holotype (pl. 33, figs. 8-10)	27	11.5(.43)	12.5(.46)	5 (.18)

This species is questionably assigned to *Kheraiceras* because it is more compressed than any known species of that genus. However, such features as its deep apertural constriction and its small umbilicus that enlarges rapidly on the body whorl suggest a close relationship with the Alaskan forms herein assigned to *Kheraiceras*. It resembles *K.? bombur* (Oppel) (1862, p. 150, pl. 48, figs. 3a, b; Quenstedt, 1887, pl. 78, figs. 12, 13) in size and sculpture, but is much more compressed.

Holotype, U.S.N.M. 108052; paratypes, U.S.N.M. 108053 a, b, c.

Chinitna formation, lower third, at U.S.G.S. Mes. locs. 21334 and 22427.

Genus Cadoceras Fischer 1882

Subgenus Cadoceras, sensu stricto

Cadoceras catostoma Pompeckj

Plate 34, figures 1–14

Cadoceras catostoma Pompeckj, Russ. K. min. Gesell. St. Petersburg Verh., ser. 2, Band 38, pp. 263–265, pl. 5, figs. 1a–e, 2a, b, 1900.

The Survey collections contain 48 specimens of this species. Shell compressed in young, moderately inflated in adult; whorls ovate in young, slightly higher than wide, becoming wider than high in adult, widest at the umbilical edge, embracing about one-half on inner whorls and three-fourths on outer whorls; flanks nearly flat in young, becoming convex in intermediate growth stages, and not separable from venter in adult; venter highly arched in young, becoming broad in adult. Umbilicus fairly narrow, step-like in young, funnel shaped in adult; wall very steep, low on young forms, then, fairly high, but becoming low again near aperture; edge evenly rounded in young, becoming sharp in adult. Body chamber represented by about five-sixths of a whorl.

The ribs on the inner whorls are high, sharp, moderately-spaced, incline strongly forward on the flanks, arch gently forward on the venter, and generally bifurcate a little below the middle of the flanks. Some of the furcation points are indistinct and about every third rib is single. During growth the ribs become broader and lower on the venter and flanks but become elevated on the umbilical edge as comma-shaped swellings that persist to the aperture. At or near the beginning of the body chamber the ribs weaken suddenly and nearly disappear for about one-third of a whorl. They then suddenly reappear and are very strong on the anterior part of the body chamber. The aperture is marked by a pronounced forwardly inclined constriction followed by a low swelling that projects forward considerably on the venter.

The suture line is typical of the genus and has been well described by Pompeckj.

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

Specimen	Diameter	Whorl height	Whorl thickness	Umbilical width
Plesiotype (pl. 34, figs. 2, 3)	32	13(0.40)	12.5(0.39)	10(0.31)
Plesiotype (pl. 34, figs. 7, 13)	57	23(.40)	33 (.57)	18(.31)
Plesiotype (pl. 34, figs. 1, 4)	88	35(.39)	?	27(.30)
Plesiotype (pl. 34, figs. 12, 14)	103	45(.43)	55 (.53)	33(.32)

This species is characterized by the high, sharp ribbing of its inner whorls, by the rather abrupt disappearance of ribbing near the beginning of the body chamber, by the abrupt reappearance of ribbing on the anterior part of the body chamber, and by the outer whorls being much more involute than the inner whorls. Of the associated Alaskan species it is most similar to *C. comma*, but is readily distinguished by its coarser ribbing and less inflated form. *C. simulans* Spath (1932, p. 61; Nikitin, 1885, p. 52, pl. 11), from Russia, has similar ribbing but is much more inflated. The small forms of *C. catostoma* have ribbing similar to that of *C. elatmae* Nikitin (1881b, pl. 11, figs. 20–22; 1885, pl. 10, fig. 47) or of *C. crassum* Madsen (1904, p. 193, pl. 9, figs. 1–3, pl. 10, fig. 1), but the medium and large forms develop a distinct umbilical rim which is not present in these species. *Cadoceras quenstedti* Spath (1932, p. 49, Quenstedt, 1887, p. 672, pl. 79, fig. 7) is similar to *C. catostoma* in lateral view but has a stouter form.

Plesiotypes, U.S.N.M. 108054a, b, c, 108055a, b, 108056.

Chinitna formation, lower two-thirds, U.S.G.S. Mes. locs. 2707, 2921, 3020, 3028, 3029, 11052a, 21288, 21348, 21349, 22419, 22430, 22432, and 22437. Shelikof formation, lower member, locs. 10803, 21359, and 22132.

Cadoceras comma Imlay, n. sp.

Plate 35, figures 1–8; plate 36, figures 1–5

This species is represented by about 80 specimens, representing various growth stages.

Shell moderately inflated in young, globose in adult; whorls ovate in young, much depressed in adult, widest at the umbilical edge, embracing about four-fifths; flanks gently convex in young, not separable from venter in adult; venter evenly arched in young, becoming broad in adult. Umbilicus fairly narrow, step-like in young, becoming funnel-shaped in adult; wall steep and fairly high; edge fairly abrupt in young, becoming sharp in adult. Body chamber represented by about five-sixths of a whorl.

The ribs are strong and widely spaced on the small and intermediate sized whorls up to a diameter of about 6.3 cm. They then begin to disappear first on the venter and then on the flanks and are replaced on the penultimate and body whorls by many, fine, forwardly inclined striae. The ribs are nearly radial on the upper part of the umbilical wall, bend abruptly forward just above the umbilical edge, and are arched forward gently on the venter. On the young the ribs are sharp on the upper part of the umbilical wall and on the lower part of the flanks and bifurcate on the lower third of the flanks into broad, strong secondaries. During growth the ribs become higher and sharper on the umbilical edge, broader and lower on the flanks and venter, the furcation points become indistinct, and some of the forked ribs are separated by intercalary ribs. Continuation of this change results in the last two whorls being nearly smooth except for lines of growth and for rather conspicuous comma-shaped umbilical swellings that persists nearly to the anterior end of the body chamber. The aperture is marked on the internal mold by a pronounced forwardly inclined constriction followed by a low swelling that projects forward on the venter.

The suture line is similar to that of *C. catostoma* Pompeckj except that the second lateral lobe is nearly as long as the external lobe and much longer than in most species of *Cadoceras*.

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

Specimen	Diameter	Whorl height	Whorl thickness	Umbilical width
Paratype (pl. 35, figs. 4, 5)	31	13.5(0.43)	15(0.48)	8(0.26)
Paratype, (pl. 35, figs. 7, 8)	44	21 (.47)	30(.68)	13(.29)
Paratype, (pl. 36, fig. 5)	62	25 (.40)	40(.64)	18(.29)
Holotype (pl. 36, figs. 1, 2)	75	32 (.42)	53(.70)	25(.33)
Paratype (pl. 35, fig. 6)	130	58 (.44)	73(.56)	39(.30)

This species is characterized by its globose, coronate form, by coarse ribbing that passes into striae on the last two whorls, and by the persistence of comma-shaped swellings on the umbilical edge. It differs from *C. catostoma* Pompeckj by being more inflated at all growth stages and by having lower, weaker ribbing that disappears earlier. Its ribbing is intermediate in strength between *C. catostoma Pompeckj* and *C. glabrum* Imlay, n. sp. Its general appearance is very similar to *C. simulans* Spath (1932, p. 61; Nikitin, 1885, p. 52, pl. 11), but its form is much less globose. *C. sublaeve* var. *rugosum* Spath (1932, p. 60; Buckman, 1922, vol. 4, pl. 275) is more coarsely ribbed, the ribs are more persistent, and the form is more inflated.

Holotype, U.S.N.M. 108057; paratypes, U.S.N.M. 108058a, b, 108059a, b, c, 108060–108063.

Chinitna formation, lower two-thirds, U.S.G.S. Mes. locs. 2921, 3020, 3028, 3029, 3042, 10989, 11052, 20759, 21338, 21339, 21344, 21348, 21349, 21781, 22425, 22432–22435, 22438, and 22452; Shelikof formation, lower member at Mes. locs. 19781 and 19911.

Cadoceras glabrum Imlay, n. sp.

Plate 36, figure 6; plate 37, figures 1–9

This species is represented by 40 specimens, including 6 that are less than 2½ cm in diameter and 8 are adult specimens more than 10 cm in diameter.

Shell compressed in young, moderately inflated in adult; whorls ovate in young, depressed in adult, widest at the umbilical edge, embracing about five-sixths; flanks evenly convex in young, not separable from venter in adult; venter evenly arched in young, becoming fairly broad in adult. Umbilicus fairly narrow, funnel-shaped; wall steep and moderately high, becoming lower on the body whorl; edge evenly rounded in young, becoming sharp on the outer three whorls. Body chamber represented by nearly a complete whorl, anterior third withdrawn slightly from umbilical edge of preceding whorl.

The ornamentation of the inner whorls up to a diameter of about 50 mm consists of moderately strong ribs that are radial on the upper part of the umbilical wall, incline strongly forward on the lower part of the flanks, and arch forward gently on the venter. They are high and sharp on the umbilical edge and low and broad on the venter. Bifurcation occurs between the lower third and lower two-fifths of the flank, but at diameters greater than 30 mm the furcation points are indistinct. In addition there are a number of intercalary ribs. At diameters greater than 50 mm the ribbing disappears rapidly from the venter and flanks, and at diameters greater than 70 mm the shell is smooth. The outermost whorl is marked only by weak growth striae. The aperture is marked by a shallow, forwardly inclined constriction followed by a low swelling. Two similar constrictions occur on the sutured part of the holotype. One constriction is about four-fifths of a whorl posterior to the beginning of the body chamber. The other constriction (plate 37, figure 5) occurs about one and one-quarter whorls posterior to the first.

The suture line is rather deeply dissected as compared with *C. comma* Imlay and is similar to the suture of *C. catostoma* Pompeckj. Its first lateral lobe is much longer than the external lobe and the second lateral lobe is much shorter.

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

Specimen	Diameter	Whorl height	Whorl thickness	Umbilical width
Holotype (pl. 37, figs. 8, 9)	94	37(0.39)	66(0.70)	32(0.34)
Paratype (pl. 37, fig. 2)	57	22(.38)	35(.61)	16(.28)
Paratype (pl. 37, fig. 3)	80	33(.41)	52(.65)	22(.27)
Paratype (pl. 36, fig. 6)	130	47(.36)	?	50(.38)

This species is characterized by becoming smooth at a fairly small size. It resembles *Cadoceras comma* Imlay in shape, but may be distinguished by finer, sharper ribbing on its inner whorls and by much earlier loss of ornamentation. *C. wosnessenski* (Grewingk) is more compressed and has coarser ribbing that persists to the body whorl. *C. doroschini* (Eichwald) is more compressed, has finer, more persistent ribbing, and its umbilicus is step-like instead of funnel-like. *C. tschernyschewi* Sokolov (1912, p. 51, pl. 1, fig. 2; pl. 2, fig. 1) has coarser ribbing and more persistent umbilical swellings. *C. sysolae* Khudyaev (1927, pp. 506, 519, pl. 27, figs. 1, 2, 2 text-figs.) appears to have a lower whorl section, but comparisons are difficult because the ornamentation of its inner whorls is unknown.

Holotype, U.S.N.M. 108064; paratypes, U.S.N.M. 108065a, b, c, 108066, 108067.

Chinitna formation, middle third, U.S.G.S. Mes. locs. 2921, 3028, 3029, 20761, 21774, 22422, and 22432 on the Iniskin Peninsula and from loc. 8571 in the Matanuska Valley. Shelikof formation, lower member, at Mes. loc. 19781.

Cadoceras bathomphalum Imlay, n. sp.

Plate 38, figures 1, 5, 6

This species is described on the basis of only one specimen, and it is broken across the middle in such a manner as to expose a great deal of the inner whorls. Shell globular; whorls depressed, much wider than high, becoming more depressed during growth, embracing about five-sixths; flanks and venter not separable, forming together a broad low arch. Umbilicus fairly narrow, funnel-like; wall high, vertical at base, steeply inclined above; edge abrupt on smallest whorls, sharp on intermediate and large whorls. Body chamber not preserved.

On the inner whorls up to a diameter of about 55 mm the ribs are radial on the upper part of the umbilical wall and curve gently forward on the combined flanks and venter. The ribs are broad, rounded, rather low, and strongest along the midventral line, and are separated by much narrower interspaces. They are swollen on the umbilical edge and then bifurcate or trifurcate. On the outermost whorl, which is probably the penultimate, the ornamentation consists of comma-shaped swellings on the umbilical edge and of faint, broad, forwardly arched swells on the venter. On these swells are superimposed weak striae.

The suture line is unknown.

The dimensions of the holotype in millimeters and ratios of the diameters are as follows:

Specimen	Diameter	Whorl height	Whorl thickness	Umbilical width
Holotype (pl. 38, figs. 1, 5, 6)	55	26(0.47)	46(0.83)	12 (0.22)
Holotype	67	30(.44)	64(.95)	15.5(.23)
Holotype	79	36(.45)	75(.95)	20 (.25)

This species is characterized by its broad, low whorl section and deep narrow umbilicus. None of the associated Alaskan species resembles it closely. Its shape is very much like *Cadoceras orbis* Spath (1932, p. 61, D'Orbigny, 1847, p. 468, pl. 170), but it has a smaller, deeper umbilicus, a sharper umbilical edge, and apparently coarser ribbing. *C. tolype* Buckman (1923, pl. 406) has coarser ribbing and a less sharp umbilical edge. *C. sublaeve* (J. Sowerby) (1814, p. 117, pl. 54) has a very similar form but is reported to have a nodate umbilical rim on the immature whorls.

Holotype, U.S.N.M. 108068.

Shelikof formation, lower member, U.S.G.S. Mes. loc. 12408. Small immature forms possibly belonging to this species occur in the Shelikof formation at U.S.G.S. Mes. loc. 12387, and in the lower part of the Chinitna formation at U.S.G.S. Mes. locs. 3029, 21343, and 21348.

Cadoceras tenuicostatum Imlay, n. sp.

Plate 38, figures 2–4, 7–12

This species is represented by 33 specimens. Shell discoidal, moderately compressed; whorls ovate, width and height about equal in small forms, much wider than high in the intermediate and adult forms, widest at the umbilical edge, embracing about four-fifths; flanks gently convex in young, becoming broadly rounded in adult; venter evenly rounded, becoming broader during growth. Umbilicus fairly narrow, step-like; wall steep and moderate in height; edge fairly abrupt in young, becoming sharp in the adult. Body chamber represented by three-fourths of a whorl.

On the smallest whorls (plate 38, figures 3, 4, 10, 11) the ribs are thin on the flanks, thick on the venter, and moderate in height and density. They are radial on the upper part of the umbilical wall, incline gently forward on the flanks, and arch forward slightly on the venter. They are slightly swollen on the umbilical edge but do not give rise to tubercles. Most ribs bifurcate on the lower third of the flanks. Intercalary ribs are common. On the larger whorls the ribs become finer and closer-spaced anteriorly and on the penultimate whorl are scarcely stronger than striae. The weak umbilical swellings persists to about the middle of the penultimate whorl. The body whorl is nearly smooth, being marked only on the venter by faint striae that arch strongly forward. The aperture is marked on the internal mold by a pronounced forwardly inclined constriction that is followed by a prominent swelling.

The suture line is typical of the genus. The first lateral lobe is as long as the external lobe. The second lateral lobe is much shorter. The external and first lateral saddles are asymmetrically divided.

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

Specimens	Diameter	Whorl height	Whorl thickness	Umbilical width
Paratype (pl. 38, figs. 10, 11)	34	16 (0.47)	16(0.47)	5.5(0.13)
Paratype (pl. 38, figs. 3, 4)	43	19.5(.45)	20(.46)	8.5(.20)
Paratype (pl. 38, fig. 2)	66	29 (.44)	38(.57)	17 (.25)
Holotype (pl. 38, figs. 8, 9)	83	37 (.44)	53(.64)	22 (.26)
Holotype (pl. 38, fig. 12)	106	49 (.46)	58(.55)	26 (.24)

Compared with *Cadoceras doroschini* (Eichwald) this species has a thicker whorl section and much finer ribbing. *C. milaschevici* (Nikitin) (1881a, p. 66, pl. 3, figs. 25–27; 1881b, p. 121, pl. 12, figs. 26, 27) has a higher trigonal whorl section. *C. tchefkini* (D'Orbigny) (1845, p. 439, pl. 35, figs. 10–15; Nikitin, 1881a, p. 64, pl. 3, figs. 21–23) is much more inflated.

Holotype, U.S.N.M. 108069; paratypes, U.S.N.M. 108070–108073.

Chinitna formation, lower part of upper half, U.S.G.S. Mes. locs. 2921, 3029, 3030, and 20763. Shelikof formation, lower and middle members, at locs. 3103, 3106, 3113, 10818, and 21356.

Cadoceras doroschini (Eichwald)

Plate 39, figures 1–12

Ammonites doroschini Eichwald, Halbinsel Mangischlak und die Aleutischen Inseln, pp. 138–142, pl. 7, fig. 6, pl. 8, figs. 1–2, 1871.

The Survey collections contain 31 specimens that are referable to this species. In addition there are specimens less than 2½ cm. in diameter that may belong to the species. Shell discoidal, compressed in young, becoming moderately inflated in adult; whorls subquadrate in young, depressed ovate in adult, as high as wide in the small forms, much wider than high in the intermediate and adult forms, widest at the umbilical edge, embracing about four-fifths; flanks flattened in young, evenly convex in adult; venter evenly rounded, becoming broader during growth. Umbilicus fairly narrow, step-like, wall steep and moderate in height; edge fairly abrupt in young, becoming sharp in the adult. Body chamber represented by about three-fourths of a whorl.

The ribs are moderate in strength and density on the inner whorls, diminish gradually in strength on the penultimate whorl, and are completely lacking on most of the body whorl. The ribs are nearly radial on the upper part of the umbilical wall, are swollen slightly on the umbilical edge, incline forward gently on the flanks, and arch forward a little on the venter. Most ribs bifurcate on the lower third or fourth of the flank, but a few ribs remain simple. There are a few intercalary ribs that begin on the lower third of the flanks. The ribs begin to disappear first on the lower third of the flanks and then on the venter. The weak swellings on the umbilical edge persist as far as the posterior end of the body chamber. The aperture is marked on the internal mold by a pronounced forwardly inclined constriction followed by a prominent swelling that projects forward on the venter.

The suture line greatly resembles that of *C. tenuicostatum* Imlay.

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

Specimen	Diameter	Whorl height	Whorl thickness	Umbilical width
Plesiotype (pl. 39, fig. 5)	37	17(0.46)	14(0.38)	7.5(0.20)
Plesiotype (pl. 39, figs. 8, 9)	42	20(.47)	18(.43)	8.5(.20)
Plesiotype (pl. 39, fig. 11)	67	29(.43)	39(.58)	18 (.27)

This species differs from *C. stenoloboide* Pompeckj by its lower whorl section, slightly wider and deeper umbilicus, and more pronounced apertural constriction. Identity with the forms that Eichwald assigned to *A. doroschini* is indicated by the moderately compressed form, deep apertural constriction, the small, step-like umbilicus, and the presence of small umbilical swellings on the inner whorls. The only other species in the Alaskan collections with this combination of characters is *C. tenuicostatum* Imlay, described herein, which differs from *C. doroschini* (Eichwald) by being a little more inflated and by having much finer ribbing. Eichwald (1871, p. 142) notes that the young individual of *C. doroschini* differs from *C. wosnessenskii* (Grewingk) (1850, p. 344, pl. 4, figs. 1a–d) by having a step-like umbilicus, forwardly arched instead of straight, inclined ribs, and knots on the umbilical edge. Pompeckj (1900, pp. 253, 254) considers that the small specimen which Eichwald (1871, pl. 8, fig. 2) assigned to *C. doroschini* resembles *C. wosnessenskii* much more than the large, flatter specimen that Eichwald (1871, pl. 7, fig. 6, pl. 8, fig. 1) likewise assigns to *C. doroschini*, but that Eichwald's descriptions and remarks are not precise enough to permit comparisons. Material now in hand indicates that the immature forms of *C. doroschini* are finer-ribbed and less stout than those of *C. wosnessenskii* and that the adult body whorl of *C. doroschini* differs from the comparable whorl of *C. wosnessenskii* by having a narrower umbilicus, a thinner whorl section, a less distinct unbilical edge, and by a complete loss of ornamentation.

Plesiotypes, U.S.N.M. 108074a, b, c, 108075a, b, 108076.

Shelikof formation, middle member, at U.S.G.S. Mes. locs. 3113 and 12387. Chinitna formation, middle third and lower part of upper third, Mes. locs. 2941, 3018, 3028, 3029, 3030, 3700, 20763, 21344, and 22435.

Cadoceras wosnessenskii (Grewingk)

Plate 40, figures 1–12

Ammonites wosnessenskii Grewingk, Russ. K. Min. Gesell. St. Petersburg Verh. 1848–1849, p. 344, pl. 4, figs. 1a–d, 1850.
Cadoceras wosnessenskii Pompeckj, Russ. K. Min. Gesell. St. Petersburg. Verh., ser. 2, Band 38, pp. 251–254, pl. 5, fig. 5a–c, 1900.

The Survey collections contain 75 specimens of this species, including 11 that are less than 2½ cm in diameter and 3 that exceed 10 cm in diameter.

Shell compressed in young, becoming moderately inflated in adult; whorls ovate, slightly wider than high in young, becoming much wider than high in adult, widest at the umbilical edge, embracing about four-fifths; flanks slightly convex in young, evenly convex in adult; venter evenly rounded, becoming broader during growth. Umbilicus fairly narrow, step-like on inner whorls; wall fairly steep and moderately high on body whorl; edge evenly rounded in young, becoming fairly abrupt in adult. Body chamber represented by about five-sixths of a whorl.

The ribs are fairly strong and fairly widely spaced on the young and intermediate-size whorls up to a diameter of about 7½ cm. At greater diameters they begin to disappear on the venter but remain fairly strong on the flanks as far as the body whorl. The ribs are nearly radial on the upper part of the umbilical wall, bend abruptly forward just above the umbilical edge, and are arched forward gently on the venter. On the young the ribs are fairly sharp on the upper part of the umbilical wall and on the lower part of the flanks and bifurcate on the lower two-fifths of the flanks into slightly weaker secondaries that broaden and become lower on the venter. During growth the ribs become higher and sharper on the umbilical wall, broader and lower on the flanks and venter, the furcation points become indistinct, and a few intercalary ribs appear. The anterior two-thirds of the body whorl is nearly smooth except for lines of growth and for persistent, small, comma-shaped umbilical swelling. The aperture is marked on the internal mold by a forwardly inclined constriction followed by a low swelling that projects forward on the venter.

The suture line is similar to that of *C. doroschini* (Eichwald) and *C. tenuicostatum* Imlay, previously described.

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

Specimen	Diameter	Whorl height	Whorl thickness	Umbilical width
Plesiotype (pl. 40, fig. 8)	32	14 (0.43)	15.5(0.48)	8.5(0.26)
Plesiotype (pl. 40, figs. 5, 6)	48	21.5(.45)	24 (.50)	11 (.23)
Plesiotype (pl. 40, figs. 2, 3)	65	31 (.47)	36 (.55)	15 (.23)
Plesiotype (pl. 40, figs. 9, 12)	114	44 (.38)	54 (.47)	33 (.29)
Holotype	48	21.5(.45)	27 (.56)	9.5(20)

This species resembles *C. comma* Imlay in the persistence of comma-shaped umbilical swellings, but may be distinguished by its more compressed form, more narrow ubilicus, and finer, closer-spaced ribbing that persists to a later growth stage. The immature forms have ribbing similar to that of *C. victor* Spath (1932, p. 67, pl. 16, figs. 6a-c), but their umbilicus is smaller and their whorls more compressed.

Plesiotypes, U.S.N.M. 108077a, b, c, 108078a, b, 108079, 108080.

Chinitna formation, middle two-thirds, U.S.G.S. Mes. locs. 2921, 3018, 3029, 3042, 10982, 20763, 21344, 21348, 22411, 22421, 22434, and 22435. Shelikof formation, lower member, at locs. 19781, 19873, 21359, and 21360. The holotype is reported to have been obtained in the Shelikof formation on the Alaskan Peninsula west of Sutwik Island, which is presumably in the Chignik Bay area.

Cadoceras kialagvikense Imlay, n. sp.

Plate 41, figures 1–7

Cadoceras doroschini Kellum, Daviess and Swinney (not Eichwald) Geology and oil possibilities of the southwestern part of the Wide Bay anticline, Alaska: U. S. Geol. Survey Pub., figs. 8a, b, 1945.

Four specimens of this species, including two adults are available in the Alaskan collections.

Shell stout at diameters greater than 4 cm; whorls broadly ovate, much wider than high, becoming wider during growth, widest at the umbilical edge, embracing about three-fourths on inner whorls and five-sixths on body whorl; flanks evenly convex; venter broadly rounded. Umbilicus narrow, steplike on inner whorls, funnellike on outer two whorls; wall very steep and fairly high, becoming lower and much less steep near aperture; edge abruptly rounded in young, becoming sharp on outer two whorls. Body chamber represented by five-sixths of a whorl. Aperture marked on internal mold by a fairly deep, forwardly inclined constriction that is followed by a fairly broad swelling.

The ribs are fairly strong on the inner whorls, but begin to weaken ventrally on the anterior part of the penultimate whorl. On the body whorl they are indistinct on the venter and weak on the flanks. The ribs are radial on the upper part of the umbilical wall, incline forward gently on the flanks and arch forward on the venter. On the innermost whorls the ribs are moderate in strength and a little narrower than the interspaces. Anteriorly they become broader and lower, but remain somewhat narrower than the interspaces. On the inner whorls the ribs are only slightly higher on the umbilical edge than on the flanks. On the outer two whorls the ribs rise on the umbilical edge into distinct comma-shaped swellings that persist to the aperture.

The suture line rivals in complexity that of *C. stenolobum* (Keyserling) in Nikitin (1881b, pl. 12 (5), fig. 30). The first lateral lobe is a little deeper than the external lobe. The second lateral lobe is much shorter. The umbilical edge passes through the inner branch of the second lateral saddle.

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

Specimen	Diameter	Whorl height	Whorl thickness	Umbilical width
Holotype (pl. 41, figs. 1–3)	57	26(0.45)	35?(0.61)	10(0.17)
Paratype (pl. 41, figs. 5, 6)	93	38(.41)	64 (.68)	20(.21)
Paratype (pl. 41, figs. 5, 6)	121	56(.46)	?	28(.23)

This species is much stouter than *C. doroschini* (Eichwald), has coarser, more persistent ribbing, and the umbilicus is deeper and more funnel-shaped. Compared with *C. wosnessenskii* (Grewingk), it is appreciably stouter and has a narrower, deeper umbilicus. *C. comma* Imlay has a much wider umbilicus and loses its ribbing earlier. The inner whorls of *C. kialagvikense* greatly resemble the inner whorls of *C. sublaeve* var. *rugosum* Spath (1932, p. 60; Buckman, 1922, pl. 275) in stoutness and shape, but the body whorl is much less depressed and the umbilical wall is lower.

Holotype, U.S.N.M. 108081; paratypes, U.S.N.M. 108082, 108083.

Chinitna formation, middle third, U.S.G.S. Mes. locs. 20763 and 21345; Shelikof formation, lower member, Mes. locs. 12408 and 19744.

Subgenus Paracadoceras Crickmay 1930

Cadoceras (Paracadoceras) moffiti Imlay, n. sp.

Plate 42, figures 3, 4, 9

This species is represented by a specimen that shows the penultimate whorl and part of the body whorl. The specimen was originally in a concretion but was partly exposed to weathering before it was collected. It was probably compressed slightly after burial.

Shell compressed; whorls ovate, wider than high in adult, widest at the umbilical edge, embracing about three-fourths; flanks of outer two whorls gently convex; venter evenly arched, becoming broader during growth. Umbilicus moderate in width; wall fairly low, steep; edge abrupt on outer two whorls. Body chamber incomplete, but represented by at least half a whorl.

The ribs on the penultimate whorl incline backward on the umbilical wall, recurve on the umbilical edge, incline forward moderately on the flanks, and arch forward gently on the venter. They are moderately spaced, coarse, highest on the umbilical edge, broadest and lowest on the venter. Some ribs remain simple, but most ribs branch on the lower third of the flanks. Anteriorly the furcation points become indistinct. There are a few intercalary ribs that extend below the middle of the flanks. On the body whorl the primary ribs become high, widely spaced, and strongly inclined forward; the secondary ribs become very weak and outnumber the primaries 3 to 1; and the umbilical wall becomes nearly smooth.

The suture line is poorly preserved.

The holotype at a diameter of 83 mm has a whorl height of 32 mm, an umbilical width of 25 mm, and an estimated whorl thickness of 47 mm.

The penultimate whorl of this species has some resemblances to the whorls at a comparable diameter on *C. catostoma* Pompeckj, but its ribbing is much coarser. The body whorl is distinguished from that of any other *Cadoceras* in Alaska by having prominent, strongly inclined, widely spaced primary ribs. Among European forms it shows some resemblance to *C. elatmae* (Nikitin) (1881b, p. 116, pl. 11, figs. 20, 21, 23; 1885, p. 54, pl. 10, fig. 47) but has stronger, more widely spaced, more persistent ribbing, a narrower umbilicus, and a more compressed form.

This species is named in honor of F. H. Moffit, who has spent more than forty years studying the geology of Alaska.

Holotype, U.S.N.M. 108084.

Chinitna formation, top of lower third, U.S.G.S. Mes. loc. 10986.

Cadoceras (Paracadoceras) multiforme Imlay, n. sp.

Plate 42, figures 1, 2, 5–8, 10

This species is represented by six specimens. Shell compressed in young, higher than wide, becoming much wider than high in adult; widest a little below middle in young, becoming widest at umbilical edge in intermediate and adult forms; embracing about two-fifths on innermost whorls, about three-fifths on adult whorls. Flanks on innermost whorls rather high and flat, rounding evenly into highly-arched venter; on intermediate and adult whorls the flanks are convex and round evenly into a broadly arched venter. Umbilicus wide for genus; wall on innermost whorls is low, vertical, and rounds evenly into flanks; wall on intermediate and outer whorls is fairly high, steep, and rounds sharply into flanks. Body chamber represented by five-sixths of a whorl. Aperture marked on internal mold by a broad, shallow forwardly inclined constriction. The anterior part of the body whorl contracts slightly from the preceding whorl, resulting in an umbilical enlargement.

