Upper Cretaceous (Campanian and Maestrichtian) Ammonites From Southern Alaska

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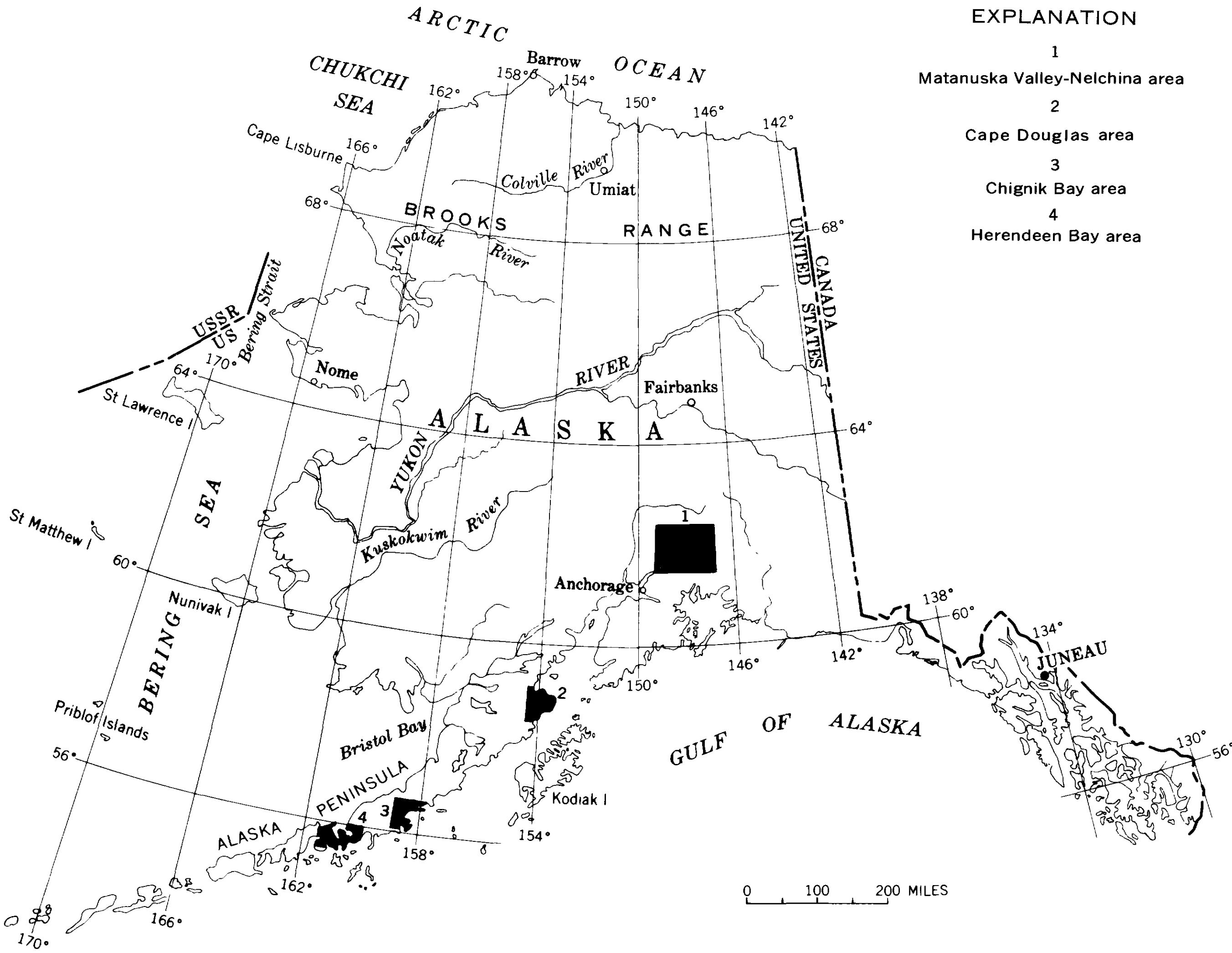

FIGURE 1.—Index map of Alaska showing principal areas of fossiliferous Upper Cretaceous rocks discussed in this report.

Co. Charles E. Kirschner of Standard Oil Co. of California, and M. C. Lachenbruch of the Western Gulf Oil Co. for supplying both specimens and locality data.

STRATIGRAPHIC SUMMARY

MATANUSKA VALLEY-NELCHINA AREA

Upper Creteceous rocks of the Matanuska Valley were originally included by Mendenhall (1900, p. 307) in the Matanuska Series and were considered of Early Cretaceous age on the basis of *Buchia crassicollis* (Keyserling). Subsequent work by Martin and Katz (1912) established the presence within this series of Lower Jurassic, Lower Cretaceous, Upper Cretaceous, and Tertiary rocks. In 1926 Martin restricted and redefined the term "Matanuska Series" and designated as Matanuska formation the Upper Cretaceous rocks of the Matanuska Valley. According to Martin and Katz (1912, p. 34), the most complete section of the Matanuska formation in the Matanuska Valley is in the gorge of Granite Creek (pl. 1), where they measured a section of about 4,000 feet of rock. The lower half of the section consists mainly of shale and the upper half of alternating beds of sandstone and shale, the sandstone predominating. Neither the lower nor the upper contact was observed in the Granite Creek section, nor were these contacts seen elsewhere in the Matanuska Valley (Martin, 1926, p. 318). Thus, the full extent and the lithologic character of the Matanuska formation could not be determined within its type area.

Martin (1926, p. 321) extended use of the term "Matanuska formation" into the upper Matanuska Valley-Nelchina area where Upper Cretaceous rocks were said to be "of the same general lithologic character as those in the lower part of the valley." Martin also pointed out that rocks of the upper Matanuska Valley-Nelchina area are much less deformed structurally than are those to the west in the vicinity of Granite Creek.

Detailed mapping by Arthur Grantz (1953; 1960 a, b, c; 1961) of the U.S. Geological Survey has shown that in the Nelchina area the Matanuska formation is more completely exposed and lithologically more complex than in the vicinity of Granite Creek. In 1953 Grantz subdivided the formation into four members as follows, in descending stratigraphic sequence:

	Thickness (feet)
Upper shale and siltstone member: Dark-gray shale and silty shale with thin fine-grained arkosic sandstone layers	1,000+
Upper sandstone and siltstone member: Olive-gray arkosic sandstone with thick pebble conglomerate, siltstone, and locally, shale beds. Local large-scale penecontemporaneous slump. Plant fragments and limestone concretions occur locally	1,500
Lower shale and siltstone member: Medium- and dark-gray shale and silty shale with numerous limestone concretions and a few thin sandstone and siltstone layers	6,000–7,000
Basal sandstone member: Thick-bedded greenish-gray and locally olive-black sandstone. Thick shale and siltstone beds occur within the unit in places	50–650

Fossils collected from these units were studied by R. W. Imlay (*in* Imlay and Reeside, 1954, p. 231–233) who recognized several faunal subdivisions said to range in age from Coniacian to late Campanian or Maestrichtian. The lowest fauna, of Coniacian age, was obtained from the basal sandstone member and the immediately overlying several hundred feet of shale. Fossils from this interval of rock cited by Imlay include *Parapuzosia* and *Prohauericeras* as well as *Inoceramus*, probably identical with *I. uwajimensis* Yehara and *I. naumanni* Yokoyama. No part of the formation was thought to be older than Coniacian (Imlay and Reeside, 1954, p. 233). The next fauna, obtained from a somewhat greater thickness of shale overlying the lowermost several hundred feet of the lower shale and siltstone member, was said to contain many specimens of *Inoceramus undulatoplicatus* and was assigned a probable Santonian age. The next highest fauna was obtained from the lower part of the upper third of the shale member and was separated from the beds containing *I. undulatoplicatus* by several hundred feet of poorly exposed and sparsely fossiliferous shale. Fossils identified from this fauna include *Pachydiscus suciaensis* (Meek), *Nostoceras hornbyense* (Whiteaves), *Neophylloceras ramosum* (Meek), and others, of probable Campanian age. The upper part of the upper third of the shale and siltstone member yielded several species of *Inoceramus* similar to species known from beds of late Campanian to early Maestrichtian age in the western interior of the conterminous United States.

Subsequent mapping by Grantz (1960 a, b, c; 1961) and faunal studies by Imlay (1959, 1960) and Jones (*in* Grantz and Jones, 1960) has resulted in a revision of the above described stratigraphic classification and geologic age assignment.

In particular, the presence of strata of Coniacian and Santonian age has not been substantiated. The identification of *Prohauericeras* was changed by Imlay (written communication to A. Grantz, 1954) to *Sonninia* of Bajocian age; this specimen was obtained from the Tuxedni formation, not the Matanuska formation. The determination of *Inoceramus undulatoplicatus* has been changed to *I. schmidti*, a change with which Imlay concurs (written communication to A. Grantz, 1955). The reported *Inoceramus uwajimensis* belongs to a new species of Cenomanian age. The only fossils of Coniacian age now known from the Matanuska formation were found in reworked concretions in a channel conglomerate of Campanian age. Santonian fossils are, as yet, unknown.

The presence of Lower Cretaceous fossils in the Matanuska formation was first established by Imlay (1959, p. 179; 1960) who described Albian fossils from a locality at the head of Billy Creek. The stratigraphic position of these fossils was not clear, and they were thought to have been reworked into beds of probable Campanian or Maestrichtian age (A. Grantz, oral communication, 1959). Subsequent restudy of this and other nearby localities indicated that the Albian fossils were indeed in place and that the Matanuska formation includes beds much older than had previously been realized. Further fossil collecting and restudy of older collections also showed that rocks of Cenomanian and Turonian ages are present and that the Turonian rocks are overlain directly by Campanian rocks.

A revised lithogenetic subdivision of the Matanuska formation, taken from reports of Grantz (1953; 1960b, c, 1961) and Grantz and Jones (1960), together with critical fossils, is as follows, in descending stratigraphic sequence. Schematic columnar sections and correlations within the Nelchina area are shown in figure 2. This section refers to rocks exposed from Sheep Mountain northward but not to rocks exposed along the northern front of the Chugach Mountains.

	Thickness (feet)
Member 1. Thinly interbedded siltstone, sandstone, and claystone. No diagnostic megafossils	1,000+
Member 2. Thickly interbedded sandstone, siltstone, and conglomerate, and units of thinly interbedded siltstone and sandstone. No megafossils	1,500
Member 3. Siltstone and claystone with limestone concretions. Lower half characterized by cone-in-cone concretions. Channel conglomerate locally present at base. *Inoceramus schmidti* zone of Campanian age restricted to lower half of member. *Pachydiscus kamishakensis* zone of late Campanian-Maestrichtian age present in upper half	6,000+

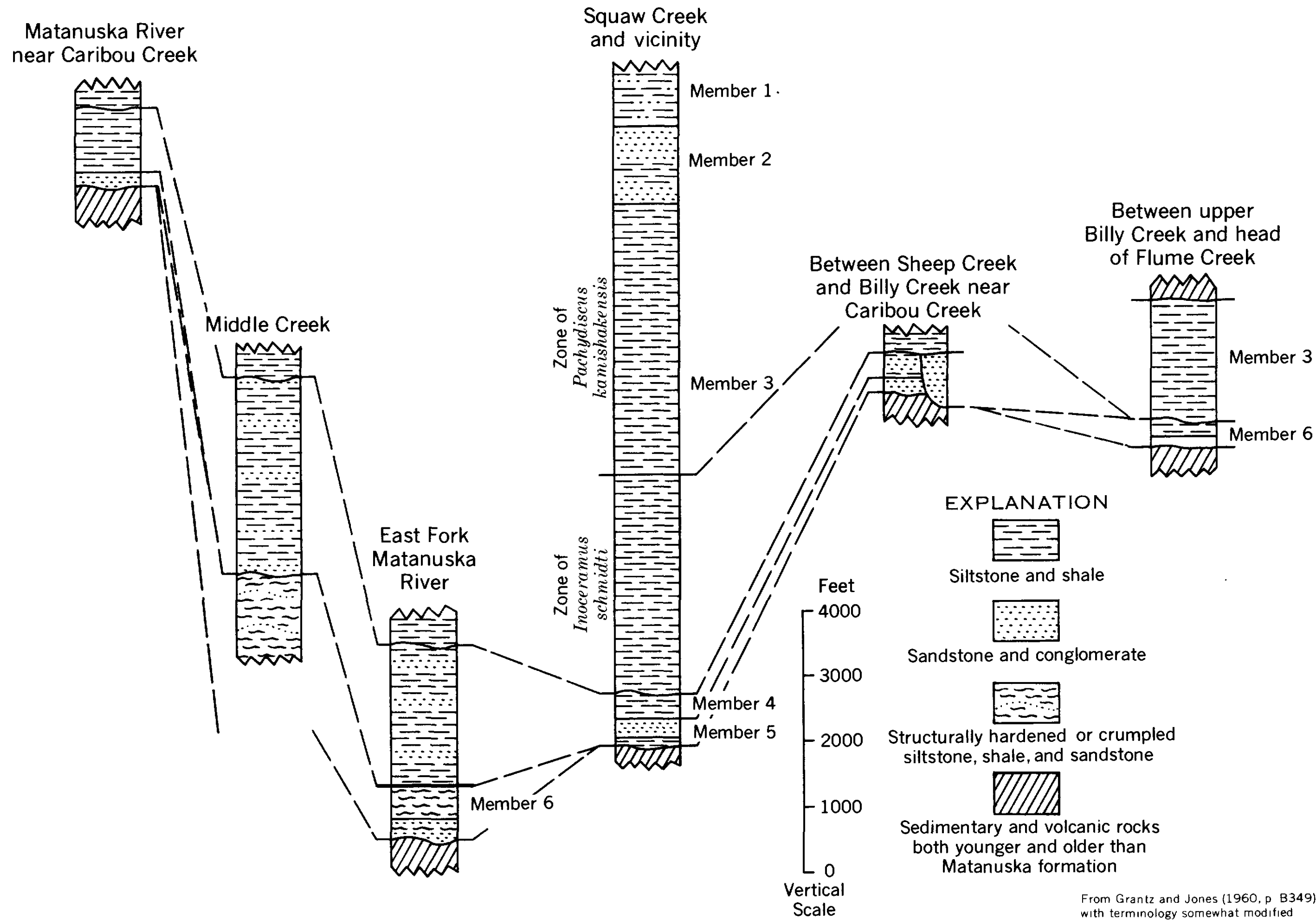

FIGURE 2.—Schematic columnar sections of Matanuska formation in Nelchina area.

	Thickness (feet)
Member 4. Siltstone with predominantly small and medium size sandy limestone concretions. Fossils include *Sciponoceras* aff. *S. bohemicus*, *Mesopuzosia indopacifica*, *Tetragonites* aff. *T. glabrus*, *Inoceramus* aff. *I. cuvierii*, and others, of Turonian age	400
Member 5. Greenish- and olive-gray sandstone, fine-grained to pebbly, locally with siltstone unit in lower part. Fossils of Cenomanian age include *Calycoceras* sp. and *Inoceramus* n. sp. close to *I. yabei* from sandstone, and *Desmoceras* (*Pseudouhligella*) *japonicum* from siltstone	400
Member 6. Coal-bearing sandstone grading up into brownish-gray concretionary claystone, Fossils of early Albian age include, among others, *Aucellina* sp., *Brewericeras hulenense*, *Freboldiceras singulare*	500

A schematic composite columnar section showing the age and position of fossils within these members is shown in figure 3.

Fossils discussed in this report were obtained from member 3. No diagnostic megafossils were found in members 1 and 2, although Berquist (written communication to A. Grantz, 1958) reported that the units contain microfossils of Maestrichtian age.

Member 3, consisting predominantly of shale and siltstone, is herein subdivided into two faunal zones: a lower *Inoceramus schmidti* zone and an upper *Pachydiscus kamishakensis* zone. Both these zones are best developed in Squaw Creek valley north of Sheep Mountain, although the section there is complicated by folding and faulting, and exposures are not continuous. The *I. schmidti* zone begins at the base of member 3, in the part of the member that is characterized by cone-in-cone concretions, and extends through 2,500 to 3,000 feet of section to about the middle of the member. Characteristic fossils of this zone are *I. schmidti* Michael and *Helcion giganteus* Schmidt. Ammonites are rare, but several specimens of *Anapachydiscus nelchinensis* Jones, n. sp., as well as single specimens of *Pseudophyllites indra* (Forbes) and *Canadoceras newberryanum* (Meek), are known.

For several hundred feet above the highest known occurrence of *Inoceramus schmidti* and below the *Pachydiscus kamishakensis* zone, the rocks are poorly exposed and fossils are lacking. However, the presence of fragments of *Pachydiscus* in the upper part of the

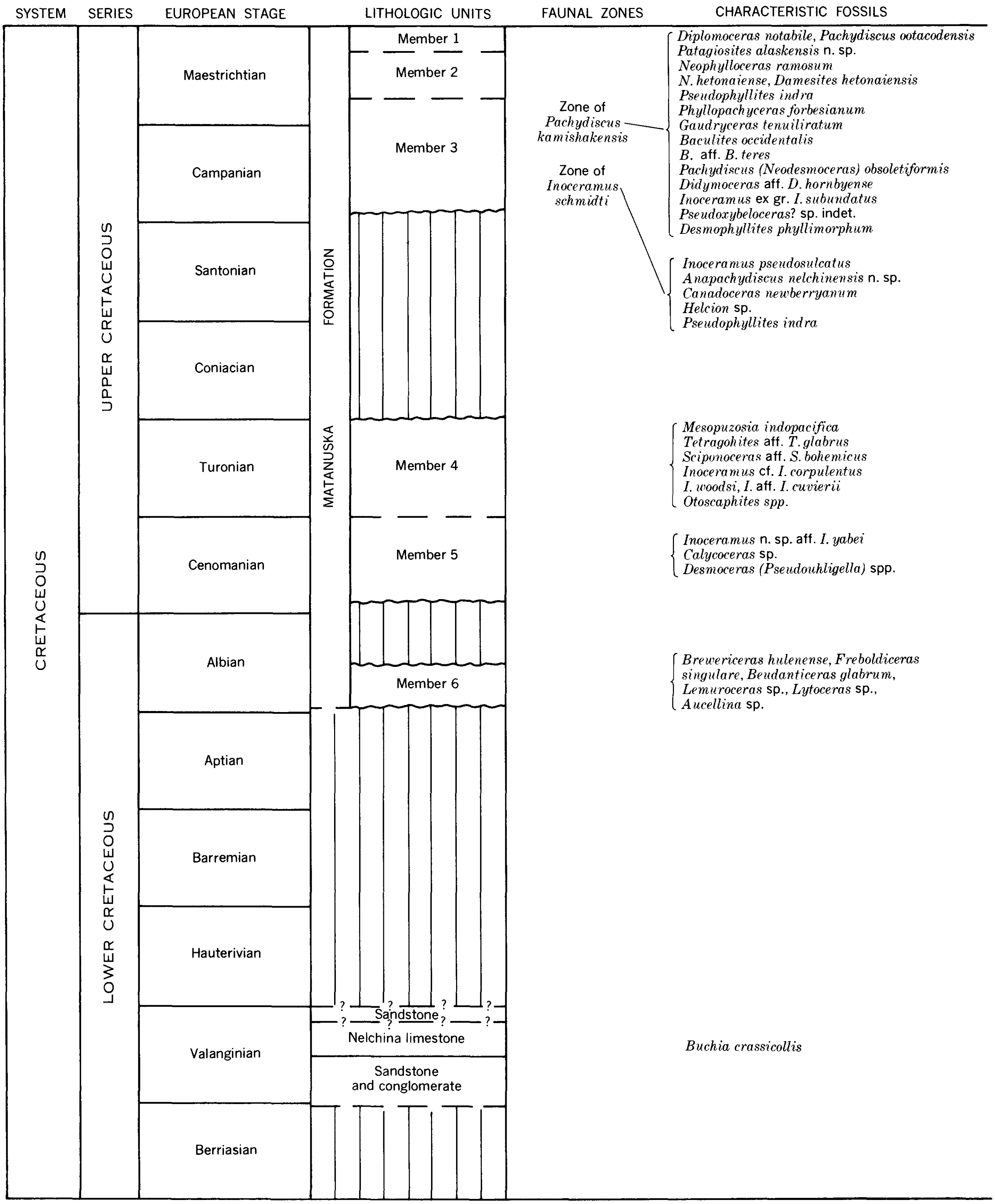

FIGURE 3.—Schematic columnar section showing age of the Matanuska formation and characteristic fossils from each member in the Nelchina area.

I. schmidti zone indicates that these two zones may be contiguous.

The *Pachydiscus kamishakensis* zone ranges through about 2,000 feet of section and extends to within 1,000 feet of the top of member 3; this upper 1,000 feet is apparently lacking in ammonites but contains *Inoceramus* ex. gr. *I. subundatus*. Characteristic fossils of this zone are:

Pachydiscus (*Pachydiscus*) *kamishakensis* zones, n. sp.
P. (*P.*) *ootacodensis* (Stoliczka)
Diplomoceras notabile Whiteaves
Didymoceras aff. *D. hornbyense* (Whiteaves)
Neophylloceras ramosum (Meek)
N. hetonaiense Matsumoto
Baculites occidentalis Meek
B. aff. *B. teres* Forbes
Patagiosites alaskensis Jones, n. sp.
Pachydiscus (*Neodesmoceras*) *obsoletiformis* Jones, n. sp.
Damesites hetonaiensis Matsumoto
Desmophyllites phyllimorphum (Kossmat)
Pseudophyllites indra (Forbes)
Phyllopachyceras forbesianum (d'Orbigny)
Gaudryceras tenuiliratum Yabe
Inoceramus ex gr. *I. subundatus* Meek
I. elegans Sokolow

Distribution of faunal zones.—The *Inoceramus schmidti* zone is well developed north of the Matanuska River in Squaw Creek valley and along Caribou Creek. It has not been found north of the Castle Mountain–Caribou fault system where rocks of the *Pachydiscus kamishakensis* zone rest directly on rocks of Albian age. East of Sheep Mountain, the *I. schmidti* zone crops out on a tributary of the Nelchina River, along the Little Nelchina River both north and south of the Glenn Highway bridge, and in the Nelchina River valley.

West of Sheep Mountain the *Inoceramus schmidti* zone is recognized at only two places: USGS Mesozoic loc. 8591 on Hicks Creek, and Mesozoic loc. 8596 on the south side of the Matanuska River. Rocks of this zone apparently are not present along Granite Creek, nor have they been recognized elsewhere in the lower Matanuska Valley.

The *Pachydiscus kamishakensis* zone is widespread throughout the entire Matanuska Valley–Nelchina area. It occurs north of the Castle Mountain–Caribou fault system at numerous localities, as well as in the lower Matanuska Valley. Most of the rocks exposed along Granite Creek belong to this zone, but younger rocks may also be present in the upper part of the section. East of Sheep Mountain the *Pachydiscus kamishakensis* zone occurs in a large landslide block at Slide Mountain north of the Glenn Highway (USGS Mesozoic locs. 20801, 24241, M567). This is the easternmost locality where fossils of this zone have been found.

CHIGNIK BAY AREA

Upper Cretaceous rocks, designated Chignik formation by Atwood (1911, p. 41), crop out along the shore of Chignik Bay and on the northwest side of Chignik Lagoon (Pl. 2). These rocks, which consist of "a series of sandstones, shales, conglomerates, and some valuable coal seams" (Atwood, 1911, p. 41), unconformably overlie the Naknek formation of Jurassic age and are overlain by nonmarine rocks of Tertiary age (Atwood, 1911, p. 58; Martin, 1926, p. 298; Knappen, 1929, p. 194). On Atwood's geologic map, but not mentioned in his text, the Chignik formation was subdivided into three unnamed members, the middle one of which is coal bearing. Martin (1926, p. 306) accepted this three-fold subdivision and stated that "the lower member of the Chignik formation has yielded only marine invertebrate fossils, the middle member has yielded fossil plants and a few marine mollusks (*Inoceramus*), and the upper member has yielded a considerable variety of both plants and marine invertebrates. The faunas and floras of the several members are quite distinctive." Knappen (1929, p. 194, 213), who made a detailed study of the Chignik coal deposits, considered the formation to be divisible into a lower nonmarine coal-bearing unit and an upper shaly marine unit; these two units were not mapped. Later work by Keller and Cass (1956), who measured a section along the northwest side of Chignik Lagoon (fig. 4), showed that marine fossils occur near the base of the formation as well as higher in the section and that at least two coal-bearing units are present, separated by nearly 600 feet of marine strata. The thickness of the formation, as measured by Atwood (1911, p. 42) on the southeastern side of Chignik Lagoon near Niggerhead, is 780 feet. Keller and Cass (1956, fig. 2) reported a partial thickness of nearly 1,600 feet on the north side of Chignik Lagoon.

The occurrence in the Chignik formation of both marine invertebrate fossils and plant fossils has long been known. Martin (1926) summarized the early work and gave complete floral and faunal lists; so there is no need to duplicate this information in the present report. Imlay and Reeside (1954, p. 234) determined the age of the Chignik formation to be Coniacian to late Santonian on the basis of *Inoceramus undulatoplicatus* (Roemer), a species that is a widespread marker for late Coniacian age. Imlay *in* Keller and Cass (1956 p. 4, 5) later realized that the determination of *I. undulatoplicatus* was in error and changed his identification to *I. schmidti*, a species that is characteristically an indication of Campanian age.

Besides *Inoceramus schmidti*, the Chignik fauna also contains several species of *Inoceramus* related to *I. subundatus* Meek together with the ammonite *Canado-*

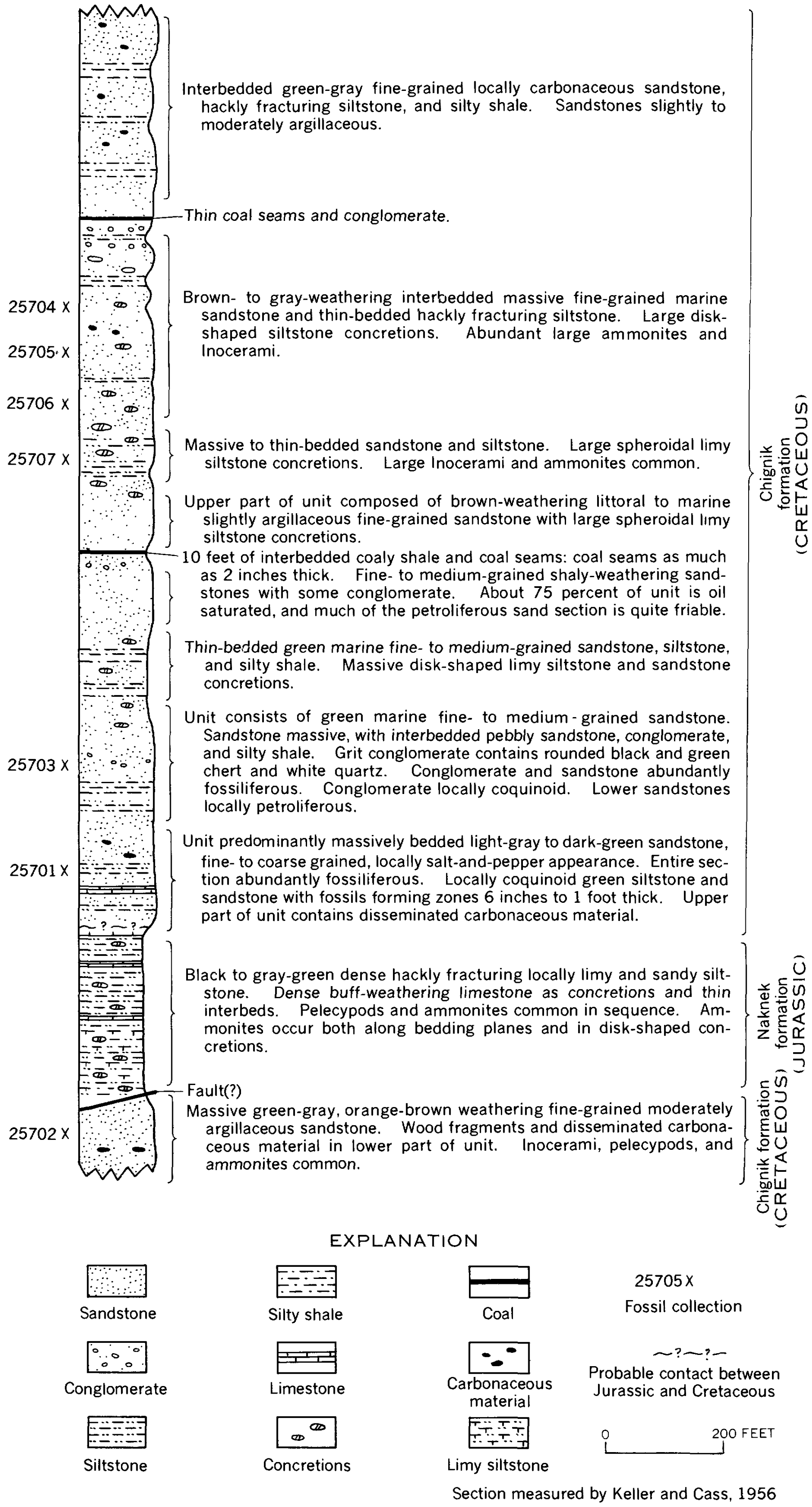

FIGURE 4.—Columnar section of rocks exposed along northwest side of Chignik Lagoon from Parallel Creek to Native Village.

ceras newberryanum (Meek). Both *I. schmidti* and *C. newberryanum* are distributed throughout the section, with the exception of the nonmarine beds, and no further faunal subdivisions are apparent with the present data.

The Chignik formation is about the same age as the lower part of member 3 of the Matanuska formation of the Nelchina area; both units can be assigned to the *Inoceramus schmidti* zone of Campanian age.

HERENDEEN BAY AREA

Rocks of both Early and Late Cretaceous age are present in the Herendeen Bay area (Atwood, 1911, p. 38; Martin, 1926, p. 290). Two formations, the Staniukovich shale and the Herendeen limestone, were originally assigned to the Lower Cretaceous by Atwood (1911, p. 38, 39); but Imlay and Reeside (1954, p. 234), on the basis of Buchias of the *B. piochii* (Gabb) type, have shown that the Staniukovich shale is of Late Jurassic age. The Herendeen limestone contains *Buchia crassicollis* and is of Valanginian age (Imlay and Reeside, 1954, p. 234).

Rocks of Late Cretaceous age, assigned to the Chignik formation by Atwood (1911, p. 41, 42), crop out on the east and southwest sides of Herendeen Bay and also in an area to the west in the vicinity of Hoodoo Lake, an area that was not included on Atwood's (1911, pl. 8) map (fig. 5).

The Chignik formation near Herendeen Bay is partly of nonmarine orgin and contains workable deposits of coal (Gates, 1944). A partial section of the formation in Mine Creek, 1.5 miles east of Mine Harbor (Coal Harbor of early reports), is given by Atwood (1911, p. 42) in descending stratigraphic order, as follows:

	Feet
Conglomerate	300+
Coal measures	300+
Shales	200±

Marine fossils consisting predominantly of *Inoceramus schmidti* are abundant in this section, but their precise stratigraphic position is unknown. Presumably, they occur both above and below the coal,

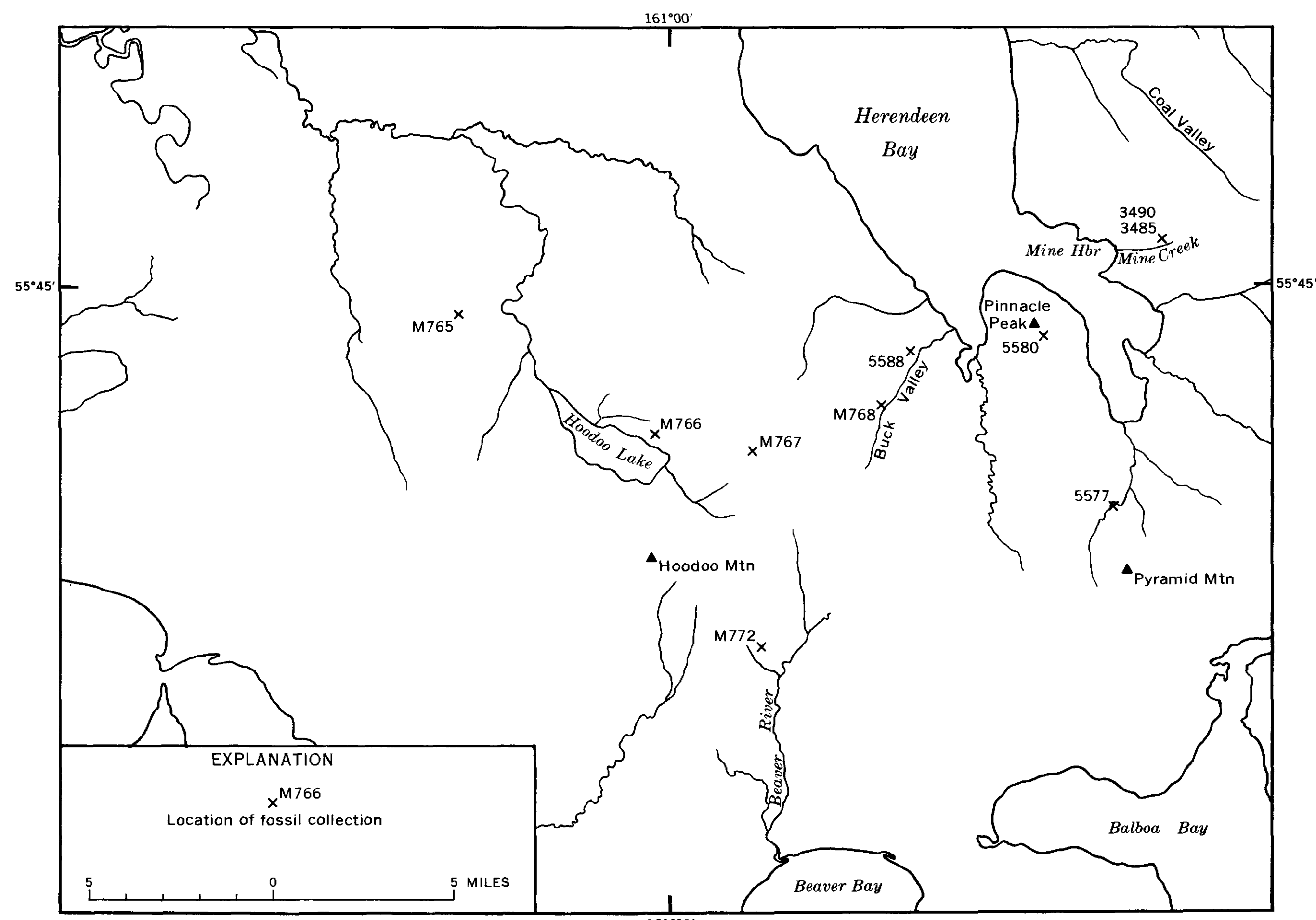

FIGURE 5.—Index map of Herendeen Bay area showing location of upper Cretaceous fossil localities.

but additional collecting is required to delimit their stratigraphic range.

Inoceramus schmidti is likewise common in the dark greenish-brown sandstone exposed to the northwest, north, and east of Hoodoo Lake. A geologic map of this area is not available, and neither the extent nor thickness of the stratigraphic units present is known. At one locality south of Hoodoo Lake, on a southeast spur of Mount Hoodoo (USGS Mesozoic loc. M772), geologists of the Western Gulf Oil Co. found a poorly preserved small fragment of a pachydiscid ammonite that resembles *Pachydiscus kamishakensis*. If this identification is correct, the presence of this fossil suggests that strata younger than that of the *Inoceramus schmidti* zone may be present in the Herendeen Bay region, but further collecting and geologic mapping are required to verify this.

Only one specimen of *Canadoceras* is known in the Geological Survey's collection from Herendeen Bay, and this specimen is herein referred to *C. yokoyamai*. The absence of *C. newberryanum* is puzzling because of its rather abundant occurrence in similar rocks that contain an otherwise similar fauna in the Chignik Bay area.

The Chignik formation in the Herendeen Bay area is approximately the same age as the type Chignik formation and member 3 of the Matanuska formation in the Nelchina area and can be assigned to the *Inoceramus schmidti* zone.

CAPE DOUGLAS AREA

Cretaceous rocks of the Cape Douglas area, which herein includes the Kamishak Bay and Cape Kaguyak areas of the Alaska Peninsula (pl. 3), were recently mapped by Keller and Reiser (1959) and named the Kaguyak formation. "The type section of the formation includes the exposures at Kaguyak and the sequence exposed in the sea cliffs from the mouth of the Big River to the Swikshak River" (Keller and Reiser, 1959, p. 273). These rocks were previously referred to the Chignik formation by Atwood (1911, p. 41), but Keller and Reiser pointed out that lithologically the Kaguyak section has little in common with the coal-bearing sequence cropping out in the Chignik Bay area, about 250 miles to the southwest.

The Kaguyak formation rests with probable disconformity on the Naknek formation of Jurassic age (Hazzard and others, 1950, p. 226) and on strata of probable Early Cretaceous age (Parkinson, 1960), but these formations are difficult to discriminate because of lithologic similarity. The Kaguyak formation is overlain by coal-bearing rocks of Eocene age (Martin, 1926, p. 300), but the contact is obscure and was not observed by Keller and Reiser (1959, p. 275). A partial thickness of 4,550 feet for the Kaguyak formation was reported by Keller and Reiser who divided the formation into three informal members, as follows: a lower, fossiliferous siltstone member; a middle, massive, locally crossbedded concretionary sandstone and interbedded siltstone and silty shale member; and an upper, thin-bedded sandstone and siltstone member. Their measured section in the type locality is as follows (see also their composite columnar section reproduced here as fig. 6):

Type section of the Kaguyak formation at Kaguyak along the sea cliffs from Big River to Swikshak River. Units in descending stratigraphic order. (From Keller and Reiser, 1959, p. 275.)

	Thickness (feet)
1. Sandstone and silt shale, gray, interbedded, very fine grained to fine-grained, argillaceous, noncalcareous, red-weathering; sandstone locally contains carbonaceous partings and minor ironstone	760
2. Sandstone, ironstone, and silt shale; platy and rusty-weathering; sandstone is fine grained. Interval largely covered	700
3. Sandstone, siltstone, and silt shale, interbedded, light-gray, fine-grained; sandstone in beds as much as 4 feet thick, with thinner interbeds of siltstone and silt shale	75
4. Silt shale, predominantly; 1-inch interbeds of sandy siltstone and silty sandstone; limy dense spheroidal siltstone concretions common	75
5. Sandstone, light- to medium-gray, fine- to medium-grained, massive, shale interbeds 1 foot thick	55
6. Sandstone, gray, medium-grained, massive, slightly argillaceous. Large spheroidal sandstone concretions	50
7. Sandstone, light-gray, fine-grained, massively bedded; siltstone concretions alined on bedding planes; black silt shale at base of unit	80
8. Sandstone, siltstone, and silt shale; rhythmically bedded. Sandstone is light gray, fine to medium grained, with shaly partings and large spheroidal siltstone concretions locally alined on bedding surfaces; silt shale is dark gray, with platy to hackly fracture; sandstone units as much as 6 feet thick; siltstone and silt shale units as much as about 8 feet thick; interbeds in shale unit several inches thick	250
9. Silt shale, siltstone, and sandstone. Rhythmically bedded unit of dark-gray well-indurated silt shale, dense noncalcareous hackly fracturing siltstone, and light-gray fine-grained well-indurated noncalcareous sandstone. Sandstone contains shaly partings and clay galls, and is found in beds 2 inches to 10 feet thick, with thinner interbeds of siltstone and silt shale. Large spheroidal siltstone and sandstone concretions locally alined on bedding surfaces	205
10. Sandstone, siltshale, and siltstone. Sporadic outcrops of light reddish-weathering fine-grained sandstone, medium-gray platy silt shale, and dense siltstone; shale galls. Partly covered	300

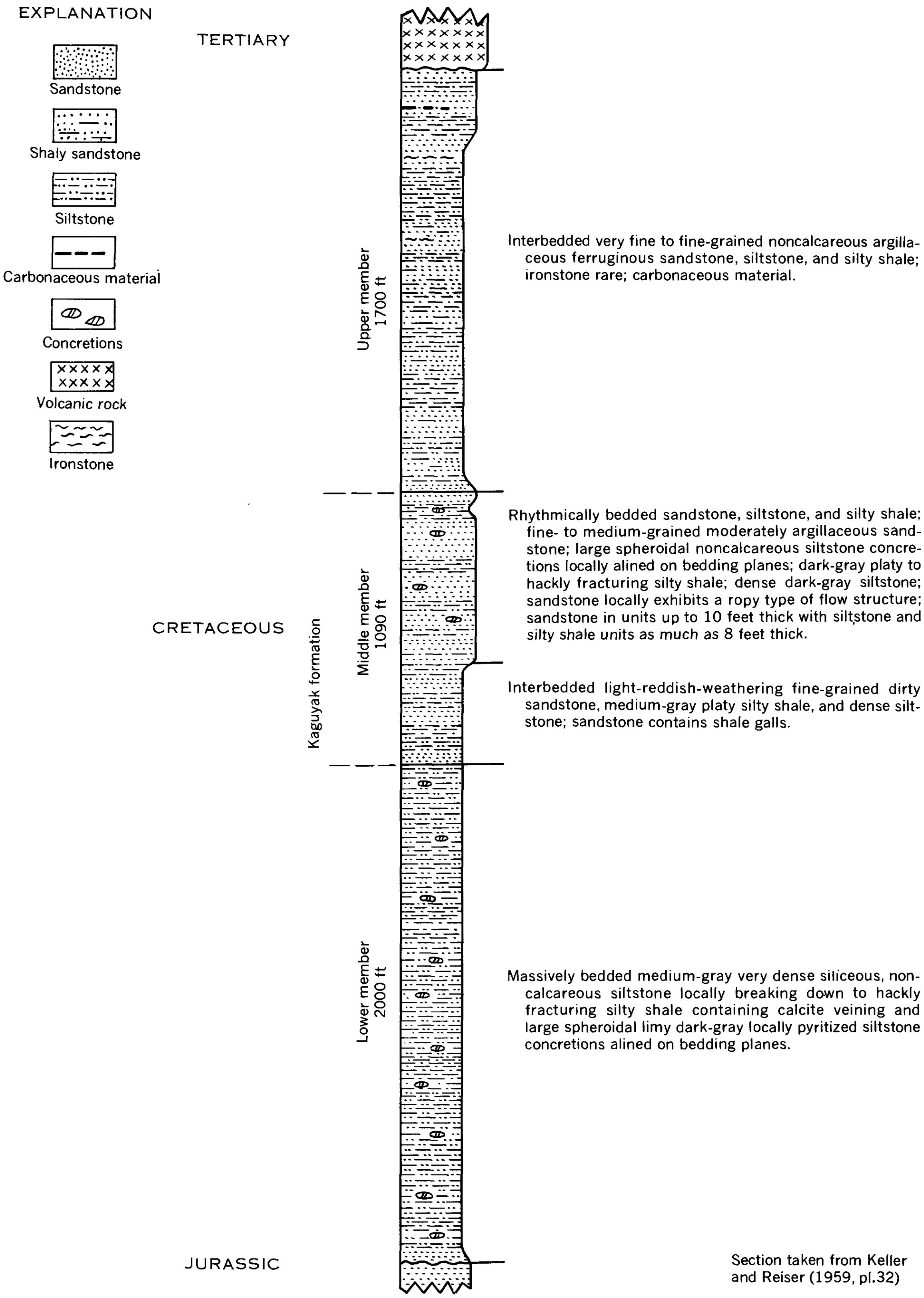

FIGURE 6.—Generalized composite stratigraphic section of the Kaguyak formation in the Cape Douglas area. Most of the fossils were obtained from the lower member.

Type section of the Kaguyak formation at Kaguyak along the sea cliffs from Big River to Swikshak River. Units in descending stratigraphic order—Continued

	Thickness (feet)
11. Andesite sill. Petrographic description (sample 54 AKe 45): Megascopically a medium dark gray phaneritic rock. Microscopically holocrystalline and equigranular. Consists predominantly of unoriented interfingering laths of plagioclase averaging 0.25 mm in length; interstices between the plagioclase laths filled with grains of augite. Plagioclase predominantly andesine; augite in part altered to amphibole. Grains of pyrite also present	40
12. Covered interval	220
13. Siltstone, dark-gray, hackly fracturing, dense, noncalcareous, with calcite veining along distinct joint system; large spheroidal limy dark-gray fossiliferous siltstone concretions alined on bedding planes have a fetid odor on fresh break. Entire section fossil bearing; fossil collection 25282 and 25283	490
14. Covered interval	230
15. Siltstone, medium-gray, very dense, massively bedded, siliceous, breaks down into needlelike fragments and hackly fracturing silt shale. Abundant large spheroidal limy dense siltstone concretions, locally pyritized and abundantly fossiliferous, alined on bedding planes. Section near base becomes slightly sandy. Fossil collection 25280 and 25281	720
16. Covered interval. Projection of strike across to Kaguyak indicates that not more than 300 feet of additional section is present between unit 15 and the contact at Kaguyak described by Hazzard (1950, p. 227)	300
Total, measured Kaguyak formation	4, 550

The distribution and extent of the Kaguyak formation away from its type section along the coast are not known with certainty, as the extension of the formation elsewhere in Keller and Reiser's map area was based largely on interpretation of vertical aerial photographs, not on ground surveys. Scattered fossiliferous exposures are present throughout the region from Kaguyak Bay northward to the sea cliffs at the mouth of the Douglas River in Kamishak Bay. where Hazzard and others (1950, p. 226) collected Upper Cretaceous fossils. To the west, the Kaguyak formation crops out at least as far as between the main fork and the South Fork of the Kamishak River.

The fauna of the Kaguyak formation is very similar to that of the upper part of member 3 of the Matanuska formation in the Nelchina area, and the rocks can be assigned to the *Pachydiscus kamishakensis* zone. Elements of the fauna common to both areas include *P.* (*Pachydiscus*) *kamishakensis*, n. sp., *P.* (*Neodesmoceras*) *obsoletiformis* n. sp., *P.* (*P.*) *ootacodensis* (Stoliczka), *Pseudophyllites indra* (Forbes), *Neophylloceras ramosum* (Meek), *N. hetonaiense* Matsumoto, *Diplomoceras notabile* Whiteaves, and several species of *Inoceramus*. As Imlay (*in* Imlay and Recside, 1954, p. 23; and *in* Keller and Reiser, 1959, p. 277) pointed out, this assemblage is younger than that of the Chignik formation and the lower part of member 3 of the Matanuska formation, units which are characterized by *Inoceramus schmidti*.

DEPOSITION AND ECOLOGIC CONDITIONS

Cretaceous sediments of the Matanuska formation were deposited in a fairly shallow unstable marine seaway. A major source of sediment probably lay to the north, but coarsening and thickening of some stratigraphic units closer to the northern front of the Chugach Mountains, as well as the absence of beds of Bajocian to Valanginian age in the southern part of the Nelchina area, suggests that the Chugach Mountains area supplied some of the sediment to the Matanuska seaway (Grantz *in* Grantz and Jones, 1960, p. 349). The unstable nature of the seaway is indicated by rapid facies changes, by intraformational unconformities that record deep erosion, and by intraformational conglomerates that contain reworked fossils. Also, absence of rocks of Cenomanian, Turonian, and Campanian (*Inoceramus schmidti* zone) ages north of the Castle Mountain–Caribou fault system and the superposition of rocks of latest Campanian or Maestrichtian age on rocks of Albian age indicate tectonic movements during deposition of the Matanuska formation. Rapid subsidence of the seaway is indicated by the great thickness of sediment deposited during a relatively short interval; the known thickness of rocks of Campanian and Maestrichtian ages is about 10,000 feet.

Much of the Matanuska formation was probably deposited below wave base, as indicated by a general lack of current-produced sedimentary structures such as crossbedding and ripple marks, although locally these structures are present. There is also a lack of characteristic heavy-shelled, shallow-water pelecypods and gastropods, such as *Trigonia*, *Glycymeris*, oysters, and *Acteonella*. The abundance of ammonites and Inocerami probably indicates a depth of water not exceeding the maximum depth permissible for photosynthetic activity, about 150 to 200 meters. A probable outer neritic zone is suggested for much of the formation, although locally areas may have been either deeper or shallower.

The relative scarcity of ammonites in the *Inoceramus schmidti* zone is puzzling because of their abundance both above and below this zone in lithologically similar rocks and because of their common occurrence with Inocerami elsewhere on the Pacific coast, notably on the Alaska Peninsula, in the Vancouver Island area, and in Japan.

The abundant ammonite faunas of the *Pachydiscus kamishakensis* zone do not seem to have a close correlation with the depth controlled ammonite groups recognized by Scott (1940) for the Cretaceous of Texas. Representatives of Scott's "Infrabathyal" group, which in Alaska includes *Phyllopachyceras forbesianum*, *Pseudophyllites indra*, and *Gaudryceras tenuiliratum*, occur with representatives of the "Epibathyal" zone, which includes pachydiscids species as well as *Desmophyllites* and *Damesites*. Representatives of the "Infraneritic" zone, including *Diplomoceras notabile*, *Didymoceras* aff. *D. hornbyense*, and *Baculites* spp., as well as representatives of the "Epineritic" zone, including *Neophylloceras* spp., occur together. These same forms occur also with representatives of the supposed deeper water zones. How much of this association of the various groups can be attributed to drifting of shells or mixing by current action after death is not known. Possibly, the thin-shelled, deep-water forms drifted into shallower water, but the relative abundance, wide distribution, and excellent state of preservation of such forms tend to refute this idea.

On the Alaska Peninsula, conditions of deposition of the Kaguyak formation were similar to those of the Matanuska formation, as evidenced by the general similarity in rock type and the close similarity of faunas. The Chignik formation of both Chignik Bay and Herendeen Bay is generally coarser grained than the Matanuska formation and was probably deposited in somewhat shallower water. Evidence for this is seen in the presence of intercalated nonmarine coal-bearing beds in a dominantly marine section and in the presence of a somewhat greater percentage of shallow water, thick-shelled pelecypods such as *Glycymeris*.

AGE AND CORRELATION

The *Inoceramus schmidti* zone, which characterizes the lower part of member 3 of the Matanuska formation as well as the Chignik formation of the Alaska Peninsula, is of Campanian age. *I. schmidti* is known from Campanian deposits in Japan, British Columbia, and California (Nagao and Matsumoto, 1940, p. 41–43; Matsumoto, 1959d, p. 87). The *I. schmidti* zone in Japan is restricted to the upper two-thirds of the Campanian and is characterized by several species of *Canadoceras*, including *C. yokoyamai* and *C. kossmati*. None of these species are known from the type area of the Campanian in Europe, so direct correlation with the international standard of reference is difficult.