The inner whorls at diameters less than 30 mm closely resemble *Pseudocadoceras grewingki* (Pompeckj) in ribbing and proportions. The ribs are narrow, moderately spaced, and stronger on the venter than on the flanks. They are radial on the umbilical wall, inclined forward moderately on the flanks, and arch forward on the venter. They are inflected gently forward below the middle of the flanks along the zone of furcation. Single ribs outnumber forked ribs. There are a few short intercalated ribs, and many of the secondary ribs are indistinctly connected with primary ribs. The ribs are swollen at the points of furcation but not tuberculated. Compared with *Pseudocadoceras grewingki* (Pompeckj) the ribs are less prominent, bifurcate lower on the flanks, and bifurcate less frequently. The ribbing at this size also resembles that on the inner whorls of *C. frearsi* (Nikitin) (1881b, pl. 11, figs. 22a, b).

At diameters greater than 30 mm *C. multiforme* contrasts greatly with *P. grewingki* by acquiring stouter, more involute whorls, a definite umbilical edge, blunter ribbing, and distinct, small, comma-shaped umbilical tubercles. It retains its inclined ribbing on the flanks, arched ribbing on the venter, and fairly open umbilicus, which features characterize the subgenus *Paracadoceras*. At diameters greater than 45 mm the ribbing is indistinct on the umbilical wall, most of the primary ribs bifurcate and there are few short intercalated ribs. Furcation occurs at about one-fourth of the height of the flanks rather than at the umbilical tubercles. The ribbing fades out quickly at the anterior end of the penultimate whorl and only traces of ribs are visible at the posterior end of the body chamber. The comma-shaped tubercles persist longer but are faint on the anterior half of the body chamber. The sharp umbilical edge persists to the aperture.

The suture line is much less disected than in most species of *Cadoceras*, but its proportions are typical.

Dimensions in millimeters and ratios of the diameter are as follows:

Specimen	Diameter	Whorl height	Whorl thickness	Umbilical width
Paratype (pl. 42, figs. 5, 7)	19	8.5(0.44)	7 (0.37)	6 (0.31)
Paratype (pl. 42, figs. 5, 7)	28	11.5(.41)	9.5(.34)	9 (.32)
Paratype (pl. 42, figs. 1, 2)	36	15 (.41)	14 (.39)	8.5(.23)
Paratype (pl. 42, figs. 1, 2)	47?	20 (.42)	22 (.47)	11 (.23)
Paratype (pl. 42, fig. 10)	71?	27 (.38)	?	20 (.28)
Holotype (pl. 42, fig. 8)	111	41? (.37)	?	39 (.35)

This species is distinguished from *C. tonniense* Imlay by coarser ribbing, more distinct umbilical tubercles, a more sharply defined umbilical edge, a steeper umbilical wall, and a wider, deeper umbilicus.

Holotype, U.S.N.M. 108085; paratypes, U.S.N.M. 108086a, b, 108087.

Chinitna formation, lower part of middle third at U.S.G.S. Mes. locs. 3019 and 21348.

Cadoceras (Paracadoceras) tonniense Imlay, n. sp.

Plate 43, figures 9–11, 13

Six specimens of this species are on hand. Shell compressed, becoming less so during growth; whorls ovate, higher than wide on innermost whorls, becoming wider than high on body whorl, widest at the umbilical edge, embracing about three-fifths; flanks evenly rounded; venter highly arched in young, evenly arched in adult, becoming broader during growth. Umbilicus fairly narrow but wide for genus; wall low and gently inclined, becoming steeper on body whorl; edge evenly rounded on inner whorls, abrupt on outer two whorls. Body chamber represented by about four-fifths of a whorl.

The ribs are radial on the upper part of the umbilical wall, incline forward strongly on the flanks, and arch forward gently on the venter. Most of them bifurcate a little below the middle of the flanks, but some remain single. They are broad and low on the flanks and venter and are slightly raised on the umbilical edge. The ribs begin to disappear on the venter of the penultimate whorl and are represented on the body whorl only by lines of growth and by weak swellings on the umbilical edge. The aperture is marked by a constriction that is strongly inclined forward.

The suture line is similar to that of *C. catostoma* Pompeckj. The external saddle is not as deeply cut as in most species of *Cadoceras*.

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

Specimen	Diameter	Whorl height	Whorl thickness	Umbilical width
Paratype (pl. 43, fig. 13)	57	23(0.40)	30 (0.52)	15.5(0.27)
Holotype (pl. 43, figs. 9, 11)	60	26(.43)	28 (.47)	15 (.25)
Holotype (pl. 43, figs. 9, 11)	92	40(.43)	48?(.52)	24 (.26)

This species is characterized by its low, gently inclined umbilical wall and moderately compressed form. These features result in a more shallow and open umbilicus than in most species of *Cadoceras* from Alaska. Among the Alaskan species, *C. multiforme* Imlay has coarser ribbing and a steeper umbilical wall. *C. harveyi* (Crickmay) (1930, p. 55, pl. 16, figs. 1, 2) is very similar in whorl shape, umbilical width, and ornamentation (see pl. 43, fig. 12) to *C. tonniense*, but lacks a well-defined umbilical edge, has a steeper umbilical wall, and its ribs are a little wider spaced. The apparent loss of ribbing on the outer whorl that was suggested on the published photographs of *C. harveyi* is not real, but due to weathering. The primary ribs actually bifurcate in a manner similar to that on *C. tonniense*.

Holotype, U.S.N.M. 108088; paratype, U.S.N.M. 108089.

Chinitna formation, lower two-fifths, U.S.G.S. Mes. locs. 20753, 20762, 21324, 21331, 21328, 11049, and 21326.

Cadoceras (Paracadoceras) aff. C. tonniense Imlay

Plate 43, figures 1, 4

One septate mold differs from *C. tonniense* by having finer ribbing, a more open umbilicus, and by lacking of a distinct umbilical edge except at its extreme anterior end. It differs from *C. harveyi* (Crickmay) by having a much wider umbilicus. It has been crushed laterally but appears to be more compressed than either of these species.

Figured specimen, U.S.N.M. 108090.

Chinitna formation, lower part of middle third at U.S.G.S. Mes. loc. 3019.

Cadoceras (Paracadoceras) chisikense Imlay, n. sp.

Plate 43, figures 5, 6

This species is based on one specimen that has been partly crushed laterally, but which shows distinctive ribbing unlike any other in the Alaskan collections of the Survey.

Shell moderately compressed; whorls ovate, becoming wider than high in adult, widest at the umbilical edge, embracing about two-thirds; flanks evenly rounded; venter evenly arched, becoming broader during growth. Umbilicus moderate in width; wall moderate in height, very steep; edge evenly rounded on inner whorls, becoming abrupt on outer two whorls. Body chamber incomplete but represented by at least half a whorl.

The ribs are nearly radial on the upper part of the umbilical wall, incline forward strongly on the flanks, and arch forward gently on the venter. The innermost whorls, as exposed in the umbilicus, have fine, closely spaced ribbing. On the penultimate whorl the ribs are moderately spaced. They are high and narrow on the umbilical edge and on the lower part of the flanks, but are low and indistinct on the venter. Anteriorly the ribs become stronger on the umbilical edge and weaker on the venter. On the posterior end of the penultimate whorl the ribs consist mostly of long unbranched primaries alternating with short secondaries, but some of the latter are indistinctly united with the primaries a little below the middle of the flanks. On the anterior end of the penultimate whorl the lower part of the flanks has pronounced primary ribs, and the venter is nearly smooth. The body chamber is marked only by strong, rather widely spaced primary ribs.

The suture line is poorly preserved.

The holotype is too crushed for accurate measurements.

Among Alaskan forms of *Cadoceras* this species most nearly resembles *C. moffiti* Imlay, but may be distinguished by its deeper umbilicus, finer ribbing, and by the disappearance of secondary ribbing on the body whorl. It has a general resemblance to *C. harveyi*

Crickmay (1930, p. 55, pl. 16, figs. 1, 2), but its body whorl has wider-spaced primary ribs and a distinct umbilical edge. It, also, greatly resembles *C. elatmae* in form and sculpture, but has somewhat weaker, more widely spaced ribbing.

Holotype, U.S.N.M. 108091.

Chinitna formation, basal part, U.S.G.S. Mes. loc. 10250.

Subgenus Stenocadoceras Imlay, n. subgen.

(See p. 46)

Cadoceras (Stenocadoceras) multicostatum Imlay, n. sp.

Plate 44, figures 1–16

This species is represented by 62 specimens. Shell discoidal, compressed; whorls subovate, considerably higher than wide in young forms, about as wide as high in adults, embracing about three fourths; flanks nearly flat in young, gently convex in adult; venter narrow, but becoming less so with growth. Umbilicus narrow; wall low and nearly vertical in young, becoming moderately high and vertical in adult; umbilical edge rounding abruptly into flanks. Body chamber represented by about four-fifths of a whorl.

The ribs are fine, closely spaced, and slightly stronger on the venter than on the flanks. They recurve backward on the umbilical wall, incline gently forward on the flanks, and arch forward slightly on the venter. On the smaller whorls most of the ribs branch between the lower third and the middle of the flanks, but some remain simple. During growth single ribs become fairly numerous, some short intercalary ribs appear, many of the furcation points become indistinct, and the ribs tend to become weaker near the umbilicus and stronger on the venter and the upper part of the flanks. Near the body chamber the ribbing weakens considerably and the body chamber appears to be fairly smooth. However, its flanks bear very fine, closely spaced, forwardly inclined ribs and its venter has low, broad swellings that are much less numerous than the flank ribs. The mouth border is marked by a rather shallow, moderately inclined constriction.

The suture line is characterized by both the first and second lateral lobes being irregularly trifid and rather slender.

The dimensions of the types in millimeters and in ratios of the diameter are as follows:

Specimen	Diameter	Whorl height	Whorl thickness	Umbilical width
Paratype (pl. 44, figs. 7, 8, 12)	28	13(0.46)	8.5(0.30)	6(0.21)
Paratype (pl. 44, fig. 11)	41	19(.46)	13.5(.33)	8(.19)
Holotype (pl. 44, figs. 1, 2)	51	24(.47)	17 (.33)	11(.21)
Paratype (pl. 44, figs. 4, 5)	67	30(.45)	27 (.40)	14(.21)
Paratype (pl. 44, fig. 14)	76	36(.47)	37 (.48)	20(.26)

The immature forms of *C. multicostatum* greatly resemble *Pseudocadoceras petelini* (Pompeckj), but have flatter flanks, a slightly smaller umbilicus, and finer, denser ribs that tend to become faint near the umbilicus instead of becoming more prominent. *P. nanseni* (Pompeckj) (1899, p. 86, pl. 2, figs. 1–3, 5, 6, text figs. 16, 17; Spath, 1932, p. 62, pl. 9, fig. 2, pl. 11, fig. 4) has more widely spaced ribs and a rounder venter. *C. striatum* Imlay, described herein, has a much more compressed form and a smaller umbilicus. *C. stenolobum* var. *densicostatum* Spath (1932, p. 62; Nikitin, 1881b, p. 121, pl. 12, figs. 28–30) has a less narrowly rounded venter and develops an umbilical rim.

Holotype, U.S.N.M. 108092; paratypes, U.S.N.M. 108093, 108094a–d, 108095a–c.

Shelikof formation, middle member, U.S.G.S. Mes. locs. 3105, 10813, 12380, and 12386. Chinitna formation, upper two-thirds, U.S.G.S. Mes. locs. 2991, 3016, 3028, 3029, 10978, 21290, 21342, 21346, 21347, 21776, 21777, 21778. Most of the collections from the Chinitna formation are from its upper 400 ft. The specimens assigned to this species from locs. 3028 and 3029 in the middle part of the Chinitna formation, are less than 25 mm in diameter, and may not be correctly identified.

Cadoceras (Stenocadoceras) striatum Imlay, n. sp.

Plate 45, figures 4–7

Four specimens are assigned to this species. Shell discoidal, compressed; whorls elliptical, considerably higher than wide at all growth stages, embracing about four-fifths; flanks flat, venter narrow. Umbilicus narrow, wall low and steep, edge rounding evenly. Body chamber represented by three-fourths of a whorl.

The ribs are fine, closely spaced, and slightly stronger on the venter than on the flanks. Up to diameters of about 65 mm the ribs curve backward on the umbilical wall, incline gently forward on the flanks, and arch forward on the venter. Most of the ribs branch between the lower third and the middle of the flanks, but some remain unbranched, and there are many short intercalary ribs. The furcation points become less distinct during growth. At diameters greater than about 65 mm the umbilical wall is smooth, the primary ribs split up on the lower third of the flank into fine, threadlike rigs and striae that pass into low, distinct ribs on the upper part of the flanks and on the venter. The body chamber is nearly smooth but when viewed under oblique light the surface exhibits faint, forwardly inclined striae. The aperture, partly preserved on the largest specimen (side not figured), is marked by a shallow inclined constriction.

The suture line is rather indistinct.

The dimensions of the types in millimeters and in ratios of the diameter are as follows:

Specimen	Diameter	Whorl height	Whorl thickness	Umbilical width
Holotype (pl. 45, fig. 6)	67	34(0.50)	20(0.30)	9.5(0.14)
Paratype (pl. 45, figs. 5, 7)	135	65(.48)	44(.32)	21 (.15)

This species greatly resemble *C. multicostatum* but has a smaller umbilicus, its whorl section remains high and narrow during growth, and its ribbing is a little finer.

Holotype, U.S.N.M. 108096; paratypes, U.S.N.M. 108097a, b.

Chinitna formation, upper part of lower third, U.S.G.S. Mes. loc. 21291.

Cadoceras (Stenocadoceras) iniskinense Imlay, n. sp.

Plate 46, figures 1, 4–9

This species is represented by 23 specimens, but only 3 show the adult character. Shell discoidal, compressed; whorls elliptical, higher than wide at all growth stages, embracing about four-fifths; flanks flattened; venter narrowly rounded but not sharpened. Umbilicus narrow; wall low and steep in young, moderately high and vertical in adult; edge evenly rounded in young, becoming abruptly rounded in adult. Body chamber incomplete, but represented by at least an entire whorl.

The ribbing is fairly coarse. On the immature forms the ribs are thin and high on the umbilical edge and flanks and are thick and moderately high on the venter. This condition exists as far as the anterior end of the penultimate whorl where the ribbing becomes less vigorous on the middle part of the flanks. Reduction in ribbing continues on the body whorl whose anterior end is marked only by faint broad ribs and striae and weak comma-shaped umbilical swellings. The ribs curve backward on the upper part of the umbilical wall, incline forward gently on the flanks, and arch forward slightly on the venter. On forms up to a diameter of about 25 mm about half the ribs bifurcate on the lower third of the flanks. The remaining single ribs alternate regularly with intercalary ribs that begin on the lower third of the flanks. At greater diameters most of the ribs remain single and are separated by 1 or 2 intercalary ribs that begin between the lower third and the middle of the flanks.

The suture line is not well enough preserved to illustrate.

Dimensions in millimeters and ratios of the diameters are as follows:

Specimen	Diameter	Whorl height	Whorl thickness	Umbilical width
Paratype (pl. 46, fig. 6)	24	11.5(0.48)	8.5(0.35)	4.5 (0.18)
Holotype (pl. 46, figs. 7, 9)	127	58 (.45)	?	24 (.19)

The immature forms of the species have ribbing comparable in coarseness with *P. grewingki* (Pompeckj), but are distinguishable by a much narrower umbilicus and a more evenly rounded venter. *P. schmidti* (Pompeckj) has a wider umbilicus and slightly finer ribbing. The adult form differs from *C. stenolobum* (Keyserling) (Sokolov, 1912, p. 52, pl. 1, fig. 4) by its weaker ribbing. In this respect it is intermediate between *C. stenolobum* and *C. stenoloboide* Pompeckj.

Holotype, U.S.N.M. 108098; paratypes, U.S.N.M. 108099a, b, 108100.

Shelikof formation, lower and middle members, U.S.G.S. Mes. locs. 3105, 3106, 3117, 10812, 10824. Chinitna formation, upper half, locs. 3018, 3029, 3030, 10990.

Cadoceras (Stenocadoceras) bowserense Imlay, n. sp.

Plate 43, figures 2, 3, 7, 8

This species is known by only two specimens. Shell discoidal, compressed; whorls subquadrate, higher than wide, embracing about five-sixths; flanks flattened, venter evenly rounded. Umbilicus narrow; wall low and vertical, edge abruptly rounded. Incomplete body chamber represented by two-thirds of a whorl.

The ribs are weak, closely spaced, and a little stronger on the venter than on the flanks. They incline forward rather strongly on the flanks and arch forward gently on the venter. They arise on the upper part of the umbilical wall, pass into weak tubercles on the umbilical edge, and then divide at or just above the tubercles into two or three secondary ribs. In addition there are a few intercalary ribs that begin on the lower fourth of the flanks. On the body chamber the ribbing changes into fine, forwardly inclined striae.

The suture line is typical of the genus and shows no unusual feature.

The holotype at a diameter of 63 mm has a whorl height of 30 mm, a whorl thickness of 28 mm, and an umbilical width of 10.5 mm.

This species represents the only compressed *Cadoceras* found thus far in the lower third of the Chinitna formation. Among the Alaskan species it resembles *C. stenoloboide* Pompeckj in general form, but is much finer ribbed. *C. milaschevici* (Nikitin) (1881a, pp. 66, 67, pl. 3, figs. 25–27) differs by having a trigonal instead of a subquadrate whorl section.

Holotype, U.S.N.M. 108101; paratype, U.S.N.M. 108102.

Chinitna formation, near base, U.S.G.S. Mes. loc. 11041.

Cadoceras (Stenocadoceras) stenoloboide Pompeckj

Plate 46, figure 3; plate 47, figures 1–15

Cadoceras stenoloboide Pompeckj. Russ. K. Min. Gesell. St. Petersburg Verh., ser. 2, Band 38, p. 255, pl. 7, figs. 2a–e, 3a, b, 1900.

This species is represented in the Survey collections by about 60 specimens that show all the growth stages. Shell discoidal, compressed; whorls ovate, a little higher than wide at all stages but becoming lower during growth, embracing about four-fifths; flanks flattened in young, becoming gently convex in adult; venter evenly rounded, becoming broader during growth. Umbilicus narrow; wall low and vertical; edge evenly rounded in young, fairly abrupt in adult. Body chamber represented by four-fifths of a whorl.

The ribs are sharp on the flanks, fairly thick on the venter, and are moderately spaced. They curve backward on the upper part of the umbilical wall, incline gently forward on the flanks, and arch forward slightly on the venter. On the umbilical edge they rise into weak comma-shaped swellings that persist to near the end of the body chamber but can scarcely be classed as tubercles. On the smallest whorls most ribs bifurcate on the lower third of the flanks, but at diameters greater than about 30 mm the furcation points become indistinct and some ribs remain unbranched. In addition there are many short ribs that begin between the lower third and the middle of the flanks. As a result, at a diameter of 52 mm there are about 2½ times as many ribs on the venter as on the lower third of the flanks. The ribbing becomes lower and less distinct on the anterior end of the penultimate whorl and on the body whorl is very low, widely spaced, and obvious only under oblique light. The body whorl also bears some striae that with the low ribs are inclined strongly forward. The aperture is marked on the internal mold by a shallow forwardly inclined constriction that is not apparent where the shell is preserved.

The suture line is similar to that of *C. multicostatum* but is less dissected and the lobes are wider.

Dimensions in millimeters and ratios of the diameters are as follows:

Specimen	Diameter	Whorl height	Whorl thickness	Umbilical width
Plesiotype (pl. 47, figs. 7, 8)	26	12(0.46)	9 (0.34)	5 (0.19)
Plesiotype (pl. 47, fig. 12)	31	15(.48)	11 (.35)	6 (.19)
Plesiotype (pl. 47, figs. 3–5)	51	25(.49)	22 (.43)	9.5(.18)
Plesiotype (pl. 47, figs. 10, 14)	57	26(.45)	22.5(.39)	11 (.19)
Plesiotype (pl. 47, figs. 13, 15)	100	49(.49)	47 (.47)	20 (.20)

This species differs from *C. stenolobum* (Keyserling) (Nikitin, 1881b, p. 121, pl. 12, figs. 28–30; Sokolov, 1912, p. 52, pl. 1, fig. 4) by its flatter flanks and much finer ribbing. It differs from *C. iniskinense* Imlay by its less compressed form and finer ribbing.

Plesiotypes, U.S.N.M. 108103a, b, 108104–108109.

Shelikof formation, middle member and top of lower member, U.S.G.S. Mes. locs, 2943, 3117, 10822, 10824, 12386, 12387, 12408, 21354, 21356, 21357, 21362. Chinitna formation, upper two-fifths, locs. 2921, 3030, 10990, 11052a, 20757, 21342, 21777.

Cadoceras (Stenocadoceras) pomeroyense Imlay, n. sp.

Plate 45, figures 1–3; plate 46, figure 2

Only one specimen of this species is known. It consists of the penultimate whorl and the beginning of the body chamber. Form moderately compressed; whorls subtrigonal on inner whorls, wider than high, becoming subovate on body chamber, embracing about five-sixths; flanks somewhat flattened and sloping from umbilical edge to narrowly rounded venter. Umbilicus fairly narrow, crater-like; wall moderately high and steeply inclined; edge abrupt on penultimate whorl and sharp on body chamber. Length of body chamber unknown.

On the innermost whorls exposed in the umbilicus the ribs are sharp, radial, and begin at the line of involution. At the beginning of the last septate whorl the ribs begin to disappear from the lower part of the umbilical wall and at end of the septate whorl the wall is completely smooth. The ribs incline forward strongly on the flanks, bifurcate on the lower one-fourth to one-third of the flanks, and arch forward in an angular manner on the venter. They are high and narrow on the umbilical edge and a little lower and broader on the flanks and venter. They are vigorous at the beginning of the last septate whorl but gradually diminish in strength anteriorly and are completely absent at the beginning of the body chamber.

The suture line is poorly preserved.

Dimensions in millimeters and ratios of the diameters are as follows:

Specimen	Diameter	Whorl height	Whorl thickness	Umbilical width
Holotype (pl. 45, figs. 1–2)	62	27(0.43)	39(0.63)	14(0.22)
Do	77	32(.41)	49(.63)	20(.26)

This species is characterized by the vigorous, strongly inclined ribbing and subtrigonal shape of its penultimate whorl and by its fairly stout form. It has a wider whorl section and stronger ribbing than any other Alaskan species of *Stenocadoceras*. *Cadoceras stenolobum* (Keyserling) (Sokolov, 1912, p. 22, 52, pl. 1, fig. 4) from northern Russia is more compressed, has finer ribs that branch higher, and is much larger. The adult of *C. nikitini* Sokolov (1912, pp. 24, 53, pl. 1, figs. 3 a-d, pl. 3, fig. 13) is very similar to *C. pomeroyense* in stoutness and in character of ribbing, but the immature forms are much more compressed and the rib branching occurs consistently much higher on the flanks.

Holotype, U.S.N.M. 108110.

Chinitna formation, upper third, U.S.G.S. Mes. loc. 22415.

Genus Pseudocadoceras Buckman 1919

Pseudocadoceras petelini (Pompeckj)

Plate 48, figures 1–6, 15

Cadoceras petelini Pompeckj, Russ. K. Min. Gesell. St. Petersburg Verh., ser. 2, Band 38, p. 267, pl. 6, figs. 4–6, 1900.

Pseudocadoceras petelini (Pompeckj). Buchman, Yorkshire type Ammonites, vol. 2, p. 121 c, 1919.

Pseudocadoceras petelini (Pompeckj). Spath, Meddelelser om Grønland, Band 87, no. 7, p. 62, 1932.

The collections in hand contain 30 specimens of this species. Shell discoidal, compressed; whorls subovate, considerably higher than wide, becoming lower during growth, thickest on lower third of flanks, embracing two-thirds; flanks flattened on inner whorls, becoming gently convex on outer whorls, converging above into narrow venter. Umbilicus fairly narrow; wall low and nearly vertical, rounding abruptly into flanks. Body chamber represented by about half a whorl, but aperture is not preserved.

The ribs on the inner whorls are fairly strong and sharp, are separated by interspaces a little wider than themselves, mostly bifurcate below the middle of the flanks, curve backward on the umbilical wall, incline slightly forward on the flanks, and arch forward on the venter. During growth the primary ribs become wider spaced and higher and sharper on the lower fourth of the flanks, many of the secondary ribs become indistinctly connected with the primary rib, and intercalary ribs appear. As a result, on the largest whorls the ribbing consists mostly of unbranched primary ribs separated by two intercalary ribs that extend slightly below the middle of the flanks. On the venter the strength and spacing of all ribs are about equal.

The suture line is much simpler than in species of *Cadoceras*, but the proportions are similar.

Dimensions in millimeters and ratios of the diameter are as follows:

Specimen	Diameter	Whorl height	Whorl thickness	Umbilical width
Plesiotype (pl. 48, figs. 5, 6)	32	14(0.44)	10(0.31)	8(0.25)
Plesiotype (pl. 48, figs. 1, 2)	23.5	11(.46)	7.5(.32)	5(.21)

This species differs from *P. grewingki* (Pompeckj) by having flatter whorls, finer ribbing, fewer single ribs on the immature whorls, and a narrower umbilicus. It differs from *P. nanseni* (Pompeckj) (1899, p. 86, pl. 2, figs. 1–3, 5, 6, text figs. 16, 17) by having more closely spaced ribbing and a narrower venter. It greatly resembles immature forms of *C. multicostatum* Imlay described herein, but may be distinguished by coarser, more widely spaced ribbing.

Plesiotypes, U.S.N.M. 108111–108113.

Shelikof formation, middle member, U.S.G.S. Mes. locs. 3113, 10822, 12385, 12386 and 12387 in the Puale Bay area.

Pseudocadoceras grewingki (Pompeckj)

Plate 49, figures 1–12

Ammonites biplex (?) Sow. Zieten. Grewingk, Russ. K. Min. Gesell St. Petersburg Verh. 1948–1849, pp. 273, 274, pl. 4, figs. 2a–c, 1850.

Ammonites milletianus D'Orbigny. Eichwald, Halbinsel Mangischlak und die aleutischen Inseln, pp. 145–146, pl. 9, fig. 4, not 3, 1871.

Cadoceras grewingki Pompeckj, Russ. K. Min. Gesell. St. Petersburg Verh., ser. 2, Band 38, p. 258, pl. 6, fig. 1a-d, not 2a-c, 1900.

Pseudocadoceras grewingki (Pompeckj). Buckman, Yorkshire type Ammonites, Vol. 2, p. 14, 1918; same volume, 1919, p. 121c.

Pseudocadoceras grewingki (Pompeckj). Spath, Meddelelser om Grønland, Band 87, no. 7, p. 62, 1932.

This species is represented by about 100 specimens in the Geological Survey's collections. Shell discoidal, compressed; inner whorls subovate, considerably higher than wide; outer whorls only slightly higher than wide, thickest on lower part of flanks, embracing from one-half to three-fifths; flanks flattened, converging above into narrow venter. Umbilicus fairly wide; wall low and steep, rounding abruptly into flanks. Body chamber on the largest specimens represented by about half a whorl but aperture not preserved.

The ribs are strong and sharp. They are closely spaced on the inner whorls, but become fairly widely spaced on the outer whorl. They curve backward on the umbilical wall, incline gently forward on the flanks and arch forward more strongly on the venter. They are highest and sharpest on the lower half of the flanks and become rather broad on the venter. Bifurcation occurs fairly regularly a little below the middle of the flanks. On the inner whorls the secondary branches are generally distinctly united with the primary ribs. Anteriorly one of the branches, usually the anterior, becomes loosely united with the primary rib. Some ribs remain unbranched.

The suture line has been well described by Pompeckj.

Dimensions in millimeters and ratios of the diameter are as follows:

Specimen	Diameter	Whorl height	Whorl thickness	Umbilical width
Lectotype	32.3	14 (0.46)	12.8(0.40)	9(0.28)
Plesiotype (pl. 49, figs. 11, 12)	43	17.5(.40)	14 (.32)	10(.23)
Plesiotype (pl. 49, figs. 3, 4)	32	13.5(.42)	11 (.34)	9(.28)
Plesiotype (pl. 49, fig. 10)	21	10 (.47)	6.5 (.31)	5(.24)

On the basis of the material now in hand it is evident that the specimens included by Pompeckj (1900, pp. 258–263, pl. 6, figs. 1–3) in his *Cadoceras grewingki* really represent two species. As Pompeckj did not select a holotype, the specimen represented by his figure 1a-d, which was first figured by Grewingk (1850, pl. 4, figs. 2a-c), is hereby designated the lectotype of *P. grewingki* (Pompeckj). The specimen figured by Pompeckj on his pl. 6, fig. 2a-c is herein referred to a new species, *Pseudocadoceras crassicostatum* Imlay, which differs from *P. grewingki* by its coarser, more widely spaced ribbing, more inflated whorl section, and deeper umbilicus. *P. grewingki* has ribbing very similar to that of *Pseudocadoceras orbignyi* Maire (1932, p. 11; 1938, pl. 1, fig. 3; D'Orbigny, 1848, pl. 179, figs. 7, 8), but its venter is less narrowed, its whorl section wider, and it has more single ribs. It differs from *Pseudocadoceras boreale* Buckman (1919, pl. 121b) by having a much wider umbilicus, a rounder venter, and more widely spaced ribs which branch lower on the flanks. It differs from *P.? concinnum* Buckman (1927, pl. 735) by having thinner ribs that are more widely spaced.

Plesiotypes, U.S.N.M. 108114, 108115a, b, 108116, 108117.

Chinitna formation, middle two-thirds, U.S.G.S. Mes. locs. 2921, 3018, 3028, 3029, 3030, 20757, 20763, 21344, 21348, 22429, 22432, 22435, 22451, and 22452. Shelikof formation, middle member and top of lower member at U.S.G.S. Mes. locs. 3105, 3113, 10813, 10822, 12386, 21358, 21362.

Pseudocadoceras crassicostatum Imlay, n. sp.

Plate 49, figures 19, 20, 22–24

Ammonites milletianus D'Orbigny. Eichwald, . . . Halbinsel Mangischlak und die Aleutischen Inseln, pp. 145, 146, pl. 9, fig. 3, 1871.

Cadoceras grewingki Pompeckj, Russ.—K. Min. Gesell, St. Petersburg. Verh., ser. 2, Band 38, p. 258, pl. 6, figs. 2a-c, not 1a-d, 1900.

This species is represented in available collections by four specimens, of which two are fragments of the outer whorl. Shell discoidal, compressed; whorls ovate, wider than high in early stages, becoming slightly higher than wide in adult, thickest near the umbilicus, embracing a little more than one-half; flanks convex; venter broadly rounded on inner whorls, somewhat narrowed on outer whorl. Umbilicus wide, wall moderately high and steep. Body chamber represented by at least half a whorl.

The ribs are very strong, widely spaced, sharp on the internal molds, but well rounded where the shell is preserved. They curve backward on the umbilical wall and incline gently forward on the flanks and venter. About two-thirds of the primary ribs bifurcate below the middle of the flanks and the remainder remain single. The points of furcation are commonly indistinct, particularly on the body whorl.