The age of the *Pachydiscus kamishakensis* zone is probably latest Campanian or early Maestrichtian; a precise determination is difficult partly because the Campanian-Maestrichtian boundary in Europe is still a matter of dispute. This boundary problem centers about disagreement as to which beds Dumont (1849, p. 361) included in his original definition of the term "Maestrichtian." Four different interpretations have been proposed (Voight, 1956, p. 12), but the leading opinion currently places the boundary between the zones of *Belemnella lanceolata* and *Belemnitella mucronata minor* (Jeletzky, 1951, p. 18, table 1) rather than lower in the section below the *Bostrychoceras polyplocum* zone as shown by Muller and Schenck (1943, fig. 6) or the very restricted interpretation advocated by van der Hiede (1954) and others (pls. 4 and 5).

In Jeletzky's interpretation, which is followed in this report, the upper Campanian beds of Europe are characterized by abundant species of *Pachydiscus*, *Hoplitoplacenticeras*, *Scaphites*, *Diplomoceras*, *Bostrychoceras*, and other forms. The lower Maestrichtian contains *Discoscaphites constrictus*, *Pachydiscus neuberg-icuse-gertoni*, and other pachydiscids. The upper Maestrichtian is dominated by species of the genus *Sphenodiscus*.

The Cedar District formation of Vancouver Island, B.C., contains abundant specimens of *Hoplitoplacenticeras vancouverensis*, *Canadoceras newberryanum*, and several species of *Pachydiscus* (Usher, 1952). This assemblage is probably of late Campanian age and may be equivalent to the European zone of *Hoplitoplacenticeras vari*. The overlying Lambert and Northumberland formations of Vancouver Island contain *Pachydiscus ootacodensis*, *P. suciaensis*, *Diplomoceras notabile*, *Pseudophyllites indra*, *Baculites occidentalis*, and other species. This zone is equivalent to the *Pachydiscus kamishakensis* zone of southern Alaska and is probably of latest Campanian or early Maestrichtian age.

Matsumoto (1959a, p. 155) considered that *Baculites occidentalis* Meek, one of the most characteristic species of the Lambert faunal assemblage, is of late Campanian age. Evidence for this, however, is not convincing. In California, Matsumoto (1960, p. 82) reported *B. occidentalis* occurring with *B. lomaensis*, *Damesites hetonaiensis fresnoensis*, and other ammonites of latest Campanian or early Maestrichtian age. No occurrence of this species in California is known in rocks of definite Campanian age. Usher's (1952, p. 99) report of *B. occidentalis* from the Cedar District formation of Campanian age on Sucia Island is suspect, as it has not again been found there in more than 80 years of collecting. Possibly the specimen, reported to have been collected from Sucia Island by J. Richardson in 1874 was obtained elsewhere and collections were mixed, or it was incorrectly labeled. This species, therefore-cannot be accepted as a late Campanian zonal marker, as proposed by Matsumoto, unless the entire Lambert, Northumberland faunal assemblage is also accepted as of late Campanian age. As this assemblage is demonstrably younger than the late Campanian Cedar District assemblage, a Maestrichtian age seems probable; however, because of the reported long range of some of the faunal elements and because of lack of means for precise correlation with Europe, the Lambert-Northumberland faunal assemblage as well as the *Pachydiscus kamishakensis* zone is herein considered to be of latest Campanian or early Maestrichtian age.

A comparison of the *Pachydiscus kamishakensis* zone with the stratigraphic sequence of Japan also suggests an early Maestrichtian age, although the evidence is not unequivocable. *P.* (*Pachydiscus*) *subcompressus* Matsumoto, a close relative of *P. kamishakensis*, was regarded by Matsumoto (1959d,) as a zonal index for the Maestrichtian of Japan, but this species has recently been found in California in deposits of late Campanian age (Matsumoto, 1959b, p. 46, 47). *Patagiosites compressus* (Matsumoto) is known only from the Maestrichtian of Japan, and a similar age is probable for its Alaskan counterpart, *Patagiosites alaskensis* Jones, n. sp. *Pachydiscus* (*Neodesmoceras*) *japonicus* occurs in Maestrichtian deposits in Japan; other occurrences of this subgenus in Baja California, Calif., and Madagascar, are also restricted to the Maestrichtian.

COMPARISON WITH OTHER AREAS

JAPAN

The Campanian-Maestrichtian faunas of southern Alaska are closely allied to those of Japan, and the following species are common to both areas (see Matsumoto, 1954, for faunal lists of Japanese Cretaceous fossils):

Neophylloceras ramosum (Meek)
N. hetonaiense Matsumoto
Gaudryceras tenuiliratum Yabe
Damesites hetonaiensis Matsumoto
Canadoceras kossmati ? Matsumoto
C. yokoyamai (Jimbo)
Inoceramus schmidti Michael
I. elegans Sokolow
I. ex. gp. *I. subundatus* Meek

In addition to these species, several Alaskan forms described herein as new are closely related to Japanese species. In particular, *Pachydiscus* (*Pachydiscus*) *kamishakensis* is close to *P.* (*P.*) *subcompressus* (Matsumoto), and *Patagiosites alaskensis* is close to *Patagiosites compressus* (Matsumoto).

In general, the number of species of both ammonites and *Inoceramus* in southern Alaska is much smaller than in Japan. Part of this reduction may be explained by differing taxonomic philosophy, and part is probably due to inadequate collecting, as the Cretaceous rocks of southern Alaska have not been adequately explored. Nevertheless, the faunal differences between the two areas seem to be real; for example, only one species of *Gaudryceras* is recognized from Campanian-Maestrichtian rocks of Alaska, but nine species, subspecies, and varieties are known from equivalent strata in Japan. *Anapachydiscus* is represented by one species and several specimens in Alaska and by at least three species and many specimens in Japan. *Eupachydiscus* is, so far, completely unknown in Alaska, but in Japan several species of this genus form an important element of the fauna.

Many other genera and species common to the Upper Cretaceous deposits of Japan are as yet unknown or only poorly represented in southern Alaska. Among these are *Submortoniceras* and *Metaplacenticeras*, the latter of which is known from only one specimen collected by geologists of the Union Oil Co. of California from a locality southeast of Mother Goose Lake on the Alaska Peninsula. Heteromorphic ammonites are rare in Alaska, with the exception of *Diplomoceras;* and such characteristic Japanese forms as *Polyptychoceras*, *Ryugasella*, and *Glyptoxoceras* are unknown.

VANCOUVER ISLAND, BRITISH COLUMBIA

Upper Cretaceous faunas from southern Alaska are very similar to those from Vancouver Island, but the Alaskan faunas contain fewer species. Those species common to the two areas are as follows:

Diplomoceras notabile Whiteaves
Didymoceras hornbyense (Whiteaves)
Baculites occidentalis Meek
Pseudophyllites indra (Forbes)
Phyllopachyceras forbesianum (d'Orbigny)
Neophylloceras ramosum (Meek)
N. hetonaiense Matsumoto (?)
Canadoceras newberryanum (Meek)
Inoceramus schmidti Michael
Inoceramus ex. gp. *I. subundatus* Meek

Cretaceous rocks of Vancouver Island and vicinity occur in two separate basins; the Nanaimo basin to the south, and the Comox basin to the north (Usher, 1952; pl. 5). Different formational names are applied to the rocks of each basin, and correlation of lithologic units between basins is not yet unanimously agreed upon. The Haslam formation, which is the oldest fossiliferous marine formation in the Nanaimo basin, has yielded a rich ammonite and *Inoceramus* fauna including *Inoceramus schmidti*, *Eupachydiscus haradai*, *Hauericeras gardeni*, *Pachydiscus buckhami*, and other species suggestive of a probable late early or middle Campanian age. A somewhat similar fauna is known from the Trent River formation of the Comox basin, which has yielded *Inoceramus* cf. *I. naumanni*, *I. schmidti*, *Eupachydiscus haradai*, *Hauericeras gardeni*, and other species found also in the Haslam formation. The probable age of this unit is late early to middle Campanian, and it is an equivalent of the Haslam formation, although Usher correlated it with the much younger Cedar District formation. This latter correlation cannot be substantiated, as the Trent River formation and the Cedar District formation have almost no species in common (Usher, 1952, p. 34, table 1). The Haslam and Trent River formations are approximately equivalent to the lower part of member 3 of the Matanuska formation and to the Chignik formation of the Alaska Peninsula.

If the equivalency of the Haslam and Trent River formations is accepted, a problem arises as to the position of the Qualicum formation, at least the part of the formation that is exposed at Northwest Bay. There, abundant specimens of *Inoceramus schmidti and Canadoceras multisulcatum* (Whiteaves) as well as a very large compressed finely ribbed species that may be *C. multicostatum* Matsumoto occur. These fossils suggest an age at least as old as middle Campanian but probably no older than the Trent River formation. According to Usher (1952, fig. 2), the Qualicum formation underlies the Trent River formation and is younger than the Haslam formation. A more reasonable interpretation would be to consider the strata at Northwest Bay as belonging to either the Haslam or Trent River formation, not to the Qualicum formation, but additional field study is necessary to establish its true relation.

An upper Campanian fauna characterized by *Hoplitoplacenticeras vancouverense* (Meek), *Baculites inornatus* Meek, *Canadoceras newberryanum*, and several species of *Pachydiscus* is found in the Cedar District formation, notably on Sucia Island. With the exception of the long-ranging species *C. newberryanum*, this fauna is unknown in southern Alaska.

The youngest fauna of the Vancouver Island area, characterized by *Baculites occidentalis*, *Pseudophyllites indra*, *Diplomoceras notabile*, *Neophylloceras ramosum* and *N. hetonaiense* (=?*N. lambertense*), *Didymoceras hornbyense*, and other species, occurs in the Lambert and Northumberland formations. This fauna is nearly identical with that of the *Pachydiscus kamishakensis* zone of southern Alaska and is probably of the same age.

In summary, the Chignik formation and the lower part of member 3 of the Matanuska formation are probably equivalent to the Haslam and Trent River formations of Vancouver Island, but the absence of diagnostic short-ranged ammonites in southern Alaska makes correlation difficult. The upper part of member 3 of the Matanuska formation and the Kaguyak formation are equivalent to the Lambert and Northumberland formations of Vancouver Island. A fauna equivalent to that of the Cedar District formation of Vancouver Island is not known from southern Alaska.

CALIFORNIA

Upper Cretaceous fossils from California have been studied in detail by Anderson (1958) and Matsumoto (1959a, b; 1960). In general, similarities exist between those from California and those from southern Alaska, but the California faunas are more varied and contain many genera and species as yet unknown from Alaska. In particular, *Metaplacenticeras*, which is extremely abundant in late Campanian deposits of California, is represented in Alaska by only one specimen from a locality southeast of Mother Goose Lake on the Alaska Peninsula. *Submortoniceras* is unknown in Alaska, and the abundant and varied *Baculites* faunas known from California are poorly developed to the north.

Despite these differences, fairly close correlation can be established between the two areas on the basis of *Inoceramus schmidti*, *Canadoceras newberryanum*, *Baculites occidentalis*, *Pachydiscus ootacodensis*, and other species common to both regions. *I. schmidti* occurs in the Forbes formation of Kirby (1943) on the west side of the Sacramento Valley, together with *C. newberryanum*. The latter species is known also from the upper part of the Chico formation on the east side of the Sacramento Valley. Both these units are equivalent to the lower part of member 3 of the Matanuska formation and the Chignik formation.

The upper part of the Panoche formation and equivalent unnamed strata along the western side of the San Joaquin Valley contain *Baculites occidentalis*, *Neophylloceras ramosum*, *N. hetonaiense*, *Pachydiscus ootacodensis*, *Baculites* aff. *B. teres*, *Diplomoceras* sp., and other forms that evidence an equivalency of these strata with the upper part of member 3 of the Matanuska formation and the Kaguyak formation of southern Alaska.

WESTERN INTERIOR OF NORTH AMERICA

Upper Cretaceous faunas of southern Alaska have little in common with the prolific ammonite and *Inoceramus* faunas of the western interior of the United States and Canada. In this region, Campanian and Maestrichtian rocks are characterized by abundant and varied species of *Scaphites*, *Placenticeras*, *Sphenodiscus*, and *Baculites*, no species of which are known from southern Alaska (Cobban and Reeside, 1952; Reeside, 1957). *Inoceramus schmidti*, *Canadoceras*, and *Anapachydiscus* are unknown from the western interior; so direct correlation with the *I. schmidti* zone is difficult. Campanian rocks of the western interior are also characterized by abundant heteromorphic ammonites including *Didymoceras*, *Emperoceras*, and *Solenoceras*, but none of these forms is conspecific with southern Alaskan species.

In general, member 3 of the Matanuska formation, the Kaguyak formation, and the Chignik formation are about equivalent to the Pierre shale, but lack of faunal similarities between the two regions makes direct and detailed comparisons impossible.

GULF COAST AREA

Upper Cretaceous fossils from the gulf coast region have rather distant affinities to faunas of the Indopacific faunal realm, but some generic groups are common to both regions and afford means of correlation. No species are known to be common to both the gulf coast and southern Alaska, but an indirect correlation through California can be established. For example, the upper part of the Chico formation of California and the upper part of the Austin chalk of Texas both contain *Submortoniceras* and are probably of early Campanian age (Young, 1958, p. 1669; 1959, p. 763; Matsumoto, 1959b, p. 126). *Canadoceras newberryanum* is also known from the upper part of the Chico formation, and the occurrence of this species in southern Alaska suggests a possible equivalency of the Chignik formation and the lower part of member 3 of the Matanuska formation with the upper part of Chico formation and the upper part of the Austin chalk of Texas. This correlation cannot be accepted without strong reservations as *C. newberryanum* is known to have a long range, throughout at least the upper two-thirds of the Campanian.

The Taylor marl and equivalents in Texas contain a fairly abundant ammonite fauna (Sellards, Adkins, and Plummer, 1932, p. 474) characterized by several species of pachydiscids, *Baculites compressus*, *B. anceps*, *Diplomoceras* sp., several species of *Nostoceras*, and other ammonites of probable late Campanian age. The overlying Neylandville marl of the Navarro group is characterized by abundant heteromorphic ammonites, several species of *Pachydiscus*, *Scaphites*, and *Placenticeras* of questionable early Maestrichtian age (Stephenson, 1941, table 1, p. 35). As no species are common to both Texas and southern Alaska, precise correlation between the two areas cannot be established. However, the upper part of member 3 of the Matanuska formation and the Kaguyak formation are probably equivalent to at least part of the Taylor marl and perhaps also to part of the Neylandville marl of Texas.

MADAGASCAR

Prolific Upper Cretaceous faunas of Madagacar have been studied in detail by Basse, Besairie, Collignon, and others. The following stratigraphic summary is taken from Besairie and Collignon (1956; see this reference for complete bibliography dealing with Cretaceous deposits and faunas of Madagascar).

Campanian deposits of the Morondava Basin are the most complete and most fossiliferous of any known in Madagascar. They have been divided into seven faunal zones, as shown on plate 4. The lower part of the Campanian, from the *Anapachydiscus wittekindi* zone to the *A. deccanensis* zone inclusive, is characterized by texanitids including *Bevahites*, *Menabites*, *Bererella*, and *Submortoniceras* and by Kossmaticeratids including *Karapadites* and *Maorites*. None of these genera are known from southern Alaska, but the occurrence of *Submortoniceras* in California serves as an intermediate point for correlation.

The middle Campanian *Eupachydiscus grossouvrei* and *E. levyi–Delawarella subdelawarensis* zones are characterized by many species of *Pachydiscus*, none of which is known to occur in southern Alaska. The upper Campanian *Hoplitoplacenticeras vari* zone contains several species of *Canadoceras* and *Pachydiscus* and is a probable equivalent of the Cedar District faunal assemblage of Vancouver Island. A comparable fauna is as yet unknown from southern Alaska.

Lower Maestrichtian deposits of Madagascar are characterized by *Pachydiscus colligatus* and *Neodesmoceras mokotibense*. *Neodesmoceras* is known elsewhere in Japan, Mexico, and California in desposits of early Maestrichtian age; the presence of *N. obsoletiformis* in southern Alaska suggests a correlation of the *Pachydiscus kamishakensis* zone with the lower Maestrichtian of Madagascar.

ANTARCTICA

Ammonite fauna from Graham Land, Antarctica, have recently been studied by Spath (1953) and assigned a late Campanian age. These faunas are dominated by Kossmaticeratids, with such genera as *Gunnarites*, *Maorites*, *Neograhamites*, and others forming the bulk of the collection. These genera are unknown in southern Alaska, although representatives of the Kossmaticeratidae are abundant in older rocks of the Chitina Valley (Matsumoto, 1959c). Other elements of the Graham Land fauna, however, are closely similar to or identical with forms from the *Pachydiscus kamisakensis* zone. Among these are *Neophylloceras hetonaiense* and *Phyllopachyceras forbesianum*. *Diplomoceras notabile* has a close southern analog in *D. lambi* Spath, and *Pseudophyllites indra* of Alaska is represented in Antarctica by the similar *P. peregrinus* Spath. The genus *Patagiosites* is common to both areas but is represented by species which do not seem to be closely related.

All the species common to both Alaska and the Antartic region have a long geologic range and therefore are not useful for precise correlations. Strata of Graham Land are probably equivalent to part of member 3 of the Matanuska formation and to part of the Kaguyak formation, but differences in the faunas preclude a more precise correlation.

GEOGRAPHIC DISTRIBUTION

The occurrence by locality and formation of Campanian-Maestrichtian ammonites from southern Alaska, together with selected *Inoceramus* species and localities, is shown in table 1.

Detailed descriptions of localities as well as stratigraphic data are given in table 2.

TABLE 1.—*Geographic distribution of Campanian–Maestrichtian ammonites and selected Inocerami from southern Alaska*

	Matanuska Valley–Nelchina area																																				
	6694	6696	8559	8562	8578	8586	8587	8591	8595	8596	8948	16398	20801	24191	24192	24193	24194	24195	24201	24208	24209	24210	24211	24212	24214	24217	24219	24226	24227	24239	24241	24242	24244	24859	24860	24861	24862
Inoceramus schmidti								X		X				X	X	X	X	X														X	X	X			
aff. *I. elegans*																																			X		
ex gr. *I. subundatus*				X		X						X															X	X			X				X	X	
Canadoceras newberryanum																																					
yokoyamai																																					
cf. *C. kossmati*?																																					
Helcion giganteus																																					
Anapachydiscus nelchinensis n. sp						X																				X											
Pseudophyllites indra				X								X																									
Pachydiscus (Pachydiscus) kamishakensis n. sp												X							X			X	X	X							X						X
ootacodensis												X																									
hazzardi n. sp																																					
(*Neodesmoceras*) *obsoletiformis* n. sp																																			X		
Patagiosites alaskensis n. sp																									X											X	
Desmophyllites phyllimorphum												X																									
Damesites hetonaiensis																													X								
Diplomoceras notabile	X	X		X	X				X		X	X	X							X															X		
Phyllopachyceras forbesianum				X																																	
Neophylloceras ramosum																													X								
hetonaiense		X	X	X								X																							X	X	
Gaudryceras tenuiliratum												X									X							X		X						X	
Baculites occidentalis				X																																	
aff. *B. teres*																																					
Didymoceras aff. ?*D. hornbyense*							X					X										X															
Pseudoxybeloceras? sp. indet																																					
Pachydiscus sp. indet																X																					

	Matanuska Valley–Nelchina area—Continued																																				
	24863	24864	24865	24868	24869	24870	24871	24872	24873	24875	25321	25324	25325	25326	25327	25331	25386	25949	25950	25951	25952	25953	25954	25955	25956	25959	26030	26031	M550	M551	M552	M558	M560	M562	M564	M565	M566
Inoceramus schmidti																		X	X	X	X	X	X	X	X		X	X	X								
aff. *I. elegans*								X																													
ex gr. *I. subundatus*		X	X	X	X	X	X		X	X		X				X														X		X	X	X		X	
Canadoceras newberryanum																																					
yokoyamai																																					
cf. *C. kossmati*?																																					
Helcion giganteus																																					
Anapachydiscus nelchinensis n. sp																	X																				
Pseudophyllites indra													X													X						X		X			
Pachydiscus (Pachydiscus) kamishakensis n. sp	X											X																						X		X	
ootacodensis							X							X	X																						
hazzardi n. sp																																					
(*Neodesmoceras*) *obsoletiformis* n. sp									X																											X	X
Patagiosites alaskensis n. sp						X	X								X															X	X		X				
Desmophyllites phyllimorphum																																		X			
Damesites hetonaiensis																															X						
Diplomoceras notabile					X			?		X		X																				X		X	X		
Phyllopachyceras forbesianum													X																								
Neophylloceras ramosum				X								X				X															X	X	X	X			
hetonaiense								X			?																			X		X	X				
Gaudryceras tenuiliratum				X		X				X					X											X				X		X	X				
Baculites occidentalis																										X							X			X	
aff. *B. teres*		X								X																						X					
Didymoceras aff. *D. hornbyense*																																					
Pseudoxybeloceras? sp. indet																																					
Pachydiscus sp. indet							X																														

TABLE 1.—*Geographic distribution of Campanian–Maestrichtian ammonites and selected Inocerami from southern Alaska*—Continued

	Matanuska Valley-Nelchina area—Continued															Chignik Bay area																					
	M567	M573	M576	M577	M578	M580	M582	M584	M588	M592	M593	M594	M1032	M1033	SOC-T1335	3116	5796	5799	11361	11362	13466	13468	13470	13472	13473	13474	13480	13481	13482	13483	13484	25699	25701	25702	25703	25704	25705
Inoceramus schmidti		X								X	X	X				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X		
aff. *I. elegans*																																					
ex gr. *I. subundatus*			X			X	X																										X			X	
Canadoceras newberryanum															X													X		X				X		X	X
yokoyamai																																					
cf. *C. kossmati*?																																					
Helcion giganteus																																					
Anapachydiscus nelchinensis n. sp																																					
Pseudophyllites indra																																					
Pachydiscus (Pachydiscus) kamishakensis n. sp																																					
ootacodensis																																					
hazzardi n. sp																																					
(Neodesmoceras) obsoletiformis n. sp														X																							
Patagiosites alaskensis n. sp																																					
Desmophyllites phyllimorphum																																					
Damesites hetonaiensis																																					
Diplomoceras notabile	X							X	X																												
Phyllopachyceras forbesianum																																					
Neophylloceras ramosum			?																																		
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Gaudryceras tenuiliratum				X									X																								
Baculites occidentalis																																					
aff. *B. teres*							X																														
Didymoceras aff. *D. hornbyense*																																					
Pseudoxybeloceras? sp. indeter					X																																
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	Chignik Bay area—Continued										Herendeen Bay area										Mount Katmai area																
	25706	25707	M764	SOC-M131	SOC-M135A	SOC-M138	SOC-M139	SOC-M176	SOC-M342	SOC-M395	3485	3490	5577	5580	5588	M765	M766	M767	M768	M772	3121	24958	24959	24960	25281	25282	25855	25856	25857	25858	25859	25860	25861	25862	JCH-1753	JCH-1754	MEM-2
Inoceramus schmidti			X		X						X	X			X	X	X	X	X																		
aff. *I. elegans*																																					
ex gr. *I. subundatus*	X									X			X								X	X							X					X			
Canadoceras newberryanum	X	X		X		X	X		X																												
yokoyamai														X																							
cf. *C. kossmati*?								X																													
Helcion giganteus																																					
Anapachydiscus n. sp																																					
Pseudophyllites indra																						X															
Pachydiscus (Pachydiscus) kamishakensis n. sp																								X				X	X								
ootacodensis																												X									
hazzardi n. sp																							X					?							X	X	
(Neodesmoceras) obsoletiformis n. sp																												X	X								
Patagiosites alaskensis n. sp																																					
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Damesites hetonaiensis																																					
Diplomoceras notabile																						X							X								
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Neophylloceras ramosum																						X															
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Gaudryceras tenuiliratum																																					
Baculites occidentalis																																					
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Didymoceras aff. *D. hornbyense*																																					X
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Pachydiscus sp. indet																				X	X	X			X		X			X	X	X					

TABLE 2.—*Campanian-Maestrichtian ammonites and selected* Inoceramus-*bearing localities in Upper Cretaceous rocks of southern Alaska*