The suture line differs from that of *P. grewingki* (Pompeckj) by having broader saddles and a more slender first lateral lobe.

Dimensions in millimeters and ratios of the diameter are as follows:

Specimen	Diameter	Whorl height	Whorl thickness	Umbilical width
Holotype (pl. 49, figs. 22, 24)	41	18(0.44)	16.5(0.40)	12.5(0.30)
Paratype (pl. 49, figs. 19, 20)	33	15(.45)	12(.36)	8.5(.26)

Pseudocadoceras? laminatum Buckman (1927, pl. 727) appears to have a smaller umbilicus and thicker, more closely spaced ribs. The apparently small umbilicus on the specimen figured by Eichwald (1871, pl. 9, fig. 3) is probably a result of crushing, as many other specimens from Alaska show similar distortion.

Holotype, U.S.N.M. 108118; paratype, U.S.N.M. 108119.

Chinitna formation, upper third, U.S.G.S. Mes. loc. 11060. Shelikof formation, middle member, at locs. 3105 and 12387.

Pseudocadoceras chinitnense Imlay, n. sp.

Plate 48, figures 7–10

Four specimens of this species are in hand. Shell discoidal, compressed; whorls elliptical, much higher than wide, thickest on the lower third of the flank, embracing two-thirds; flanks gently convex, converging above into narrow venter. Umbilicus fairly narrow; wall low and nearly vertical, rounding fairly abruptly into flank. Body chamber represented by at least three-fourths of a whorl but aperture is not preserved.

The ribs on the penultimate whorl are high, sharp, and moderately spaced. The primaries curve backward on the umbilical wall, incline forward moderately on the flanks, and bifurcate at about one-third of the height of the whorl. The secondaries are nearly as strong as the primaries and arch forward gently on the venter. Most forked ribs are separated by single, intercalary ribs. On the body whorl the primaries become higher and much more widely spaced, and are especially prominent at the furcation points. The posterior branch of many forked ribs is indistinctly connected with the primary rib, so that in places there are unbranched primary ribs separated by two intercalary ribs that extend below the middle of the flanks. All secondary and intercalary ribs are of equal strength, are most pronounced on the venter, incline forward considerably on the upper parts of the flanks, and arch forward strongly on the venter. The strength of the ribbing increases steadily toward the anterior end of the body chamber.

The suture line is poorly preserved.

All the specimens have been crushed laterally, but the form shown on plate 48, figs. 7, 8 appears to be only slightly deformed. At a diameter of 32 mm, its whorl height is 15 mm, its whorl thickness 11 mm, and its umbilical width 8 mm.

This species is characterized by the prominent, widely spaced primary ribs on the body whorl. *P. crassicostatum* Imlay has stouter whorls, a wider umbilicus, and fewer, stronger secondary ribs. *P. petelini* (Pompeckj) is more compressed and has weaker, more closely spaced ribbing.

Holotype, U.S.N.M. 108120; paratype, U.S.N.M. 108121, 108122.

Chinitna formation, upper two-fifths, U.S.G.S. Mes. locs. 2991, 10978, 21777 and 21778.

Pseudocadoceras schmidti (Pompeckj)

Plate 49, figures 17, 18

Cadoceras schmidti Pompeckj, Russ. K. Min. Gesell. St. Petersburg Verh., ser. 2, Band 38, p. 265, pl. 5, figs. 3a–d, 4a, b, 1900.
Pseudocadoceras schmidti (Pompeckj). Buckman, Yorkshire type Ammonites, Vol .2, p. 121c, 1919.

Only one specimen has been found in the Survey collections from southwestern Alaska that agrees with Pompeckj's description and illustrations of *C. schmidti.* The anterior end of this specimen has been somewhat crushed laterally, but otherwise is excellently preserved. It may be described as follows:

Shell discoidal, compressed; whorls subquadrate, higher than wide, thickest on the lower third of the flanks, embracing a little more than one-half; flanks flattened, venter evenly rounded. Umbilicus fairly wide; wall low and nearly vertical, rounding rather abruptly into flanks. Body chamber represented by about three-fourths of a whorl.

The ribs are fairly closely spaced, sharp and elevated on the flanks, and thickened and less elevated on the venter. They curve backward on the umbilical wall, incline forward gently on the flanks, and arch forward slightly on the venter. Most of the ribs fork near the middle of the flanks, but some remain simple. Anteriorly the furcation points become indistinct resulting in the alternation of long unbranched ribs with short secondary ribs.

The suture line is only partly preserved, but agrees fairly well with those figured by Pompeckj.

This species differs from *P. grewingki* by its flatter flanks, evenly rounded venter; finer, denser ribbing, and fewer single ribs. Its ribbing is similar to that of *C. iniskinense*, described herein, but it has a much wider umbilicus and a thinner whorl section. Compared with *P. nanseni* (Pompeckj) (1900, p. 86, pl. 2, figs. 1–3, 5, 6, text figs. 16, 17) it has a wider umbilicus and coarser ribbing.

Plesiotype, U.S.N.M. 108123.

Shelikof formation, middle member, U.S.G.S. Mes. loc. 10824.

Genus Kepplerites Neumayr 1892

Subgenus Seymourites Kilian and Reboul 1909

Kepplerites (Seymourites) alticostatus Imlay, n. sp.

Plate 48, figures 11, 16

Only three internal molds of this species are available. Form moderately stout; body whorl subquadrate, slightly wider than high; flanks high, flattened, nearly parallel at posterior end of body whorl, gently convergent at anterior end, rounding rather rapidly into venter, rounding abruptly into umbilical wall; venter moderately wide, nearly flat along mid-line. Umbilicus narrow on inner whorls, widens slowly on anterior half of body whorl until it embraces only three-fifths of the penultimate whorl; wall moderate in height, vertical or nearly vertical. Body chamber represented by a nearly complete whorl that is not contracted anteriorly. Aperture not preserved, but the weakness of the last rib suggests that the shell is nearly complete.

The ribs are narrow and widely separated. They are low on the septate part of the body whorl, but anteriorly on the body chamber rapidly become very high and sharp. The primary ribs on the septate part of the shell are scarcely stronger than the secondary ribs, but anteriorly become much higher. They are radial on the umbilical wall, curve backward on the umbilical shoulder, curve forward gently on the flanks, and terminate at about one-third of the height of the flanks in tubercles. The latter are weak on the septate part of the shell but become prominent anteriorly on the body chamber. The secondary ribs curve forward on the middle of the flanks, then recurve, and cross the venter transversely. Bifurcation and trifurcation are about equally common. In case of trifurcation one of the branches is generally indistinctly connected with the tubercle. In addition, single intercalary ribs occur between most sets of branched ribs. The holotype has 34 primary ribs and 109 secondary ribs on its body whorl.

The suture line is not well preserved.

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

Specimen	Diameter	Whorl height	Whorl thickness	Umbilical width
Holotype (pl. 48, figs. 11, 16)	93	33(0.35)	35(0.37)	19(0.20)
Do	104	50(.48)	52(.50)	25(.24)

This species is characterized by the high, thin ribbing on its body chamber. It differs also, from other Alaskan species described herein by its longer and less evolute body chamber. It is distinguished from *Kepplerites loganianus* (Whiteaves) (1876, pl. 8, fig. 2), judging from a plaster cast of the type before me, by being more compressed and less evolute, and by having shorter primary ribs and much higher, thinner secondary ribs. *K. plenus* (McLearn) (1929, p. 5, pl. 1, fig. 1, pl. 2, figs. 1, 2) has a thicker whorl section, is more evolute, and has less elevated ribbing. *K. mclearni* Imlay (1948, p. 24, pl. 8, figs. 1, 2, 5, 7–10, pl. 9, fig. 1) is more compressed and its ribbing is not as high and sharp. *K. acuticostatum* Kobayashi (1947, p. 28, pl. 7, fig. 2) has similar high, thin ribs but is much more evolute.

Holotype, U.S.N.M. 108124.

Chinitna formation, lower third, at U.S.G.S. Mes. locs. 2992, 22431, and 22433.

Kepplerites (Seymourites) tychonis Ravn

Plate 48, figures 14, 17

?*Macrocephalites* sp. cf. *compressus* (Quenstedt) Madsen, Meddelelser om Grønland, Bind 29, p. 192, 1904.

Kepplerites tychonis Ravn, Meddelelser om Grønland, Bind 45, p. 490, pl. 37, fig. 1, 1911.

Kepplerites (*Seymourites*) *tychonis* Ravn. Spath, Meddelelser om Grønland, Bind 87, pp. 83–87, pl. 23, figs. 1–3, pl. 24, fig. 6, pl. 25, figs. 1–3, pl. 26, figs. 3, 6, 1932.

Kepplerites (*Seymourites*) cf. *K. tychonis* Ravn. Imlay, U. S. Geol. Survey Prof. Paper 214–B, p. 25, pl. 8, figs. 3, 4, 6, 1948.

One specimen from Alaska agrees so closely with *K. tychonis* in its compressed form and the dense, untuberculate ribbing of its outer whorls that specific identity seems certain. At a diameter of 100 mm, which marks the beginning of the body chamber, the whorl height is 51 mm, the whorl thickness is 45 mm, and the umbilical width is 14 mm. The umbilicus enlarges rapidly beyond this diameter, as shown by an impressed line on the mold marking the position of the body chamber. This impressed line indicates that the body chamber occupied about three-fourths of a whorl. Only a part of the posterior end of the body chamber is preserved, but this part has ribbing similar to that on the penultimate whorl, which bears sharp, closely spaced primary and secondary ribs. There are three to four secondary ribs to each primary, but about one rib out of four arises independently of the primaries along the zone of furcation. The ventral ends of the primaries are elevated but not distinctly tuberculated. Compared with the illustrated Greenland forms of *K. tychonis*, the Alaskan form appears to be more involute, but since it is septate to a larger diameter this difference is probably not important. Allowing for the slightly larger size of the Alaskan form, its degree of involution greatly resembles that of some forms from Greenland (Spath, 1932, pl. 26, fig. 6; Ravn, 1911, pl. 37, fig. 1a). Also, in this regard Spath (1932, p. 86) notes that some Greenland specimens are much more involute than others.

Plesiotype; U.S.N.M. 108125.

Chinitna formation, near base, U.S.G.S. Mes. loc. 21287; probably represented at Mes. loc. 20755.

Kepplerites (Seymourites) multus (McLearn)

Plate 51, figures 1, 4

Seymourites multus McLearn, Canada Nat. Mus. Bull. 54, p. 7, pl. 3, fig. 2, 1929.

The Alaskan collections contain two specimens of this species. These are only about two-thirds as large as the holotype, but as they agree very closely in whorl shape and ornamentation the difference in size is discounted. Among other ammonites, for example some species of *Scaphites*, even greater size differences have been noted.

Form stout; whorls ovate, wider than high; flanks and venter evenly rounded. Umbilicus narrow on inner whorls, enlarges very rapidly on anterior half of body whorl; wall high, vertical on lower part, steeply inclined above, rounding abruptly into flanks. Body chamber represented by at least half a whorl. Aperture not preserved.

The ribbing of the inner whorls is not known. On the penultimate whorl, exposed in the umbilicus, the ribbing is fine and dense. Four or five secondary ribs branch from tiny tubercles at the ends of the primary ribs. On the body whorl the primary ribs are moderately strong, angular in cross-section, radial on the umbilical wall, inclined gently forward on the flanks, and terminate in small, acute tubercles at about one-third of the height of the flanks. From the tubercles arise three, or generally four secondary ribs, and between the branched ribs are some intercalary ribs. This results in about five secondary ribs for each primary rib. The secondary ribs are fine, low, and fairly closely spaced, although separated by somewhat wider interspaces. They incline forward rather strongly on the middle of the flanks, then recurve, and cross the venter transversely.

The suture line cannot be determined on the Alaskan specimens, owing to crushing of the septate part of the body whorl.

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

Specimen	Diameter	Whorl height	Whorl thickness	Umbilical width
Holotype, Nat. Mus. Canada 9001	145	55(0.38)	62(0.42)	50(0.34)
Plesiotype (pl. 51, figs. 1, 4)	110	40(.36)	55(.50)	34(.31)

This species is characterized by its dense ribbing, rather inflated body whorl, and high umbilical wall. *Keplerites mcevoyi* (McLearn) (1928, p. 20, pl. 4, figs. 1, 2) has similar ribbing but has a much more compressed body whorl. *K. tychonis* (Ravn) (1911, p. 490, pl. 37, fig. 1) has a much higher whorl section, denser primary ribbing, and weaker tuberculation.

Plesiotype, U.S.N.M. 108126.

Chinitna formation, top of middle third, U.S.G.S. Mes. loc. 20763. The holotype is from a sandstone bed near the top of the Yakoun formation on the northeast shore of Maude Island.

Kepplerites (Seymourites) ingrahami (McLearn)

Plate 48, figures 12, 13; plate 50, figures 1–4; plate 51, figure 2

Yakounoceras ingrahami McLearn, Canada Nat. Mus. Bull. 54, p. 9, pl. 7, figs. 1, 2, 1929.

Yakounites sp. A, Kellum, Daviess, and Swinney, U. S. Geol. Survey prelim. Report on geology and oil possibilities of the southwestern part of the Wide Bay anticline, figs, 9a, b, 1945.

This species is represented in the Alaskan collections by 15 specimens of which 6 are fairly complete adults. Most of these retain much more of the shell than the holotype and consequently show the ornamentation to better advantage. The small specimen shown on plate 48, figures 12, 13 may be a young individual of *K. ingrahami.*

Form moderately stout; whorls subquadrate, a little wider than high; flanks flattened or nearly flat, becoming gently convex on the body chamber, rounding fairly abruptly into venter and umbilicus; venter flattened, especially on anterior end of body chamber. Umbilicus widens rapidly on anterior end of ultimate whorl; wall low, vertical at base, steeply inclined above. Body chamber represented by a little more than half a whorl, becomes slightly contracted at anterior end. Aperture marked on internal mold by a broad forwardly inclined constriction which is scarcely apparent where the shell is preserved. The constriction is followed by a low swelling that is abruptly truncated.

The ribs are narrow, moderately elevated, and separated by much wider interspaces. They trend backward on the umbilical wall, curve forward strongly on the flanks, and cross the venter transversely. The primary ribs are thicker and higher than the secondary ribs and terminate at about two-fifths of the height of the flanks in small, compressed tubercles that are very small on the septate part of the shell and fairly prominent on the body chamber. Bifurcation and trifurcation are about equally common. Many rib branches are separated by intercalary ribs that begin along the line of tubercles. During growth the ribbing gradually becomes stronger and more widely spaced. This condition prevails nearly to the very edge of the aperture where only the last rib is weaker than the preceding ribs. The holotype has about 29 primary ribs and 115 to 120 secondary ribs. The form illustrated on plate 50, figure 2 has about 30 primary ribs and 113 secondary ribs. The form illustrated on plate 50, figures 1, 3 has about 42 primary ribs and 123 secondary ribs.

The suture line of the Alaskan specimen shown on plate 50, figures 1, 3 and plate 51, figure 2 resembles that of *K. plenus* (McLearn) (1929, pls. 1 and 2) but is less dissected. The first lateral lobe is about the same length as the external lobe and its median lobule is not especially elongate. The second lateral lobe is short and rather narrow. The saddles are much wider than the lobes. The external saddle is unequally divided by a long lobule into a large outer branch and a small, slender inner branch. The first lateral saddle is about two-thirds as large as the external saddle, is slightly longer than wide, and is nearly symmetrical. The second lateral saddle is much smaller than the first, is nearly symmetrical, and has its inner branch on the umbilical margin.

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

Specimen	Diameter	Whorl height	Whorl thickness	Umbilical width
Holotype	105	35(0.33)	44.6(0.42)	33(0.31)
Holotype	78.3	46(.58)	57.3(.73)	?
Plesiotype (pl. 50, fig. 2)	95	32(.33)	38(.40)	32(.33)
Plesiotype (pl. 50, figs. 1, 2)	89	36(.40)	43(.48)	26(.29)

This species is characterized by its subquadrate whorl shape and flattened venter. It differs from *K. gitinsi* (McLearn) (1929, p. 8, pl. 3, fig. 1, pl. 4, fig. 1, pl. 8, fig. 5) by having denser ribbing, fewer secondaries per primary rib, and a flattened venter. It is not as stout as *K. abruptus* McLearn (1929, p. 9, pl. 5, fig. 1, pl. 6, figs. 1, 2) and has fewer primary ribs. *K. tychonis* Ravn (1911, p. 490, pl. 37, fig. 1) has much denser ribbing and a higher, rounder whorl section.

Plesiotypes, U.S.N.M. 108127–108129.

Chinitna formation, lower two-thirds, U.S.G.S. Mes. locs. 20763, 12074, and 22431. Shelikof formation, middle member, Mes. loc. 19793. The holotype is from the upper part of the Yakoun formation at Alliford Bay in the Queen Charlotte Islands, British Columbia.

Kepplerites (Seymourites) mcevoyi (McLearn)

Plate 51, figures 3, 5–8

Yakounites mcevoyi McLearn, Canada Geol. Survey Bull. 49, p. 20, pl. 4, figs. 1, 2, 1928.

This species is represented in the Alaskan collections by two specimens that show the characteristics of the outer two whorls.

Form moderately stout, becoming compressed on body chamber; whorls ovate, wider than high; flanks flattened on penultimate whorl, becoming gently convex on body whorl, merging gradually into evenly arched venter. Umbilicus narrow on inner whorls, widens considerably but slowly on outer whorl; wall low, vertical, rounding rather abruptly into flanks. Body chamber represented by about half a whorl, contracted considerably at anterior end. Aperture marked on internal mold by a broad, shallow, forwardly inclined constriction that is nearly smooth.

The ribbing is rather fine and dense. The primary ribs are narrow, angular, are radial or incline slightly backward on the umbilical wall, incline gently forward on the flanks, and pass into acute tubercles at about one-third of the height of the flanks. On the penultimate whorl the secondary ribs branch by threes or fours and on the body whorl by fours or fives. In addition there are many intercalary ribs that arise along the zone of tuberculation. The secondary ribs are fine, low, and separated by somewhat wider interspaces. They incline forward on the flanks, but cross the venter transversely. The body whorl of the largest specimen (plate 51, figures 6, 8) has 31 primary ribs and about 152 secondary ribs.

The suture line is well shown on one of the Alaskan specimens. The first lateral lobe is a little longer than the external lobe and has a long median lobule. The second lateral lobe is much shorter than the first. The saddles are a little wider than the lobes. The external saddle is divided on its inner side by a long, narrow lobule. The first lateral saddle is considerably smaller than the external saddle and is nearly symmetrically divided by a secondary lobule. The second lateral saddle is ventral to the umbilical edge.

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

Specimen	Diameter	Whorl height	Whorl thickness	Umbilical width
Plesiotype (pl. 51, figs. 5, 7)	75	34(0.45)	41(0.54)	15(0.20)
Holotype Nat. Mus. Canada 5018	95	35(.37)	41(.43)	26(.27)
Plesiotype (pl. 51, figs. 6, 8)	96	38(.40)	44(.46)	29(.30)
Plesiotype (pl. 51, figs. 6, 8)	110	37(.33)	45(.41)	39(.35)

From these dimensions it appears that the holotype is not quite as stout as the Alaskan specimens. However, the difference is not great and the holotype is clearly somewhat deformed. As regards ornamentation, there is no obvious difference.

K. mcevoyi differs from *K. multus* (McLearn) by having a much more shallow umbilicus, a more slowly enlarging umbilicus, and a thinner whorl section. Its shape somewhat resembles *K. rosenkrantzi* Spath (1932, p. 89, pl. 26, figs. 1a, b), but the ornamentation on its body chamber is much stronger and it remains tuberculate to the aperture.

Plesiotypes, U.S.N.M. 108131, 108132.

Chinitna formation, top of middle third, U.S.G.S. Mes. locs. 10992 and 20763.

Kepplerites (Seymourites) gitinsi (McLearn)

Plate 52, figures 1, 2

Yakounoceras gitinsi McLearn, Trans. Roy. Soc. Canada 3d ser; vol. 21, sec. 4, p. 72, pl. 1, fig. 2, 1927.
Yakounoceras gitinsi McLearn, Canada Nat. Mus. Bull. 54, p. 8, pl. 3, fig. 1, pl. 4, fig. 1, pl. 8, fig. 5, 1929.

This species is represented in the Alaskan collections by two specimens both showing part of the body chamber and one showing part of the penultimate whorl. The adult whorl section appears to be a little wider than that of the holotype but the latter has been slightly crushed laterally. Otherwise the Alaskan specimens agree very well as regards ornamentation and the rather slowly enlarging umbilicus.

Plesiotype, U.S.N.M. 108130.

Chinitna formation, upper part of middle third at U.S.G.S. Mes. loc. 2921.

Kepplerites (Seymourites) abruptus (McLearn)

Plate 52, figures 3–6

Yakounoceras abruptum McLearn, Canada Nat. Mus. Bull. 54, p. 9, pl. 5, fig. 1, pl. 6, figs. 1, 2, 1929.

Two adult and two septate shells from the Alaskan Jurassic are assigned to this species. Form very stout on penultimate whorl and fairly stout on adult whorl. Whorls subquadrate, wider than high. Flanks nearly flat, rounding rather abruptly into umbilical wall, merging evenly into venter, which is broadly rounded on the penultimate whorl and flattened on the body whorl. Umbilicus narrow on the penultimate whorl but widens rapidly on the anterior half of the body whorl; wall low, vertical at base, steeply inclined above. Body chamber represented by three-fourths of a whorl. Aperture marked on internal mold by a broad forwardly inclined constriction that is followed by a prominent swelling which is abruptly truncated.

The ribs are high and thin where the shell is preserved but rather low and rounded on the internal mold. They incline backward on the umbilical wall, incline forward considerably on the flanks, and cross the venter transversely. The primary ribs are considerably thicker and higher than the secondary ribs and terminate at about one-third of the height of the flanks in radially compressed tubercles that are fairly prominent on the outer two whorls. Trifurcation is the common mode of branching and most sets of branched ribs are separated by single intercalary ribs. During growth the ribbing gradually becomes more widely spaced on the venter but does not become stronger anteriorly. The holotype has about 35 primary ribs and 120 secondary ribs. The specimen shown on plate 52, figure 1, has about 40 primary ribs and 136 secondary ribs.

The external saddle and the first lateral lobe of the specimen shown on plate 52, figures 3–5, are more slender than those of the holotype but were drawn at a considerably smaller diameter.

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

Specimen	Diameter	Whorl height	Whorl thickness	Umbilical width
Holotype	118	44(0.37)	56(0.47)	31(0.26)
Holotype	98	46(.47)	54(.55)	15(.15)
Plesiotype (pl. 52, fig. 6)	152	46(.30)	?	48(.31)
Plesiotype same	131	51(.39)	55?(.42)	34(.26)
Plesiotype (pl. 52, figs. 3-5)	76	40(.53)	47(.62)	11.5(.15)

K. abruptus (McLearn) is characterized by the small umbilicus and stoutness of its penultimate whorl, by the rapid umbilical enlargement on the anterior half of the body whorl, and by the sharpness of its ribbing. Its ribbing is similar to that of *K. gitinsi* (McLearn) but its whorl section is much stouter. *K. alticostatus* Imlay has a more compressed whorl section and more prominent ribbing on the body whorl.

Plesiotypes: U.S.N.M. 108133, 108134.

Chinitna formation, lower third, U.S.G.S. Mes. locs. 21330, 22433, and 22559. The holotype is from a sandstone bed near the top of the Yakoun formation on the northeast shore of Maude Island, British Columbia.

Kepplerites (Seymourites) plenus (McLearn)

Plate 49, figure 21

Yakounites plenus McLearn, Trans. Roy. Soc. Canada 3d ser., vol. 21, sec. 4, p. 71, pl. 1, fig. 1, 1927.
Seymourites plenus (McLearn), Canada Nat. Mus. Bull. 54, p. 5, pl. 1, fig. 1, pl. 2, figs. 1, 2, 1929.

One specimen from southwestern Alaska is very similar to the holotype of *K. plenus* (McLearn) in size, stoutness of whorls, umbilical enlargement, and ornamentation. The tubercles may be a little more prominent but this probably reflects better preservation. Also, the anterior end of the body chamber has a flattened mid ventral area about 15 mm in width which cannot be demonstrated on the holotype because of crushing.

It seems possible that *K. plenus* is a synonym of *K. loganianus* (Whiteaves) (1876, p. 27, pl. 8, fig. 2), as they have very similar ornamentation. McLearn (1929, pp. 6, 7) notes that *K. plenus* "at the same stage of growth is somewhat larger and has relatively stouter whorls and somewhat smaller umbilicus than *Seymourites loganianus* (Whiteaves)." However, the difference in size does not seem to be beyond the range in variation shown by other species of ammonites. The difference in stoutness may be explained by the obvious greater lateral crushing of the type of *K. loganianus* than of *K. plenus*. The difference in the width of the umbilicus is certainly minor as shown by actual measurements and by inspection of plaster casts of the types. The settlement of possible synonymy of these species will have to await additional collecting and comparing of large numbers of specimens, as the holotype of *K. loganianus* is too imperfect to warrant definite identification.

Plesiotype, U.S.N.M. 108135.

Shelikof formation, lower member, at U.S.G.S. Mes. loc. 19793.

Genus Gowericeras Buckman 1921

Gowericeras snugharborense Imlay, n. sp.

Plate 53, figure 9

The species is represented for certain only by the holotype, which has been crushed laterally. It appears that the whorl section is ovate, probably wider than high, and that the flanks and venter are evenly convex. The umbilicus is moderately wide and enlarges gradually during growth. The umbilical wall is fairly high, vertical at base, rounding rapidly into flanks. The body chamber is not completely preserved but is represented by at least five-sixths of a whorl.

The inner whorls, exposed in the umbilicus, bear prominent, rather widely spaced primary ribs that terminate in conical tubercles just below the line of involution. On the body whorl the primary ribs are moderate in strength, are radial on the umbilical wall, incline slightly forward on the lower third of the flanks, and terminate in small conical tubercles. From each of these arise three, or less commonly two, secondary ribs that are a little weaker than the primary ribs and are only slightly inclined forward. Between sets of branched ribs are generally single intercalary ribs that begin along the zone of furcation. It is estimated that the body whorl has 40 primary ribs and 140 secondary ribs. The primary ribs are more closely spaced at the anterior end of the body whorl than at the posterior end.

This species resembles *Gowericeras toricellii* (Oppel) (1862, p. 153; Buckman, 1922, pl. 292) but appears to have denser primary ribbing, more prominent tubercles, and a thicker body whorl. *G. childanum* Buckcan (1923, pl. 404) has wider-spaced ribbing and a smaller umbilicus. *G. trichophorum* Buckman (1922, pl. 291) has weaker ribbing and a smaller umbilicus.

Holotype, U.S.N.M. 108137.

Chinitna formation, near base, U.S.G.S. Mes. loc. 3015.

Gowericeras spinosum Imlay, n. sp.

Plate 53, figures 8, 11

The species is known by only one slightly crushed specimen. Whorl ovate in section, a little wider than high, embracing about three-fifths except at anterior end of body whorl. Flanks and venter evenly convex.

Umbilicus fairly wide, enlarging rapidly near anterior end of body chamber; umbilical wall moderate in height, vertical, rounding rather abruptly into flanks. The body chamber is represented by about three-fourths of a whorl. The aperture is abruptly truncated and is preceded by several weak primary ribs.

The body whorl and the penultimate whorl bear coarse, widely spaced primary ribs that incline backward on the umbilical wall, incline slightly forward on the flanks and terminate in prominent, conical tubercles at about two-fifths of the height of the flanks. From the tubercles arise two or three sharp secondary ribs that are considerably weaker than the primary ribs and incline forward gently on the flanks. Single ribs arise along the zone of furcation between the sets of branched ribs. The body whorl has 28 primary ribs and about 100 secondary ribs.

The first lateral lobe is slightly longer than the external lobe. The second lateral lobe is very short. The external saddle is wider than the first lateral lobe or the first lateral saddle. The tubercle is in the inner branch of the first lateral saddle.

The holotype at a diameter of 94 mm has a whorl height of 24 mm, an umbilical width of 38 mm, and an estimated whorl thickness of 35 mm.

This species greatly resembles *Gowericeras ventrale* Buckman (1922, pl. 288) but has longer primary ribs and fewer secondary ribs. Compared with *G. approximatum* (Buckman) (1922, pl. 336), it has more prominent tubercles, more secondary ribs, and a thicker whorl section.

Holotype, U.S.N.M. 108138.

Chinitna formation, lower part of middle third, at U.S.G.S. Mes. loc. 22432.

Gowericeras sp.

Plate 53, figures 6, 7, 10

One specimen from the same locality as *G. snugharborense* differs apparently from that species by having a thicker whorl section, weaker primary ribs and more strongly inclined secondary ribs. However, direct comparisons cannot be made because only a small part of the body chamber is preserved. The suture line is well preserved. The first lateral lobe is slightly longer than the external lobe. The second lateral lobe is very short. The external saddle is a little wider than the first lateral lobe and is asymmetrically divided by a short lobule. The first lateral saddle is as wide as the external saddle and is nearly symmetrically divided by a short lobule. The tubercle is in the outer branch of the second lateral saddle.

Figured specimen, U.S.N.M. 108139.

Chinitna formation, near base, U.S.G.S. Mes. loc. 3015.

Genus Cosmoceras Waagen 1869

Subgenus Cosmoceras, sensu stricto

Cosmoceras (Cosmoceras) cf. C. spinosum (J. de C. Sowerby)

Plate 53, figures 4, 5

One specimen has poorly preserved inner whorls and has been crushed ventrally in such a manner as to make the flanks bulge out. However, it is clearly markedly evolute for the genus, has a fairly thick whorl section, and a broad flat venter. On the inner whorls the primary ribs are high, narrow, fairly widely spaced; and terminate in prominent spines along the line of involution. In several places two adjoining primary ribs unite in a spine. On the outer whorl the ribs are similarly high, sharp and fairly widely spaced, and are nearly as prominent on the venter as on the flanks. They are radial, or inclined forward slightly on the flanks but cross the venter transversely. About half of the ribs pass from the umbilicus to the venter without bifurcating or bearing tubercles on the flanks. These alternate fairly regularly with ribs that bifurcate at or slightly above the middle of the flanks and bear fairly prominent lateral tubercles. All the secondary ribs bear distinct ventral tubercles and none are joined at the ventral tubercles.

This species seems to be intermediate between *C. compressum* (Quenstedt) (Arkell, 1939, p. 191) and *C. spinosum* (J. de C. Sowerby) (Arkell, 1939, p. 187). It resembles *C. spinosum* in its evolute form, thick whorl section, and numerous unbranched ribs. It differs in its finer ribbing, less prominent ventral tubercles, and broader venter; in these respects it is more like *C. compressum*. The failure of any of its secondary ribs to join at the ventral tubercles suggests that it is distinct from either of these species.