Geological Survey Mesozoic loc.	Field No.	Collector, year of collection, description of locality, stratigraphic assignment, and age
		Matanuska Valley–Nelchina area
6694	18	G. C. Martin and T. Chapin, 1910. East bank of Kings River, three quarters of a mile below USLM no. 1. Upper part of Matanuska formation. Late Campanian or Maestrichtian.
6696		A. H. Brooks and G. C. Martin, 1910. Creek entering Granite Creek from west 5 miles above main trail, about half a mile above junction with Granite Creek. Upper part of Matanuska formation. Late Campanian or Maestrichtian.
8559	1	G. C. Martin, 1913. Float from Black Shale Creek, tributary to Boulder Creek. Upper part of Matanuska formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.
8562	4	G. C. Martin, 1913. North slope of Anthracite Ridge near crest, and on first tributary to Boulder Creek below junction of Boulder Creek and unnamed east fork of Boulder Creek. Upper part of Matanuska formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.
8578	28	G. C. Martin, 1913. Billy Creek, about 4⅘ miles (airline) above mouth at altitude of 3,800 feet. Upper part of member 3, Matanuska formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.
8586	37	G. C. Martin, 1913. Mouth of Alfred Creek. About middle of member 3 of Matanuska formation. Campanian. Probably upper part of *Inoceramus schmidti* zone.
8587	38	G. C. Martin, 1913. Alfred Creek, 1,880 feet below junction with Flume Creek. Upper part of member 3 of Matanuska formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.
8591	42	G. C. Martin and Overbeck, 1913. Hicks Creek, opposite mouth of second large tributary flowing from west above mouth. Matanuska formation. Campanian. *Inoceramus schmidti* zone.
8595	50	G. C. Martin, Mertie, and Overbeck, 1913. North bank of Matanuska River, upper Matanuska Valley, about 9 miles above mouth of Chickaloon River. Matanuska formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.
8596	51	G. C. Martin, Mertie, and Overbeck, 1913. South bank of Matanuska River. Upper Matanuska Valley, 5 miles above mouth of Chickaloon River. Matanuska formation. Campanian. *Inoceramus schmidti* zone.
8948	4	T. Chapin, 1914. Ridge between Hicks Creek and Caribou Creek, 3½ miles north of Matanuska River. Matanuska formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.
16398	32-AW-1	G. A. Waring, 1932. Anthracite Ridge, upper Matanuska Valley, on south side of Ridge in headwaters of Purinton (Chikootna) Creek. Matanuska formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.
20801		A. Glover, 1947. Slide Mountain, about 2 miles north of Glenn Highway at mile 141. Upper part of member 3 of Matanuska formation. *Pachydiscus kamishakensis* zone.
24191	52-AGz-25	Grantz, Hoare, Imlay, 1952. On south tributary of Squaw Creek, 2.06 miles N. 41° W. of southeast summit of Gunsight Mountain, lat 61°52.2′ N., long 147°30.9′ W. Lower part of member 3 of Matanuska formation. Campanian. *Inoceramus schmidti* zone.
24192	52-AGz-26	Grantz, Hoare, Imlay, 1952. Same locality as 24191, but 50 feet downstream. Lower part of member 3 of Matanuska formation. Campanian. *Inoceramus schmidti* zone.
249193	52-AGz-28	Grantz, Hoare, Imlay, 1952. On south tributary of Squaw Creek, 2.67 miles N. 40° W. of southeast summit of Gunsight Mountain, lat 61°52.5′ N. long 147°31.0′ W. Lower part of member 3 of Matanuska formation. Campanian. *Inoceramus schmidti* zone.
24194	52-AGz-30	Grantz, Hoare, Imlay, 1952. On south tributary of Squaw Creek, 2.77 miles N. 39.5° W. of southeast summit of Gunsight Mountain, lat 61°52.6′ N., long 147°31.0′ W. Lower part of member 3 of Matanuska formation. Campanian. *Inoceramus schmidti* zone.
24195	52-AGz-32	Grantz, Hoare, Imlay, 1952. South tributary of Squaw Creek, 2.99 miles N. 40° W. of southeast summit of Gunsight Mountain, lat 61°52.7′ N. long 147°31.3′ W. Lower part of member 3 of Matanuska formation. Campanian. *Inoceramus schmidti* zone.
24201	52-AGz-51	Grantz, Hoare, Imlay, 1952. On north tributary of Squaw Creek, about 3.1 miles northeast of junction of Squaw Creek and Caribou Creek, at altitude of about 4,000 feet. Lat 61°54.4′ N., long 147°31.7′ W. Upper part of member 3 of Matanuska formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.
24208	52-AGz-71	Grantz, Hoare, Imlay, 1952. Squaw Creek valley, 4.9 miles northeast of junction of Squaw Creek and Caribou Creek, at altitude of about 3,500 feet, lat 61°54.2′ N., long 147°27.5′ W. Upper part of member 3 of Matanuska formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.
24209	52-AGz-75	Grantz, Hoare, Imlay, 1952. Squaw Creek valley, 4.9 miles northeast of junction of Squaw Creek and Caribou Creek. Upper part of member 3 of Matanuska formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.
24210	52-AGz-75	Grantz, Hoare, Imlay, 1952. Squaw Creek valley, 4.95 miles northeast of junction of Squaw Creek and Caribou Creek; altitude 3,500 feet. Lat 61°54.3′ N., long 147°27.5′ W. Upper part of member 3 of Matanuska formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.
24211	54-AGz-76	Grantz, Hoare, Imlay, 1952. Squaw Creek valley, 5.1 miles northeast of junction of Squaw Creek and Caribou Creek, altitude about 3,700 feet. Lat 61°54.45′ N., long 147°27.4′ W. Upper part of member 3 of Matanuska formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.
24212	52-AGz-80	Grantz, Hoare, Imlay, 1952. Squaw Creek valley, float about 2,000 feet upstream from locality 24211. Upper part of member 3 of Matanuska formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.
24214	52-AGz-177	Grantz, Hoare, Imlay, 1952. Alfred Creek, about 0.8 mile east of mouth of Flume Creek. Lat 61°57.1′ N., long 147°31.9′ W. Upper part of member 3 of Matanuska formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.
24217	52-AGz-184	Grantz, Hoare, Imlay, 1952. North bank of Alfred Creek at junction with Caribou Creek. Lower part of member 3 of Matanuska formation. Campanian. *Inoceramus schmidti* zone.
24219	52-AGz-200	Grantz, Hoare, Imlay, 1952. Squaw Creek valley, 5.3 miles northeast of junction of Squaw Creek and Caribou Creek, at altitude of 3,900 feet. Lat 61°54.55′ N., long 147°27.0′ W. Upper part of member 3 of Matanuska formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.
24226	52-AGz-241	Grantz, Hoare, Imlay, 1952. 1.85 miles N. 68° E. of mouth of Sheep Creek. Upper part of member 3 of Matanuska formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.
24227	52-AGz-254	Grantz, Hoare, Imlay, 1952. 7.77 miles S. 6.5° E. of main headwater fork of Little Nelchina River. Lat 62°0.5′ N., long 147°36.5′ W. Upper part of member 3 of Matanuska formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.
24239	52-AGz-266	A. Grantz, 1952. On south side of Alfred Creek, 3.22 miles N. 86° E. of mouth of Flume Creek. Upper part of member 3 of Matanuska formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.
24241		J. R. Williams, 1952. Landslide approximately 1.5 miles North of Glenn Highway at mile 141. Upper part of member 3 of Matanuska formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.
24242	1	J. R. Williams, 1952. Road cut on east side of Little Nelchina River near Glenn Highway. Lower part of member 3 of Matanuska formation. Campanian. *Inoceramus schmidti* zone.

TABLE 2.—*Campanian-Maestrichtian ammonites and selected* Inoceramus-*bearing localities in Upper Cretaceous rocks of southern Alaska*—Continued

Geological Survey Mesozoic loc.	Field No.	Collector, year of collection, description of locality, stratigraphic assignment, and age
		Metanuska Valley-Nelchina area—Continued
24244	3	J. R. Williams, 1952. North bank of Little Nelchina River about 2 miles downstream from Glenn Highway bridge. Lower part of member 3 of Matanuska formation. Campanian. *Inoceramus schmidti* zone.
24859	53-AGz-62	A. Grantz and L. Fay, 1953. Nelchina district, Anchorage (D-2) quad., lat 61°57′30″ N., long 147°43′04″ W., approximately 2.05 miles N. 47.5° W. of the junction of Sheep Creek and Caribou Creek, on a northtrending tributary of Caribou Creek, approximately 0.76 mile upstream. Lower part of member 3 of Matanuska formation. Campanian. *Inoceramus schmidti* zone.
24860	53-AGz-78A	A. Grantz and L. Fay, 1953. Nelchina district, Talkeetna mountains (A-2) quad. Lat 62°04′50½″ N., long 147°50′07″ W. Upper part of member 3 of Matanuska formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.
24861	53-AGz-103	A. Grantz and L. Fay, 1953. Nelchina district, Anchorage (D-3) quad. Lat 61°59′25″ N., long 147°50′07″ W., on east bank of Caribou Creek, approximately 1.6 miles from junction with Chitna Creek. Upper part of member 3 of Matanuska formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.
24862	53-AGz-115	A. Grantz and L. Fay, 1953. Nelchina district, Anchorage (D-2) quad. Lat 61°58′27″ N., long 147°53′18″ W., approximately 3 miles N. 33° W. of the junction of Caribou and Sheep Creek. Upper part of member 3 of Matanuska formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.
24863	53-AGz-129	A. Grantz and L. Fay, 1953. Nelchina district, Talkeetna Mountains (A-2) quad. Lat 62°00′45″ N., long 147°40′38″ W. Upper part of member 3 of Matanuska formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.
24864	53-AGz-130	A. Grantz and L. Fay, 1953. Nelchina district, Talkeetna Mountains (A-2) quad. Lat 62°01′08½″ N., long 147°41′15″ W. Upper part of member 3 of Matanuska formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.
24865	53-AGz-131	A. Grantz and L. Fay, 1953. Nelchina district, Talkeetna Mountains (A-2) quad. Lat 62°01′12″ N., long 147°40′59″ W. Upper part of member 3 of Matanuska formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.
24868	53-AGz-141	A. Grantz and L. Fay, 1953. Nelchina district, Talkeetna Mountains (A-2) quad. Lat 62°01′00½″ N., long 147°37′23″ W. from talus. Upper part of member 3 of Matanuska formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.
24869	53-AGz-147	A. Grantz and L. Fay, 1953. Nelchina district, Talkeetna Mountains (A-2) quad. Lat 62°01′28½″ N., long 147°38′19″ W. Upper part of member 3 of Matanuska formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.
24870	53-AGz-148	A. Grantz and L. Fay, 1953. Nelchina district, Talkeetna Mountains (A-2) quad. Lat 62°01′27″ N., long 147°38′13″ W. Upper part of member 3 of Matanuska formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.
24871	53-AGz-151	A. Grantz and L. Fay, 1953. Nelchina district, Talkeetna Mountains (A-2) quad. Lat 62°00′34″ N., long 147°35′25½″ W. Upper part of member 3 of Matanuska formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.
24872	53-AGz-221	A. Grantz and L. Fay, 1953. Nelchina district, Talkeetna Mountains (A-2) quad. Lat 62°08′28″ N., long 147°48′37″ W. Upper part of member 3 of Matanuska formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.
24873	53-AGz-238A	A. Grantz and L. Fay, 1953. Nelchina district, Talkeetna Mountains (A-2) quad. Lat 62°09′33″ N., long 147°45′52″ W. Upper part of member 3 of Matanuska formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.

TABLE 2.—*Campanian-Maestrichtian ammonites and selected* Inoceramus-*bearing localities in Upper Cretaceous rocks of southern Alaska*—Continued

Geological Survey Mesozoic loc.	Field No.	Collector, year of collection, description of locality, stratigraphic assignment, and age
		Matanuska Valley-Nelchina area—Continued
24875	53-AF-3	L. Fay, 1953. Nelchina district, Talkeetna Mountains (A-2) quad. Lat 62°01′28½″ N., long 147°38′46″ W. Upper part of member 3 of Matanuska formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.
25321	54-AGz-54	A. Grantz, 1954. Talkeetna Mountains (A-2) quad. Lat 62°00′44″ N., long 147°34′55½″ W. Upper part of member 3 of Matanuska formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.
25324	54-AGz-551	A. Grantz, 1954. Talkeetna Mountains (A-2) quad. Lat 62°00′49″ N., long 147°34′51″ W. Upper part of member 3 of Matanuska formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.
25325	54-AGz-55M	A. Grantz, 1954. Talkeetna Mountains (A-2) quad. Lat 62°00′46″ N., long 147°34′54″ W. Upper part of member 3 of Matanuska formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.
25326	54-AGz-55N	A. Grantz, 1954. Same locality as 25325 but lower in section. Upper part of member 3 of Matanuska formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.
25327	54-AGz-55P	A. Grantz, 1954. Same locality as 25326 but lower in section. Upper part of member 3 of Matanuska formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.
25331	54-AGz-56W	A. Grantz, 1954. Same locality as 25327 but lower in section. Upper part of member 3 of Matanuska formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.
25386		J. Watson, 1954. Glenn Highway, at mile 137.5, lat 61°51.5′ N., long 146°57′ W. Lower part of member 3 of Matanuska formation. Campanian. *Inoceramus schmidti* zone.
25949	55-AGz-5	A Grantz, 1955. Anchorage (D-2) quad. Talkeetna Mountains. Lat 61°55′41½″ N., long 147°04′15″ W. Lower part of member 3 of Matanuska formation. Campanian. *Inoceramus schmidti* zone.
25950	55-AGz-17	A. Grantz, 1955. Valdez (D-8) quad. Lat 61°58′07″ N., long 146′47′14″ W. Western part Copper River basin, Alaska. Lower part of member 3 of Matanuska formation. Campanian. *Inoceramus schmidti* zone.
25951	55-AGz-23	A. Grantz, 1955. Valdez (D-8) quad. Lat 61°58′13″ N., long 146°46′26″ W. West part Copper River basin. Lower part of member 3 of Matanuska formation. Campanian. *Inoceramus schmidti* zone.
25952	55-AGz-27	A. Grantz, 1955. Valdez (D-8) quad. Lat 61°58′22″ N., long 146°45′35″ W. Northwest of fault at G-2360. Lower part of member 3 of Matanuska formation. Campanian. *Inoceramus schmidti* zone.
25953	55-AGz-30	A. Grantz, 1955. Valdez (D-8) quad. Lat 61°58′55″ N., long 146°45′50″ W. Lower part of member 3 of Matanuska formation. Campanian. *Inoceramus schmidti* zone.
25954	55-AGz-36	A. Grantz, 1955. Valdez (D-8) quad. Lat 61°59′09″ N., long 146°44′00″ W. Lower part of member 3 of Matanuska formation. Campanian. *Inoceramus schmidti* zone.
25955	55-AGz-83C	A. Grantz, 1955. Valdez (D-8) quad. Lat 61°58′15″ N., long 146°52′54″ W. Copper River basin. Lower part of member 3 of Matanuska formation. Campanian. *Inoceramus schmidti* zone.
25956	55-AGz-83d	A. Grantz, 1955. Valdez (D-8) quad. Lat 61°58′19″ N., long 146°52′58″ W. Copper River basin. Lower part of member 3 of Matanuska formation. Campanian. *Inoceramus schmidti* zone.
25959	55-AGz-102b	A. Grantz, 1955. Gulkana (A-6) quad. Lat 62°03′17″ N., long 146°58′43″ W. Copper River basin. Upper part of member 3 of Matanuska formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.
26030	55-AGz-8	A. Grantz, 1955. Anchorage (D-1) quad. Talkeetna Mountains. Lat 61°55′14″ N., long 147°07′18″ W. Lower part of member 3 of Matanuska formation. Campanian. *Inoceramus schmidti* zone.

TABLE 2.—*Campanian-Maestrichtian ammonites and selected* Inoceramus-*bearing localities in Upper Cretacoeus rocks of southern Alaska*—Continued

Geological Survey Mesozoic loc.	Field No.	Collector, year of collection, description of locality, stratigraphic assignment, and age
		Matanuska Valley-Nelchina area—Continued
26031	55-AGz-236	A. Grantz, 1955. Anchorage (D-1) quad. Talkeetna Mountains. Lat 61°59′14″ N., long 147°16′57″ W. Lower part of member 3 of Matanuska formation. Campanian. *Inoceramus schmidti* zone.
M550	59-AGz-M1/2	A. Grantz and D. L. Jones, 1959. Valdez (D-8) quad. Little Nelchina River. Lat 61°59′25″–30″ N., long 146°56′30″ W. Lower part of member 3 of Matanuska formation. Campanian. *Inoceramus schmidti* zone.
M551	59-AGz-M1D	A. Grantz and D. L. Jones, 1959. Talkeetna Mountains (A-2) quad. Limestone Gulch. Lat 62°1′35″–40″ N., long 147°39′15″ W. Upper part of member 3 of Matanuska formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.
M552	59-AGz-M1E	A. Grantz and D. L. Jones, 1959. Talkeetna Mountains (A-2) quad. Limestone Gulch. Lat 62°1′35″–40″ N., long 147°39′15″ W. Upper part of member 3 of Matanuska formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.
M558	59-AGz-M4A	A. Grantz and D. L. Jones, 1959. Talkeetna Mountains (A-2) quad. Limestone Gulch. Lat 62°1′30″ N., long 147°34′50″ W. Upper part of member 3 of Matanuska formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.
M560	59-AGz-M10	A. Grantz and D. L. Jones, 1959. Anchorage (D-3) quad. Caribou Creek. Lat 61°59′25″ N., long 147°46′40″ W. Upper part of member 3 of Matanuska formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.
M562	59-AGz-M20	A. Grantz and D. L. Jones, 1959. Talkeetna Mountains (A-2) quad. Mazuma Creek. Lat 62°4′50″ N., long 147°50′00″ W. Upper part of member 3 of Matanuska formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.
M564	59-AGz-M24	A. Grantz and D. L. Jones, 1959. Anchorage (D-3) quad. Boulder Creek. Lat 61°57′50″ N., long 147°59′55″ W. Upper part of member 3 of Matanuska formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.
M565	59-AGz-M25A	A. Grantz and D. L. Jones. Talkeetna Mountains (A-2) quad. Lat 62°9′30″ N., long 147°46′00″ W. Upper part of member 3 of Matanuska formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.
M566	59-AGz-M29	A. Grantz and D. L. Jones, 1959. Anchorage (D-2) quad. West end of Syncline Mountain. Lat 61°55′15″ N.–61°55′25″ N., long 147°34′00″ W.–147°34′10″ W. Upper part of member 3 of Matanuska formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.
M567	59-AGz-M30	A. Grantz and D. L. Jones, 1959. Gulkana (A-6) quad. Slide Mountain. Lat 62°00′20″ N., long 146′50′55″ W. Upper part of member 3 of Matanuska formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.
M573	59-AGz-M59	A. Grantz and D. L. Jones, 1959. Valdez (D-8) quad. South bank, Little Nelchina River. Lat 61°59′8″–11″ N., long 146°55′40″–55″ W. Lower part of member 3 of Matanuska formation. Campanian. *Inoceramus schmidti* zone.
M576	59-AGz-M93	A. Grantz and D. L. Jones, 1959. Anchorage (C-6) quad. Wolverine Creek. Lat 61°39′33″ N., long 149°2′30″ W. Upper part of member 3 of Matanuska formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.
M577	59-AGz-M96	A. Grantz and D. L. Jones, 1959. Anchorage (C-6) quad. Lat 61°41′35″ N., long 148°56′47″ W. Upper part of member 3 of Matanuska formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.
M578	59-AGz-M97	A. Grantz and D. L. Jones, 1959. Anchorage (C-6) quad. Lat 61°41′30″ N., long 148°56′46″ W. Upper part of member 3 of Matanuska formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.
M580	59-AGz-M103	A. Grantz and D. L. Jones, 1959. Anchorage (C-6) quad. Lat 61°41′10″ N., long 148°57′45″ W. Upper part of member 3 of Matanuska formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.
M582	59-AGz-M108	A. Grantz and D. L. Jones, 1959. Anchorage (D-5) quad. Lat 61°43′45″ N., long 148°44′50″ W. Upper part of member 3 of Matanuska formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.
M584	59-AGz-M111B	A. Grantz and D. L. Jones, 1959. Anchorage (D-5) quad. Lat 61°45′00″–61°45′15″ N., long 148°37′25″–148°38′00″ W. Upper part of member 3 of Matanuska formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.
M588	59-AGz-M121	A. Grantz and D. L. Jones, 1959. Anchorage (D-5) quad. Granite Creek. Lat 61°45′32″ N., long 148°50′23″ W. Upper part of member 3 of Matanuska formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.
M592	59-AGz-M153	A. Grantz and D. L. Jones, 1959. Valdez (D-8) quad. Little Nelchina River. Lat 61°58′20″ N., long 146°52′50″ W. Lower part of member 3 of Matanuska formation. Campanian. *Inoceramus schmidti* zone.
M593	59-AGz-M154	A. Grantz and D. L. Jones, 1959. Valdez (D-8) quad. Little Nelchina River. Lat 61°59′10″ N., long 146°54′25″ W. Lower part of member 3 of Matanuska formation. Campanian. *Inoceramus schmidti* zone.
M594	59-AGz-M154A	A. Grantz and D. L. Jones, 1959. Valdez (D-8) quad. Little Nelchina River. Lat 61°59′10″ N., long 146°54′20″ W. Lower part of member 3 of Matanuska formation. Campanian. *Inoceramus schmidti* zone.
M1032	52-AGz-237	A. Grantz, 1952. On eastern tributary of Sheep Creek, 3,700 feet east of junction with east fork of Sheep Creek at altitude of 3,700 feet. Lat 61°57.3′ N., long 142°37.7′ W. Upper part of member 3 of Matanuska formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.
M1033	52-AGz-239	A. Grantz, 1952. Between Sheep Creek and Flume Creek at altitude of about 4,500 feet. Lat 61°59.65′ N., long 142°37.8′ W. Upper part of member 3 of Matanuska formation. *Pachydiscus kamishakensis* zone.
------------	Soc. T1335	Collector unknown. Nelchina River, same locality as 25953. Lower part of member 3 of Matanuska formation. Campanian. *Inoceramus schmidti* zone.

Geological Survey Mesozoic loc.	Field No.	Collector, year of collection, description of locality, stratigraphic assignment, and age
		Chignik Bay Area
3116	959	R. W. Stone, 1904. Chignik Bay, Whalers Creek, about 5 miles west of Alaska Packers Assoc. Cannery. From beds underlying coal which is about one-quarter mile distant. Chignik formation. Campanian. *Inoceramus schmidt* zone.
5796	52	W. W. Atwood and H. M. Eakin, 1908. North side of Chignik Bay, 1 mile north by east from the head of the sandspit at the entrance of Chignik lagoon. Chignik formation. Campanian. *Inoceramus schmidti* zone.
5799	58	H. M. Eakin, 1908. Chignik Lagoon about opposite Alaska Packer's Association Cannery. Chignik formation. Campanian. *Inoceramus schmidti* zone.
11361	35	W. R. Smith. Head of creek that flows into Hook Bay. Chignik formation. Campanian. *Inoceramus schmidti* zone.
11362	36	W. R. Smith, 1922. Chignik Bay, 1 mile north by east from head of sandspit. Same as loc. 5796. Chignik formation. Campanian. *Inoceramus schmidti* zone.
13466	72, 77, 164	R. S. Knappen, 1925. Exact locality uncertain, probably 2¼ miles northeast of Native Village, head of Chignik Bay, on beach. Chignik formation. Campanian. *Inoceramus schmidti* zone.
13468	74	R. S. Knappen, 1925. Northwest side of Chignik Bay, one-quarter mile northeast of coal outcrop, 100 feet above coal. Niggerhead bears S. 40° E. Chignik formation. Campanian. *Inoceramus schmidti* zone.
13470	76	R. S. Knappen, 1925. Northwest shore of Chignik Bay, 2 miles northeast of Native Village, 100 feet below coal. Chignik formation. Campanian. *Inoceramus schmidti* zone.