Figured specimen: U.S.N.M. 108140.

Chinitna formation (?) at U.S.G.S. Mes. loc. 10991. The specimen was found as float, but the sharpness of its ribbing shows that it was not carried far. Its location suggests that it was derived from the upper part of the middle third of the Chinitna formation.

Subgenus Gulielmiceras Buckman 1920

Cosmoceras (Gulielmiceras) alaskanum Imlay, n. sp.

Plate 49, figures 13–16

The species is represented by two external molds and one internal mold. Form compressed, discoidal; whorls subquadrate, considerably higher than wide; flanks high, flattened, parallel below, converging gently above, rounding abruptly into umbilicus; venter truncated, fairly narrow, concave but becoming less so near aperture. Umbilicus fairly narrow, enlarging slowly; wall fairly low and vertical. Length of body chamber not known. Aperture marked by a prolonged lateral lappet.

The ribs are thin, moderate in height and spacing, and gently flexuous. The primary ribs are a little more prominent than the secondary ribs. They incline backward on the upper part of the umbilical wall, incline forward on the flank, and terminate in small conical tubercles at about one-third of the height of the flanks. The primary ribs are swollen on the umbilical edge but do not form tubercles there. The secondary ribs incline forward in a gently flexuous manner on the inner whorls and on the posterior part of the body whorl. Anteriorly on the body whorl they bend forward increasingly near the middle of the flank. Near the aperture they form a prominent bulge that is prolonged in the lateral lappet. The secondary ribs pass from the lateral tubercles mostly in pairs, but on the body whorl some of the secondaries are indistinctly connected with the lateral tubercles and a few secondaries arise free of any tubercle. All the secondaries terminate ventrally in small radially elongated tubercles that bound the flattened ventral area and are connected across the venter by ribs that are a little weaker than the flank ribs.

The suture line is not preserved and the specimens are too imperfect for accurate measurements.

This species is very similar to *C. knechteli* Imlay from the *Kepplerites mclearni* beds of Montana (Imlay, 1953, p. 31). In lateral view it greatly resembles a *Gulielmiceras* from England figured by Brinkmann (1929, pl. 1, fig. 1) as *G. gulielmii* Sowerby but considered by Arkell (1945, p. 341) an unnamed species. It differs from most of the described species of *Gulielmiceras* (e. g. Buckman, 1920, pl. 194; 1924, pl. 531, 532) by lacking a distinct umbilical tubercle and by having a ribbed venter. However, a species from Russia described by Nikitin (1881a, p. 70, pl. 4, fig. 31) does not have umbilical tubercles, but only swellings at the edge of the umbilicus, as in the Alaskan species. Also, a species from east Greenland (Spath, 1932, p. 96, pl. 24, figs. 3a, b, pl. 26, fig. 5) lacks both umbilical and lateral tubercles and has ventral ribbing on the anterior part of the body whorl. Spath (1932, p. 97) notes that similar feebly tuberculate forms occur in the Kellaways beds in Yorkshire. The ornamentation of the Alaskan species is similar to that of immature forms of some species of *Kepplerites* except for greater compression, more flexuous ribbing, and the prolonged lateral lappet. Assignment to *Sigaloceras* is not possible because that genus develops a smooth body chamber, is typically untuberculate, and generally has much denser ribbing. Likewise *Gulielmites* is distinguished by a smooth body whorl and an absence of lappets.

Holotype, U.S.N.M. 108141, paratypes, U.S.N.M. 108142a, b.

Chinitna formation, near base, U.S.G.S. Mes. locs. 2920 and 20755.

Genus Reineckeia Boyle 1878

Subgenus Kellawaysites Buckman 1925

Reineckeia (Kellawaysites) shelikofana Imlay n. sp.

Plate 55, figures 1, 2, 5–8

This species is represented only by the holotype. Form moderately stout; whorls evolute, inner whorls greatly depressed and having divergent flanks, outer whorls ovate, slightly depressed, and thickest near the middle of the flanks. Venter on inner whorls very broad, depressed, and making a sharp angle with the flanks along the line of tuberculation. During growth the venter becomes more convex and on body whorl rounds evenly into flanks. Umbilicus very wide; wall steep at base, rounding evenly into flanks, moderately high, becoming higher during growth. Characters of body chamber not known as shell is septate to end. The protoconch is well exposed and represents about one-fifth of a whorl.

The ornamentation changes considerably during growth. The first two whorls are smooth. The third whorl, which attains a diameter of about 2 mm, has faint swellings along the middle of the flanks. The fourth and fifth whorls have widely-spaced, prominent nodes along the flanks just below the line of involution. These nodes mark the termination of low, broad ribs that begin on the upper part of the umbilical wall, trend radial at first, and then incline strongly forward. On the sixth and seventh whorls, from diameters of 8 to 37 mm, the primary ribs gradually become closer spaced, narrower, less strongly inclined, and their terminations are marked by fairly regular alteration of weak and strong nodes. These nodes mark the bases of high spines that are preserved at several places. The secondary ribs are exposed only on the outer seventh to ninth whorls from diameters of 37 to about 160 mm. They are slightly stronger than the primary ribs, closer spaced, triangular in cross-section, and arch forward strongly on the venter. On the seventh and eighth whorls the secondary ribs generally branch from the strong nodes by three's and from the weak nodes by two's. Some of the secondary ribs arise singly from weak nodes. On the ninth whorl the secondary ribs become more widely spaced, bifurcate from weak tubercles, and generally one of the branches is indistinctly connected with the tubercle. A weak median sinus is evident on the venter of the seventh whorl. It cannot be seen on the outer two whorls.

The suture line is excellent confirmation of the generic position of *R. shelikofana*, as shown by the obliquity of the suture with respect to the radius of the shell, by the considerable width of the saddles, by the greater length of the external lobe than of the first lateral lobe, and by the small, oblique second lateral lobe. The general pattern of the suture is similar to that on *R.* (***K***) *oxyptychoides* (Spath) (1933, pl. 126, fig. 1). The main difference is in the outer branch of the first lateral saddle, which is shorter than the inner branch on the Alaskan specimen. The shortness of this branch is possibly related to its position on the ventral shoulder or to the location of tubercles.

The proportions at a diameter of about 113 mm are shown on the outline drawing on plate 55, figure 2. The outer two whorls are too crushed for accurate measurement.

This species is distinguished by the rather closely spaced ribbing on its outer whorls and its rather high point of rib branching from such species as *R. multicostata* (Petitclerc) (1915, p. 98, pl. 12, fig. 2), *R. oxyptychoides* Spath (1928, p. 266, pl. 4, figs. 5a, b), and *R. greppini* (Oppel) (1862, p. 154; Neumayr, 1870, p. 151, pl. 8, fig. 2). The density of its ribbing is approached by *R. bukowskii* Till (1911, p. 13, pl. 1, figs. 7, 8), which Loczy (1915, p. 374, 433, pl. 19, figs. 6–8) considers a synonym of *R. plana* Lee, but the latter has flatter flanks and a higher whorl section. None of the Mexican or South American species of *Reineckeia* are closely comparable. Forms comparable in size with the Alaskan species have been figured by Loczy (1915, pl. 20, fig. 5, pl. 21, fig. 1).

Holotype, U.S.N.M. 108143.

Shelikof formation, about 350 feet above base at U.S.G.S. Mes. loc. 21355 at Wide Bay.

Genus Procerites Siemiradzki 1898

Procerites spp.

Plate 53, figures 1–3

Fragmentary specimens referable to *Procerites* have been found at the very base of the Chinitna formation at several localities. One species (pl. 53, fig. 1), from Mesozoic localities 22446 and 22448, bears ribbing similar to *Procerites evolutus* (Neumayr) (1871, p. 41, pl. 14, figs. 2a, b). It differs mainly by having a more compressed whorl section and by the secondary ribs arching forward on the venter. Many of the bifurcation points are indistinct and some of the secondary ribs arise independently of the primary ribs. Deep constrictions occur on two fragments. The ribbing is a little coarser and more even than on the inner whorls of *Procerites? irregularis* described herein.

Another species (pl. 53, figs. 2, 3), from Mesozoic locality 22446, resembles *P. funatus* (Oppel) in Neumayr (1871, pl. 14, figs. 1a, b) in whorl shape, degree of involution and strength of ribbing, but its secondary ribs are fewer in number and arch forward on the venter. A constriction is present on the penultimate whorl. Arching of the ribs similar to that on these Alaskan specimens occurs on *P. hians* (Waagen) (1875, p. 153, pl. 17, figs. 2a–c) from India and on a *Procerites* from Hungary figured by Loczy (1915, p. 425, text-fig. 139).

Figured specimens, U.S.N.M. 108144, 108145.

Chinitna formation, near base, at U.S.G.S. Mes. locs. 22446 and 22448.

Procerites? irregularis Imlay, n. sp.

Plate 54, figures 1, 2

This species is represented by only one large specimen from a level near the base of the Chinitna formation on Chisik Island. The specimen has been much crushed laterally so that measurements are useless and the whorls appear to be nearly flat. Originally the whorls were probably nearly ovate. The body whorl embraces the penultimate whorl about one-third. The umbilicus is wide and the umbilical wall is low and gently inclined. The body chamber is represented by five-sixths of a whorl and its aperture is not preserved.

The ribbing on the sutured whorls is moderate but irregular in strength and inclined forward. The ribs begin weakly on the umbilical wall and are strongest at the line of involution. There are 6 or 7 constrictions per whorl and a similar number of swollen ribs. Portions of the venter exposed at a diameter of 30 mm show that the ribs become broader and lower on the venter, are arched forward less strongly than on the flanks and that some ribs bifurcate. On the body whorl the ribs become weaker and broader but more uniform in strength. Most of them begin at the line of involution but some begin near the middle of the flanks and a few occur only on the venter.

The suture line is distinguished from that of other described species of *Procerites* by a somewhat broader first lateral saddle and a longer second lateral lobe.

This species is tentatively placed in *Procerites* because it is more evolute and has more single ribs than any of the described species. However, it would certainly appear much less evolute if it were not crushed. Similarly large and evolute species of *Choffatia* are distinguished by coarser and more widely spaced primary ribs and generally by more numerous secondary ribs, although Spath (1931, p. 357, pl. 79, figs. 5a, b) figures a specimen of *Choffatia* having an outer whorl similar to that of the Alaskan species. The large specimens of *Sivajiceras* from India described by Spath (1931, pp. 287–295) have much coarser ribbing on their inner whorls and are more robust.

Holotype, U.S.N.M. 108146.

Chinitna formation, near base, U.S.G.S. Mes. loc. 21273.

Genus Grossouvria Siemiradzki 1898

Grossouvria sp.

Plate 55, figures 3, 4

The genus *Grossouvria* is represented by half a whorl that has been much crushed. The fragment shows prominent, sharp, rather widely spaced primary ribs, most of which divide rather high on the flanks into secondaries that curve backward strongly on the venter. Three sets of parabolar nodes on the ventral margins mark the terminations of pairs of primary ribs. Species of *Grossouvria* having similar ornamentation are illustrated in monographic works by Corroy (1932, pl. 17, figs. 7, 8, pl. 18, figs. 6–9) and Pfaehler-Erath (1938, pl. 1).

Figured specimen, U.S.N.M. 108147.

Chinitna formation, lower third, U.S.G.S. Mes. loc. 22431.

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[Italic numbers indicate descriptions]

PLATES 25–55

PLATE 25

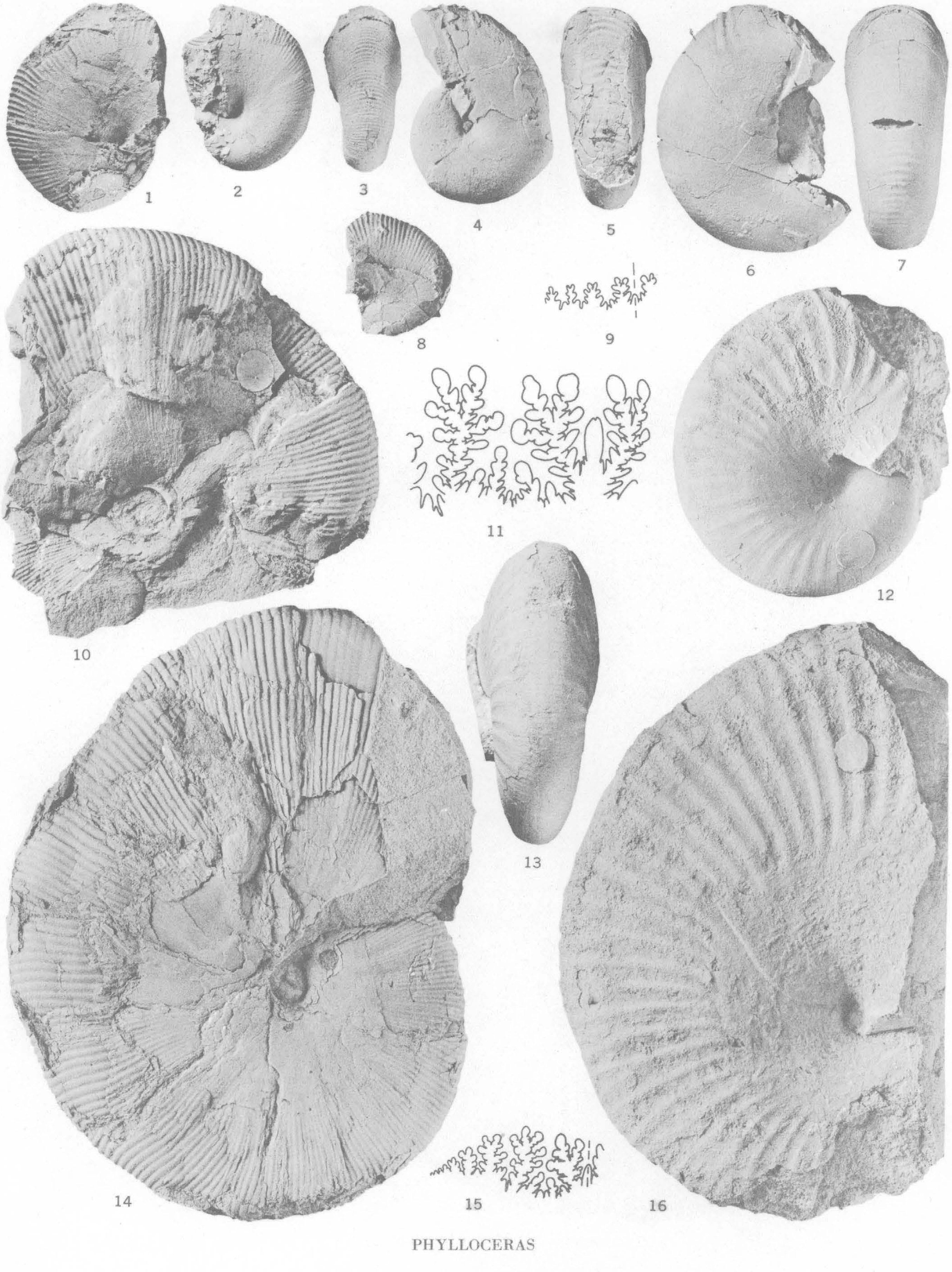
[All figures natural size]

FIGURES 1–3, 8. *Phylloceras* (*Partschiceras*) *subobtusiforme* Pompeckj (p. 73).
1. Plesiotype, U.S.N.M. 108010, from U.S.G.S. Mes. loc. 22411, Chinitna formation.
2, 3. Lateral and ventral views of plesiotype, U.S.N.M. 108011, from U.S.G.S. Mes. loc. 21348, Chinitna formation.
8. Plesiotype, U.S.N.M. 108009, from U.S.G.S. Mes. loc. 3029, Chinitna formation.

4–7, 9. *Phylloceras* (*Partschiceras*) *grantzi* Imlay, n. sp. (p. 73).
4, 5, 9. Holotype, U.S.N.M. 108012, from U.S.G.S. Mes. loc. 22432, Chinitna formation.
6, 7. Paratype, U.S.N.M. 108013, from U.S.G.S. Mes. loc. 22432, Chinitna formation.

10, 14. *Phylloceras bakeri* Imlay, n. sp. (p. 72).
10. Paratype, U.S.N.M. 108005, from U.S.G.S. Mes. loc. 2990, Chinitna formation.
14. Holotype, U.S.N.M. 108004, from U.S.G.S. Mes. loc. 10997, Chinitna formation.

11–13, 15, 16. *Phylloceras* (*Macrophylloceras*) *grossicostatum* Imlay, n. sp. (p. 74).
11. Suture line of paratype, U.S.N.M. 108017, from U.S.G.S. Mes. loc. 11047, Chinitna formation.
12, 13. Paratype, U.S.N.M. 108015, from U.S.G.S. Mes. loc. 2921, Chinitna formation.
15. Suture line of paratype, U.S.N.M. 108016, from U.S.G.S. Mes. loc. 3029, Chinitna formation.
16. Holotype, U.S.N.M. 108014, from U.S.G.S. Mes. loc. 3015, Chinitna formation.



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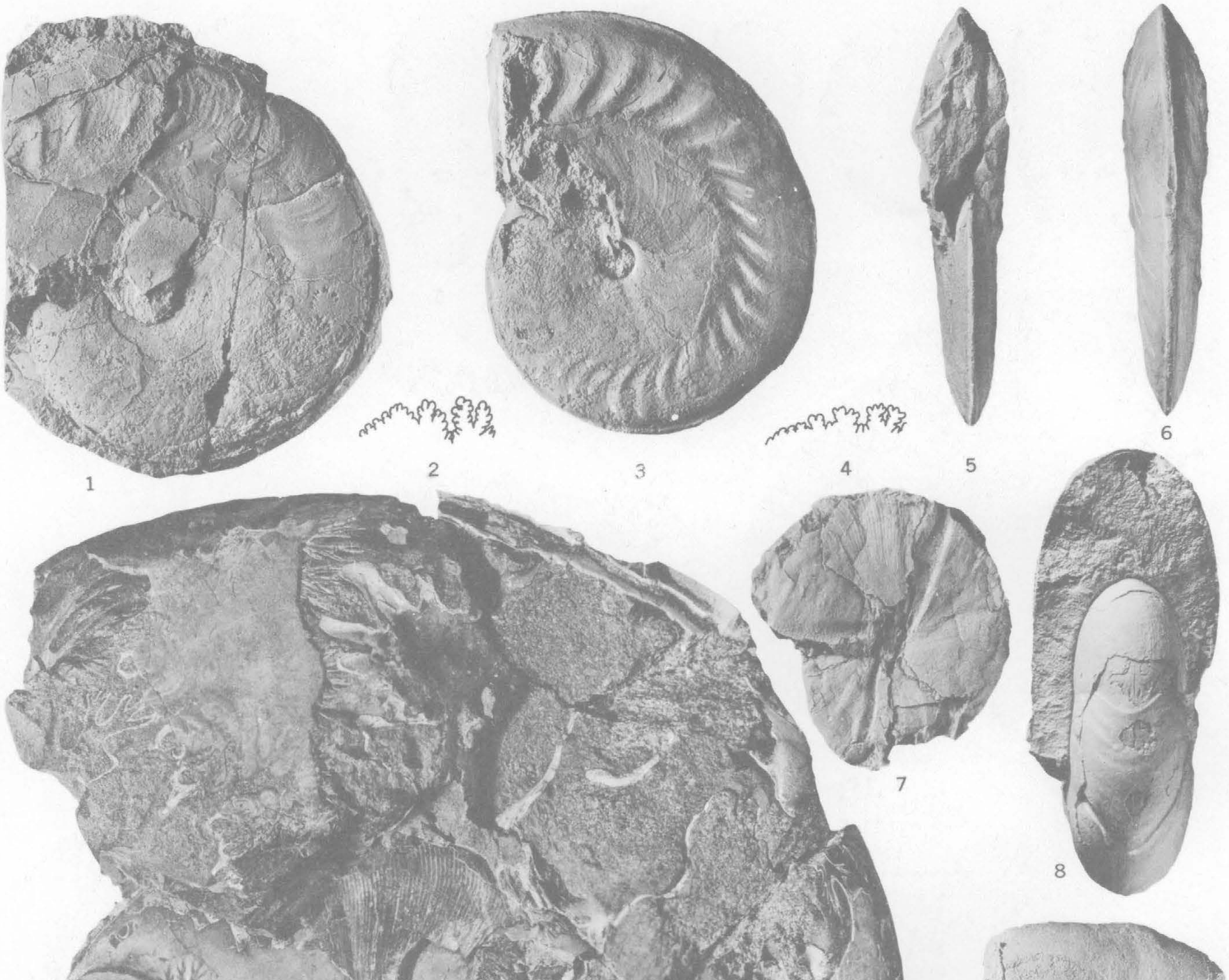


1 2 3 4 5 6 7 8 9 10 11

PHYLLOCERAS AND OPPELIA

PLATE 26

[All figures natural size]

FIGURES 1, 2. *Oppelia* (*Oxycerites*) sp. (p. 75). Lateral view of specimen, U.S.N.M. 108019 from U.S.G.S. Mes. loc. 3020, Chinitna formation.

3–6. *Oppelia* (*Oxycerites*) *chinitnana* Imlay, n. sp. (p. 74). Lateral, apertural, ventral views and suture line of holotype, U.S.N.M. 108018 from U.S.G.S. Mes. loc. 3029, Chinitna formation.

7–11. *Phylloceras* (*Calliphylloceras*) *freibrocki* Imlay, n. sp. (p. 73).

7. Paratype, U.S.N.M. 108007 from U.S.G.S. Mes. loc. 2941, Chinitna formation.

8, 9. Paratype, U.S.N.M. 108008 from U.S.G.S. Mes. loc. 11047, Chinitna formation.

10, 11. Holotype, U.S.N.M. 108006 from U.S.G.S. Mes. loc. 3104, Shelikof formation.

PLATE 27

[All figures natural size]

FIGURES 1–9. *Lilloettia buckmani* (Crickmay) (p. 75).

1. Plesiotype, U.S.N.M. 108022 from U.S.G.S. Mes. loc. 21322, Chinitna formation.

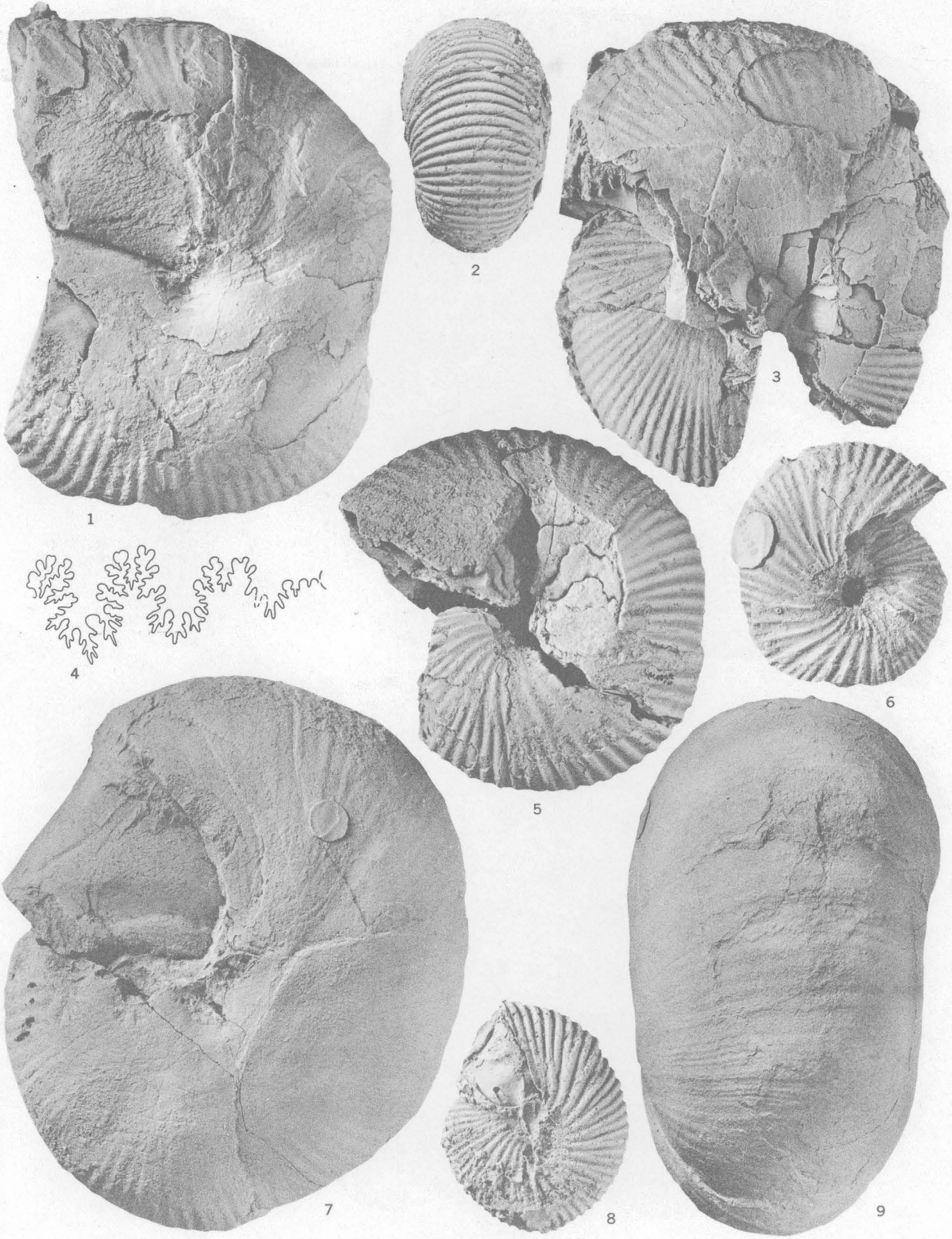
2, 5, 8. Plesiotype U.S.N.M. 108025 from U.S.G.S. Mes. loc. 21359, Shelikof formation. Figs. 2 and 8 represent a rubber mold of the interior of the specimen shown in fig. 5.

3. Plesiotype, U.S.N.M. 108026b from U.S.G.S. Mes. loc. 21360, Shelikof formation.

4. Suture line of plesiotype, U.S.N.M. 108023 from U.S.G.S. Mes. loc. 19902, Shelikof formation.

6. Plesiotype, U.S.N.M. 108024 from U.S.G.S. Mes. loc. 21332, Chinitna formation.

7, 9. Plesiotype, U.S.N.M. 108021 from U.S.G.S. Mes. loc. 3029, Chinitna formation.



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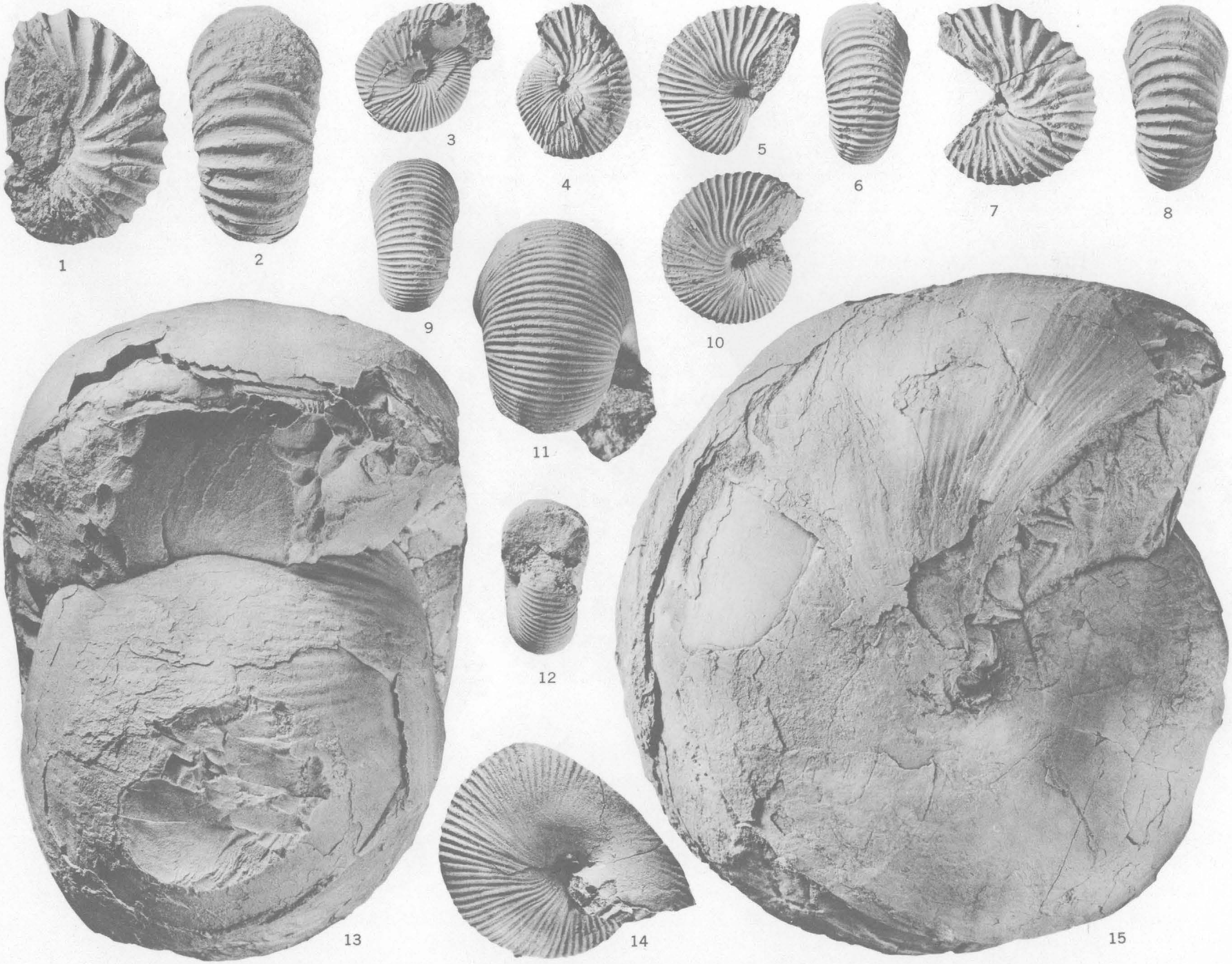


LILLOETTIA AND XENOCEPHALITES

PLATE 28

[All figures natural size]

FIGURES 1–8. *Xenocephalites vicarius* Imlay, n. sp. (p. 78).

1, 2. Lateral and ventral views of complete body chamber of paratype, U.S.N.M. 108042 from U.S.G.S. Mes. loc. 22437, Chinitna formation.

3, 4. Lateral views of paratype, U.S.N.M. 108043 from U.S.G.S. Mes. loc. 3028, Chinitna formation.

5, 6. Paratype, U.S.N.M. 108044 from U.S.G.S. Mes. loc. 21321, Chinitna formation.