TABLE 2.—*Campanian-Maestrichtian ammonites and selected* Inoceramus-*bearing localities in Upper Cretaceous rocks of southern Alaska*—Continued

Geological Survey Mesozoic loc.	Field No.	Collector, year of collection, description of locality, stratigraphic assignment, and age
		Chignik Bay area—Continued
13472	90	R. S. Knappen, 1925. Northwest side of Chignik Bay, 300 feet southwest of coal outcrop; Niggerhead bears S. 40° E. Chignik formation. Campanian. *Inoceramus schmidti* zone.
13473	97, 112	R. S. Knappen, 1925. Northwest side of Chignik Bay, 2.6 miles northeast of Native Village, 100 feet above coal; Niggerhead bears S. 40° E. Chignik formation. Campanian. *Inoceramus schmidti* zone.
13474	98	R. S. Knappen, 1925. Northwest side of Chignik Lagoon, 3,660 feet southwest of Native Village. Chignik formation. Campanian. *Inoceramus schmidti* zone.
13480	190	R. S. Knappen, 1925. Chignik Bay, 3 miles north of Native Village, on seacliff one-quarter mile northeast of coal outcrop, 75 feet above coal; Niggerhead bears S. 40° E. Chignik formation. Campanian. *Inoceramus schmidti* zone.
13481	191	R. S. Knappen, 1925. Northwest side of Chignik Lagoon, 4 miles southwest of Native Village, northwest of Alaska Packers Association Cannery. Chignik formation. Campanian. *Inoceramus schmidti* zone.
13482	192	R. S. Knappen, 1925. Northwest side of Chignik Bay, 3 miles north of Native Village, on seacliff one-half mile east of coal outcrop, about 100 feet above coal; Niggerhead bears approximately S. 38° E. Chignik formation. Campanian. *Inoceramus schmidti* zone.
13483	193	R. S. Knappen, 1925. Northwest side of Chignik Lagoon, 4,250 feet southwest of Native Village. Chignik formation. Campanian. *Inoceramus schmidti* zone.
13484	300	R. S. Knappen, 1925. Northwest side of Chignik Bay, 2.5 miles northeast of Native Village, at base of Chignik formation. Campanian. *Inoceramus schmidti* zone.
25699	55-AKe-10	A. S. Keller and J. T. Cass, 1955. Float from cutbanks on Whalers Creek about 2½ miles above its mouth. Chignik formation. Campanian. *Inoceramus schmidti* zone.
25701	55-AKe-11	A. S. Keller and J. T. Cass, 1955. North side of Chignik Lagoon between the Chignik Fisheries building and the sandspit at the mouth of lagoon. From 150 feet of gray to green sandstone at base of Chignik formation. Campanian. *Inoceramus schmidti* zone.
25702	55-AKe-15	A. S. Keller and J. T. Cass, 1955. North side of Chignik Lagoon, just southwest of Parallel Creek. From 100 feet of massive greenish-gray shaly sandstone. Chignik formation. Campanian. *Inoceramus schmidti* zone.
25703	55-AKe-20	A. S. Keller and J. T. Cass, 1955. Beach on north side of Chignik Lagoon. From green sandstone about 150 feet above base of Chignik formation. Campanian. *Inoceramus schmidti* zone.
25704	55-AKe-21	A. S. Keller and J. T. Cass, 1955. Beach on north side of Chignik Lagoon. From 100 feet of massive sandstone and thin-bedded siltstone about 1,180 feet above base of Chignik formation. Campanian. *Inoceramus schmidti* zone.
25705	55-AKe-22	A. S. Keller and J. T. Cass, 1955. Beach on north side of Chignik Lagoon. From 100 feet of grayish-green sandstone about 1,080 feet above base of Chignik formation. Campanian. *Inoceramus schmidti* zone.
25706	55-AKe-23	A. S. Keller and J. T. Cass, 1955, North side of Chignik Lagoon. From 130 feet of massive sandstone and siltstone about 850 feet above base of Chignik formation. Campanian. *Inoceramus schmidti* zone.
25707	55-AKe-24	A. S. Keller and J. T. Cass, 1955. North side of Chignik Lagoon. From 100 feet of massive to thin-bedded sandstone and siltstone about 750 feet above base of Chignik formation. Campanian. *Inoceramus schmidti* zone.
M764	MCL782-F	M. C. Lachenbruch, 1959. Chignik Bay, on beach between Thompson Valley and McKinsey Valley. Lat 56°27.8′ N., long 158°24.3′ W. Chignik formation. Campanian. *Inoceramus schmidti* zone.
------------	SOC M131	Collector and date unknown. Northwest side of Chignik Lagoon, at mouth of Parallel Creek. Chignik formation. Campanian. *Inoceramus schmidti* zone.
------------	SOC 135A	Collector and date unknown. Northwest side of Chignik Lagoon, approximately 1¼ miles northeast of mouth of Parallel Creek. Chignik formation. Campanian. *Inoceramus schmidti* zone.
------------	SOC M176	Collector and date unknown. Northwest side of Chignik Bay, at mouth of Through Creek. Chignik formation. Campanian. *Inoceramus schmidti* zone.
------------	SOC M138	Collector and date unknown. Northwest side of Chignik Lagoon, 1.9 miles northeast of mouth of Parallel Creek. Chignik formation. Campanian. *Inoceramus schmidti* zone.
------------	SOC M139	Collector and date unknown. Northwest side of Chignik Lagoon, 2.9 miles northeast of mouth of Parallel Creek. Chignik formation. Campanian. *Inoceramus schmidti* zone.
------------	SOC M342	Collector and date unknown. Northwest side of Chignik Lagoon, approximately same locality as SOC M139. Chignik formation. Campanian. *Inoceramus schmidti* zone.
------------	SOC M395	Collector and date unknown. Northwest side of Chignik Lagoon, approximately same locality as SOC M139. Chignik formation. Campanian. *Inoceramus schmidti* zone.
		Herendeen Bay area
3485	a	Sidney Paige, 1905. Herendeen Bay, left fork of Mine Creek, just above coal. Chignik formation. Campanian. *Inoceramus schmidti* zone.
3490	b	Sidney Paige, 1905. Herendeen Bay, about 200 yards above fork of Mine Creek. Chignik formation. Campanian. *Inoceramus schmidti* zone.
5577	18	W. W. Atwood, 1908. About 4 miles south of Herendeen Bay in canyon north of Pyramid Mountain. Chignik formation. Campanian. *Inoceramus schmidti* zone.
5580	23	W. W. Atwood, 1908. Herendeen Bay, canyon on east face of Pinnacle Peak, near summit. Chignik formation. Campanian. *Inoceramus schmidti* zone.
5588	38	W. W. Atwood, 1908. Herendeen Bay, west side of Buck Valley, about 1½ miles from shore of of Herendeen Bay. Chignik formation. Campanian. *Inoceramus schmidti* zone.
M765	MCL706-F	M. C. Lachenbruch, 1959. Port Moller 1:250,000 quad. Near top of 1,400-foot hill north of Hoodoo Lake. Lat 55°44.3′ N., long 161°8.8′ W. Chignik formation. Campanian. *Inoceramus schmidti* zone.
M766	MCL657-F	M. C. Lachenbruch, 1959. Port Moller 1:250,000 quad., north side of Hoodoo Lake at altitude of 1,400 feet. Lat 55°41.6′ N., long 161°0.5′ W. Chignik formation. Campanian. *Inoceramus schmidti* zone.
M767	MCL656-F	M. C. Lachenbruch, 1959. Port Moller 1:250,000 quad., east of Hoodoo Lake at altitude of 1,800 feet. Lat 55°41′ N., long 160°56.4′ W. Chignik formation. Campanian. *Inoceramus schmidti* zone.
M768	MCL604-F	M. C. Lachenbruch, 1959. Port Moller 1:250,000 quad., west side of Buck Valley. Lat 55°42.3′ N., long 160°51.5′ W. Chignik formation. Campanian. *Inoceramus schmidti* zone.
M772	CS-7-F	M. C. Lachenbruch, 1959. Port Moller 1:250,000 quad., west of upper Beaver River at altitude of 800 feet. Lat 55°36.5′ N., long 160°56.2′ W. Unnamed formation or upper part of Chignik formation. Late Campanian or possibly early Maestrichtian(?).
		Cape Douglas area
3121	------------------	G. C. Martin, 1904. Afognak 1:250,000 quad., 1 mile below head of Kaguyak Bay, on north shore. Kaguyak formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.
24958	J.E.H. 27-A, 27-B.	J. E. Heppert, 1953. Afognak 1:250,000 quad. From seacliff and reef at Cape Kaguyak. Kaguyak formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.
24959	MEM 3	C. E. Kirschner and J. E. Heppert, 1953. Afognak 1:250,000 quad. Lat 58°57.4′ N., long 153°56.8′ W. In sandstone about 400 feet below top of section measured in Kamishak Hills between Douglas River and Kamishak River. Kaguyak formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.
24960	MEM 1	C. E. Kirschner and J. E. Heppert, 1953. Mount Katmai 1:250,000 quad. Lat 58°55.2′ N., long 154°2.0′ W. On small stream draining into the Kamishak River. At about same stratigraphic position as loc. 24959. Kaguyak formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.

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TABLE 2.—*Campanian-Maestrichtian ammonites and selected* Inoceramus-*bearing localities in Upper Cretaceous rocks of southern Alaska*—Continued

Geological Survey Mesozoic loc.	Field No.	Collector, year of collection, description of locality, stratigraphic assignment, and age
		Cape Douglas area—Continued
25281	54-AKe-41	A. S. Keller, 1954. Afognak 1:250,000 quad. In cut banks along coast north of Kaguyak. Lat 58°37′ N., long 153°55′ W. Siltstone and limestone lense between 900 and 1,000 feet above base of Kaguyak formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.
25282	54-AKe-42	A. S. Keller, 1954. Afognak 1:250,000 quad. Cut banks along coast north of Kaguyak, same locality as 25281, 1,300 to 1,500 feet above base of Kaguyak formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.
25855	CEK 742	C. E. Kirschner, 1955. Mount Katmai 1:250,000 quad. Lat 58°51.6′ N., long 154°3.6′ W. Kamishak Hills, between South Fork Kamishak River and Douglas River. Kaguyak formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.
25856	CEK 744	C. E. Kirschner, 1955. Mount Katmai 1:250,000 quad. Kamishak Hills, same locality as 25855.
25857	CEK 745	C. E. Kirschner, 1955. Mount Katmai 1:250,000 quad. Lat 58°47.7′ N., long 154°4.2′ W. South Fork Kamishak River. Kaguyak formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.
25858	CEK 749	C. E. Kirschner, 1955. Afognak 1:250,000 quad. Unnamed north fork of east branch of Douglas River. Lat 58°52.7′ N., long 153°46.5′ W. Kaguyak formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.
25859	CEK 751	C. E. Kirschner, 1955. Afognak 1:250,000 quad. Lat 58°52.8′ N., long 151.3°45.0′ W. Unnamed north fork of east branch of Douglas River. Kaguyak formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.
25860	CEK 788	C. E. Kirschner, 1955. Afognak 1:250,000 quad. Lat 58°56.4′ N., long 153°53.1′ W. West fork of Douglas River. Kaguyak formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.
25861	CEK 829	C. E. Kirschner, 1955. Afognak 1:250,000 quad. Cape Kaguyak, south shore of Kaguyak Bay. Kaguyak formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.
25862	RPO 147	R. P. Ottenstein, 1955. Afognak 1:250,000 quad. Lat 58°49.6′ N., long 153°54.6′ W. On north-east flank of hill west of Douglas River. Kaguyak formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.
	JCH-1753	J. C. Hazzard, date unknown. Afognak 1:250,000 quad. Kaguyak Bay. Exact locality unknown. Kaguyak formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.
	JCH-1754	J. C. Hazzard, date unknown. Afognak 1:250,000 quad. Kaguyak Bay. Exact locality unknown. Kaguyak formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.
	MEM-2	C. E. Kirschner and J. E. Heppert, 1953. Mount Katmai 1:250,000 quad. Lat 58°55.2′ N., long 154°6.3′ W. Between Kamishak and Douglas Rivers. Kaguyak formation. Late Campanian or Maestrichtian. *Pachydiscus kamishakensis* zone.

SYSTEMATIC DESCRIPTIONS

Class CEPHALOPODA
Order AMMONOIDEA
Suborder PHYLLOCERATINA
Superfamily PHYLLOCERATACEAE
Family PHYLLOCERATIDAE
Subfamily PHYLLOCERATINAE

Genus NEOPHYLLOCERAS Shimizu

Neophylloceras, Shimizu, 1934, *in* Iwanami Lect. Ser. Geology and Paleontology, p. 61.

Type species (original designation): *Ammonites* (*Scaphites*?) *ramosus* Meek, 1858.

The genus *Neophylloceras* comprises several species characterized by compressed phylloceratid whorl section; small umbilicus; fine, threadlike radial or sigmoidal ribs; and, in particular, by a complex suture line that lacks phylloid saddle terminals (Wright and Matsumoto, 1954, p. 109; Matsumoto, 1959c, p. 56, 57). Wright (1957, p. 189) regarded *Neophylloceras* as a junior synonym of *Hypophylloceras* Salfed, but Packard (1960) has illustrated the suture line of *Phylloceras onoense* Stanton, the type species of *Hypophylloceras*, and there seems to be little question that the phylloid suture of this species is sufficiently distinct from that of *N. ramosum* to warrant generic separation of the two species.

Neophylloceras ramosum (Meek)

Plate 6, figures 1–8; text figure 7

1858. *Ammonites* (*Scaphites*?) *ramosus* Meek, Albany Inst. Trans., v. 4, p. 45.

1942. *Neophylloceras ramosum* (Meek). Matsumoto. Imp. Acad. Japan Proc., v. 18, no. 133, p. 674, text fig. $1a_2$, b_2.

1952. *Neophylloceras ramosum* (Meek). Usher, Canada Geol. Survey Bull. 21, p. 49, pl. 1, figs. 4, 5.

1959. *Neophylloceras ramosum* (Meek). Matsumoto, Kyūshū Univ., Mem. Fac. Sci., ser. D, spec. v. 1, pt. 2, p. 1, pl. 1, figs. 1a–d; pl. 2; pl. 8, figs. 1a–c. (See Matsumoto's paper for complete synonymy.)

Neophylloceras ramosum has been discussed, and the holotype and other specimens have been figured by Matsumoto (1959b, p. 1, pl. 1, fig. 1; pl. 2, fig. 2). Diagnostic features of this species are compressed whorl section with flat nearly parallel flanks; very fine, sinuous subcostae; and a relatively wide umbilicus (as compared with other species of *Neophylloceras*). Near the umbilical margin, indistinct broad swellings and shallow furrows are present, but disappear on the lower one-third of the flank. These swellings are not as prominent or as regularly developed as on *N. hetonaiense* Matsumoto. The suture line is very complex, with deeply incised saddles that lack phylloid terminals (fig. 7).

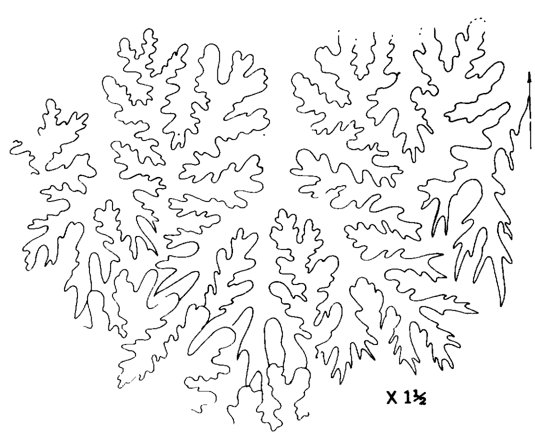


FIGURE 7.—Suture line of *Neophylloceras ramosum* (Meek), plesiotype USNM 131221 from USGS. Mesozoic loc. 24227. × 1½.

The first lateral lobe is deeper than the ventral lobe, and the suspensive lobe is composed of numerous small lobes and bifid saddles that form an adorally concave arc.

Alaskan specimens appear to be slightly more compressed than those from California measured by Matsumoto (1959b, p. 2). This difference is due, in part, to secondary crushing of some of the Alaskan specimens and probably is not of taxonomic significance.

Neophylloceras ramosum has a wide geographic distribution and a long geologic range. It occurs on Vancouver Island, the type area, in beds of late Campanian or early Maestrichtian age, and in California in beds of late Turonian to late Campanian age (Matsumoto, 1959b, p. 1–4). Specimens from Japan previously regarded as a distinct species, *N. compressum*, are now considered by Matsumoto (1959b, p. 2) to be identical with *N. ramosum.*

Measurements (mm)

Specimen	Diameter	Height	Breadth	Ratio of breadth to height	Width of umbilicus	Umbilicus, percent of diameter
USNM 131172	52	31	17	0.55	4.5	8.6
Do	64	40	19	.47	5.0	7.8
Do	----	101	46+	.45	----	----
USNM 131173	25	15	7	.46	2.7	10.6
USNM 131221	49	29	15	.52	4.0	8.2
USNM 12451	47.1	----	----	----	----	----
Do	39.2	22.3	11.7	.52	3.2	8
GSC 5811	47.0	27.2	14.1	.52	2.8	6

Holotype: USNM 12451

Type locality: "Komooks," Vancouver Island. According to Usher (1952, p. 50), the type locality may be Hornby Island, B.C.

Figured specimens: USNM 131172, 131173, 131221.

Number of specimens: 15, plus many fragments.

Collecting localities: Matanuska Valley–Nelchina area: USGS Mesozoic locs. 24227, 24868, 25324, 25331, M552, M558, M560, M562, M576(?). Cape Douglas area: USGS Mesozoic loc. 24958.

Stratigraphic position: Upper part of member 3 of Matanuska formation. Kaguyak formation. *Pachydiscus kamishakensis* zone.

Neophylloceras hetonaiense Matsumoto

Plate 6, figures 9, 10; plate 7, figures 1–5; text figure 12

1942. *Neophylloceras hetonaiense* Matsumoto, Imp. Acad. Japan Proc., v. 18, p. 675; text figs. $1a_3$, b_3.

?1952. *Neophylloceras lambertense* Usher, Canada Geol. Survey Bull. 21, p. 50, pl. 1, figs. 1–3.

1953. *Neophylloceras hetonaiense* Matsumoto. Spath, Falkland Islands Dependencies Survey Sci. Rept. 3, p. 5, fig. 1, fig. 2.

1959. *Neophylloceras hetonaiense* Matsumoto. Matsumoto, Kyūshū Univ., Mem. Fac. Sci., ser. D, spec. v. 1, pt. 2, p. 5, pl. 3, figs. 1a–d.

Neophylloceras hetonaiense is characterized by a compressed whorl section; slightly inflated and rounded flanks; small pitlike umbilicus; fine, only slightly sinuous subcostae; and prominent regular pinched bullae or tubercles on the lower one-third of the flanks. These tubercles are generally much more pronounced than those on *N. ramosum*, although in some specimens they are only poorly developed or nearly lacking. The subcostae of *N. hetonaiense* differ from those of *N. ramosum* by having a much less flexed, or sinuous, course on the flanks and by being less strongly projected forward on crossing the venter. At comparable diameters, the subcostae of *N. hetonaiense* are slightly coarser, particularly on the ventral region, than those of *N. ramosum.*

The suture line of *Neophylloceras hetonaiense* is nearly identical with that of *N. ramosum*, although some of its elements appear to be slightly less massive and more delicately frilled (fig. 8).

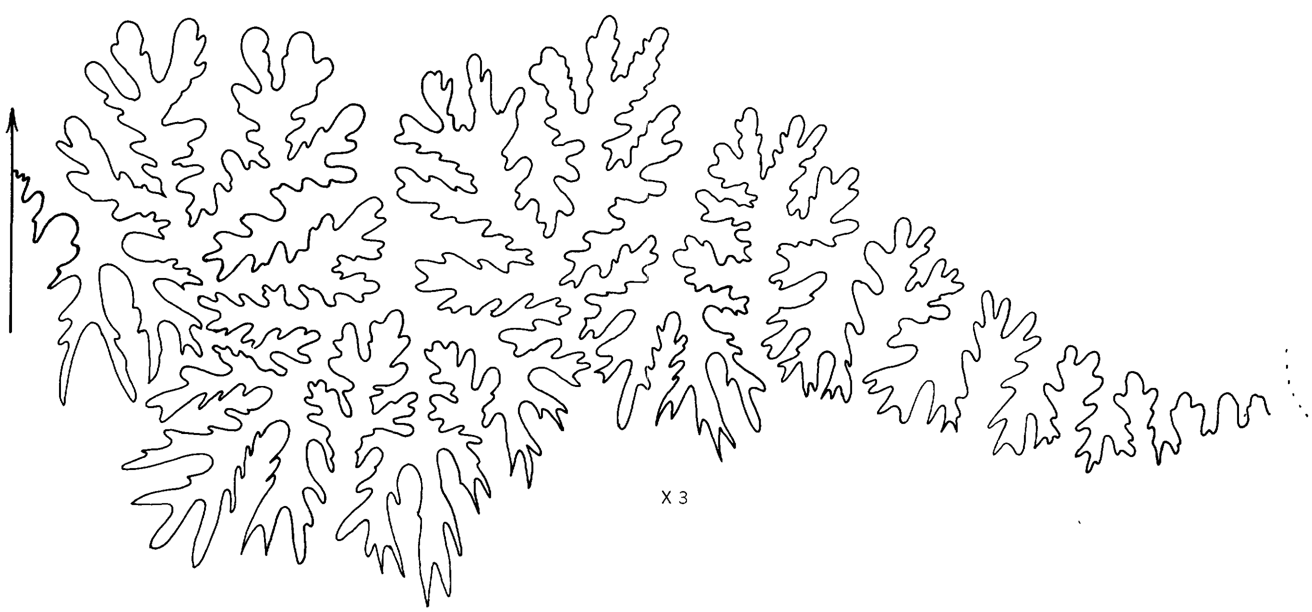


FIGURE 8.—Suture line of *Neophylloceras hetonaiense* Matsumoto, plesiotype USNM 131226 from USGS Mesozoic loc. M560. × 3.

Neophylloceras lambertense Usher is very close to *N. hetonaiense*, as was pointed out by Matsumoto (1959b, p. 5). According to Matsumoto, the differences are "the much less flexuous subcostae and more inflated flanks of *N. lambertense* than *N. hetonaiense*". Also, well-defined umbilical ribs or tubercles have not been reported on *N. lambertense*, although Usher (1952, p. 51) mentions the presence of faint shallow radial depressions that begin at the umbilical border and disappear before reaching midflank. As only one specimen of *N. lambertense* has yet been figured, it is difficult to access the above stated differences. However, among the Alaskan specimens there is considerable variation in regard to inflation of the flanks and sinuosity of subcostae, so fine splitting into separate taxa on the basis of slight morphologic differences does not seem to be warranted. For this reason, *N. lambertense* is herein regarded as a probable synonym of *N. hetonaiense*.

This species has very wide geographic distribution, occurring in Japan, California (Matsumoto, 1959b, p. 5) Graham Land, Antarctica (Spath, 1953, p. 5), probably in British Columbia, and in Alaska. Its geologic range is fairly short, particularly for a phylloceratid species, being from Campanian to Maestrichtian (Matsumoto, 1959b, p. 6).

Measurements (mm)

Specimen	Diameter	Height	Breadth	Ratio of breadth to height	Width of umbilicus	Umbilicus, percent of diameter
1	19.5	11.6	7.6	0.65	1.2	6.2
USNM 131174	26.3	15	9	.60	2.1	8
3	43	24.5	13	.53	2.7	6.3
USNM 131175	------	20	11	.55	------	------
Do	105±	60	29+	.48.5+	6	5.7
USNM 131176	60	34.7	15.5	.44.5	4	[1] 6.7
7	------	23	11	.48	------	------
8	------	21	10.8	.52	------	------
H3801a [2]	31.0	17.5	10	.57	2	6
[3]	33	20.5	11.6	.56	3.7	6
GSC 5811a [4]	74	44	22	.50	3.7	5

[1] Crushed.
[2] Lectotype. Matsumoto, 1959b, p. 5.
[3] Spath, 1953, p. 5.
[4] *Neophylloceras lambertense*. Calculated from percentages given by Usher, 1952, p. 51.

Lectotype (designated by Matsumoto, 1959b, p. 5). GK. H3801a.

Type locality: Hetonai area, Hokkaido, loc. H12b.

Figured specimens: USNM 131174, 131175, 131176, 131226.

Number of specimens: 15, plus fragments.

Collecting localities: Matanuska Valley–Nelchina area: USGS Mesozoic loc. 6696, 8559, 8562, 16398, 24860, 24861, 24872, 25321(?), M551, M558, M560, M582. Cape Douglas area: USGS Mesozoic loc. 25861.

Stratigraphic position: Upper part of member 3 of Matanuska formation. Kaguyak formation. *Pachydiscus kamishakensis* zone.

Genus PHYLLOPACHYCERAS Spath

Phyllopachyceras Spath, 1925, Mus. Hist. Nat. Marseille Ann., v. 20, p. 101.

Type species (original designation): *Ammonites infundibulum* d'Orbigny, 1841.

The genus *Phyllopachyceras* includes phylloceratid species characterized by an inflated whorl section; small pitlike umbilicus; tetraphylloid terminals on the first and second lateral saddles; and the presence of strong, rounded ribs, at least on outer whorls. Some Upper Cretaceous forms tend to be only weakly ornamented.

According to Wright (1957, p. 187), the range of the genus is Barremian to Maestrichtian.

Phyllopachyceras forbesianum (d'Orbigny)

Plate 41, figures 2, 4–6; text figure 9

1845. *Ammonites rouyanus* Forbes (not d'Orbigny), Geol. Soc. London Trans., v. 7, p. 108, pl. 8, fig. 6.
1850. *Ammonites forbesianum* d'Orbigny, Prodr. de Paleont., v. 2, p. 213.
1938. *Phyllopachyceras forbesianum* (d'Orbigny). Roman, Ammon. Jur. et Cret., p. 17, 26.
1952. *Phyllopachyceras forbesianum* (d'Orbigny). Usher, Canada Geol. Survey Bull. 21, p. 52, pl. 2, figs. 1–5; pl. 31, figs. 11, 12. (See Usher's report for complete synonymy.)
1953. *Phyllopachyceras forbesianum* (d'Orbigny). Spath, Falkland Islands Dependencies Survey Sci. Rept. 3, p. 6, pl. 1, figs. 3–5.

Only two specimens of *Phyllopachyceras forbesianum* are in the Geological Survey's collection from the Matanuska formation; both came from USGS Mesozoic locality 16398. These specimens show the characteristic inflated, rounded, deeply involute whorl section, small pitlike umbilicus, as well as tetraphylloid terminals on the first and second lateral saddles (fig. 9).

FIGURE 9.—Suture line of *Phyllopachyceras forbesianum* (d'Orbigny), plesiotype USNM 131219 from USGS Mesozoic loc. 16398. × 1½.

Ornamentation consists of very faint crowded radial striae, preserved only on the ventral area, and nearly imperceptible broad radial ribs on the flanks of the last whorl. These ribs are not as well developed on the Alaskan specimen as they are on a specimen from Vancouver Island, figured by Usher (1952, pl. 2, figs. 1, 2). Usher's figure does not adequately show these radial ribs, but they are readily apparent on a plaster cast.

Spath (1953, p. 6, 7) suggested that *Phyllopachyceras forbesianum* and *P. ezoense* (Yokoyama, 1890, p. 178, pl. 19, figs. 2a–c) are conspecific and that their supposed differences in whorl shape are not important. This observation may be valid in regard to Yokoyama's original specimen, but the specimen figured by Yabe and Shimizu (1921, pl. 8, fig. 2) has much coarser ribs and may belong to a different species.