7, 8. Lateral and ventral views of complete body chamber of holotype, U.S.N.M. 108041 from U.S.G.S. Mes. loc. 22437, Chinitna formation.

9, 10, 12. *Xenocephalites hartsocki* Imlay, n. sp. (p. 79).

Ventral, lateral and apertural views of holotype, U.S.N.M. 108045 from U.S.G.S. Mes. loc. 21341, Chinitna formation.

11, 13–15. *Lilloettia milleri* Imlay, n. sp. (p. 75).

11, 14. Paratype, U.S.N.M. 108029 from U.S.G.S. Mes. loc. 22434, Chinitna formation.

13, 15. Holotype, U.S.N.M. 108027 from U.S.G.S. Mes. loc. 21322, Chinitna formation.

PLATE 29

[All figures natural size]

FIGURES 1–5, 9, 10. *Lilloettia stantoni* Imlay, n. sp. (p. 77).

1. Plesiotype, U.S.N.M. 108037b; 5, plesiotype, U.S.N.M. 108037a. Both from U.S.G.S. Mes. loc. 21359, Shelikof formation.

2, 3, 9, 10. Holotype, U.S.N.M. 108035 from U.S.G.S. Mes. loc. 11049, Chinitna formation. Figs. 9 and 10 are from a rubber cast of the interior of the holotype.

4. Paratype, U.S.N.M. 108036 from U.S.G.S. Mes. loc. 3028.

6–8, 11. *Xenocephalites hebetus* Imlay, n. sp. (p. 78).

6, 7. Ventral and lateral views of complete body chamber of paratype, U.S.N.M. 108039 from U.S.G.S. Mes. loc. 22434, Chinitna formation.

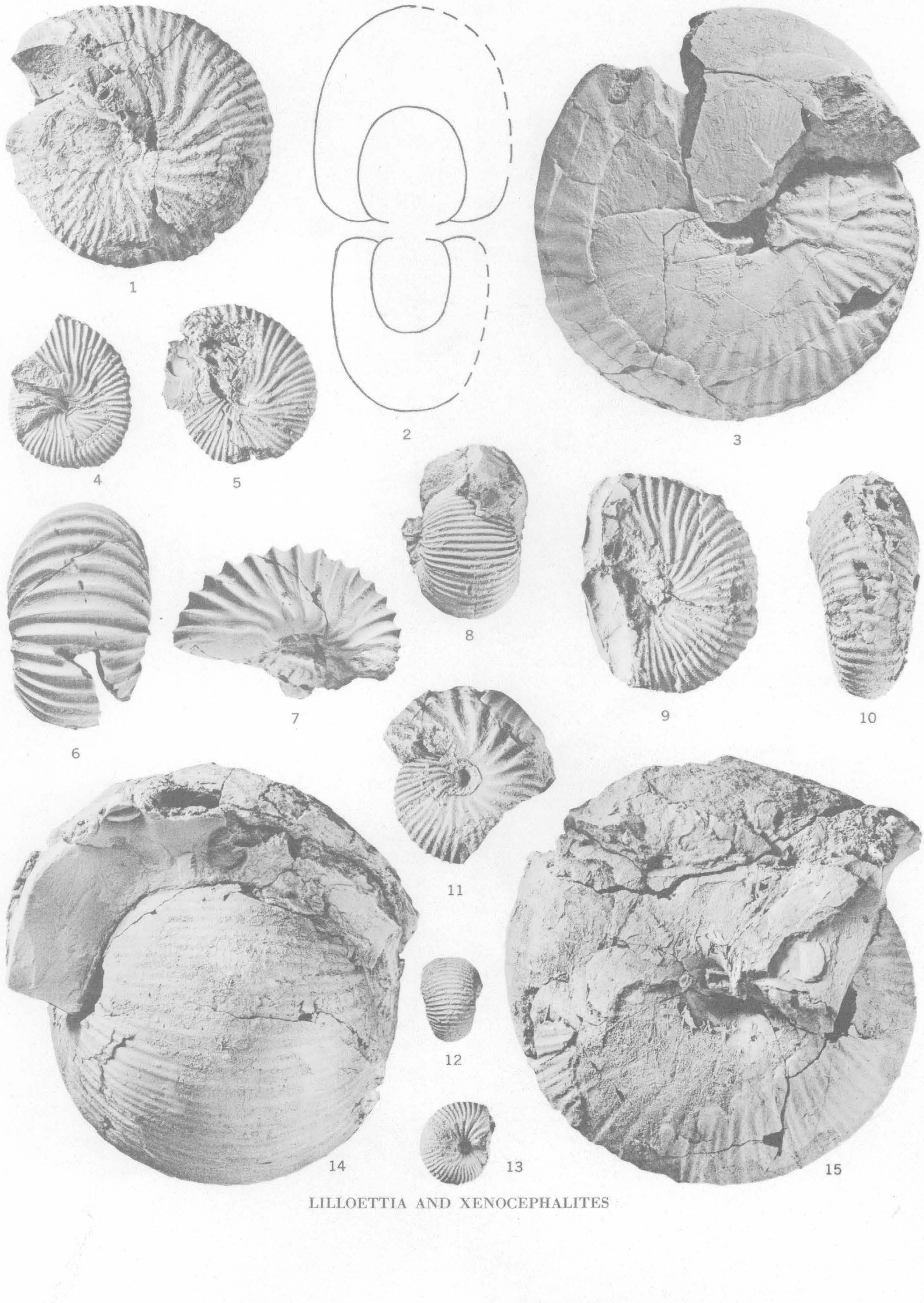
8, 11. Apertural and lateral views of holotype U.S.N.M. 108038 from U.S.G.S. Mes. loc. 21329, Chinitna formation.

12, 13. *Xenocephalites* sp. juv. cf. *X. hebetus* Imlay n. sp. (p. 78).

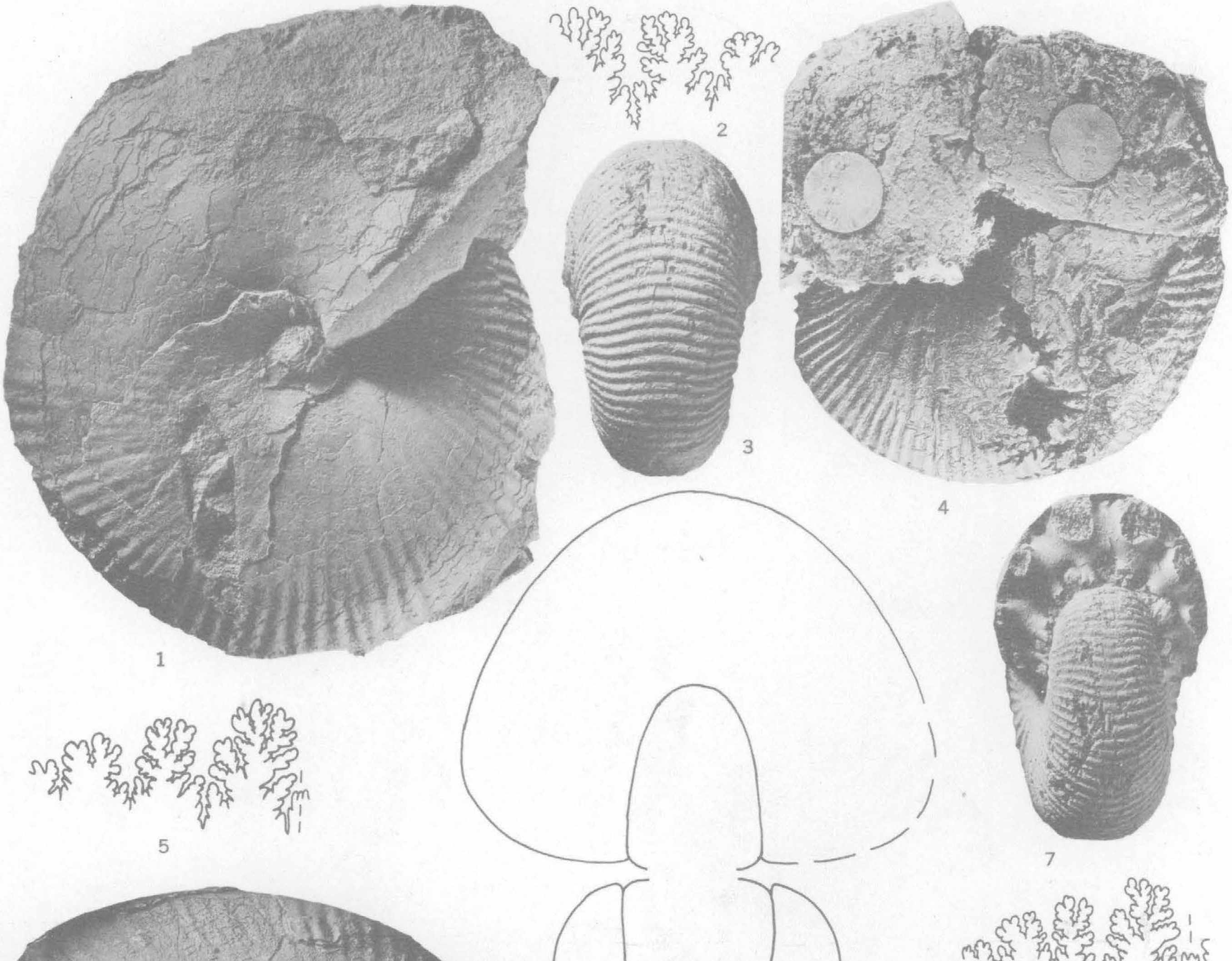
Specimen U.S.N.M. 108040 from U.S.G.S. Mes. loc. 3028, Chinitna formation.

14, 15. *Lilloettia milleri* Imlay, n. sp. (p. 75).

Septate penultimate whorl from which the body chamber has been removed. Paratype, U.S.N.M. 108028 from U.S.G.S. Mes. loc. 21322, Chinitna formation.



LILLOETTIA AND XENOCEPHALITES



LILLOETTIA

PLATE 30

[All figures natural size]

FIGURES 1, 2, 4, 8. *Lilloettia lilloetensis* Crickmay (p. 77).

1, 2. Plesiotype, U.S.N.M.108034 from U.S.G.S. Mes. loc. 21360, Shelikof formation. About half a whorl of body chamber has been removed.

4, 8. Plesiotype, U.S.N.M. 108033 from U.S.G.S. Mes. loc. 21340, Chinitna formation.

3, 5–7, 9–11. *Lilloettia mertonyarwoodi* Crickmay (p. 76).

5, 11. Plesiotype, U.S.N.M. 108030 from U.S.G.S. Mes. loc. 3028, Chinitna formation.

6, 9. Plesiotype, U.S.N.M. 108031 from U.S.G.S. Mes. loc. 21322. About one-third of a whorl has been removed.

3, 7, 10. Plesiotype, U.S.N.M. 108032 from U.S.G.S. Mes. loc. 21362, Shelikof formation.

PLATE 31

[All figures natural size]

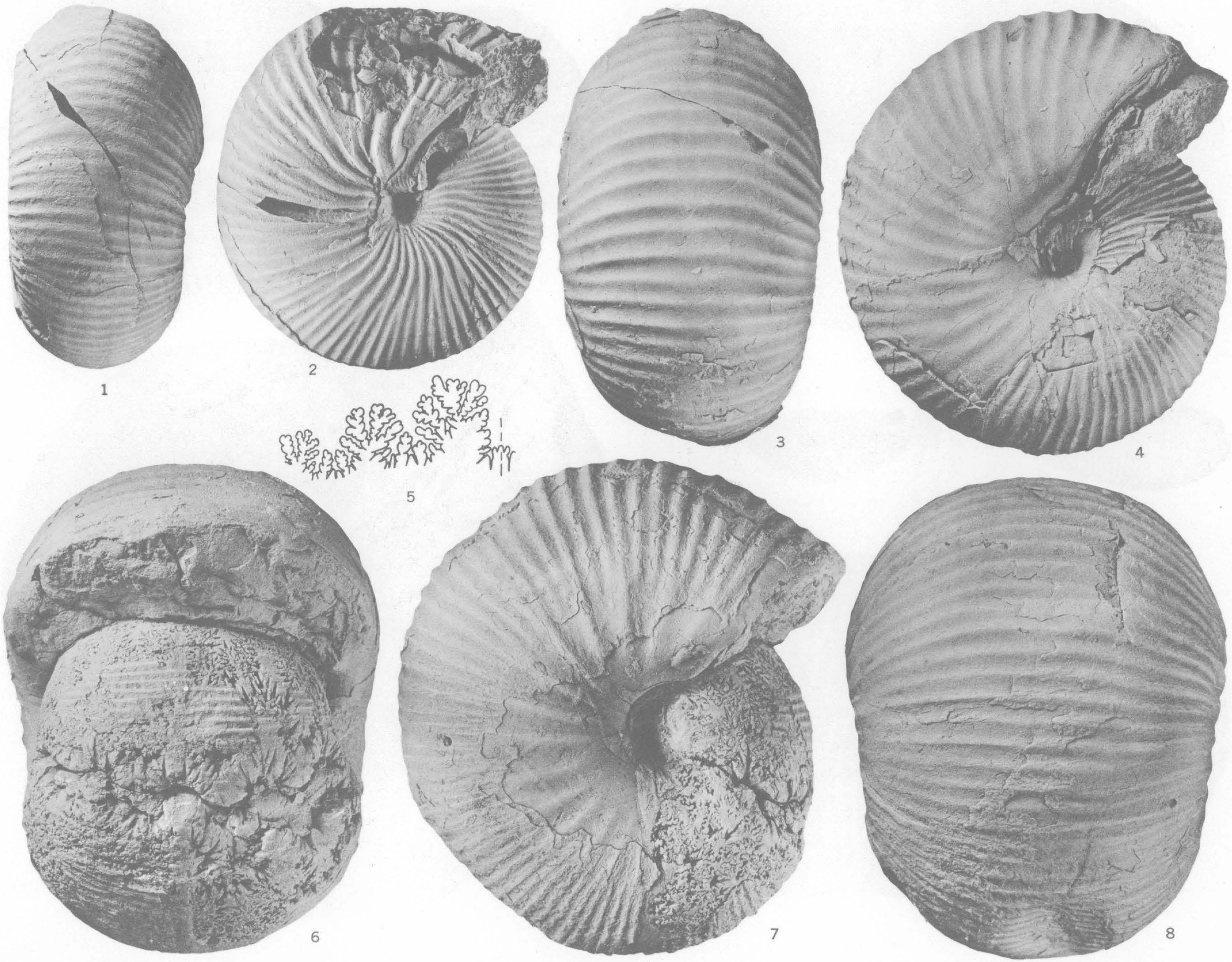
FIGURES 1–4. *Kheraiceras intermedium* Imlay, n. sp. (p. 81).

1, 2. Paratype, U.S.N.M. 108225 from U.S.G.S. Mes. loc. 3014, Chinitna formation. Body chamber complete, but partly crushed.

3, 4. Holotype, U.S.N.M. 108223 from U.S.G.S. Mes. loc. 21272, Chinitna formation.

5–8. *Kheraiceras magniforme* Imlay, n. sp. (p. 79).

Holotype, U.S.N.M. 108047 from Chinitna formation on east shore of Iniskin Bay. Exact location unknown.



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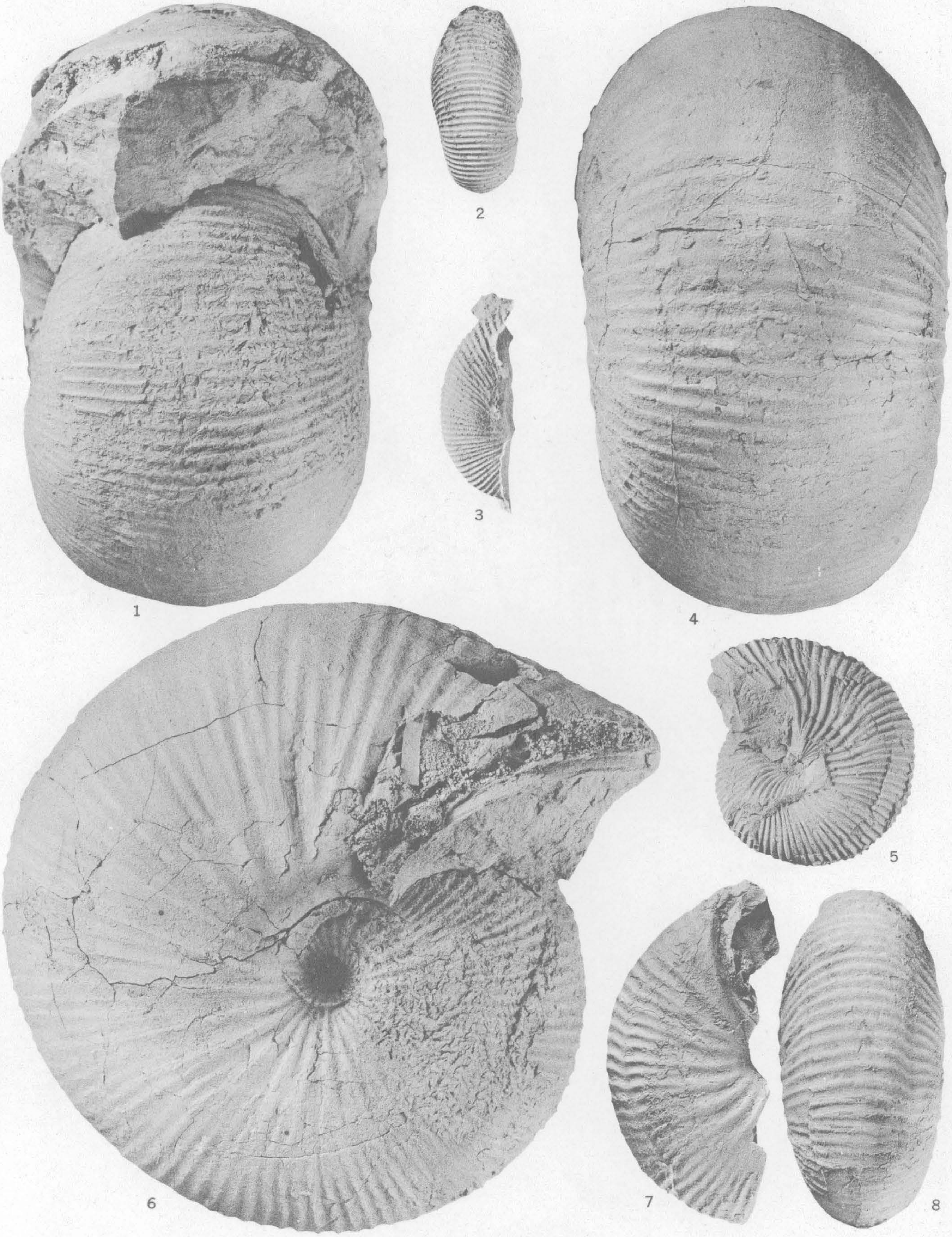


KHERAICERAS

PLATE 32

[All figures natural size]

FIGURES 1, 4, 6. *Kheraiceras martini* Imlay, n. sp. (p. 80).
Holotype, U.S.N.M. 108048 from U.S.G.S. Mes. loc. 22446, Chinitna formation.

2, 3, 5, 7, 8. *Kheraiceras intermedium* Imlay, n. sp. (p. 81).
2, 3, 7, 8. Paratype, U.S.N.M. 108051 from U.S.G.S. Mes. loc. 21334, Chinitna formation. Figs. 2 and 3 are from a rubber cast of the interior of specimen shown in figs. 7 and 8.
5. Paratype, U.S.N.M. 108224 from U.S.G.S. Mes. loc. 21273, Chinitna formation. Represents an immature form.

PLATE 33

[All figures natural size]

FIGURES 1, 7, 11, 13. *Kheraiceras abruptum* Imlay, n. sp. (p. 80).

Ventral and lateral views of both penultimate and body whorls of holotype, U.S.N.M. 108049 from U.S.G.S. Mes. loc. 22433, Chinitna formation. Note abrupt coarsening of ribbing at beginning of body chamber.

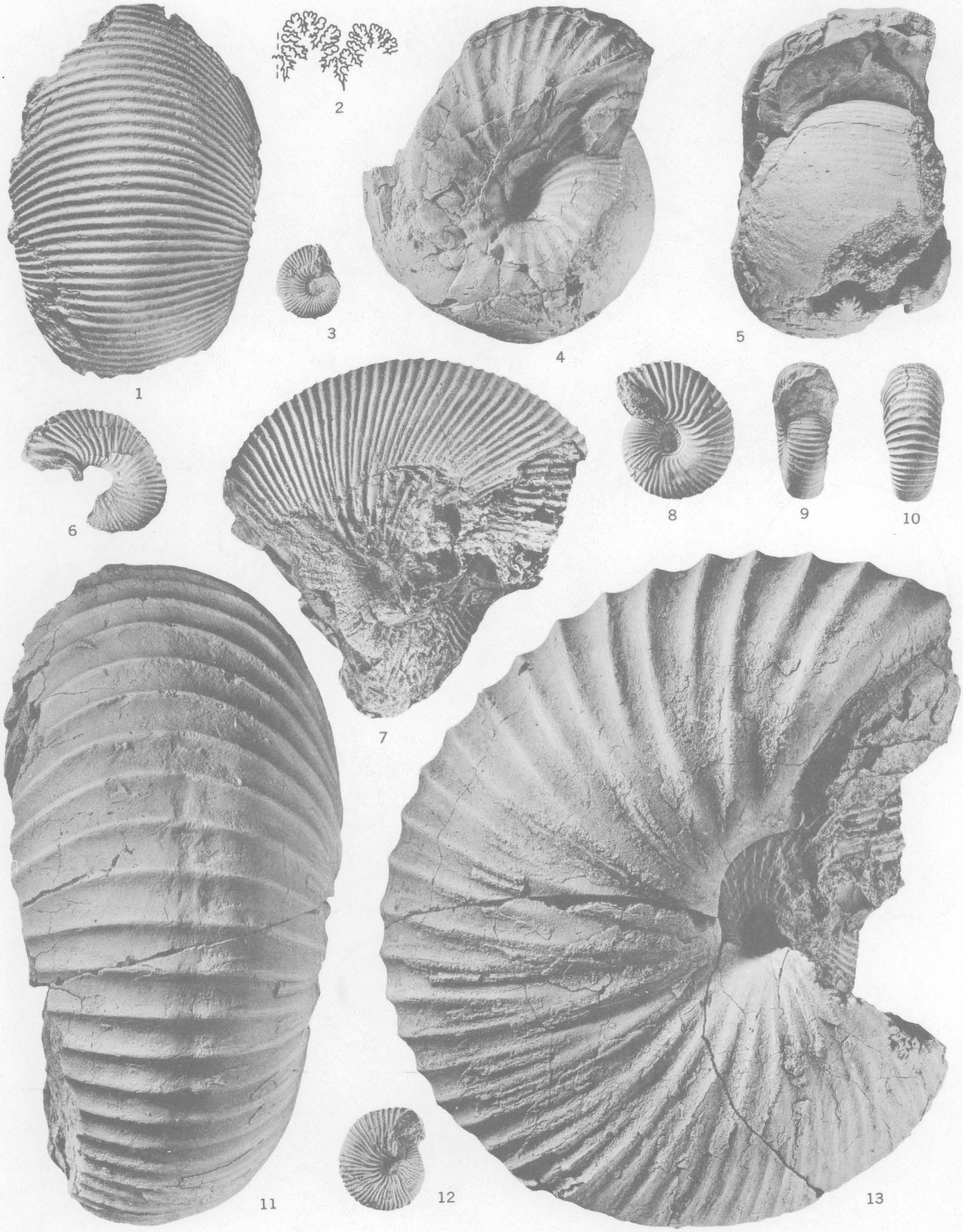
2, 4, 5. *Kheraiceras varicostatum* Imlay, n. sp. (p. 81).

Suture line, lateral and ventral views of holotype, U.S.N.M. 108050 from U.S.G.S. Mes. loc. 20760, Chinitna formation.

3, 6, 8–10, 12. *Kheraiceras? parviforme* Imlay, n. sp. (p. 82).

3. Paratype, U.S.N.M. 108053c; 6, paratype, U.S.N.M. 108053a; 12, paratype, U.S.N.M. 108053b. All from U.S.G.S. Mes. loc. 21334, Chinitna formation.

8–10. Holotype, U.S.N.M. 108052 from U.S.G.S. Mes. loc. 21334, Chinitna formation. Note apertural constriction.



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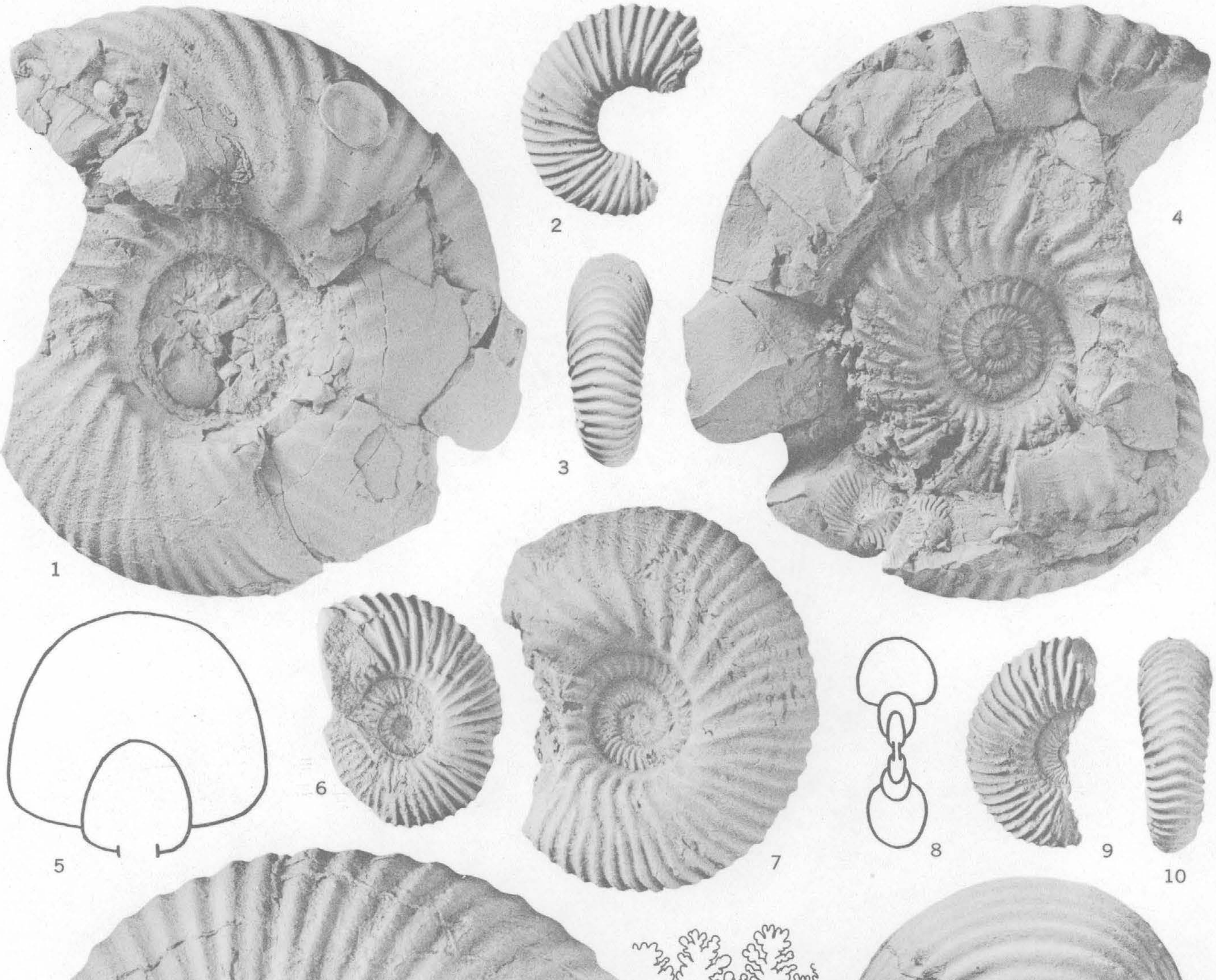


CADOCERAS

PLATE 34

[All figures natural size]

FIGURES 1–14. *Cadoceras catostoma* Pompeckj (p. 82).

1, 4, 5. Plesiotype, U.S.N.M. 108056 from U.S.G.S. Mes loc. 21288, Chinitna formation.

2, 3. Plesiotype, U.S.N.M. 108054c; 6, plesiotype, U.S.N.M. 108054b; 12, 14, plesiotype, U.S.N.M. 108054a. All from U.S.G.S. Mes. loc. 2921, Chinitna formation.

7, 11, 13. Plesiotype, U.S.N.M. 108055a; 8–10, plesiotype, U.S.N.M. 108055b. Both from U.S.G.S. Mes. loc. 3028, Chinitna formation.

PLATE 35

[All figures natural size]

FIGURES 1–8. *Cadoceras comma* Imlay, n. sp. (p. 83).

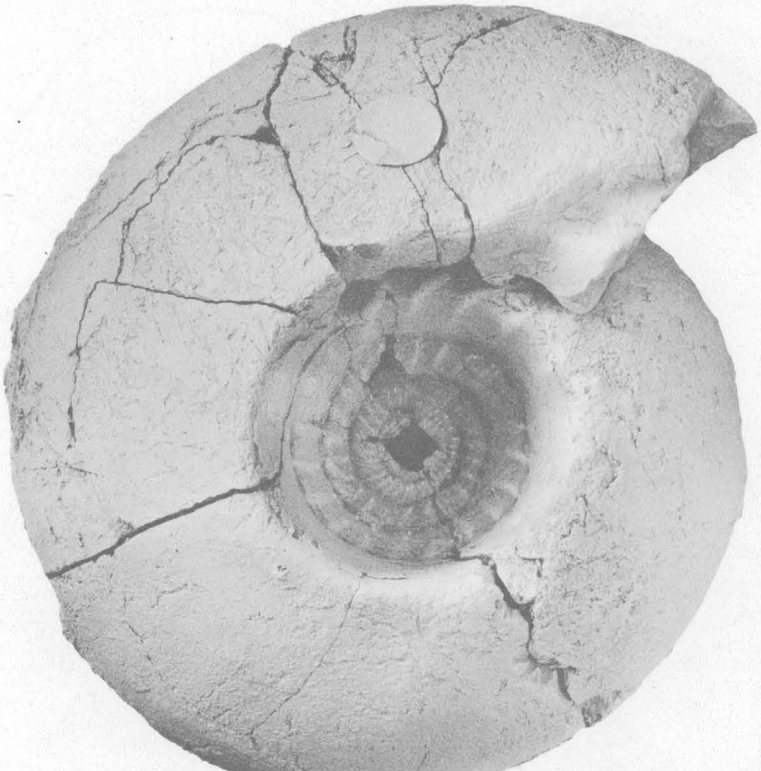
1, 2. Paratype, U.S.N.M. 108063 from U.S.G.S. Mes. loc. 21349, Chinitna formation.