Phyllopachyceras forbesianum is widely distributed throughout the Indopacific region from Alaska to Graham Land (Spath, 1953, p. 6), and from India (Forbes, 1846–56, p. 108) to Vancouver Island (Usher, 1952, p. 52). It is apparently restricted to the Campanian or lowermost Maestrichtian.

Measurements (mm)

Specimen	Diameter	Height	Breadth	Ratio of breadth to height	Width of umbilicus	Umbilicus, percent of diameter
USNM 131219	10	6	5	0.83	----------	----------
Do	76	43	38	.88	2	2.6
GSC 10014 [1]	17	10.2	8.5	.83	0.5	3
5812	53	32	26.5	.84	1.6	3
10013	73	42.5	36.5	.86	2.9	4

[1] Recalculated from percentages given by Usher, 1952, p. 53.

Type locality: Pondicherry, southern India.

Figured specimen: USNM 131219, from USGS Mesozoic loc. 16398.

Stratigraphic position: Upper part of member 3 of Matanuska formation. *Pachydiscus kamishakensis* zone.

Suborder LYTOCERATINA
Superfamily LYTOCERATINACEAE
Family TETRAGONITIDAE
Subfamily TETRAGONITINAE

Genus PSEUDOPHYLLITES Kossmat

Pseudophyllites Kossmat, 1895, Beitr. Paläontologie. u. Geol. Österr.-Ungarns u. des Orients, v. 9, p. 137.

Type species (original designation): *Ammonites indra* Forbes, 1846.

The characteristic features of *Pseudophyllites* are smooth rounded whorls which rapidly increase in height; relatively small umbilicus with steeply sloping umbilical wall; lack of constrictions at all growth stages; and very complex, finely divided suture. Ornamentation of adult shells consists of broadly curved radial growth lines and faint longitudinal striae.

Pseudophyllites indra (Forbes)

Plate 7, figures 6, 7; plate 8; plate 29, figures 7–12; text figure 10

1846. *Ammonites indra* Forbes, Geol. Soc. London Trans., ser. 2, v. 7, p. 105, pl. 11, figs. 7a–c.
1865. *Ammonites indra* Forbes. Stoliczka, India Geol. Survey Mem., Palaeontologia Indica, ser. 3, v. 1, p. 102, pl. 58, figs 2, 2a, 2b.
1879. *Ammonites indra* Forbes. Whiteaves, Mesozoic fossils, v. 1, pt. 2, p. 105, pl. 13, figs. 2, 2a.
1895. *Pseudophyllites indra* (Forbes). Kossmat, Beitr. Paläontologie u. Geol. Österr.-Ungarns u. des Orients, v. 9, p. 137, pl. 16, figs. 6–9; pl. 17, fig. 6; pl. 18, fig. 3.
1906. *Lytoceras indra* (Forbes). Boule, Lemoine and Thevenin, Annales paléontologie, v. 1, pl. 1, figs. 1, 1a, 1b.
1906. *Pseudophyllites* cf. *indra* (Forbes). Woods, South African Mus. Ann., v. 4, p. 334, pl. 41, figs. 6a, b.
1909. *Pseudophyllites indra* (Forbes). Kilian and Reboul, Wiss. Erg. Schwed Südpolar Exp., 1901–1903, v. 3, no. 6, p. 14, text fig. 3.
1935. *Parapachydiscus catarinae* Anderson and Hanna, California Acad. Sci. Proc., ser. 4, v. 23, p. 19 [in part], pl. 3, figs. 2, 3.
1938. *Pseudophyllites indra* (Forbes). Collignon, Madagascar Serv. Mines Ann. Geol., fasc. 9, p. 73 [in part].
1952. *Pseudophyllites indra* (Forbes). Usher, Canada Geol. Survey Bull. 21, p. 57, pl. 3, figs. 2–13; pl. 31, figs. 15–17.
1959. *Pseudophyllites* cf. *indra* (Forbes). Matsumoto, Kyūshū Univ., Mem. Fac. Sci., ser. D, spec. v. 1, p. 154.

Pseudophyllites indra is represented by eight specimens from the Matanuska formation and one from the Kaguyak formation on the Alaskan Peninsula. This well-known species is characterized by rapid increase of whorl height in relation to whorl breadth (fig. 11) and by a small umbilicus with abruptly rounded umbilical shoulder and a steeply sloping umbilical wall. Ornamentation consists of faint radial ridges that bend broadly backward on crossing the venter and indistinct spiral striations. A reticulate pattern is formed by the intersection of these two sets of striae. The internal mold is smooth.

The suture consists of numerous deeply incised elements; the ventral saddle is slender and lanceolate; the first lateral saddle is irregularly trifid; and the first lateral lobe is slightly deeper than the ventral lobe. Saddle terminations, at least on early whorls, may be slightly phylloid (Kossmat, 1895, p. 138), but this feature was not observed on any of the specimens at hand (fig. 10).

The Alaskan specimens are indistinguishable from those from Vancouver Island described by Whiteaves (1879) and Usher (1952) and also from Indian specimens figured by Forbes, Stoliczka, and Kossmat. Specimen number 3 from Anclimaka, Madagascar, illustrated by Collignon (1938, p. 73, text fig. E), however, differs from the above specimens by having a broader and lower whorl section and may be a new species. Collignon's specimens 1 and 2 are undoubtedly *Pseudophyllites indra* (fig. 11). *Pseudophyllites peregrinus* Spath (1953, p. 7, pl. 1, figs. 6–9), from Graham Land, differs from *P. indra* by having a slightly broader venter; a vertical umbilical wall; and a broad, rather than lanceolate, ventral saddle.

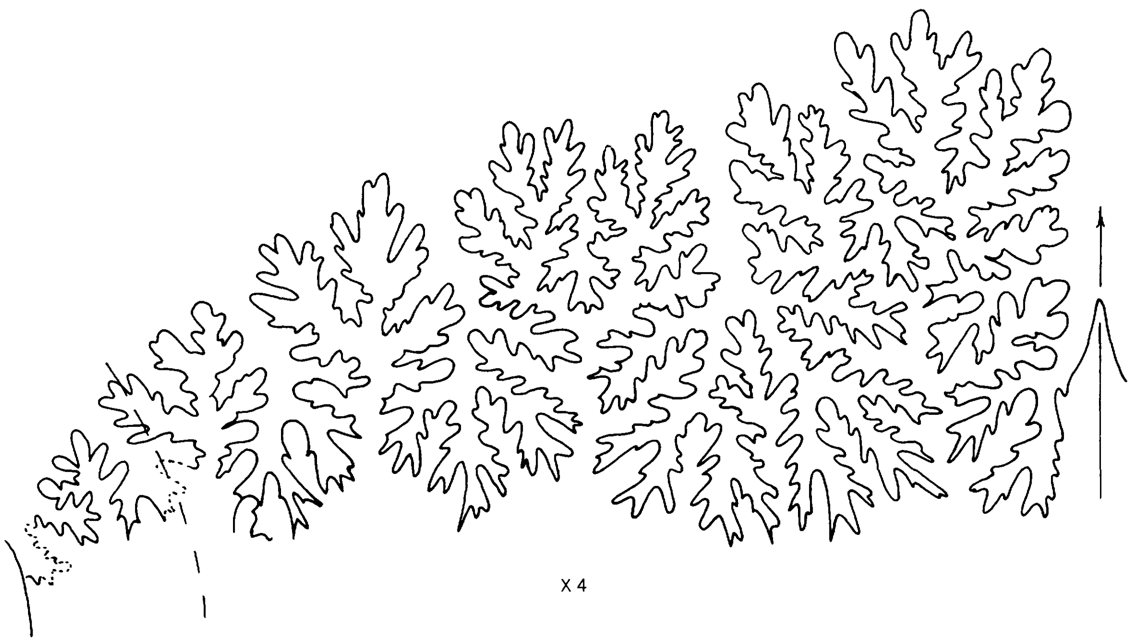


FIGURE 10.—Suture line of *Pseudophyllites indra* (Forbes), plesiotype USNM 131177 from USGS Mesozoic loc. M562. × 4.

Measurements (mm)

Specimen	Diameter	Height	Breadth	Ratio of breadth to height	Width of umbilicus	Umbilicus, percent of diameter
USNM						
131177	42	20	19	0.95	11	26
Do	60	30	27.5	.92	13	22
Do	73	39	33	.85	16	22
Do	135	70	58	.83	26	19
Do	198	111	92	.83	31	15.6
131207	---	13	14	1.04	---	---
131206	30	12.6	12.6	1.00	10	33
Do	41	17	15.5	.91	12	29
4	22	10	10	1.0	6	36.5
Do	30	14	13.7	.98	7.7	39
5	16	8	8	1.0	4.6	25
Do	20	9	9	1.0	5	25
6	56	26	23	.89	15	27
Do	110	53	44	.83	---	---
Usher (1952)						
GSC 10018	5.8	2.6	3.0	1.15	1.97	34
10019	8	3.7	4	1.08	2.4	30
10020	14	6.4	7	1.08	4.5	32
10021	24	12	12	1.0	6	25
10022	86	44.7	40.9	.89	17	20
10023	95	50.3	40	.79	20	21
Forbes' type specimen						
	64	35	32	0.91	12.8	20
Collignon (1938)						
1	108	59	50	0.85	35	32
2	110	59	53	.89	35	32
3	150	80	79	.99	46	31

Type locality: Pondicherry, southern India.

Figured specimens: USNM 131177, 131206, 131207.

Number of specimens: 12.

Collecting localities: Matanuska Valley-Nelchina area. USGS Mesozoic loc. 8562, 16398, 25325, 25959, M558, M562. Cape Douglas area. USGS Mesozoic loc. 24958.

Stratigraphic position: Most common in upper part of member 3 of Matanuska formation and Kaguyak formation. Zone of *Pachydiscus kamishakensis*. One specimen from lower part of member 3 of Matanuska formation. *Inoceramus schmidti* zone.

Subfamily GAUDRYCERATINAE

Genus GAUDRYCERAS Grossouvre

Gaudryceras Grossouvre, 1894, Mém. Carte géol. dét. France, p. 225.

Type species (subsequent designation, Boule, Lemoine, and Thevenin, 1906, p. 183): *Ammonites mitis* Hauer, 1866.

The genus *Gaudryceras* comprises many species characterized by rounded whorl section; fairly wide umbilicus; fine to coarse sinuous ribs; and the presence of constrictions, at least on early whorls. The suture line is complex with retracted auxiliary lobes.

Shimizu (1935) proposed several genera and subgenera of gaudryceratids, including *Neogaudryceras* and *Pseudogaudryceras* with type species designated, respectively, as *Gaudryceras tenuiliratum* Yabe and *G. tenuiliratum* var. *intermedia* Yabe. The differences between these two forms seem to be minor, if significant at all, and subgeneric separation does not seem to be warranted. Likewise, no compelling reason is apparent for separating either form from the type species of the genus, so both names are herein regarded as subjective synonyms of *Gaudryceras*.

Gaudryceras tenuiliratum Yabe

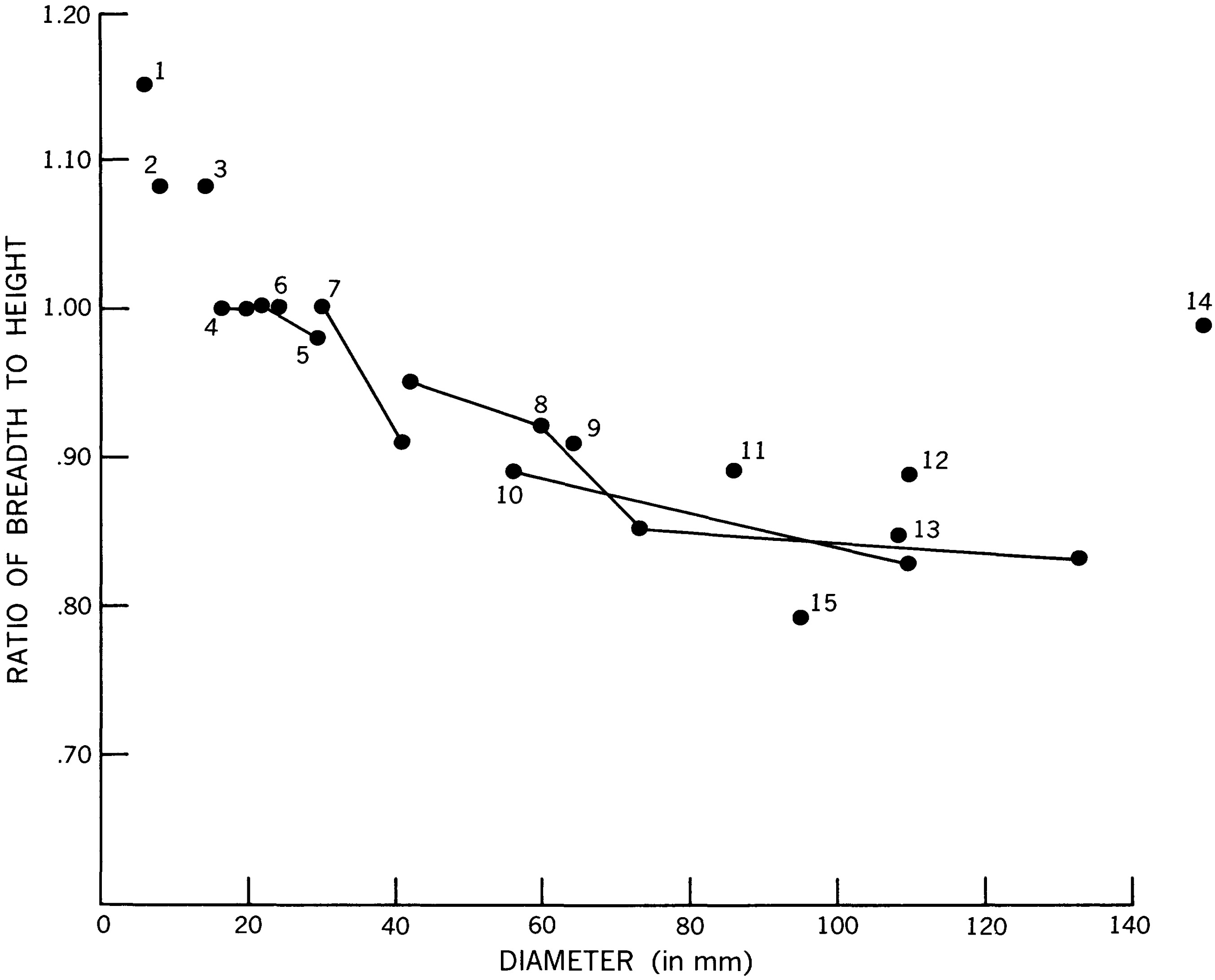
Plate 9; plate 10, figures 1–3; text figure 12

1890. *Lytoceras sacya* Yokoyama (not Forbes), Palaeontographica, v. 36, p. 178, pl. 18, figs. 12, 13.

1894. *Lytoceras sacya* Jimbo (not Forbes), Paleont. Abh., N. F., v. 2. no. p. 34, pl. 6, fig. 1.

1903. *Gaudryceras tenuiliratum* Yabe, Tokyo, Imp. Univ. Coll. Sci., Jour., v. 18, art. 3, p. 19, pl. 3, figs. 3, 4.

1942. *Gaudryceras tenuiliratum* Yabe. Matsumoto, Imp. Acad. Japan Proc., v. 18, p. 667, fig. 1.



1. GSC. 10018, Vancouver Island, B.C.
2. GSC. 10019, Vancouver Island, B.C.
3. GSC. 10020, Vancouver Island, B.C.
4. Matanuska formation, USGS Mesozoic loc. 25325.
5. Matanuska formation USGS Mezozoic loc, 8562.
6. GSC. 10021, Vancouver Island, B.C.
7. USNM plesiotype 131206 from USGS Mesozoic loc. M592.
8. USNM plesiotype 131177 from USGS Mesozoic loc. M562.
9. Forbes' type specimen.
10. Kaguyak formation, USGS Mesozoic loc. 24958
11. GSC. 10022, Vancouver Island, B.C.
12. Madagascar, Collignon's specimen 2.
13. Madagascar, Collignon's specimen 1.
14. Madagascar, Collignon's specimen 3.
15. GSC. 10023, Vancouver Island, B.C.

FIGURE 11.—Graph showing relation of diameter to ratio of breadth to height of whorl in *Pseudophyllites indra* (Forbes).

Shell discoidal, compressed; whorls rounded, breadth greater than height during early growth stages, less than height during later stages; flanks rounded, becoming progressively flatter with increased diameter; venter broadly rounded; umbilicus fairly wide with subvertical wall and evenly rounded shoulder. Suture line complex with retracted auxiliary lobes (fig. 12).

Ornamentation on early whorls consists of threadlike sigmoidal ribs and periodic constrictions which number about five per whorl. Each constriction is bordered on the posterior side by a prominent heavy rib. The threadlike ribs begin at the umbilical seam and run strongly forward on the umbilical wall. Just above the umbilical shoulder these ribs, at least on some part of the whorl, split into many fine lirae similar to those on *Vertebrites*. On the lower part of the flanks the ribs bend backward to form a broad adorally convex curve; at about midflank the curve reverses and the ribs cross the venter with slight anterior projection. Development of the *Vertebrites*-type striae on the flanks and ventral area is variable; on some specimens development is restricted to very early whorls, but on other specimens it persists to a diameter of 50 mm or more. On parts of the whorls where striae are not developed the ribs cross the venter with little or no diminution in strength.

Ornamentation of later whorls consists of sigmoidal periodic major ribs bordering indistinct constrictions as well as intervening somewhat weaker secondary ribs. Both types of ribs are strongly asymmetrical, with the anterior side forming a long slightly concave slope and the posterior side, an abruptly truncated steep slope.

A characteristic feature of the major ribs is their tendency to split on the flanks into two or three minor subcostae.

Small specimens of *Gaudryceras tenuiliratum* cannot be differentiated positively from small specimens of *G. denmanense* (Whiteaves, 1903 p. 329; Usher, 1952, p. 59, pl. 4, figs. 1, 2). Matsumoto (1959b, p. 145) thought that the two species could be distinguished on the basis of the lack of fine lirae of the *Vertebrites* type on the ventral area of *G. denmanense.* However, early whorls of the specimen figured by Matsumoto (1959b, pl. 37, fig. 2) as *G. denmanense* have lirae identical with those of *G. tenuiliratum,* as does *Lytoceras* (*Gaudryceras*) *alamedense* (Anderson, 1958, p. 182, pl. 41, fig. 5), a species that was questionably referred to as *G. denmanense* by Matsumoto. It would thus seem that the presence or absence of lirae may not be a positive criterion to distinguish small specimens of these two species.

Large specimens of *Gaudryceras tenuiliratum* and *G. denmanense* can be differentiated readily. The former species retains both primary and secondary ribs at all growth stages, and the primary ribs usually carry 2 to 3 subcostae. The latter species has only simple coarse ribs on the outer whorl, and these have a less sinuous course on the flanks than do those of *G. tenuiliratum.*

Measurements (mm)

Specimen	Diameter	Height	Breadth	Ratio of breadth to height	Width of umbilicus	Umbilicus, percent of diameter
USNM						
131179	91	36.5	31+	0.86	34	36
Do		18	18	1.0		
Do		22	21	.95		
131178	175	69	44+	.70+	50	[1] 31
Yabe's (1903) specimens						
1	300	160	165	1.03	55	18
2	230	130	120	.92	48	20
3	42		16		18	42
4	39.5	14.5	14.5	1.0	16	40
5	35	13	13.5	1.1	15	42

[1] Slightly compressed.

Lectotype (here designated): Lytoceras sacya Yokoyama, 1890, pl. 18, fig. 12.

Type locality: Ibui, Japan.

Figured specimens: USNM 131178, 131179.

Number of specimens: 30, plus fragments.

Collecting localities: Matanuska Valley-Nelchina area. USGS Mesozoic loc. 16398, 24209, 24226, 24239, 24861, 24868, 24870, 24875, 25327, 25959, M551, M558, M560, M577, M1032.

Stratigraphic position: Upper part of member 3 of Matanuska formation. *Pachydiscus kamishakensis* zone.

FIGURE 12.—Suture line of *Gaudryceras tenuiliratum* Yabe, plesiotype USNM 131179 from USGS Mesozoic loc. 24209. X 3.

Superfamily TURRILITACEAE
Family BACULITIDAE

Genus BACULITES Lamarck

Baculites Lamarck, 1799, Paris, Mém. Soc. Hist. Nat., p. 80.

Type species (subsequent designation by Meek, 1876, p. 391): *Baculites vertebralis* Defrance, 1830.

The genus *Baculites,* which is poorly represented in southern Alaska, has been adequately discussed by Wright (1957, p. 218) and Matsumoto (1959a, p. 111); little new material can be added here. Only two species of *Baculites* are represented in the Geological Survey's Alaskan collection, and these by relatively few specimens from the Matanuska formation. No specimens of *Baculites* are in the Survey's collection from the Alaska Peninsula.

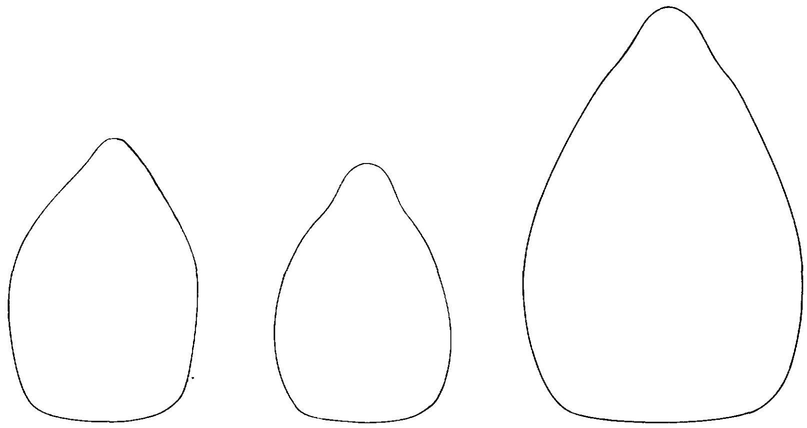
Baculites occidentalis Meek

Plate 11; text figure 13

1862. *Baculites occidentalis* Meek, Philadelphia Acad. Nat. Sci. Proc., v. 13, p. 316.

1959. *Baculites occidentalis* Meek. Matsumoto, Kyūshū Univ., Mem. Fac. Sci. Ser. D, v. 8, no. 4, p. 150, pl. 35, figs. 2a–d, 3a–d; pl. 36, figs. 1a–d; pl. 41, figs. 1a–d; pl. 42, figs. 1a–c; text figs. 64, 65a, 66, 67–71. (See Matsumoto's paper for complete synonymy.)

One large specimen and several small broken fragments of *Baculites occidentalis* are known from the Matanuska formation. The illustrated specimen (pl. 11) is a part of the body chamber of a very large individual, the measurements of which are as follows:



A B C

FIGURE 13.—Sections of *Baculites occidentalis* Meek. *A.*, *B.* Two of Meek's syntypes, USNM 1363, redrawn from Matsumoto, 1959a, p. 153, figs. 67, 68. *C.* Plesiotype USNM 131181 from USGS Mesozoic loc. M565. × 1.

	mm
Length	188
Height	60
Breadth	40
Ratio of breadth to height	.66

This is apparently the largest known specimen of this species.

Baculites occidentalis is characterized by a flattened dorsal (antisiphonal) surface and a narrow abruptly rounded ventral (siphonal) side. Two very shallow, almost indiscernible, longitudinal grooves are on the ventrolateral area, but these are not as prominent as indicated by Matsumoto (1959a, p. 152, 153) in his drawings of the sections of Meek's syntypes. An examination of plaster casts of these syntypes (USNM 1363A and 1363B) indicates that although the grooves are present, they were exaggerated in Matsumoto's drawings (fig. 13).

Ornamentation consists of weak ribs that are swollen on the flanks to form low, broad, distantly spaced, adorally concave bullae. On crossing the flattened dorsal side the ribs swing forward to form an adorally convex curve. On ventrolateral portions of the flanks the ribs are almost obsolete, but on the venter they reappear as a series of indistinct broad nodes.

The suture line, which is only preserved on several very small fragments, appears to be similar to that illustrated by Matsumoto (1959a, p. 152, text figs. 64–66).

Types: Several syntypes, USNM 1363. As Matsumoto (1959a, p. 150) pointed out, the specimen with the illustrated suture (Meek, 1876, pl. 4, fig. lb) is lost.

Type locality: "Komooks", Vancouver Island. All the localities of *Baculites occidentalis* cited by Usher (1952, p. 99) are on Hornby Island, with the exception of one locality on Sucia Island. The Sucia Island specimen was collected by J. Richardson in 1874, and since that time, no other specimen has been found there. This suggests that the reported Sucia Island occurrence may be in error; and if so, the only known occurence for the species in the Vancouver Island area is from the Lambert formation on Hornby Island.

Figured specimen: USNM 131181.

Number of specimens: 6.

Collecting localities: Matanuska Valley-Nelchina area: USGS Mesozoic loc. M565, 8562.

Stratigraphic position: Upper part of member 3 of Matanuska formation. *Pachydiscus kamishakensis* zone.

Baculites aff. B. teres Forbes

Plate 16, figures 10–12, 14; text figure 14

Compare:

1846. *Baculites teres* Forbes, Geol. Soc. London Trans., ser. 2, v. 7, p. 115, pl. 10, fig. 5.