3. Suture line of paratype, U.S.N.M. 108059b from U.S.G.S. Mes. loc. 3029, Chinitna formation.

4, 5. Paratype, U.S.N.M. 108058b from U.S.G.S. Mes. loc. 21348, Chinitna formation.

6. Paratype, U.S.N.M. 108059a from U.S.G.S. Mes. loc. 3029, Chinitna formation.

7, 8. Paratype, U.S.N.M. 108059c from U.S.G.S. Mes. loc. 3029, Chinitna formation.



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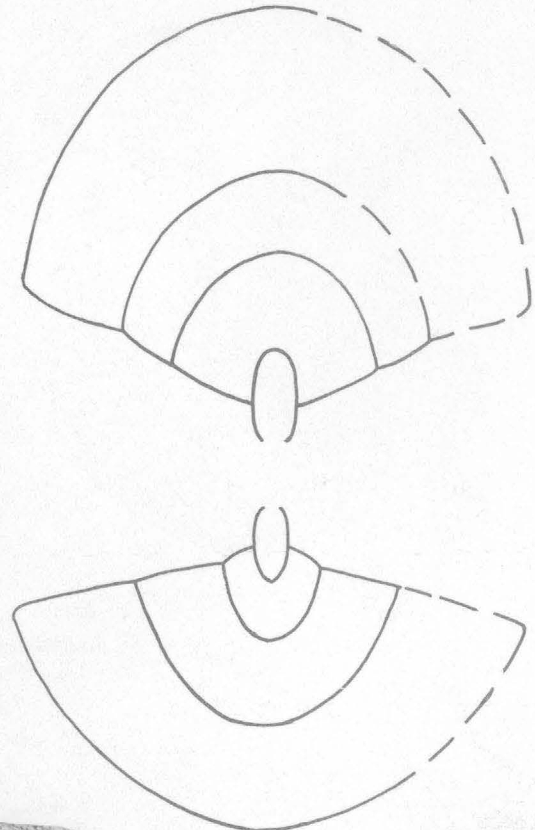

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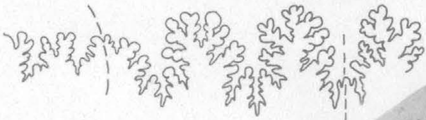

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CADOCERAS


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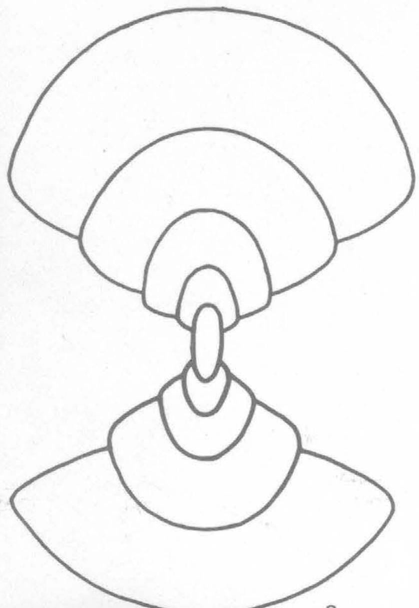
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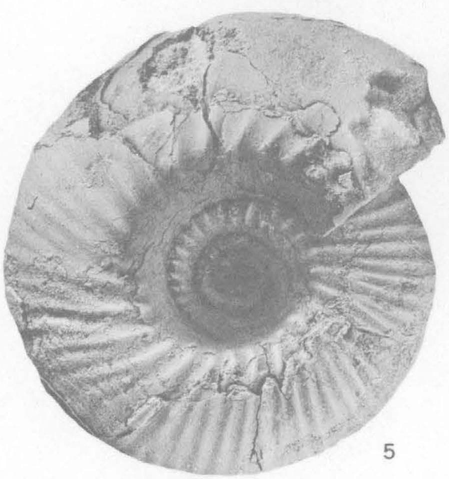
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6

CADOCERAS

PLATE 36

[All figures natural size]

FIGURES 1–5. *Cadoceras comma* Imlay, n. sp. (p. 83).

1, 2. Holotype, U.S.N.M. 108057 from U.S.G.S. Mes. loc. 21348, Chinitna formation.

3. Sectional view of paratype, U.S.N.M. 108060 from U.S.G.S. Mes. loc. 2921, Chinitna formation.

4. Paratype, U.S.N.M. 108061 from U.S.G.S. Mes. loc. 3020, Chinitna formation.

5. Paratype, U.S.N.M. 108058a from U.S.G.S. Mes. loc. 21348, Chinitna formation.

6. *Cadoceras glabrum* Imlay, n. sp. (p. 84). Paratype, U.S.N.M. 108067 from U.S.G.S. Mes. loc. 3029, Chinitna formation. Shows complete body chamber.

PLATE 37

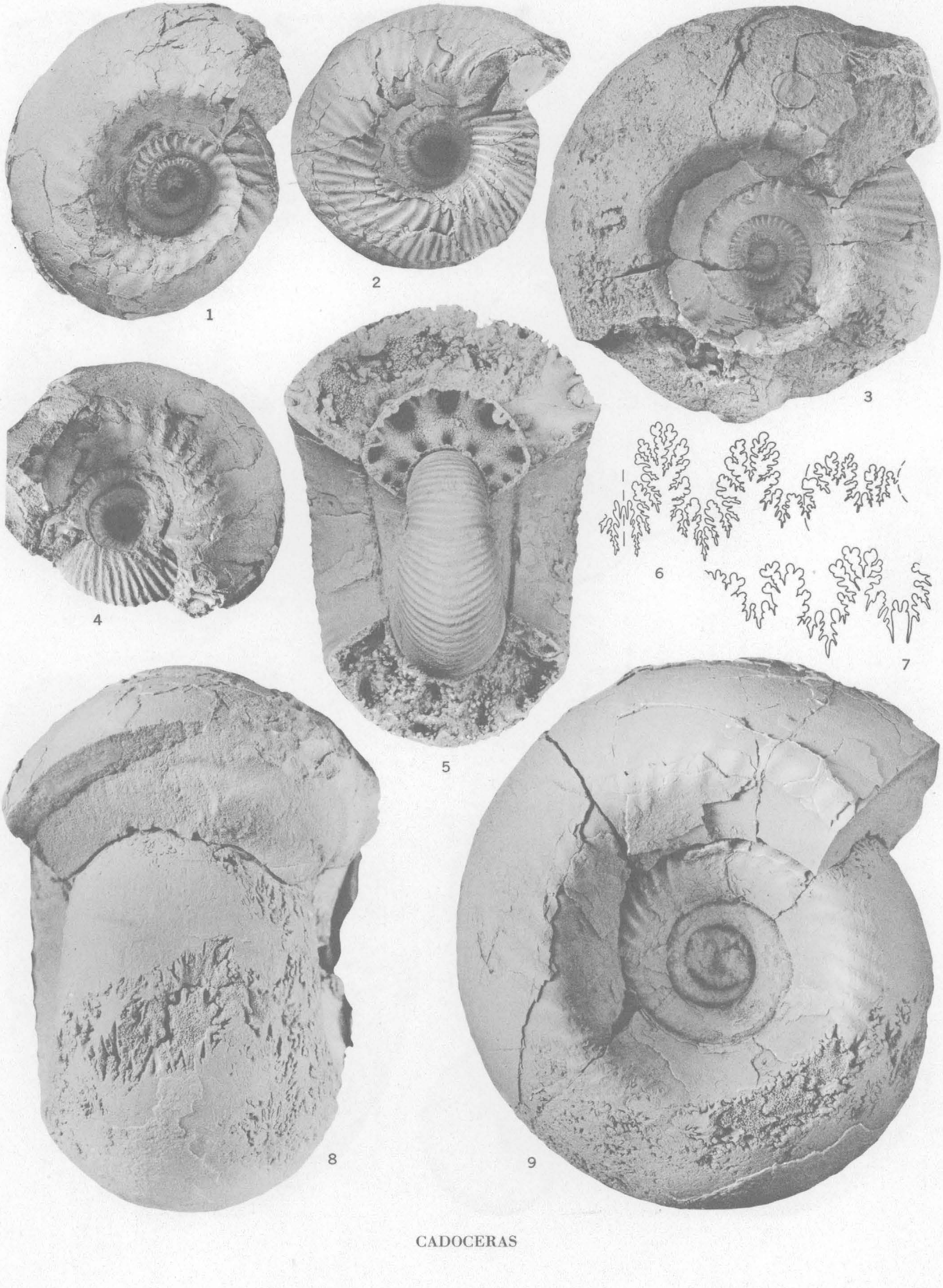
[All figures natural size]

FIGURES 1–9. *Cadoceras glabrum* Imlay, n. sp. (p. 84).

1. Inner whorls of paratype U.S.N.M. 108065c; 2, paratype, U.S.N.M. 108065b; 4, paratype, U.S.N.M. 108065a. All from U.S.G.S. Mes. loc. 2921, Chinitna formation.

3, 7. Paratype, U.S.N.M. 108066 from U.S.G.S. Mes. loc. 3028, Chinitna formation. Body chamber incomplete.

5, 6, 8, 9. Holotype, U.S.N.M. 108064 from U.S.G.S. Mes. loc. 19781, Shelikof formation. Body chamber incomplete. Note constriction on inner whorls shown in fig. 5.



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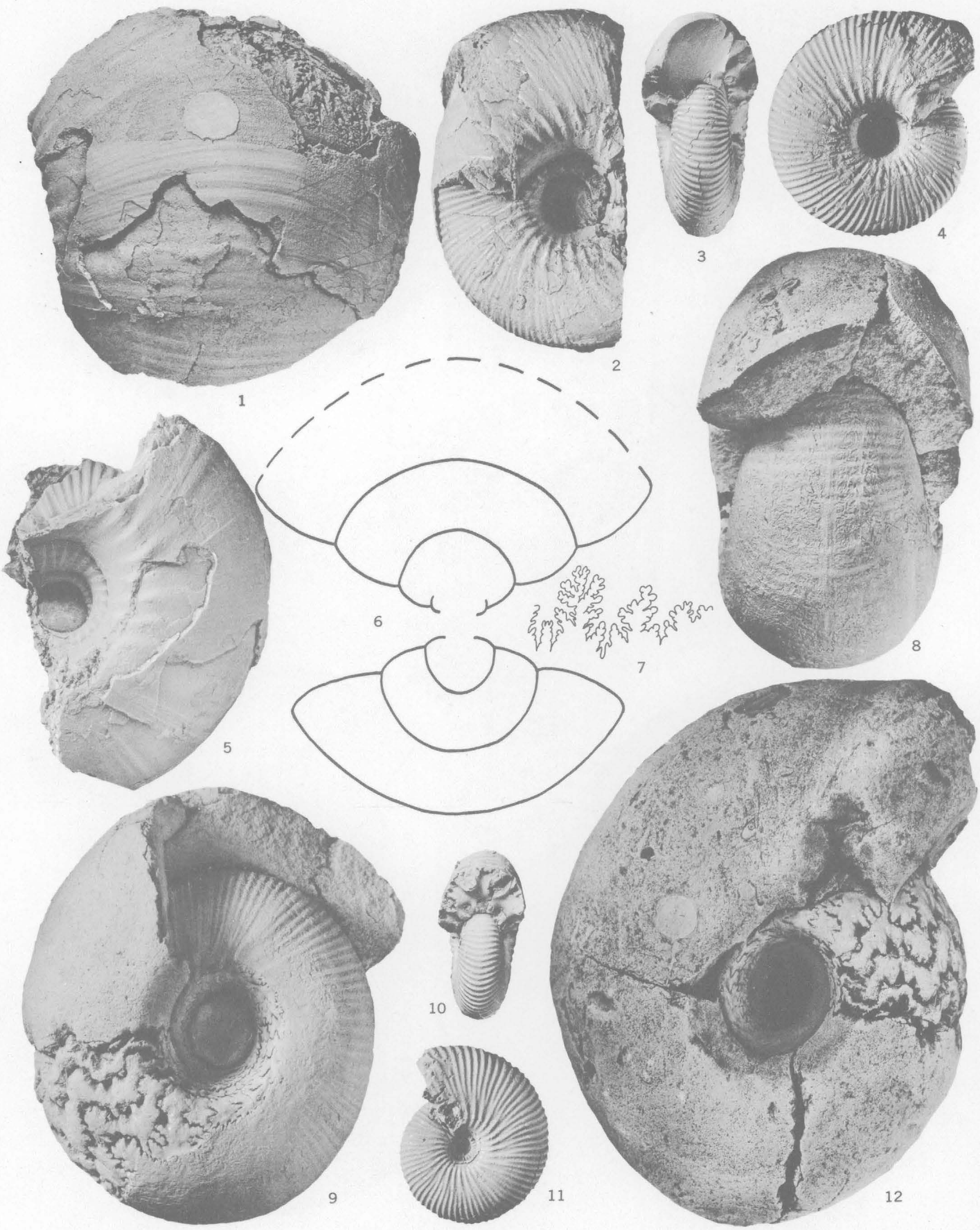


CADOCERAS

PLATE 38

[All figures natural size]

FIGURES 1, 5, 6. *Cadoceras bathomphalum* Imlay, n. sp. (p. 84). Holotype, U.S.N.M. 108068 from U.S.G.S. Mes. loc. 12408, Shelikof formation. Body chamber not preserved.

2–4, 7–12. *Cadoceras tenuicostatum* Imlay, n. sp. (p. 85).

2. Paratype, U.S.N.M. 108072 from U.S.G.S. Mes. loc. 20763, Chinitna formation.

3, 4. Paratype, U.S.N.M. 108073 from U.S.G.S. Mes. loc. 21356, Shelikof formation.

7. Suture line of paratype, U.S.N.M. 108070 at a diameter of 56 mm., U.S.G.S. Mes. loc. 3029, Chinitna formation.

8, 9, 12. Holotype, U.S.N.M. 108069 from U.S.G.S. Mes. loc. 3029, Chinitna formation. Fig. 12 shows complete body chamber.

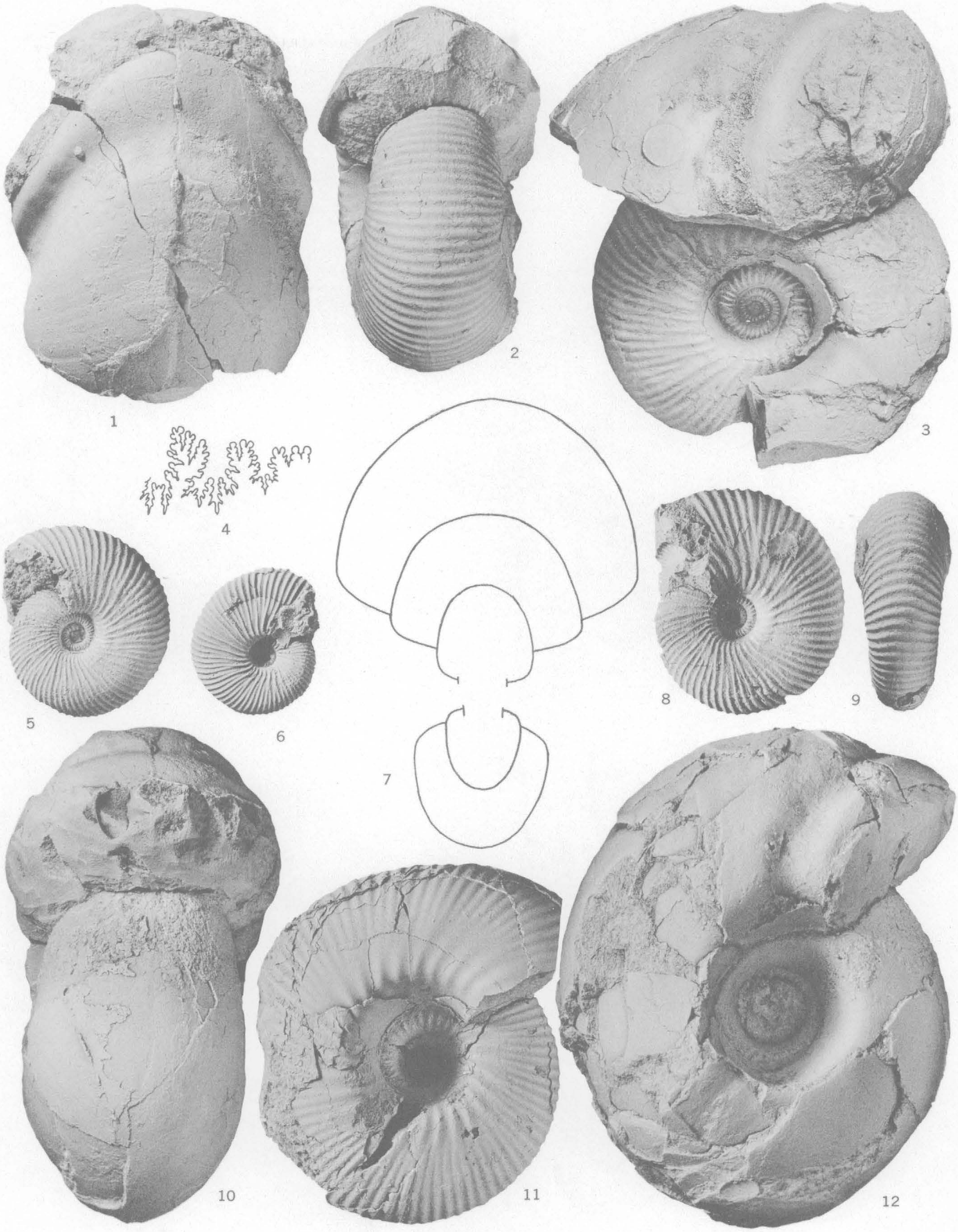
10, 11. Paratype, U.S.N.M. 108071 from U.S.G.S. Mes. loc. 3113, Shelikof formation.

PLATE 39

[All figures natural size]

FIGURES 1–12. *Cadoceras doroschini* (Eichwald) (p. 85).

1, 3, 7. Plesiotype, U.S.N.M. 108074b from U.S.G.S. Mes. loc. 3028, Chinitna formation.
2, 4, 11. Plesiotype, U.S.N.M. 108076 from U.S.G.S. Mes. loc. 3113, Shelikof formation.
5. Plesiotype, U.S.N.M. 108074c from U.S.G.S. Mes. loc. 3028, Chinitna formation.
6. Plesiotype, U.S.N.M. 108075a from U.S.G.S. Mes. loc. 3029, Chinitna formation.
8, 9. Plesiotype, U.S.N.M. 108075b from U.S.G.S. Mes. loc. 3029, Chinitna formation.
10, 12. Plesiotype, U.S.N.M. 108074a from U.S.G.S. Mes. loc. 3028, Chinitna formation.



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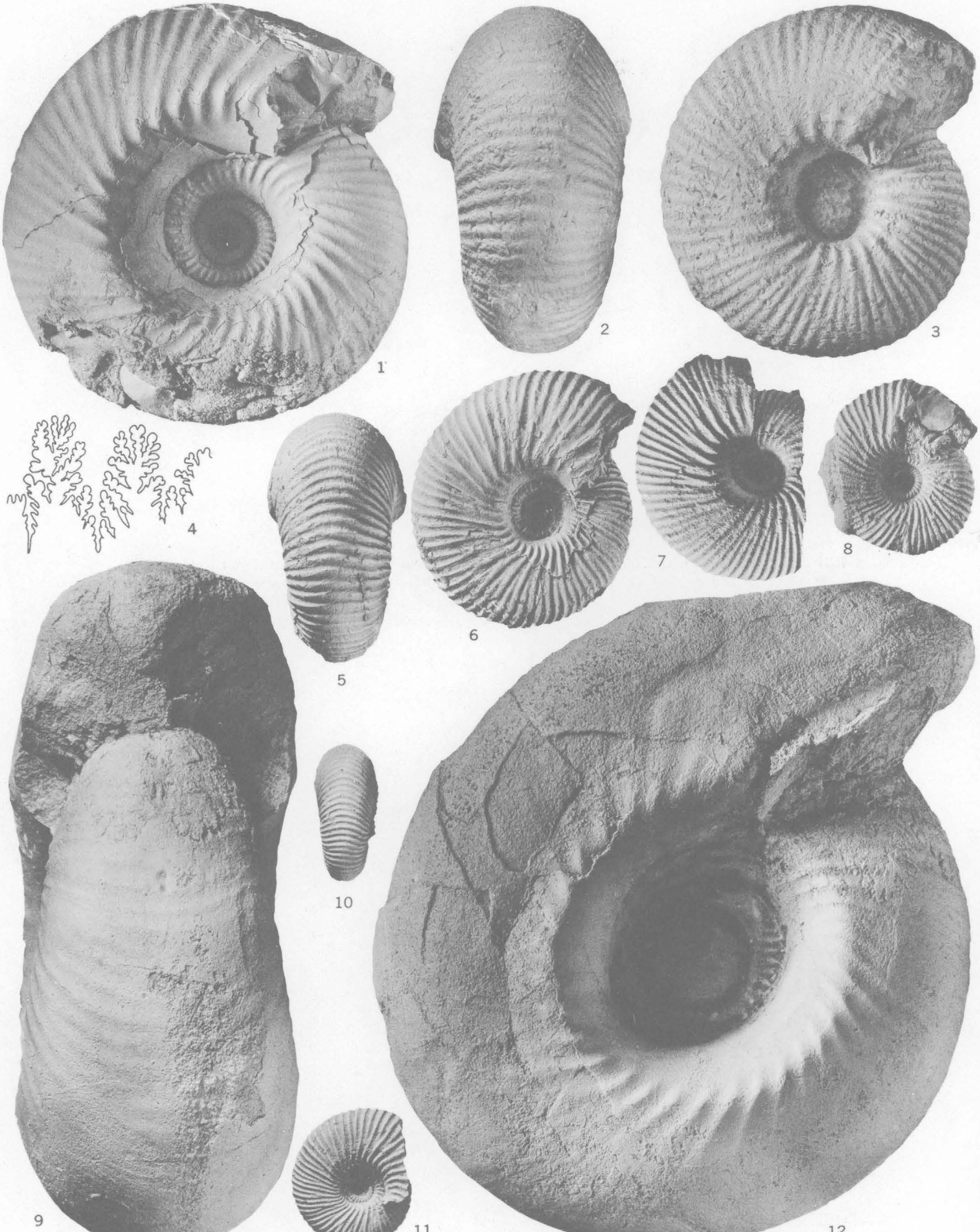


CADOCERAS

PLATE 40

[All figures natural size]

FIGURES 1–12. *Cadoceras wosnessenskii* (Grewingk) (p. 86).

1, 4. Septate plesiotype, U.S.N.M. 108080 from U.S.G.S. Mes. loc. 21360, Shelikof formation.

2, 3. Plesiotype, U.S.N.M. 108078b; 5, 6, plesiotype, U.S.N.M. 108078a. Both from U.S.G.S. Mes. loc. 2921, Chinitna formation.

7. Plesiotype, U.S.N.M. 108079 from U.S.G.S. Mes. loc. 3018, Chinitna formation.

8. Plesiotype, U.S.N.M. 108077c; 10, 11, plesiotype, U.S.N.M. 108077b; 9, 12, Plesiotype, U.S.N.M. 108077a All from U.S.G.S. Mes. loc. 3029, Chinitna formation.

PLATE 41

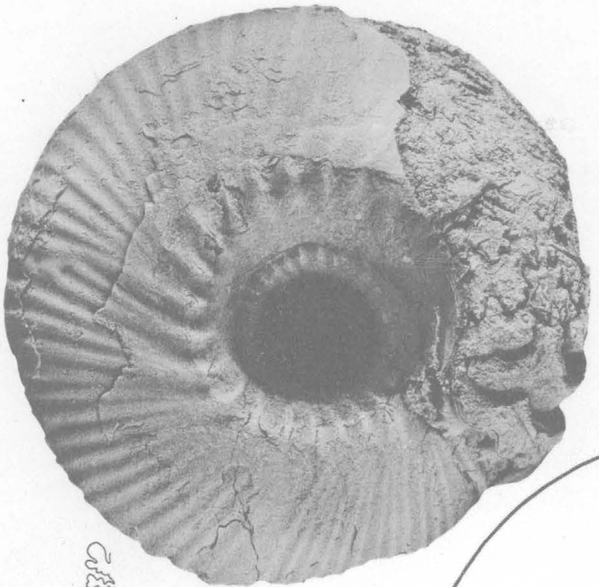
[All figures natural size]

FIGURES 1–7. *Cadoceras kialagvikense* Imlay, n. sp. (p. 87).

1, 2, 4. Lateral and sectional views of holotype, U.S.N.M. 108081 from U.S.G.S. Mes. loc. 12408, Shelikof formation.

3, 7. Suture line and septate penultimate whorl of paratype, U.S.N.M. 108083 from U.S.G.S. Mes. loc. 21345, Chinitna formation. The body chamber is partly crushed and has been removed.

5, 6. Paratype, U.S.N.M. 108082 from U.S.G.S. Mes. loc. 19744, Shelikof formation. Shows complete body chamber.



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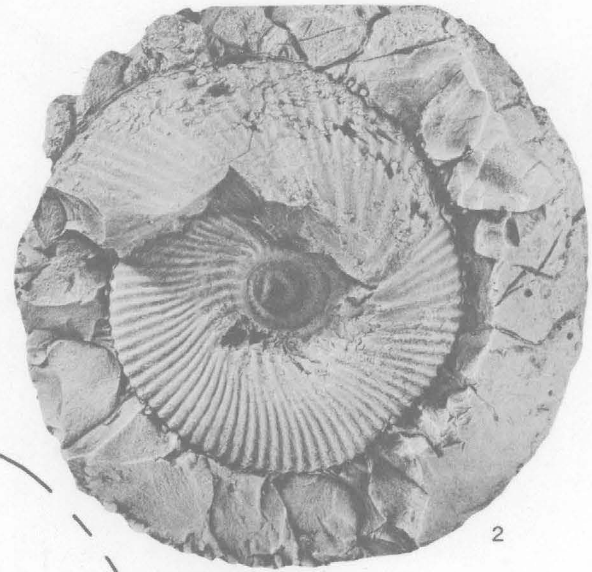

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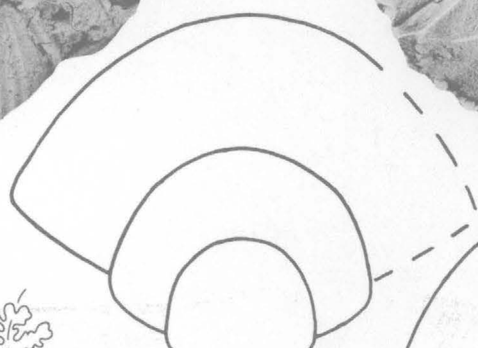

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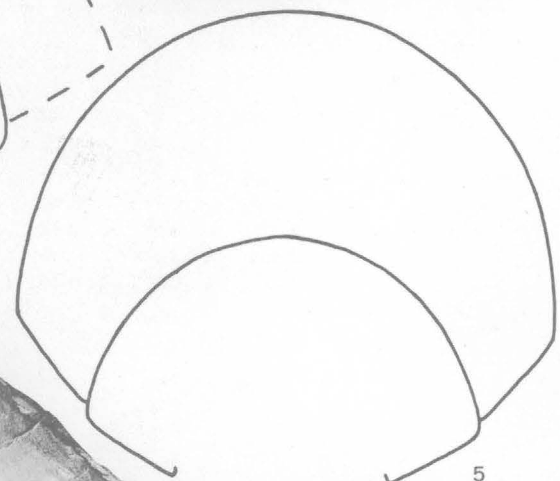

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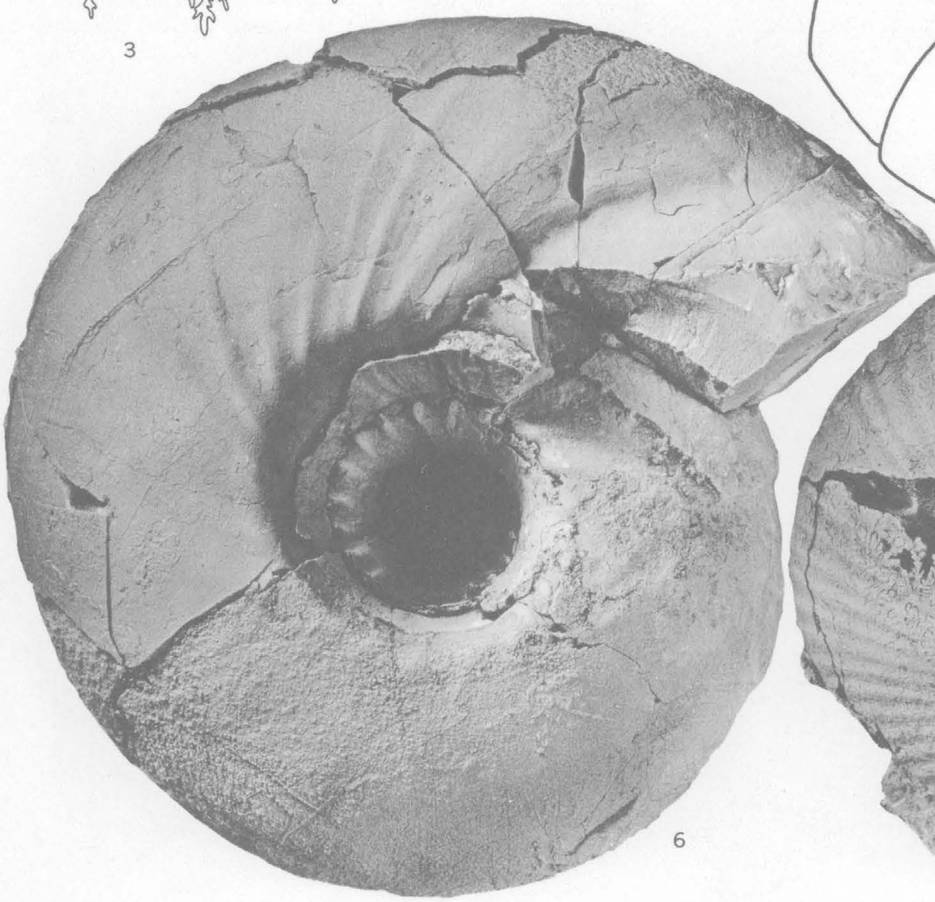

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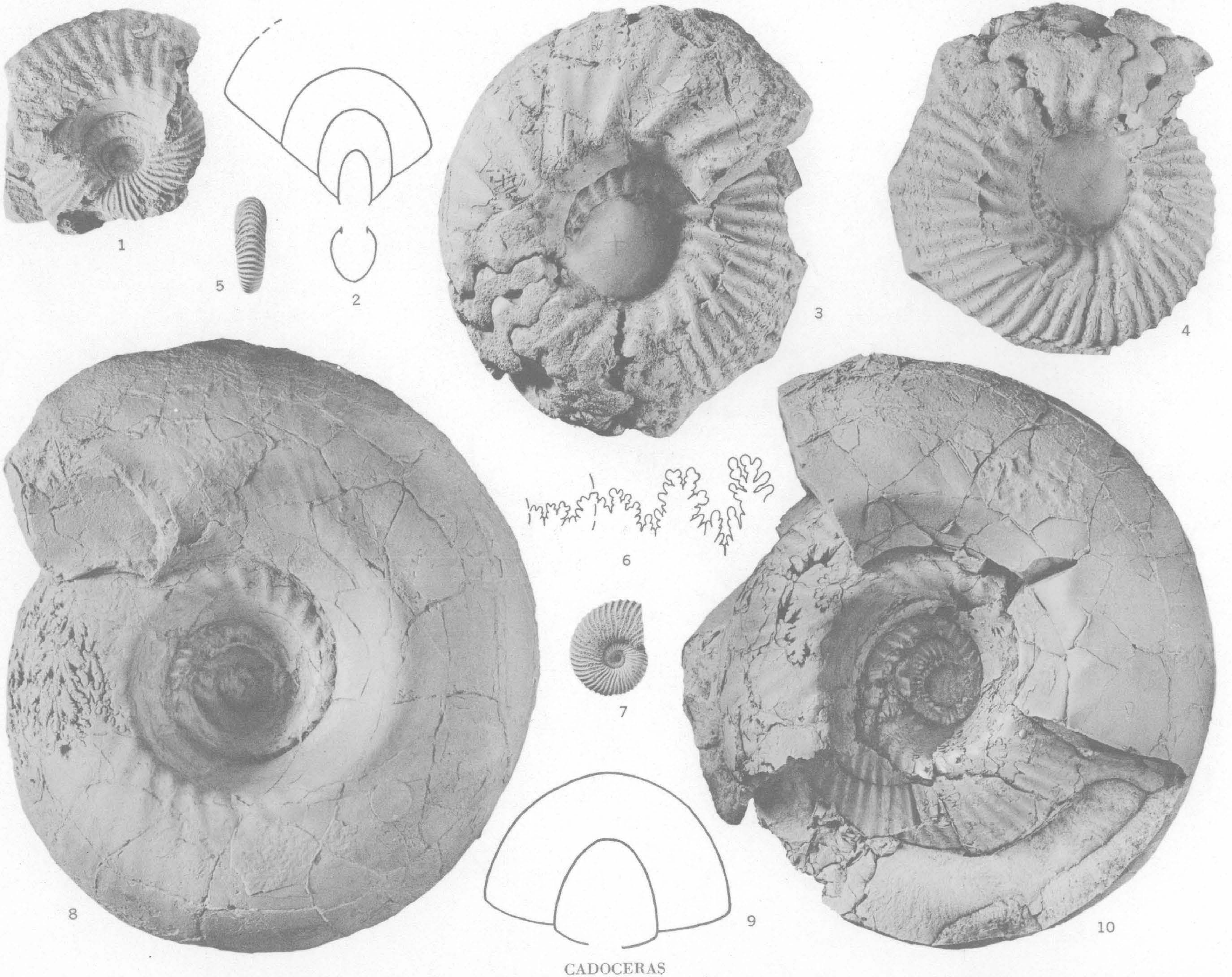
CADOCERAS



CADOCERAS

PLATE 42

[All figures natural size]

FIGURES 1, 2, 5–8, 10. *Cadoceras* (*Paracadoceras*) *multiforme* Imlay, n. sp. (p. 88).