1865. *Baculites teres* Forbes. Stoliczka, India Geol. Survey Mem., Palaeontologia Indica, ser. 3, v. 1, p. 197, pl. 90, fig. 12 (not fig. 13).

1895. *Baculites teres* Forbes. Kossmat, Beitr. Paläontologie u. Geol. Osterr-Ungarno u.des Orients, v. 9, 155.

1959. *Baculites*(?) aff. *B. teres* Forbes. Matsumoto, Kyūshū Univ., Mem. Fac. Sci., ser. D, v. 8, no. 4, p. 163, pl. 45, figs. 5a–d, 6a–c; text figs. 82 a–c, 83.

Several small fragments appear to be closely related to *Baculites teres* Forbes. These consist of small slowly tapering shells with a nearly circular crosssection that lack ornamentation. The suture line is simple (fig. 14);

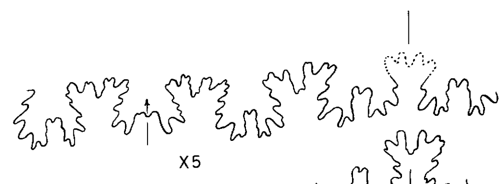


FIGURE 14.—Suture line of *Baculites* aff. *B. teres* Forbes, plesiotype USNM 131222 from USGS Mesozoic loc. M582. × 5.

with nearly symmetrically bifid saddles and lobes. The first lateral lobe is slightly wider and deeper than the ventral lobe: the second lateral lobe is wider than the first lateral lobe; and the dorsal lobe is small and high.

In general shape, the Alaskan specimens are similar to *Baculites teres* as described by Forbes and Stoliczka. They differ from the Indian species by apparently lacking the "obscure undulating oblique transverse folds" (Forbes, 1846, p. 115), although the absence may be due in part to poor preservation. The specimen from California figured by Matsumoto (1959a, p. 45, figs. 5, 6), has fairly distinct ribs, a collared aperture, and occasional strong ribs with accompanying indistinct grooves, all of which may be lacking in the Alaskan material. The sutures of the Alaskan and Californian specimens differ slightly; in the former, the lobes are split by a fairly prominent secondary saddle which is not developed in the latter.

Matsumoto (1959a, p. 165) has questioned the relationship of *Baculites teres* to other *Baculites* and suggested that this species, as well as *B. columna* Morton, might constitute a new genus or subgenus. Unfortunately, the Alaskan material is too scanty and fragmentary to cast much light on this problem, although the known differences between the two groups is perhaps sufficient for at least subgeneric differentiation.

(*Measurements* (*mm*)

Specimen	Fragment length	Height	Breadth	Ratio of breadth to height
USNM 131188c	30.6	5.6	5.3	0.95
Do		4.5	4.3	.96
131189	45	4.6	4.1	.90
UC 33521 [1]	22.0	5.5	5.3	.96
Do		4.2	3.9	.93
UC 33522 [1]		8.0	7.5	.89

[1] Matsumoto, 1959a, p. 164.

Figured specimens: USNM 131188 a, b, c; 131189; 131222.

Number of specimens: 8 fragments.

Collecting localities: Matanuska Valley–Nelchina area. USGS Mesozoic loc. M558, M582.

Stratigraphic position: Upper part of member 3 of Matanuska formation. *Pachydiscus kamishakensis* zone.

Family NOSTOCERATIDAE

Genus DIDYMOCERAS Hyatt

Didymoceras Hyatt, 1894. Am. Philos. Soc. Proc., v. 32, no. 143, p. 573.

Type species (original designation): *Ancyloceras*? *nebrascense* Meek and Hayden, 1856 (Hyatt, 1894, pl. 14, figs. 13, 14).

The genus *Didymoceras* comprises several species characterized by early helicoid whorls followed by a U-shaped retroversal loop. Two rows of ventral nodes are present, at least on the body chamber. *Didymoceras* differs from the closely related genus *Nostoceras* Hyatt (1894, p. 569) in that the helicoid whorls of the former do not touch, as they do in the latter, and so lack a contact furrow. Also, *Didymoceras* characteristically is larger than *Nostoceras* (Wright, 1957, p. 224) and seems to have somewhat more complex ribs that show a greater tendency to bifurcate at, and alternate between, ventral nodes.

Unfortunately, all figured specimens of *Didymoceras* consist of fragments, so it is very difficult to reconstruct an entire individual. In particular, the early whorls are poorly known, and it has not yet been established whether they are in contact or not. Thus, differentiation of small specimens of *Nostoceras* and *Didymoceras* is difficult, if indeed at all possible. It seems likely that the distinctions between these two genera are entirely artificial and that intergradations between the two named extremes may occur; if so, *Didymoceras* could be rejected in favor of *Nostoceras* or relegated to subgeneric rank.

Wright (1957, p. 224) considered *Didymoceras* to be a subjective synonym of *Cirroceras* Conrad (1868, p. 730), a name that was introduced in a faunal list, with type species, by monotypy as *Ammonceratites conradi* Morton (1842, p. 212, pl. 10, fig. 1). The illustrated specimen of this species is a small fragment of a heteromorphic ammonite which shows similarities not only to *Didymoceras* but also to *Emperoceras* Hyatt and *Bostrychoceras* Hyatt. Thus, the generic affinities of *A. conradi* cannot be established, and it seems best to regard *Cirroceras* as a *nomen dubium* and to retain *Didymoceras* as a valid generic name.

Didymoceras aff. D. hornbyense (Whiteaves)

Plate 23, figure 1

Compare:

1876. *Heteroceras cooperi* (Gabb). Meek, U.S. Geol. and Geog. Survey Terr. Bull., v. 2, p. 367, pl. 3, figs. 7, 7a.
1895. *Anisoceras vancouverensis* (Gabb). Whiteaves, Canada Rec. Sci., v. 6, p. 313, pl. 2.
1895. *Heteroceras hornbyense* Whiteaves, Idem., p. 316.
1895. *Heteroceras perversum* Whiteaves, Idem., p. 317.
1896. *Anisoceras vancouverensis* (Gabb). Whiteaves, Royal Soc. Canada Trans., ser. 3, v. 1, sec. 4, p. 130.
1903. *Anisoceras cooperi* (Gabb). Whiteaves, Canada Geol. Survey, Mesozoic fossils, v. 1, pt. 5, p. 336, pl. 43, fig. 1.
1903. *Heteroceras hornbyense* Whiteaves, Idem., p. 332, pl. 42, 29, figs. 1–4.
1952. *Nostoceras hornbyense* (Whiteaves). Usher, Canada Geol. Survey Bull. 21, p. 103, pl. 27, figs. 1, 2; pl. 28, fig. 2; pl. 31, fig. 23.
1952. *Anisoceras cooperi* (Gabb). Usher, Idem., p. 107, pl. 29, fig. 1.
1959. *Didymoceras hornbyense* (Whiteaves). Matsumoto, Kyūshū Univ., Mem. Fac. Sci., spec. v. 1, p. 157.

The nomenclature of nostoceratid ammonites from the Pacific Coast of North America is confused because some of the named species were based on small indeterminable fragments. Gabb (1864, p. 69, 70) originally named two species, *Ammonites? cooperi* and *Hamites vancouverensis*. The former species was obtained on the west side of Point Loma, near San Diego, southern California. Gabb's original specimen (UC 12119) is refigured in this report on plate 23, figure 3. This specimen consists of a small flattened fragment of the ventral part of an heteromorphic ammonite and shows ventral nodes and crisscross ribbing characteristic of *Didymoceras*. Other than this questionable generic assignment, the species *D. cooperi* (Gabb) seems indeterminable. Gabb's other species, *Hamites vancouverensis*, came from Vancouver Island, but the exact locality is unknown. The specimen illustrated cannot be located, but Gabb's (1864, pl. 13, fig. 18) figure shows a rather large fragment consisting of two straight shafts connected by an abruptly curved part. Ribs are strong, simple, and are described (Gabb, 1864, p. 70) as "carrying a small flattened tubercle on the latero-dorsal [= ventrolateral] side."

Since the introduction of these two species, both names have been assigned to heteromorphic ammonites from the Vancouver Island area but with little agreement among various authors as to precise definitions of either species. In addition to Gabb's species, two new species were proposed by Whiteaves (1895; 1903, p. 332), *Heteroceras hornbyense* and *H. perversum*, both from Hornby Island. *H. perversum* probably is not distinct from *H. hornbyense* but only a sinistral variety of the typically dextral form, as Whiteaves (1903, p. 332) himself pointed out.

The relation of *Heteroceras hornbyense* to Gabb's two species is difficult to assess owing to poor preservation and lack of detailed knowledge concerning *Hamites vancouverensis* and *Ammonites cooperi*. For this reason, it seems best to regard both these species as *Nomina dubia* until more adequate diagnoses are available.

Heteroceras hornbyense and the specimen figured by Whiteaves (1903, pl. 43, fig. 1) as *Anisoceras cooperi*—renamed *Didymoceras whiteavesi* by Anderson (1958, p. 196)—probably belong to the same species; the slight differences between them would thus be due in part to weathering and to normal intraspecific variation. Likewise, the retroversal loop with coarse and fairly regular ornamentation figured by Usher (1952, pl. 29, fig. 1) as *Anisoceras cooperi* may very well belong to *H. hornbyense*, although additional intermediate and large-sized specimens are needed to evidence this relationship.

Heteroceras hornbyense is probably best assigned to *Didymoceras* rather than *Nostoceras* because the helically coiled whorls, after a few initial turns, are separated and lack a contact furrow. Also, the large size attained by some of the specimens is more characteristic of *Didymoceras* than *Nostoceras*.

Only four specimens of *Didymoceras* are available in the Geological Survey's collection from southern Alaska. The largest specimen consists of a retroversal loop intermediate between the finely ribbed typical *D. hornbyense* and the coarsely ribbed specimen illustrated by Usher (1952, p. 29, fig. 1). It shows the characteristic double row of ventral tubercles, and has the ribs particularly on the sharply bent part, crisscrossing back and forth between successive tubercles. Other specimens consist of retroversal loops; one helical part is in the collection of the California Academy of Sciences.

Several new species named by Anderson (1958) were based on fragmentary specimens and cannot be adequately diagnosed. *Nostoceras mexicanum* (Anderson, 1958, p. 196, pl. 58, fig. 3) from Santa Catarina, Baja California; *Didymoceras kernense* (Anderson, 1958, p. 196, pl. 65, figs. 1, 1a, 2) from Kern County, Calif.; and *Exiteloceras desertenese* (Anderson, 1958, p. 202, pl. 66, figs. 2, 2a) from Fresno County, Calif., may all be syonyms of *D. hornbyense*. Similarly, the more coarsely ribbed *Didymoceras fresnoense* (Anderson, 1958, p. 197, pl. 68, fig. 2) and *Exiteloceras bennisoni* (Anderson, 1958, p. 210, pl. 72, fig. 7) may belong to *Didymoceras*, but their specific relations are not clear.

Figured specimen: USNM 131196 from USGS Mesozoic loc. 8587.

Number of specimens: 4.

Collecting localities: Matanuska Valley–Nelchina area: USGS Mesozoic loc. 8587, 16398, 24210. Cape Douglas area: Mem. 2.

Stratigraphic position: Upper part of member 3 of Matanuska formation. Kaguyak formation. *Pachydiscus kamishakensis* zone.

Family DIPLOMOCERATIDAE

Genus PSEUDOXYBELOCERAS Wright and Matsumoto

Pseudoxybeloceras Wright and Matsumoto, 1954, Kyushu Univ., Mem. Fac. Sci., ser. D, v. 4, no. 2, p. 119.

Type species (original designation): *Hamites quadrinodosus* Jimbo, 1894.

Wright (1957, p. 228) has characterized *Pseudoxybeloceras* as follows: "Early part of shell slightly helical, coiling flattened elliptical in plan; with fine simple prorsiradiate ribs, each bearing lower and upper ventrolateral spines." This genus differs from *Solenoceras* Conrad and *Oxybeloceras* Hyatt by having separated rather than appressed arms and by having four rows of ventral tubercles rather than two rows.

Pseudoxybeloceras? sp. indeter.

Plate 16, figure 9

A single fragment, herein referred questionably to *Pseudoxybeloceras*, is known from the Matanuska formation. This specimen shows well-developed, sharp, slightly oblique ribs, some of which carry double ventrolateral tubercles. It differs from other species of

Pseudoxybeloceras, however, in that its arms are closely appressed rather than separated, and in this respect it resembles *Solenoceras* or *Oxybeloceras*. The appressed arms possibly may be due to crushing and compression rather than being a normal growth habit, but because of the lack of adequate material, the proper allocation of this specimen cannot be determined.

Figured specimen: USMN 131187 from USGS Mesozoic loc. M578.

Stratigraphic position: Upper part of member 3 of Matanuska formation. *Pachydiscus kamishakensis* zone.

Genus DIPLOMOCERAS Hyatt

Diplomoceras Hyatt, Alpheus, 1900, *in:* Zittel, K. A., Textbook of paleontology; Eastman, C. R., editor and translator, v. 1, p. 571.

Type species (original designation): *Baculites cylindracea* Defrance, 1816, Dict. des sci. nat., v. 3, p. 160, Suppl. (fide d'Orbigny, 1840–42, p. 551).

The genus *Diplomoceras* includes several species characterized as follows: "Loose helicoid followed by 2 or 3 subparallel straight or curved shafts; section circular to oval; fine, dense, rather subdued ribbing, weaker on inside than on outside of shell" (Wright, 1957, p. 227). The suture line is distinctive and is characterized by "* * * high and small, trifid internal lobe, inconspicuous between the two internal saddles which often coalesce at the base into one slender element" (Spath, 1953, p. 15).

Some individuals of this genus are very large; one specimen in the Geological Survey's collection from southern Alaska has a body chamber nearly 370 mm long.

Several specimens of *Diplomoceras notabile* from the Matanuska formation exhibit very well preserved muscle-attachment impressions near the adapical end of the body chamber (Jones, 1961). These consist of a pair of bean-shaped dorsal retractor-muscle attachment scars and a single round ventral attachment scar, the function of which is not known.

Diplomoceras notabile Whiteaves

Plate 21; figure 1; text figure 15

1903. *Diplomoceras notabile* Whiteaves, Canada Geol. Survey, Mesozoic fossils, v. 1, pt. 5, p. 335, pl. 44, figs. 4, 4a, 4b.

1952. *Diplomoceras notabile* Whiteaves. Usher, Canada Geol. Survey Bull. 21, p. 109, pl. 29, fig. 2; pl. 30, fig. 1; pl. 31, figs. 26, 27.

1953. *Diplomoceras notabile* Whiteaves. Spath, Falkland Islands Dependencies Survey Sci. Rept. 3, pl. 2, figs. 4 a, b, c.

Diplomoceras notabile is very common in the upper part of member 3 of the Matanuska formation, although most of the specimens consist of small fragments, and complete individuals are rare. The whorl section of this species is broadly oval, slightly compressed laterally, with a flattened dorsal side and a more narrowly rounded ventral side. Ribs are numerous, rounded, oblique, and separated by rounded interspaces about equal to the ribs in width. On the dorsal side the ribs become weak and may disappear. Constrictions are irregularly developed; one usually occurs near the adoral end of the body chamber, and another may occur at the adapical end, just above the last septum. The Alaskan representatives differ somewhat from typical examples of *D. notabile* from Vancouver Island in that they have slightly coarser ribs. The Alaskan forms average 11 to 12 ribs in a distance equal to the long diameter as opposed to 15 to 16 ribs for the Vancouver Island forms. In whorl shape, however, the Alaskan and Vancouver Island specimens appear to be identical; so no taxonomic distinction is made for the slightly coarser ribbed form.

The suture line (fig. 15) is florid with thin-stemmed deeply incised saddles and irregularly bifid lobes. The external saddle is small and slender, and the second lateral saddle is higher than the first lateral saddle. The first lateral lobe is much deeper than the ventral lobe, the internal lobe is small and high. The internal saddles are fused at the base to form one narrow-stemmed saddle.

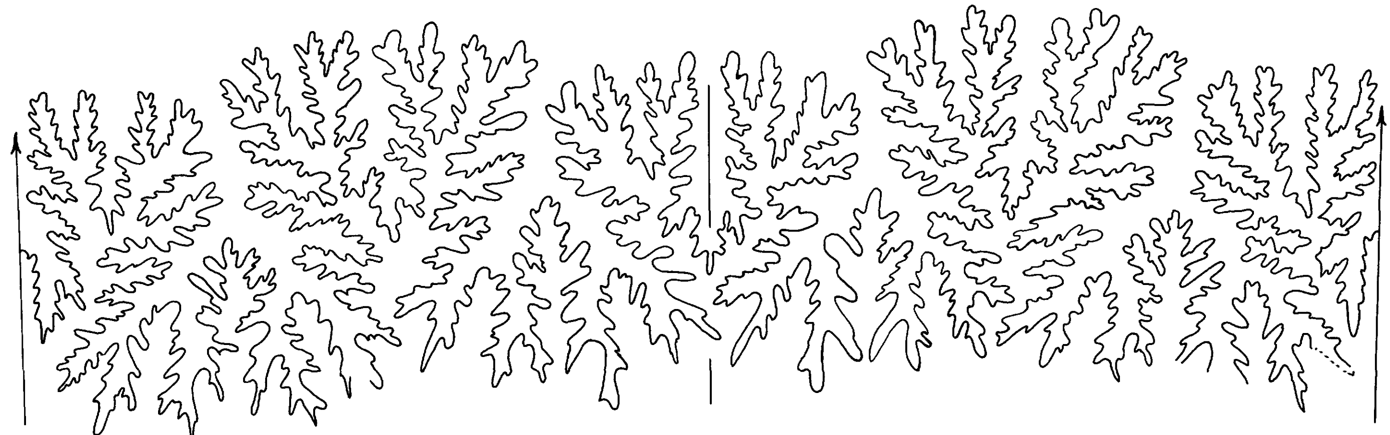


FIGURE 15.—Suture line of *Diplomoceras notabile* Whiteaves, plesiotype USNM 131220 from USGS Mesozoic loc. 24869. X 2½.

Diplomoceras notabile differs from *D. lambi* Spath (1953, p. 17, pl. 2, figs. 1–3; pl. 3, fig. 1) mainly by having a slightly oval, or compressed, whorl section rather than a round whorl section. Spath (1953, p. 17) also stated that the two species differ by details of suture line, but these differences are not readily apparent from Spath's figures.

Measurements (mm)

Specimen	Whorl height (ventral-dorsal)	Whorl breadth (lateral)	Ratio of whorl breadth to height
USNM 131194	36	32	[1] 0.89
	44	35	.80
USNM 130867 [2]	36	31	.86
	44	37	.84

[1] Specimen crushed.
[2] Jones, 1961.

Holotype: Canada Geol. Survey No. 10064.
Type locality: Northwest side of Hornby Island, British Columbia.
Figured specimens: USNM 131194, 131220.
Number of specimens: 30–40, many fragments.
Collecting localities: Matanuska Valley–Nelchina area: USGS Mesozoic loc. 6694, 6696, 8562, 8578, 8595, 8948, 16398, 20801, 24208, 24860, 24869, 24872(?), 24875, 25324, M558, M562, M564, M573, M584, M588. Cape Douglas area: USGS Mesozoic loc. 24958, 25857.
Stratigraphic position: Upper part of member 3 of Matanuska formation. Kaguyak formation. *Pachydiscus kamishakensis* zone.

Suborder AMMONITINA
Superfamily DESMOCERATACEAE
Family DESMOCERATIDAE
Subfamily DESMOCERATINAE

Genus DESMOPHYLLITES Spath

Desmophyllites Spath, 1929, The Naturalist, no. 871, p. 270.

Synonym, Schlüteria Grossouvre, 1894, p. 216 (not Fritsch and Kafka, 1887).

Type species (subsequent designation for *Schlüteria* by Spath, 1921, Durban Mus. Ann., v. 3, pt. 2, p. 46): *Desmoceras larteti* Seunes, 1891.

The genus *Desmophyllites* comprises several species characterized by very involute whorls, flat to rounded flanks, rounded venter, pitlike umbilicus, strongly sigmoidal and projected constrictions, and a desmoceratid suture line.

Desmophyllites is very similar to other compressed desmoceratids, notably *Desmoceras* (*Psudouhligella*), a subgenus from which it differs only by having a smaller umbilicus, stronger ventral projection of the constrictions, and a slightly more complex suture line (Matsumoto and Obata, 1955, p. 121) (fig. 16). These differences are so slight that, were it not for their different stratigraphic ranges (Santonian to Campanian or lower Maestrichtian for *Desmophyllites*, upper Albian to lower Turonian for *Pseudouhligella*), the two groups would probably be placed in the same genus. It is possible that connecting species will eventually be

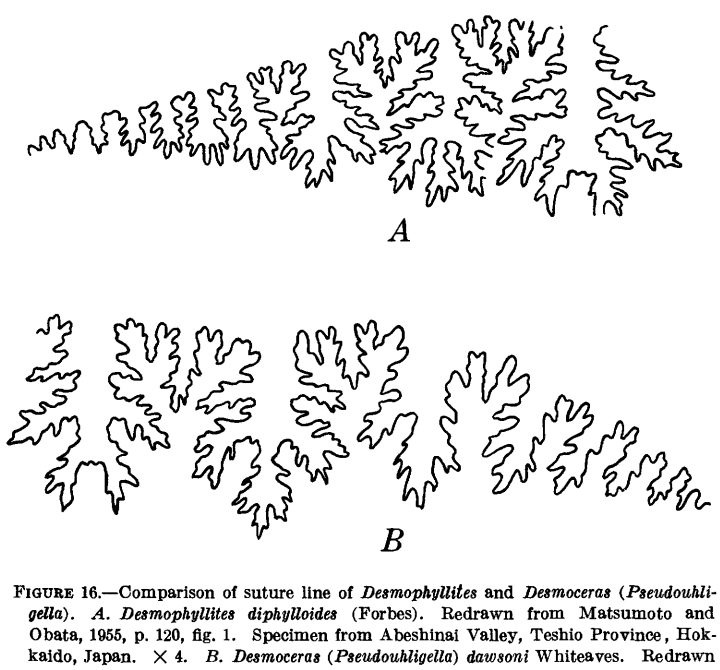


FIGURE 16.—Comparison of suture line of *Desmophyllites* and *Desmoceras* (*Pseudouhligella*). *A. Desmophyllites diphylloides* (Forbes). Redrawn from Matsumoto and Obata, 1955, p. 120, fig. 1. Specimen from Abeshinai Valley, Teshio Province, Hokkaido, Japan. × 4. *B. Desmoceras* (*Pseudouhligella*) *dawsoni* Whiteaves. Redrawn from Matsumoto, 1959a, p. 60, fig. 8. Specimen from Chitina Valley, Alaska. Whorl height 15 mm.

found; and if so, rejection of *Pseudouhligella* as a synonym of *Desmophyllites* will be necessary.

Desmophyllites phyllimorphum (Kossmat)

Plate 10, figures 4–6

1898. *Desmoceras phyllimorphum* Kossmat, Beitr. Paläontologie u. Geol. Österr.-Ungarns u. des Orients, v. 11, no. 3, p. 110, pl. 19 [25], figs. 10a–c.

1925. *Puzosia* (*Latidorsella*) *phyllimorpha* (Kossmat), Diener, Fossilium Catalogus, u. 1, Animalia, pars. 29, p. 126.

Only three specimens of *Desmophyllites* from the Matanuska formation are in the Geological Survey's collection. These are referred to *D. phyllimorphum* (Kossmat) because of their large size, slightly inflated and rounded flanks, and small umbilicus. The Alaskan forms differ slightly from Kossmat's type specimen by having more strongly projected constrictions on the ventral area, but in view of the close similarities in other morphologic features, it is not thought that this difference is significant.

Desmophyllites phyllimorphum differs from *D. diphylloides* (Forbes, 1846) by being much larger, with slightly rounded rather than flattened flanks, somewhat more sinuous constrictions, and by having a more compressed whorl section and a slightly smaller umbilicus. It differs from *D. larteti* (Seunes), the type species of the genus, by having a more inflated whorl section and a broader venter.

This species was previously known only from the Arrialoor group of southern India (Kossmat, 1898, p. 110).

Measurements (mm)

Specimen	Diameter	Height	Breadth	Ratio of breadth to height	Width of umbilicus	Umbilicus, percent of diameter
[1]	81.5	43.5	30.5	0.70		
USNM 181180		43	30	.70		
Do	84	46	32	.70	6	7
Do	113	62	41	.66	8	7
[2]	77	42	25	.59	6	7.9

[1] Kossmat, 1898, p. 110.
[2] *Desmophyllites larteti* (Seunes, 1891, p. 20).

Type area: Ootacod, southern India.

Figured specimen: USNM 131180, from USGS Mesozoic loc. 24227.

Collecting localities: Matanuska Valley–Nelchina area: USGS Mesozoic loc. 16398, 24227, M562.

Stratigraphic position: Upper part of member 3 of Matanuska formation. *Pachydiscus kamishakensis* zone.

Genus DAMESITES Matsumoto

Damesites Matsumoto, 1942, Imp. Acad. Japan Proc., v. 18, p. 24.

Type species (original designation): *Desmoceras damesi* Jimbo, 1894.

The genus *Damesites* comprises several species that morphologically are very similar to *Desmophyllites* but which differ by having a well-developed ventral keel and generally less prominent constrictions.

Damesites hetonaiensis Matsumoto

Plate 29, figures 4–6

1942. *Damesites hetonaiensis* Matsumoto, Imp. Acad. Japan Proc., v. 18, p. 27, table 3, p. 28, text fig. lg_1, g_2.