1, 2. Inner whorls of paratype, U.S.N.M. 108087 from U.S.G.S. Mes. loc. 21343, Chinitna formation. Part of one whorl removed from fig. 1.

5, 7. Inner whorls of paratype, U.S.N.M. 108086b from U.S.G.S. Mes. loc. 3019, Chinitna formation.

6, 10. Paratype, U.S.N.M. 108086a from U.S.G.S. Mes. loc. 3019, Chinitna formation. Suture drawn from posterior end of body chamber which has been removed to show the inner whorls.

8. Holotype, U.S.N.M. 108085 from U.S.G.S. Mes. loc. 3019, Chinitna formation. Shows nearly complete body chamber.

3, 4, 9. *Cadoceras* (*Paracadoceras*) *moffiti* Imlay, n. sp. (p. 87).

Lateral and sectional views of holotype, U.S.N.M. 108084 from U.S.G.S. Mes. loc. 10986, Chinitna formation. In fig. 4 the incomplete body chamber is removed in order to show the strong ribbing of the penultimate whorl.

PLATE 43

[All figures natural size]

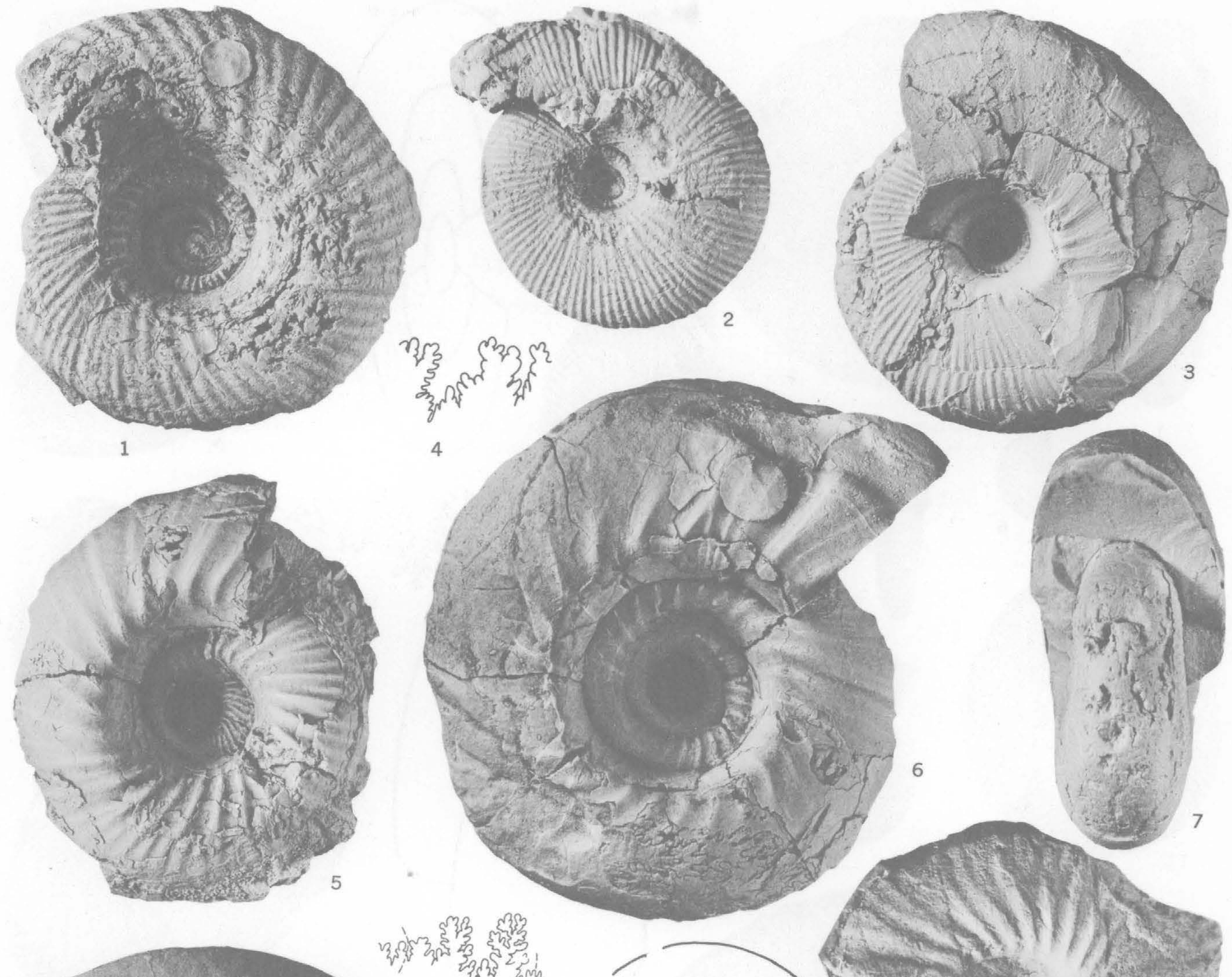
FIGURES 1, 4. *Cadoceras* (*Paracadoceras*) aff. *C. tonniense* Imlay, n. sp. (p. 89).
Specimen, U.S.N.M. 108090 from U.S.G.S. Mes. loc. 3019, Chinitna formation.

2, 3, 7, 8. *Cadoceras* (*Stenocadoceras*) *bowserense* Imlay, n. sp. (p. 91).
2, 8. Paratype, U.S.N.M. 108102 from U.S.G.S. Mes. loc. 11041, Chinitna formation.
3, 7. Holotype, U.S.N.M. 108101 from U.S.G.S. Mes. loc. 11041, Chinitna formation.

5, 6. *Cadoceras* (*Paracadoceras*) *chisikense* Imlay, n. sp. (p. 89).
Holotype, U.S.N.M. 108091 from U.S.G.S. Mes. loc. 10250, Chinitna formation. Fig. 5 shows the ribbing of the penultimate whorl.

9–11, 13. *Cadoceras* (*Paracadoceras*) *tonniense* Imlay, n. sp. (p. 88).
9–11. Holotype, U.S.N.M. 108088 from U.S.G.S. Mes. loc. 21340, Chinitna formation. Only about one-fourth of a whorl is body chamber.
13. Paratype, U.S.N.M. 108089 from U.S.G.S. Mes. loc. 21326, Chinitna formation.

12. *Cadoceras* (*Paracadoceras*) *harveyi* (Crickmay) (p. 44).
Lateral view of plaster cast of holotype from Harrison Lake area, British Columbia.



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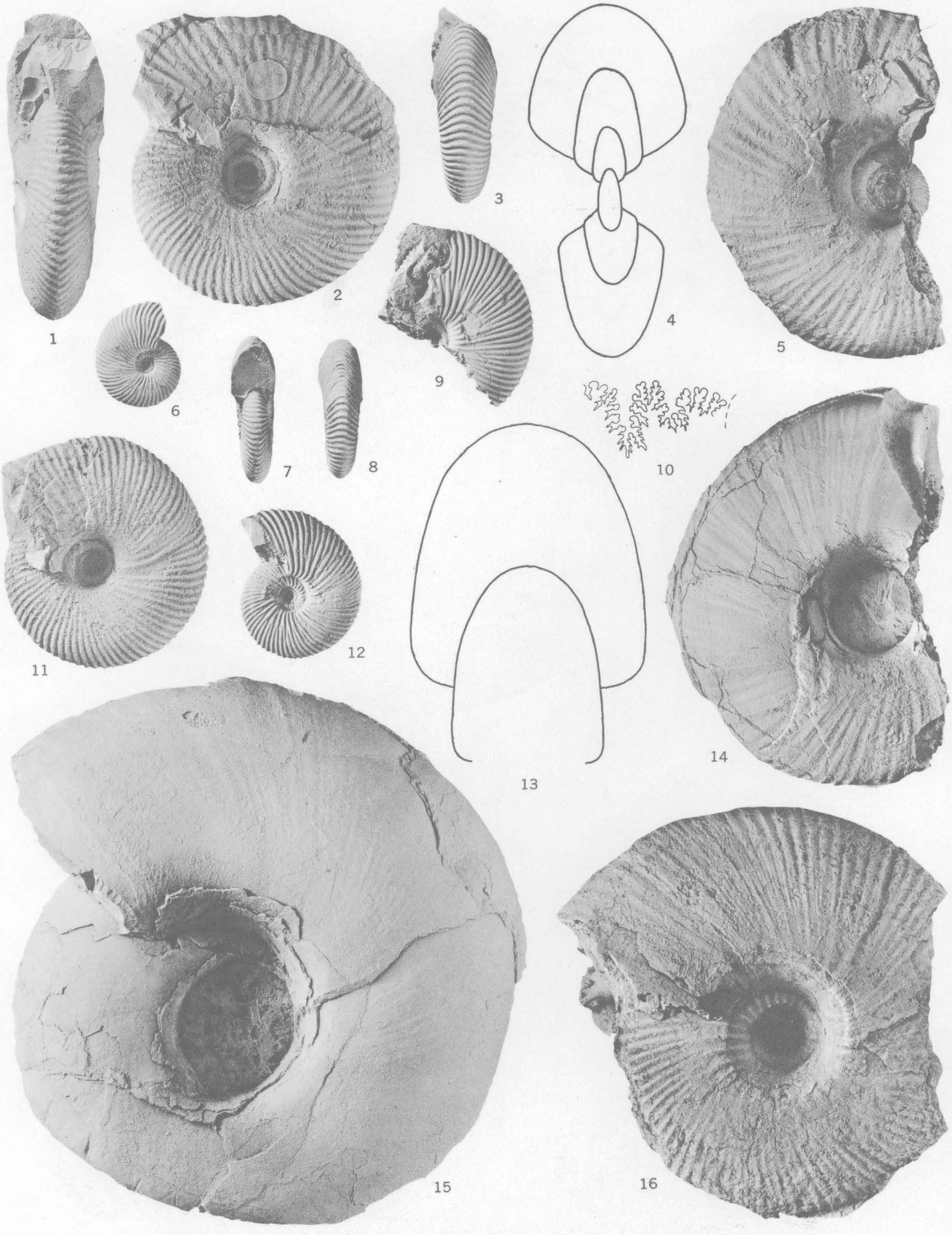


CADOCERAS

PLATE 44

[All figures natural size]

FIGURES 1–16. *Cadoceras* (*Stenocadoceras*) *multicostatum* Imlay, n. sp. (p. 90).

1, 2. Holotype, U.S.N.M. 108092 from U.S.G.S. Mes. loc. 2991, Chinitna formation.
3, 9. Paratype, U.S.N.M. 108095c from U.S.G.S. Mes. loc. 12386, Shelikof formation.
4, 5. Paratype, U.S.N.M. 108094b from U.S.G.S. Mes. loc. 21290, Chinitna formation.
6. Paratype, U.S.N.M. 108095a from U.S.G.S. Mes. loc. 12386, Shelikof formation.
7, 8, 12. Paratype, U.S.N.M. 108095b from U.S.G.S. Mes. loc. 12386, Shelikof formation.
10, 14. Paratype, U.S.N.M. 108094c from U.S.G.S. Mes. loc. 21290, Chinitna formation.
11. Paratype, U.S.N.M. 108094d from U.S.G.S. Mes. loc. 21290, Chinitna formation.
13, 15. Paratype, U.S.N.M. 108094a from U.S.G.S. Mes. loc. 21290, Chinitna formation. Shows complete body chamber.
16. Paratype, U.S.N.M. 108093 from U.S.G.S. Mes. loc. 10813, Shelikof formation.

PLATE 45

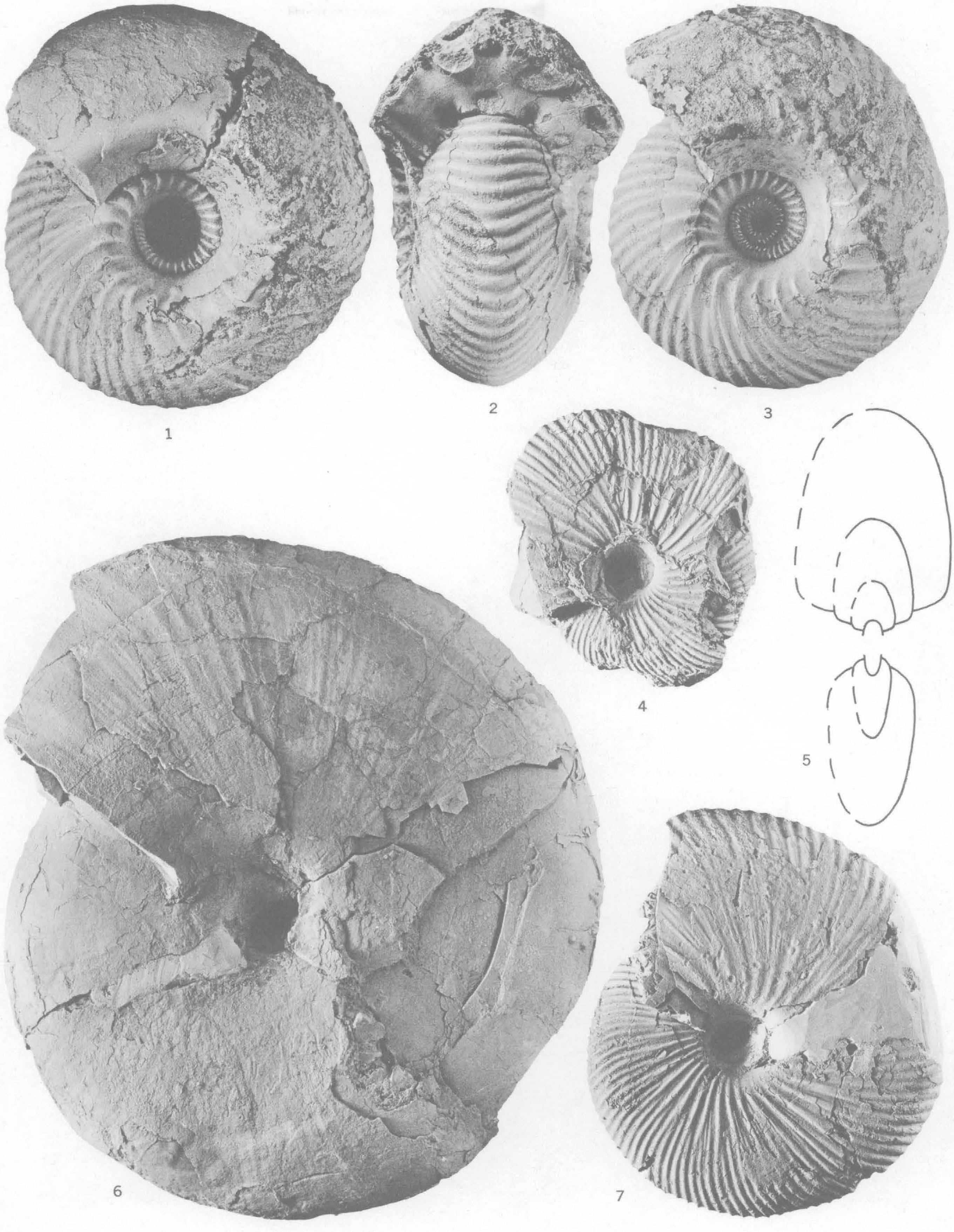
[All figures natural size]

FIGURES 1–3. *Cadoceras* (*Stenocadoceras*) *pomeroyense* Imlay, n. sp. (p. 92).

Holotype, U.S.N.M. 108110 from U.S.G.S. Mes. loc. 22415, Chinitna formation. Part of body chamber shown in fig. 1. Note ventral view in pl. 46, fig. 2.

4–7. *Cadoceras* (*Stenocadoceras*) *striatum* Imlay, n. sp. (p. 90).

4. Septate paratype, U.S.N.M. 108097b; 5, 7, septate holotype, U.S.N.M. 108096; 6, paratype, U.S.N.M. 108097a showing about one-half whorl of body chamber. All specimens from U.S.G.S. Mes. loc. 21291, Chinitna formation.



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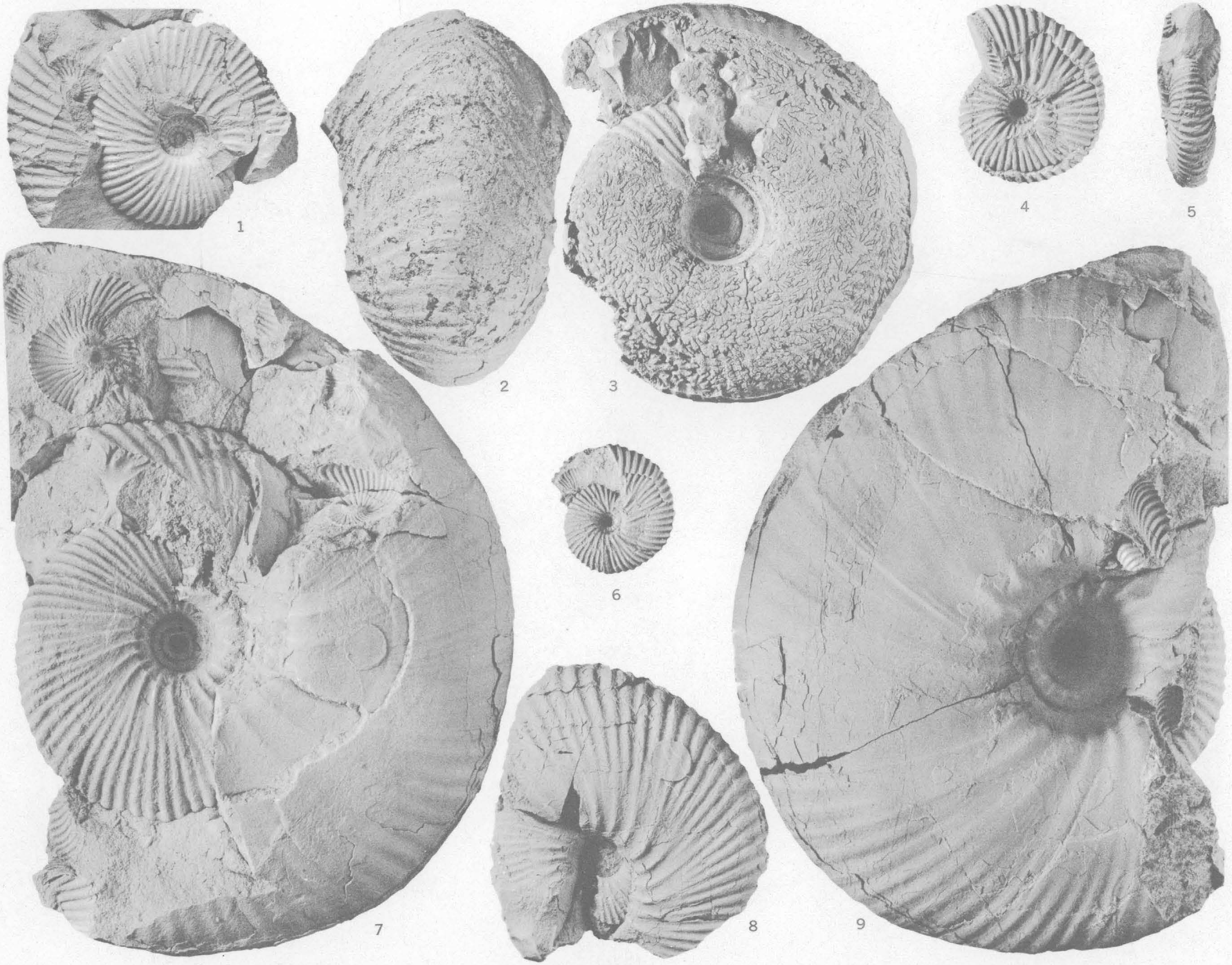


CADOCERAS

PLATE 46

[All figures natural size]

FIGURES 1, 4–9. *Cadoceras* (*Stenocadoceras*) *iniskinense* Imlay, n. sp. (p. 91).

1, 8. Lateral views of paratype, U.S.N.M. 108100 from U.S.G.S. Mes. loc. 3117, Shelikof formation.

4, 5. Paratype, U.S.N.M. 108099a; 6, paratype, U.S.N.M. 108099b. Both from U.S.G.S. Mes. loc. 3030, Chinitna formation.

7, 9. Lateral views of holotype, U.S.N.M. 108098 from U.S.G.S. Mes. loc. 3030, Chinitna formation.

2. *Cadoceras* (*Stenocadoceras*) *pomeroyense* Imlay, n. sp. (p. 92).

Ventral view of holotype, U.S.N.M. 108110 from U.S.G.S. Mes. loc. 22415, Chinitna formation.

3. *Cadoceras* (*Stenocadoceras*) *stenoloboide* Pompeckj (p. 92).

Plesiotype, U.S.N.M. 108108 from U.S.G.S. Mes. loc. 21357, Shelikof formation. Note sutural pattern.

PLATE 47

[All figures natural size]

FIGURES 1–15. *Cadoceras (Stenocadoceras) stenoloboide* Pompeckj (p. 92).

1, 2, 6. Plesiotype, U.S.N.M. 108106 from U.S.G.S. Mes. loc. 12387, Shelikof formation.

3–5. Plesiotype, U.S.N.M. 108105 from U.S.G.S. Mes. loc. 11052a, Chinitna formation.

7, 8. Plesiotype, U.S.N.M. 108103b from U.S.G.S. Mes. loc. 12386, Shelikof formation.

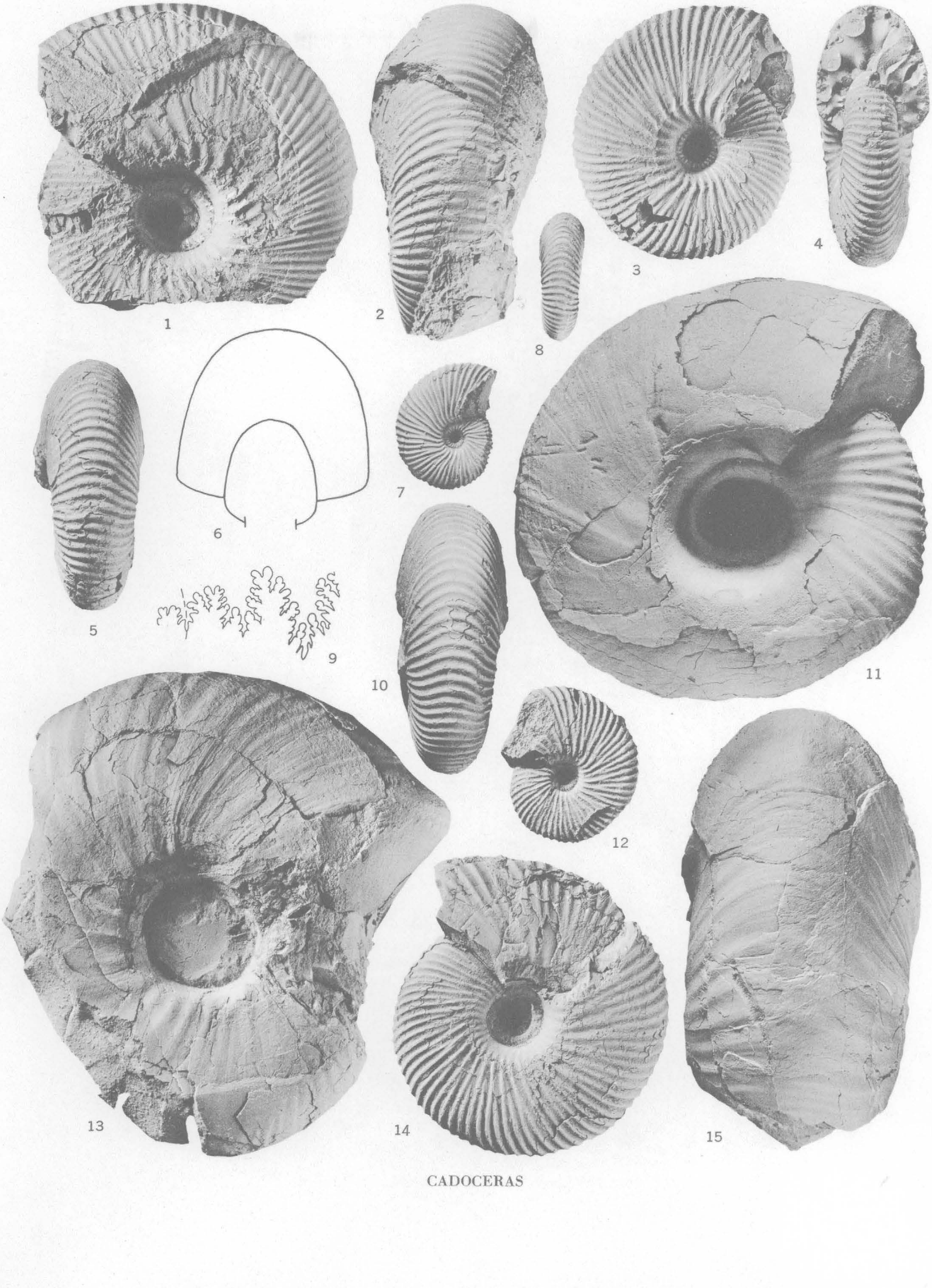
9. Suture line of plesiotype, U.S.N.M. 108108 from U.S.G.S. Mes. loc. 21357, Shelikof formation. Same specimen shown on pl. 46, fig. 3.

10, 14. Plesiotype, U.S.N.M. 108107 from U.S.G.S. Mes. loc. 12408, Shelikof formation.

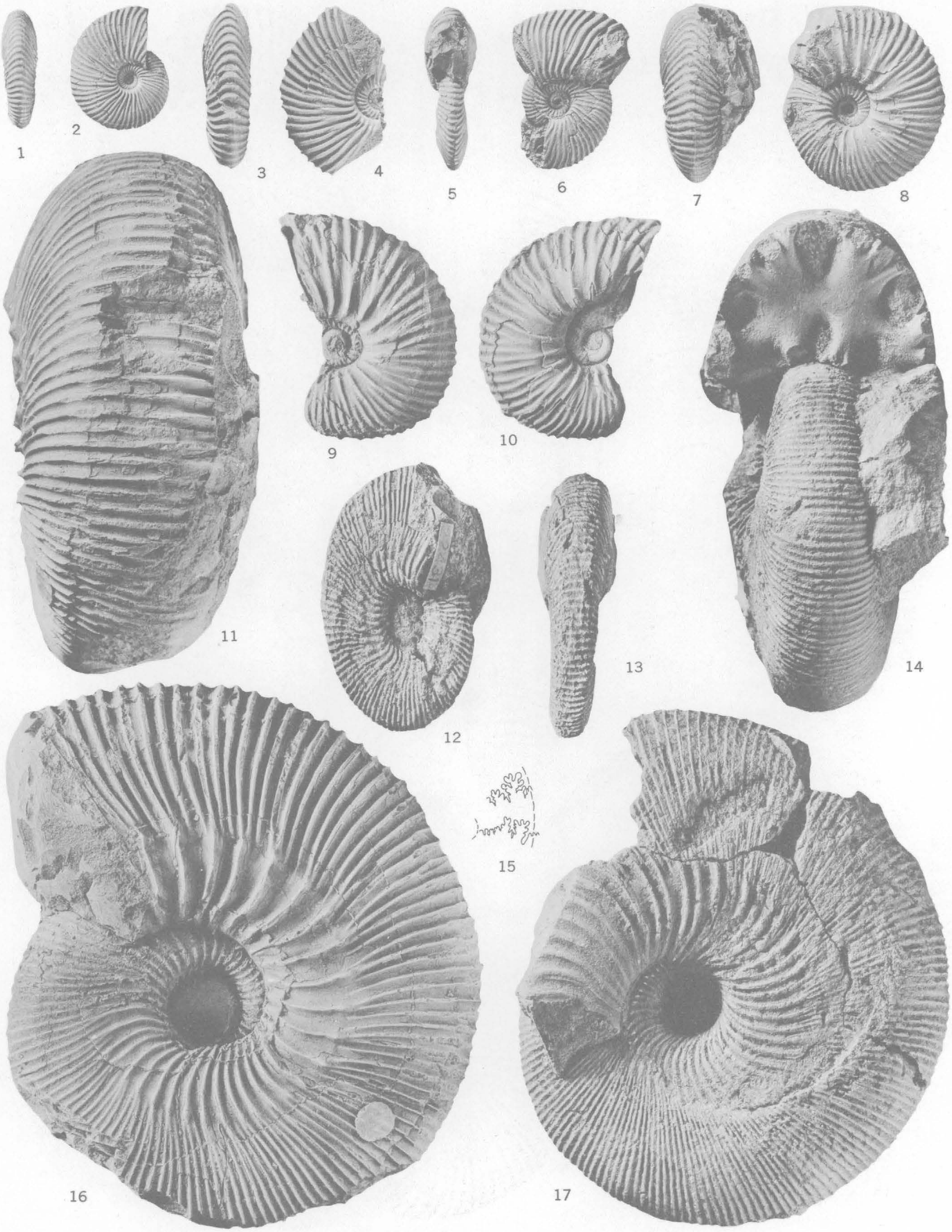
11. Plesiotype, U.S.N.M. 108109 from U.S.G.S. Mes. loc. 21777, Chinitna formation. Note abrupt weakening of ribbing at beginning of body chamber.

12. Plesiotype, U.S.N.M. 108104 from U.S.G.S. Mes. loc. 3030, Chinitna formation.

13, 15. Plesiotype, U.S.N.M. 108103a from U.S.G.S. Mes. loc. 12386, Shelikof formation. Note apertural constriction on internal mold.



CADOCERAS



PSEUDOCADOCERAS AND KEPPLERITES

PLATE 48

[All figures natural size]

FIGURES 1–6, 15. *Pseudocadoceras petelini* (Pompeckj) (p. 93).

1, 2. Plesiotype, U.S.N.M. 108112 from U.S.G.S. Mes. loc. 12386, Shelikof formation.

3, 4. Plesiotype, U.S.N.M. 108111 from U.S.G.S. Mes. loc. 10822, Shelikof formation.

5, 6, 15. Plesiotype, U.S.N.M. 108113 from U.S.G.S. Mes. loc. 12387, Shelikof formation. Suture line drawn at whorl height of 9 mm.

7–10. *Pseudocadoceras chinitnense* Imlay, n. sp. (p. 94).

7, 8. Paratype, U.S.N.M. 108121 from U.S.G.S. Mes. loc. 10978, Chinitna formation.

9, 10. Holotype, U.S.N.M. 108120 from U.S.G.S. Mes. loc. 21777, Chinitna formation.

11, 16. *Kepplerites* (*Seymourites*) *alticostatus* Imlay, n. sp. (p. 95).

Holotype, U.S.N.M. 108124 from U.S.G.S. Mes. loc. 2992, Chinitna formation.

12, 13. *Kepplerites* sp. juv. aff. *K. ingrahami* (McLearn) (p. 97).

Specimen, U.S.N.M. 108136 from U.S.G.S. Mes. loc. 22431, Chinitna formation.

14, 17. *Kepplerites* (*Seymourites*) *tychonis* Ravn (p. 96).

Plesiotype, U.S.N.M. 108125 from U.S.G.S. Mes. loc. 21287, Chinitna formation. Beginning of body chamber shown in last inch of anterior end of specimen. Note impression of body chamber on penultimate whorl.

PLATE 49

[All figures natural size]

FIGURES 1–12. *Pseudocadoceras grewingki* (Pompeckj) (p. 93).

1, 2, 8. Plesiotype, U.S.N.M. 108115b from U.S.G.S. Mes. loc. 12386, Shelikof formation.

3, 4, 9. Plesiotype, U.S.N.M. 108116 from U.S.G.S. Mes. loc. 20757, Chinitna formation.

5–7. Plesiotype, U.S.N.M. 108117 from U.S.G.S. Mes. loc. 21348, Chinitna formation.

10. Plesiotype, U.S.N.M. 108115a from U.S.G.S. Mes. loc. 12386, Shelikof formation.

11, 12. Plesiotype, U.S.N.M. 108114 from U.S.G.S. Mes. loc. 3030, Chinitna formation.

13–16. *Cosmoceras* (*Gulielmiceras*) *alaskanum* Imlay, n. sp. (p. 100).

13, 14. Paratype, U.S.N.M. 108142b; 16, paratype, U.S.N.M. 108142a. Both from U.S.G.S. Mes. loc. 20755, Chinitna formation. Fig. 16 is from a rubber cast.

15. Holotype, U.S.N.M. 108141 from U.S.G.S. Mes. loc. 2920, Chinitna formation. Photographed from a rubber cast.

17, 18. *Pseudocadoceras schmidti* (Pompeckj) (p. 95).

Plesiotype, U.S.N.M. 108123 from U.S.G.S. Mes. loc. 10824, Shelikof formation.

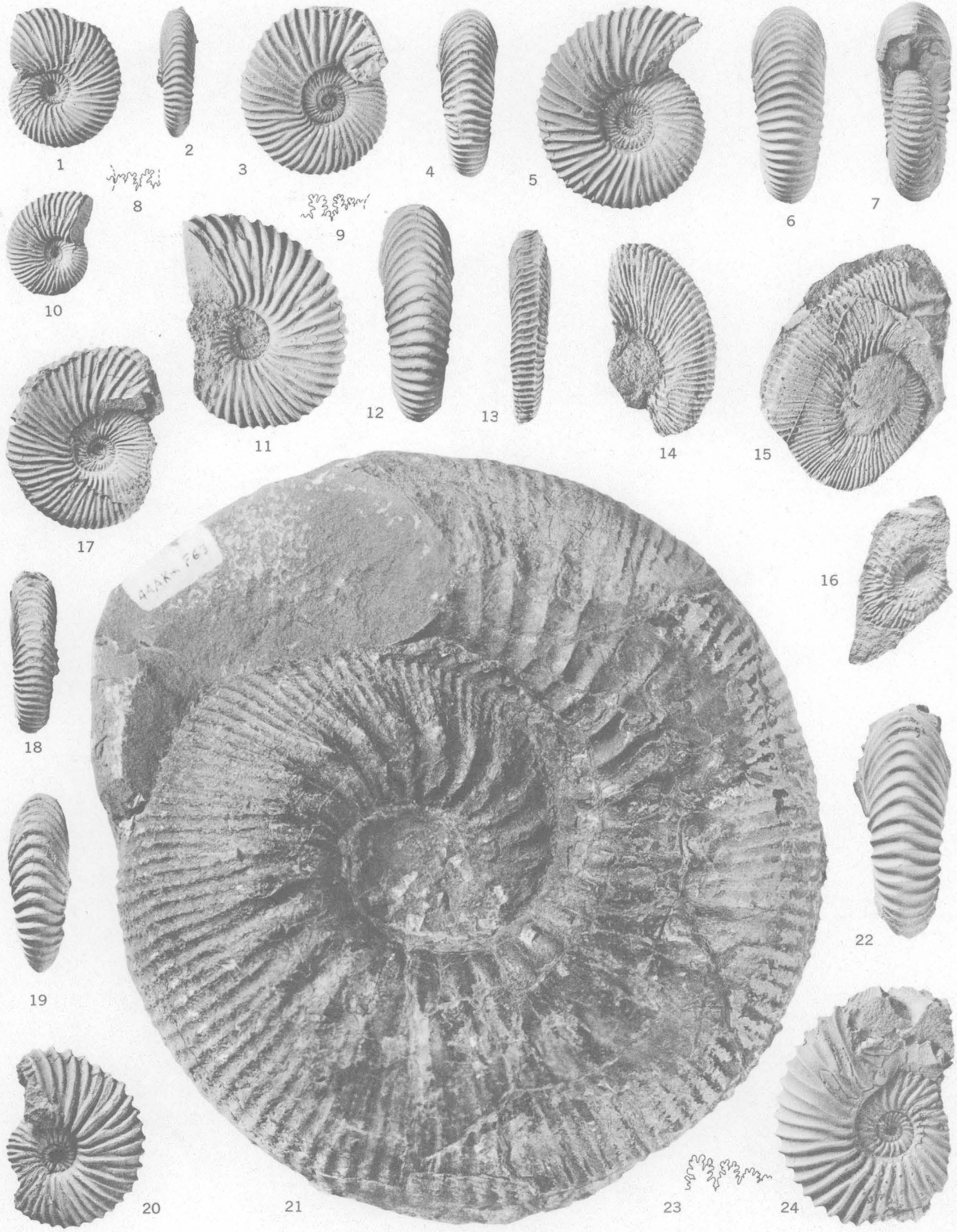
19, 20, 22–24. *Pseudocadoceras crassicostatum* Imlay, n. sp. (p. 94).

19, 20. Paratype, U.S.N.M. 108119 from U.S.G.S. Mes. loc. 11060, Chinitna formation.

22–24. Holotype, U.S.N.M. 108118 from U.S.G.S. Mes. loc. 12387, Shelikof formation. The suture line drawn lies directly behind the body chamber at a diameter of 34 mm.

21. *Kepplerites* (*Seymourites*) *plenus* (McLearn) (p. 99).

Plesiotype, U.S.N.M. 108135 from U.S.G.S. Mes. loc. 19793, Shelikof formation.



PSEUDOCADOCERAS, KEPPLERITES, AND COSMOCERAS

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KEPPLERITES

PLATE 50

[All figures natural size]

Figures 1–4. *Kepplerites* (*Seymourites*) *ingrahami* (McLearn) (p. 97).

1, 3. Plesiotype, U.S.N.M. 108127 from U.S.G.S. Mes. loc. 12074, Chinitna formation. Note ventral flattening.

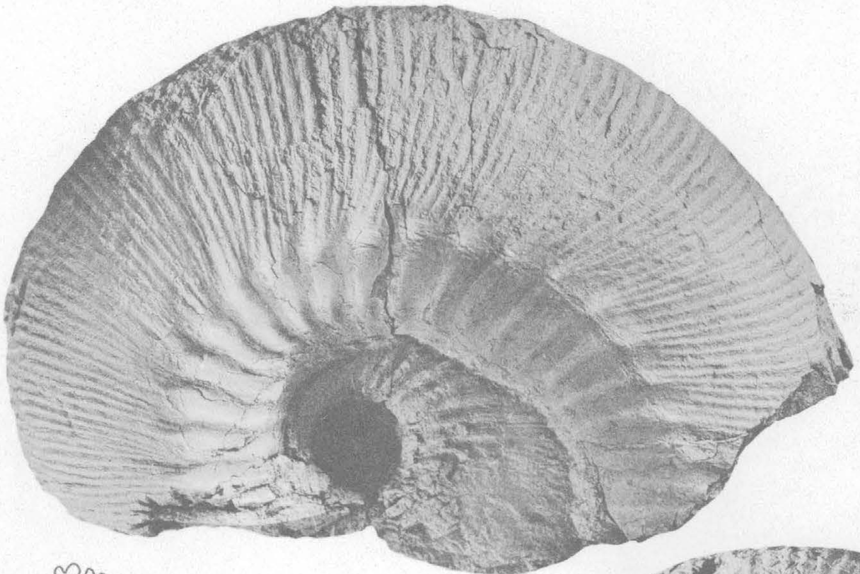
2. Plesiotype, U.S.N.M. 108129 from U.S.G.S. Mes. loc. 20763, Chinitna formation.

4. Plesiotype, U.S.N.M. 108128 from U.S.G.S. Mes. loc. 19793, Shelikof formation.

PLATE 51

[All figures natural size]

FIGURES 1, 4. *Kepplerites* (*Seymourites*) *multus* (McLearn) (p. 96).
Plesiotype, U.S.N.M. 108126 from U.S.G.S. Mes. loc. 20763, Chinitna formation.
2. *Kepplerites* (*Seymourites*) *ingrahami* (McLearn) (p. 97).
Suture line of plesiotype, U.S.N.M. 108127 shown in pl. 50, fig. 1.
3, 5–8. *Kepplerites* (*Seymourites*) *mcevoyi* (McLearn) (p. 97).
3, 6, 8. Plesiotype, U.S.N.M. 108132 from U.S.G.S. Mes. loc. 10922, Chinitna formation. Note weak apertural constriction.
4, 5. Plesiotype, U.S.N.M. 108131 from U.S.G.S. Mes. loc. 20763, Chinitna formation.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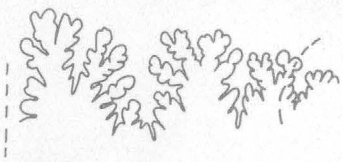
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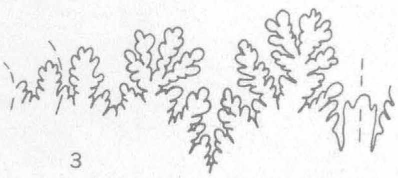
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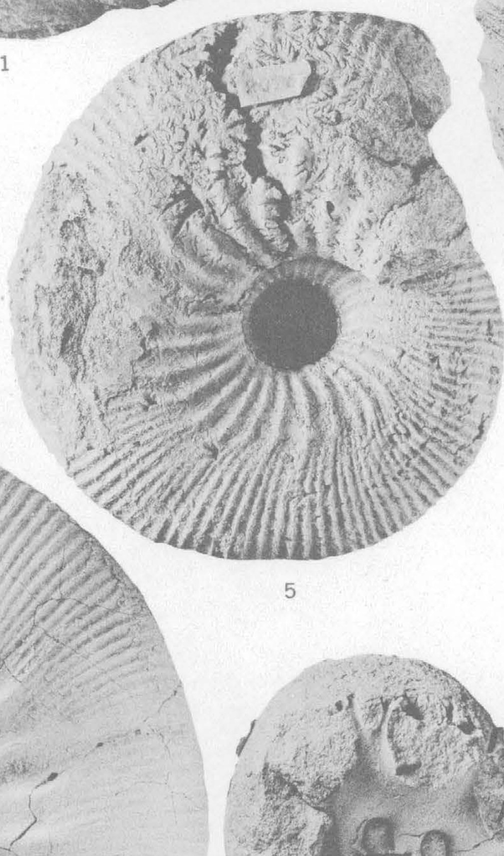
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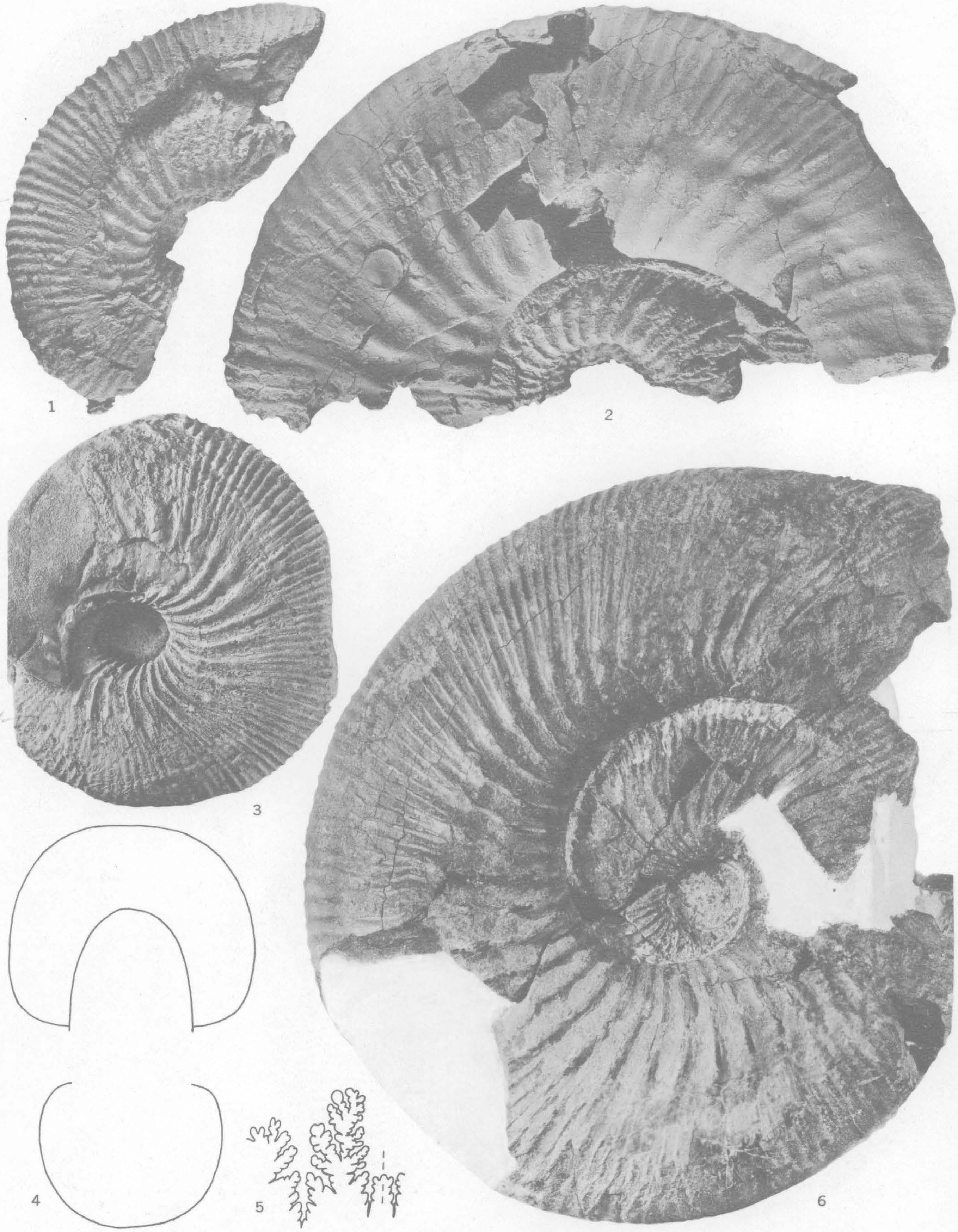
KEPPLERITES



KEPPLERITES

PLATE 52

[All figures natural size]

FIGURES 1, 2. *Kepplerites* (*Seymourites*) *gilinsi* (McLearn) (p. 98).
Incomplete penultimate whorl and body chamber of plesiotype, U.S.N.M. 108130 from U.S.G.S. Mes. loc. 2921, Chinitna formation.

3–6. *Kepplerites* (*Seymourites*) *abruptus* (McLearn) (p. 98).
3–5. Septate plesiotype, U.S.N.M. 108133 from U.S.G.S. Mes. loc. 21330, Chinitna formation. Suture line drawn at whorl height of 28 mm.
6. Plesiotype, U.S.N.M. 108134 from U.S.G.S. Mes. loc. 22433, Chinitna formation. Note apertural constriction.

PLATE 53

[All figures natural size unless otherwise indicated]

FIGURE 1. *Procerites* sp. (p. 102).
Septate fragment, U.S.N.M. 108145 from U.S.G.S. Mes. loc. 22448, Chinitna formation.

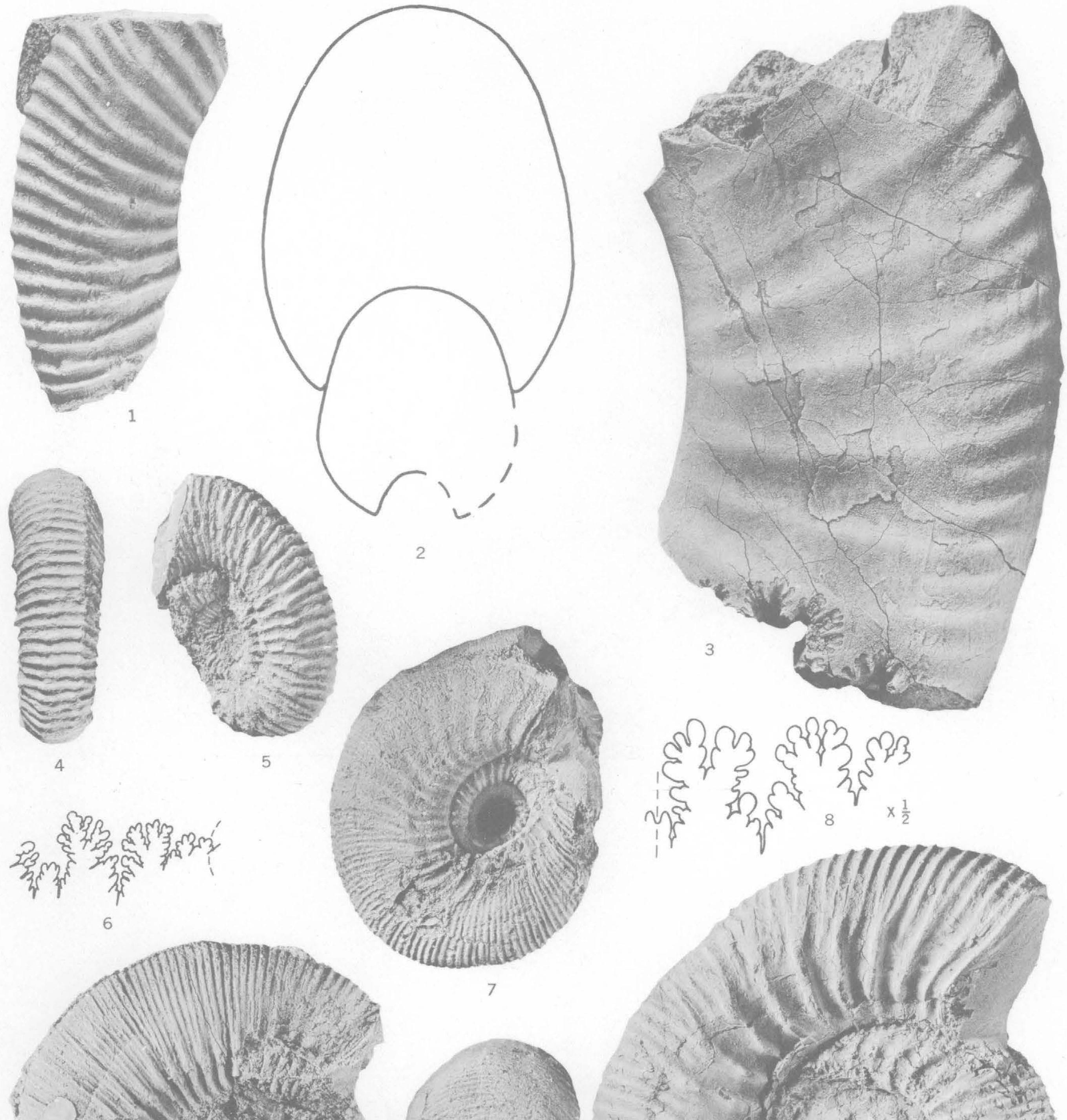
2, 3. *Procerites* sp. (p. 102).
Posterior part of body chamber and sectional view of specimen U.S.N.M. 108144 from U.S.G.S. Mes. loc. 22446, Chinitna formation. A fragment of the penultimate whorl has been omitted from photograph.

4, 5. *Cosmoceras* (*Cosmoceras*) cf. *C. spinosum* (J. de C. Sowerby) (p. 100).
Ventral and lateral views of specimen, U.S.N.M. 108140 from U.S.G.S. Mes. loc. 10991. Float probably derived from Chinitna formation.

6, 7, 10. *Gowericeras* sp. (p. 100).
Specimen, U.S.N.M. 108139 from U.S.G.S. Mes. loc. 3015, Chinitna formation. Suture line drawn at diameter of 48 mm.

8, 11. *Gowericeras spinosum* Imlay, n. sp. (p. 99).
Holotype, U.S.N.M. 108138 from U.S.G.S. Mes. loc. 22432, Chinitna formation. Suture line drawn is about one inch posterior to body whorl.

9. *Gowericeras snugharborense* Imlay, n. sp. (p. 99).
Holotype, U.S.N.M. 108137 from U.S.G.S. Mes. loc. 3015, Chinitna formation.



PROCERITES, COSMOCERAS, AND GOWERICERAS

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X $\frac{19}{20}$

2 X $1\frac{1}{2}$

PROCERITES?

PLATE 54

[Figures slightly reduced or enlarged as indicated]

FIGURES 1, 2. *Procerites*? *irregularis* Imlay, n. sp. (p. 102).
Holotype, U.S.N.M. 108146 from U.S.G.S. Mes. loc. 21273, Chinitna formation. Suture line from about 1½ in. posterior to body chamber.

PLATE 55

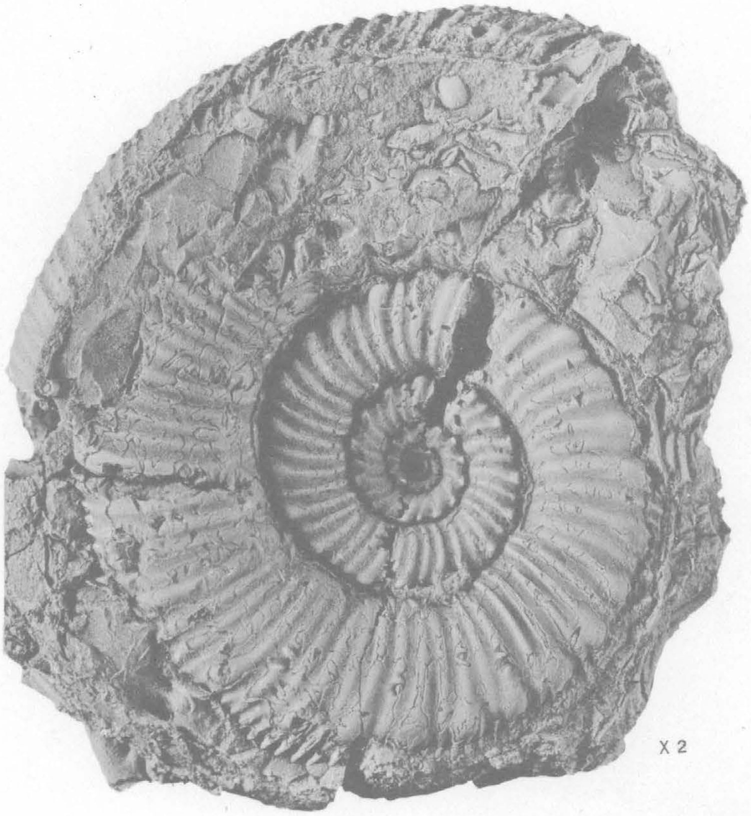
[Figures natural size unless otherwise indicated]

FIGURES 1, 2, 5–8. *Reineckeia* (*Kellawaysites*) *shelikofana* Imlay, n. sp. (p. 101).

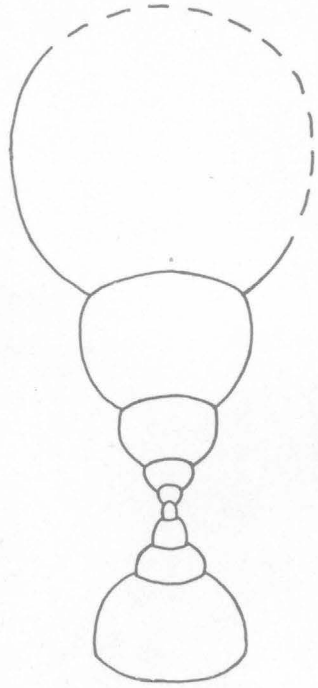
Holotype, U.S.N.M. 108143 from U.S.G.S. Mes. loc. 21355, Shelikof formation. Figs. 1 and 7 are enlargements of internal whorls. Suture line shown in fig. 6 drawn at diameter of 17 mm. Suture line shown in fig. 5 drawn at diameter of 40 mm. Sectional view of fig. 2 drawn from point A to A′. Note specimen is entirely septate.

3, 4. *Grossouvria* sp. (p. 102).

Lateral views of crushed specimen, U.S.N.M. 108147 from U.S.G.S. Mes. loc. 22431, Chinitna formation.



1



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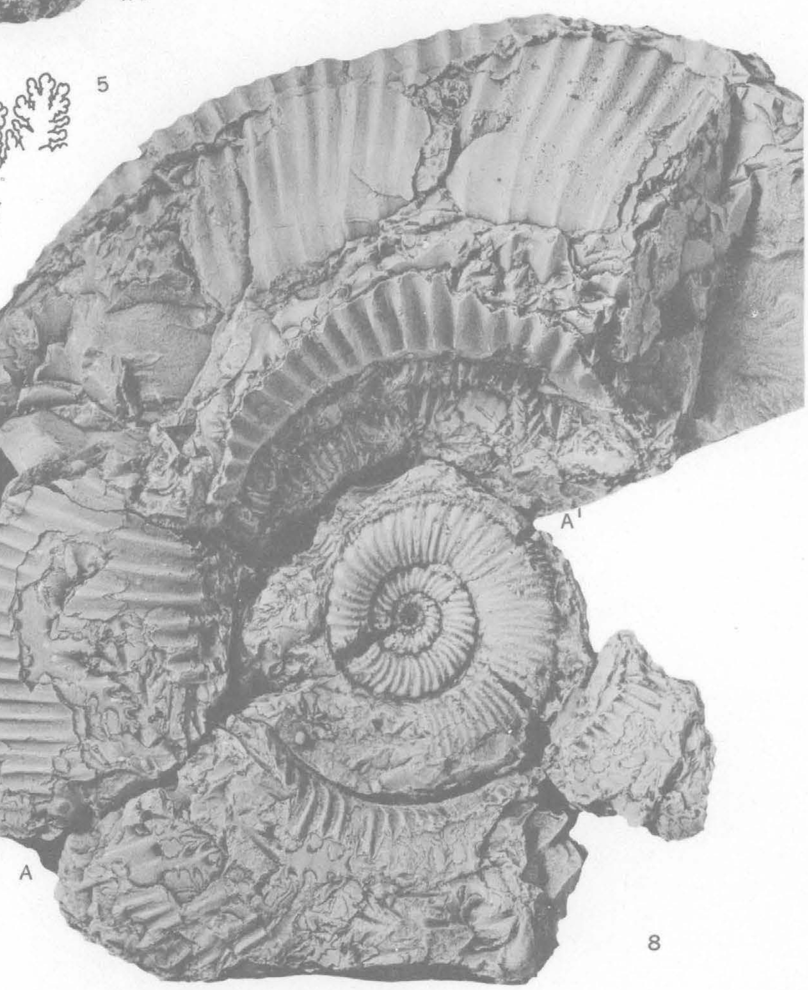

8

REINECKEIA AND GROSSOUVRIA