1954. *Damesites hetonaiensis* Matsumoto. Matsumoto, The Cretaceous System in the Japanese Islands, App., p. 271, pl. 6, figs. 1–3, text fig. 12.

?1958. *Neokotoceras fresnoensis* Anderson, Geol. Soc. America Mem. 71, p. 218, pl. 57, figs. 1–5.

?1959. *Damesites hetonaiensis fresnoensis* (Anderson). Matsumoto, Kyūshū Univ., Mem. Fac. Sci., ser. D, spec. v. 1, pt. 2, p. 14.

Damesites hetonaiensis is rare in the Matanuska formation and is represented by only two specimens. This species is characterized by a compressed whorl section; flattened flanks; a very small craterlike umbilicus; a rounded umbilical wall; a narrow, sharp, keel; and the absence of ornamentation other than faint striae. Constrictions, which are weakly developed, are only slightly sigmoidal on the flanks and are strongly projected forward on the venter.

Damesites fresnoensis (Anderson), which Matsumoto (1959b) considered to be a subspecies of *D. hetonaiensis*, differs from that species only by being somewhat larger and by having faint subcostae on the outer whorl. These differences appear to be minor, and *D. fresnoensis* is herein regarded as a probable synonym of *D. hetonaiensis*.

Damesites hetonaiensis is known from Hokkaido, Japan, where it occurs in beds of probable Maestrichtian age (Matsumoto, 1954, p. 272), and in California in beds of higest Campanian or Maestrichtian age (Matsumoto, 1959b, p. 15).

Specimen	Diameter	Height	Breadth	Ratio of breadth to height	Width of umbilicus	Umbilicus, percent of diameter
GK H3836	44	26	17	.65	3.3	7.5
USNM 131205	35	19	12.5	.66	2.8	8.0

Holotype: GK H3836 (Kyūshū University).

Type locality: Lower sandy siltstone of the Upper Hakobuchi group, Hetonai area, Iburi Province, Hokkaido, Japan. Locality H12d2.

Figured specimen: USNM 131205 from USGS Mesozoic loc. M552.

Collecting localities: Matanuska Valley–Nelchina area: USGS Mesozoic loc. M552, 6696.

Stratigraphic position: Upper part of member 3 of Matanuska formation. *Pachydiscus kamishakensis* zone.

Family PACHYDISCIDAE

Genus PACHYDISCUS Zittel

Pachydiscus Zittel, 1884. Handbuch d. Palaeontologie, abteil. 1, v. 2, p. 466.

Type species (subsequent designation, Grossouvre, 1894, p. 177): *Ammonites neubergicus v.* Hauer.

Characteristic features of *Pachydiscus*, as exemplified by the type species as well as by *P. gollevillensis* (d'Orbigny), *P. egertoni* (Forbes), *P. compressus* (Spath), and *P. subcompressus* Matsumoto, are: compressed whorls attaining very large size, moderate umbilicus, and generally well-developed ornamentation, at least on early whorls. Ornamentation consists of both major and minor ribs; major ribs begin at umbilical tubercles and extend across the venter but tend to weaken on midflank. Minor ribs are more numerous than major ribs and are restricted to the ventral portion of the whorl, although some may reach midflank or slightly lower. Ribs weaken with progressive increase in shell size and are obsolete in large shells.

Several species of *Pachydiscus* differ from typical forms by being more inflated, generally with a smaller umbilicus and with less well-developed ornamentation that lacks a tendency to differentiate into umbilical and ventral ribs. Among these species are *Pachydiscus ootacodensis* (Stoliczka) and *P. colligatus* (Binkhorst). On the basis of their inflated whorls, such species approach *Anapachydiscus,* and perhaps are intermediate between this genus and *Pachydiscus.* For the sake of convenience, this inflated group is herein considered to belong to *Pachydiscus s.s.*

Pachydiscus (Pachydiscus) kamishakensis Jones, n. sp.

Plate 16, figures 4–6; plates 17–20; plate 21, figures 2, 3; plate 22; plate 23, figure 2; plate 24, 25; plate 26, figures 2, 3; plate 35, figures 1–3, 5, 6; text figure 17

Shell discoidal, compressed, attaining very large size; umbilicus fairly narrow; whorl height slightly larger than whorl breadth in early whorls, much larger in later whorls; venter evenly rounded up to diameter of about 150 mm, after which it gradually becomes acutely rounded; flanks gently rounded on early whorls, later becoming nearly flat and convergent; greatest width of whorl in lower one-third of flank, just above rounded umbilical shoulder; umbilical wall subvertical on early whorls, sloping on later whorls.

Ornamentation on early whorls, at diameters less than 25 to 30 mm, consists of indistinct umbilical bullae. At slightly larger diameters, umbilical bullae are well developed; short low radial riblets extend from these bullae to about midflank, where they disappear (pl. 35, figs. 1, 5, 6). At a diameter of about 35 mm, weak secondary ribs appear intercalated between primary ribs. These secondary ribs begin just above the umbilical shoulder and extend to about midflank but do not cross the venter (pl. 16, fig. 4). As the diameter of the shell increases, both primary and secondary ribs gradually extend farther up the flanks, until, at a diameter of about 45 mm, both sets of ribs cross the venter, although with a great reduction in strength. From diameters of about 45 mm to about 90 mm, ornamentation remains nearly constant and consists of fairly prominent radial primary ribs; weak umbilical bullae; and irregular, less prominent, intercalated secondary ribs (pl. 17). Primary ribs average 10 to 12 per whorl and are separated by 1 to 3 secondary ribs. The latter ribs are of varying length; some begin on or near the umbilical shoulder, but others begin at or just above midflank. Some of the primary ribs bifurcate at midflank and give rise to two secondary ribs of equal strength. All the ribs are radial on the flanks but bend slightly at the ventrolateral shoulder and cross the venter with a forward projection.

At diameters greater than about 90 mm, ornamentation begins to weaken and secondary ribs disappear (pls. 18, 19, 22). From a diameter of 130 to 220 mm, ornamentation consists of low broad umbilical bullae from which radial ribs extend to about the outer one-third of the flank but which only rarely cross the venter as indistinct swellings. At diameters greater than 220 mm, to as much as a known maximum of over 500 mm, the shell is smooth except for rare irregular swellings along the umbilical shoulder (pls. 20, 24).

The suture line is characteristic of *Pachydiscus* with deeply incised thin-stemmed saddles and very narrow lobes. The first lateral lobe is much deeper than either the ventral lobe or the second lateral lobe (fig. 17).

Pachydiscus (*Pachydiscus*) *kamishakensis* differs from typical pachydiscids, such as the group of *P. neubergicus, P. egertoni* (Forbes), and *P. gollevillensis* (d'Orbigny), by lacking well-differentiated umbilical and ventral ribs and by having a more compressed whorl section and more a rapid disappearance of ornamentation. *P.* (*P.*) *kamishakensis* is closely related to both *P.* (*P.*) *suciaensis* (Meek) from Vancouver Island (Usher 1952, p. 68, pl. 9, figs. 1–11; pl. 10, figs. 1–3) and *P.* (*P.*) *subcompressus* Matsumoto (1954, p. 287, pl. 10, fig. 4; pl. 12, fig. 1) from Japan. *P.* (*P.*) *kamishakensis* differs from *P.* (*P.*) *suciaensis* by having a more compressed whorl section with flatter, more convergent flanks and a more acutely rounded venter. Ornamentation of the two species is generally similar up to a diameter of about 90 mm, but as no larger specimens of *P.* (*P.*) *suciaensis* have yet been figured, comparisons at greater diameters is difficult. *P.* (*P.*) *kamishakensis* differs from the Japanese species (*P.*(*P.*) *subcompressus* by being slightly less compressed and by having somewhat different ornamentation; the latter species has more flexiradiate primary ribs and more numerous, shorter, secondary ribs that are mainly confined to the ventral area, although some may reach midflank or even lower (Matsumoto, 1954, p. 288). Primary ribs of the Japanese form also have a stronger tendency to weaken on midflank so that the characteristic feature of separated umbilical and ventral ribbing is produced, although not to such an extent as is found in the type species of the genus. Ornamentation also tends to persist to a larger shell size in *P.* (*P.*) *subcompressus* than in *P.* (*P.*) *kamishakensis*.

The differences between *Pachydiscus* (*P.*) *subcompressus* and *P.* (*P.*) *kamishakensis* seem to be real, but the two species are closely related and discrimination may be difficult, particularly if material is poorly preserved.

Pachydiscus (*P.*) *kamishakensis* differs from *P.* (*P.*) *hazzardi* Jones, n. sp., by having a more compressed, less convergent whorl section and a larger umbilicus with a more sloping umbilical wall; the former species retains umbilical bullae and radial ribs to a much larger diameter, and it has a slightly more complex suture line.

Measurements (mm)

Specimen	Diameter	Height	Breadth	Ratio of breadth to height	Width of umbilicus	Umbilicus, percent of diameter
USNM						
131193	106	49	40	0.81	25	23
Do	217	96	79	.82	54	25
Do	------	103	81	.78	------	------
Do	284	121	44×2	.73	70	24
191195	183	83	66	.79	46	25
	214	94	37×2	.79	53	24.5
131191	73	32	27.5	.85	21	29
	93	41	32	.78	25	26
	127	55	22×2	.80	36	28
131190	79	36	29	.81	20	25
131186	43	17	16	.94	12	28
	54	22	21	.95	16	29
131192	155	64	53	.83	41	26
131199	101	44	31	.70	23	23
131197	32	15	14	.93	------	------
	47	22	20	.90	12	25
	501	210	132	.63	124	22
9	204	94	78	.83	53	26
***Pachydiscus subcompressus* Matsumoto**						
GT I-2815 [1]	148	67	28?	0.4	38	25.6
GT I-2824	165	77	31	.4	41	24.8
GH	152.5	67.6	44	.65	36.3	23.0
	------	46.9	34.2	.73	------	------
	200	------	------	------	------	------
Unnumbered specimens [2]						
Paratype	129.5	58.5	39.5	0.67	29	22
Do	86.7	40.8	29.2	.71	20.3	22

[1] Matsumoto, 1954, p. 288.
[2] Matsumoto, 1959b, p. 47.

Holotype: USNM 131193.

Type locality: USGS Mesozoic loc. 25856.

Figured specimens: 131186, 131190, 131191, 131192, 131193, 131195, 131197, 131199.

Number of specimens: 30.

Collecting localities: Matanuska Valley–Nelchina area: USGS Mesozoic loc. 16398, 24201, 24210, 24211, 24212, 24241, 24862, 24863, 25324, M562, M565. Alaska Peninsula; Cape Douglas area: USGS Mesozoic loc. 24960, 25856, 25857.

Stratigraphic position: Upper part of member 3 of Matanuska formation. Kaguyak formation. *Pachydiscus kamishakensis* zone.

Pachydiscus (Pachydiscus) hazzardi Jones, n. sp.

Plates 12–15, 16, figures 1–3, 7, 8, 13, 15, 16; text figure 18

Shell discoidal, attaining large size, narrowly umbilicate; moderately compressed; early whorls about as high as broad, with height increasing slowly with increased diameter; early whorls have slightly inflated convergent flanks and broadly rounded venter; later whorls inflated with flat strongly convergent flanks and somewhat flattened venter, giving a characteristic strongly triangular shape to the whorl section; greatest width of whorls just above rounded umbilical shoulder; umbilicus fairly narrow with subvertical umbilical wall.

Ornamentation of early whorls, at a shell diameter of about 20 mm, consists of radial primary ribs that begin at elongate umbilical bullae and disappear just above midflank, together with 1 or 2 intercalated secondary ribs that begin on the umbilical shoulder and disappear at or just above midflank. At a diameter of about 35 mm, both sets of ribs cross the venter with a slight forward projection and with some reduction in strength at midventer. At this stage, the primary ribs average about 11 per whorl (pl. 16, fig. 1). At a diameter of about 60 mm, the ribs begin to weaken and the distance between them increases; also, ribs become somewhat more sinuous and prorsiradiate on the flanks (pl. 16, fig. 7). At a diameter of 80 to 100 mm, umbilical bullae have nearly disappeared, and both primary and secondary ribs are reduced to low, irregular, somewhat flexiradiate swellings, which, on the outer layer of the shell, are covered with fine riblets or growth striae (pl. 16, fig. 13). At larger diameters, all ornamentation is lost except for occasional low, irregular swellings along the umbilical margin (pl. 12–14).

The suture line (pl. 7, fig. 1; text fig. 18) is typical of *Pachydiscus*, with thin-stemmed deeply incised saddles and narrow lobes. In general plan, the suture lines of *P.* (*P.*) *hazzardi* and *P.* (*P.*) *kamishakensis* are similar, but that of the former species seems to be slightly less complex and less deeply and finely incised than the latter.

One specimen from USGS locality 25856 (USNM 131184, see pl. 10) is much more compressed and has a

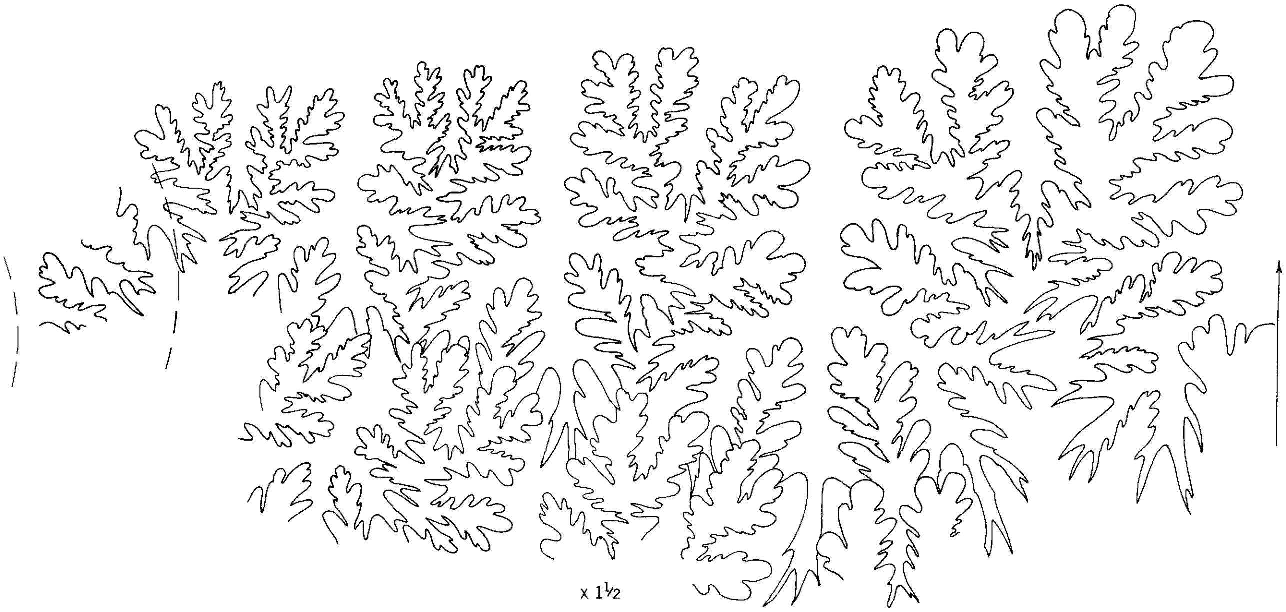


FIGURE 17.—Suture line of *Pachydiscus (Pachydiscus) kamishakensis* Jones, n. sp.: Holotype USNM 131193, from USGS Mesozoic loc. 25856. Whorl height of 92 mm. × 1½.

less pronounced triangular whorl section than does the type specimen of *Pachydiscus* (*P.*) *hazzardi*. In whorl shape, this specimen approaches that of *P.* (*P.*) *kamishakensis*, from which it differs by having a smaller umbilicus, subvertical umbilical wall, less complex suture, and a much earlier disappearance of ornamentation (fig. 18). In these respects it agrees with *P.* (*P.*) *hazzardi*, to which it is questionably referred.

Pachydiscus (*P.*) *hazzardi* differs from other species of *Pachydiscus* by having a strongly convergent whorl section and by the early disappearance of ornamentation. *P.* (*P.*) *hazzardi* and *P.* (*P.*) *kamishakensis* are closely related but can be readily distinguished by the differences in whorl shape and in the longer retention of ornamentation in the latter species. The stratigraphic relations of these two species are not known precisely, but the common occurrence of *P.* (*P.*) *kamishakensis* and *P.* (*P.*) *hazzardi*? indicates that they were probably contemporaneous.

Measurements (mm)

Specimen	Diameter	Height	Breadth	Ratio of breadth to height	Width of umbilicus	Umbilicus, percent of diameter
USNM 131185	36	16	16	1.0	11	30
Do	59	29.5	28	.94	14.5	24
Do	92	45	40	.88	19	20
USNM 131182	229	107	92	.86	48	21
USNM 131184	184	87	67	.77	35	19
Do	----------	53	42	.79	----------	----------
USNM 131183	----------	86	76	.88	----------	----------
16	58	28	22.5	.80	12	20.6
Do	----------	54	44	.82	----------	----------
17	216	94	86	.91	----------	----------

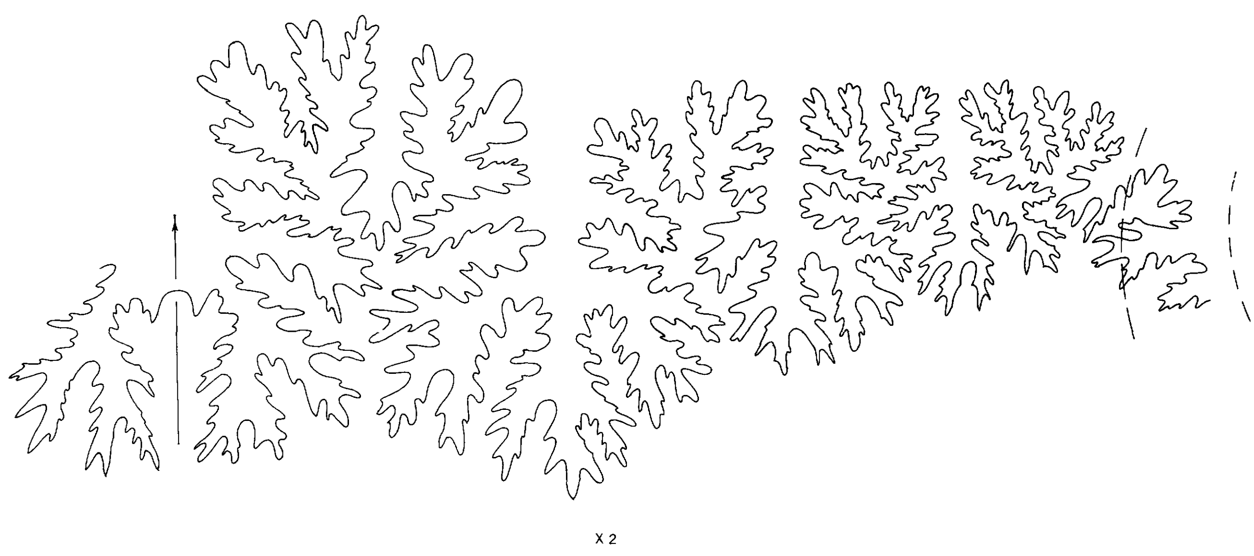


FIGURE 18.—Suture line of *Pachydiscus (Pachydiscus) hazzardi*?, USNM 131184, from USGS Mesozoic loc. 25856. Whorl height of 53 mm. × 2.

Pachydiscus hazzardi is known only from the Cape Douglas area, Alaska Peninsula

Holotype: USNM 131185.
Type locality: JCH–1753. Kaguyak Bay, Alaska Peninsula.
Figured specimens: USNM 131182, 131183, 131184, 131185.
Number of specimens: 6.
Collecting localities: Cape Douglas area: USGS Mesozoic loc. 24959, 25856(?). Union Oil Company loc. JCH 1753, 1754.
Stratigraphic position: Kaguyak formation. *Pachydiscus kamishakensis* zone.

Pachydiscus (Pachydiscus) ootacodensis (Stoliczka)

Plate 29, figures 1–3, 13–16; plates 30, 31; plate 32, figure 1

1865. *Ammonites ootacodensis* Stoliczka, India Geol. Survey Mem., Palaeontologia p. 109, pl. 54, figs. 3, 4; pl. 56 (not pl. 57).
1898. *Pachydiscus ootacodensis* (Stolizka). Kossmat, Beitr. Pläontologie u. Geol. Österr.-Ungarns u. des Orients, v. 11, no. 3, p. 98, pl. 16, figs. 1a, b; pl. 17, fig.1.
1922. *Parapachydiscus* aff. *ootacodensis* (Stoliczka). Spath, Royal Soc. South Africa Trans., v. 10, pt. 3, p. 132, pl. 7, fig. 6.
1935. *Parapachydiscus ootacodensis* (Stoliczka). Anderson and Hanna, California Acad. Sci. Proc., 4th ser., v. 23, no. 1, p. 20, pl. 6, figs. 1, 2.

Pachydiscus ootacodensis, as originally established by Stoliczka, included smooth specimens, fairly coarsely ribbed specimens with umbilical tubercles, and specimens on which ornamentation was restricted to short ventral ribs. Kossmat (1898, p. 98–101) restricted the concept of the species to those specimens that were either smooth or had ventral and lateral ribs but on which the umbilical ornamentation was obsolete. Unfortunately, a lectotype of *P. ootacodensis* was not designated by Kossmat, nor by any subsequent worker; consequently, a fairly wide range in interpretation of specific characters is still possible. Without an opportunity to examine Stoliczka's original material, this writer hesitates to designate a lectotype. Instead, the specimen figured by Kossmat (1898, pl. 16, figs. 1a, b) is herein accepted as a representative specimen of the species, even though this specimen may not correspond exactly to what Stoliczka had in mind when he named the species.

The characteristic features of *Pachydiscus* (*P.*) *ootacodensis*, as illustrated by Kossmat, are inflated whorl section with a whorl height equal to, or slightly less than the whorl breadth; an evenly rounded venter; a fairly narrow, steplike umbilicus with an overhanging umbilical wall; distantly spaced ribs that rise on the flanks and cross the venter with a forward projection; and lack of well-developed umbilical tubercles.

The Alaskan specimens correspond well with this general description, except that on early whorls an occasional rib is continuous across the flanks and, just above the umbilical shoulder, is pinched into a very thin, elongate, bulla (pl. 32, fig. 1). Such bullae are confined to shell diameters of less than about 50 mm, above which size the umbilical shoulder area is smooth as in the Indian examples. Ventral ornamentation becomes progressively weaker with increased diameter and eventually is completely obsolete. The largest specimen in the Geological Survey's collection, still septate at a diameter of 442 mm, shows very faint broad and low undulations on the lower part of the flanks but no trace of ornamentation on the ventral region. Other features, such as the small steplike umbilicus, flattened flanks, and whorl proportions, are nearly identical on the Alaskan and Indian specimens.

Other specimens previously assigned to *Pachydiscus ootacodensis* include those from Vancouver Island discussed by Kossmat (1898, p. 100); Whiteaves (1903, p. 340, pl. 46, fig. 1, text fig. 20); and Usher (1952, p. 85, pl. 17, figs. 1–5; pl. 18; pl. 19, fig. 1; pl. 20, figs. 1, 2,). All these specimens are herein regarded as distinct from *P.* (*P.*) *ootacodensis*, and are assigned to a new species, *Pachydiscus* (*P.*) *hornbyense*, described below.

Measurements (mm)

Specimen	Diameter	Height	Breadth	Ratio of breadth to height	Width of umbilicus	Umbilicus, percent of diameter
USNM						
131202	19	10	10	1.0	4	21
Do	24	12	12	1.0	5	21
1	30	15	17	1.13	7	23
Do	43	22	24	1.1	9	21
131203	33	16	18	1.12	7	21
Do	43	21	21	1.0	9	21
131204	170	84	83	.99	35	20.5
131208	292	148	135	.91	53	18
2	339	153	143	.93	75	22
Do	442	211	99×2	.94	98	22
Kossmat (1898)						
a	175	85	82	0.97	37	21
Do		42	40	.95		
b	107	52	54	1.04	21	20
Do		22	28	1.27		
c	71	35	33	.94	14	20
Do		15	15	1.0		
d	38	19	24	1.26	8	21
Do		9	10	1.1		

Figured specimens: USNM 131202, 131203, 131204, 131208.
Number of specimens: 7.
Collecting localities: Matanuska Valley–Nelchina area: USGS Mesozoic loc. 6696(?), 16398, 24871, 25326, 25327. Cape Douglas area: USGS Mesozoic loc. 25856.
Stratigraphic position: Upper part of member 3 of Matanuska formation. Kaguyak formation. *Pachydiscus kamishakensis* zone.

Pachydiscus (Pachydiscus) hornbyense Jones, n. sp.

Plate 32, figures 2–6; plate 33; text figure 19

?1903. *Pachydiscus otacodensis* (Stoliczka). Whiteaves, Canada Geol. Survey, Mesozoic fossils, v. 1, pt. 5, p. 340, pl. 46, fig. 1; text figure 20.

1952. *Pachydiscus ootacodensis* (Stoliczka). Usher, Canada Geol. Survey Bull. 21, p. 85, pl. 17, figs. 1–5; pl. 18; (questionably pls. 19, 20).

Shell large, moderately inflated, involute, with relatively small, deep, umbilicus; early whorls inflated and depressed with whorl height slightly less than whorl breadth; in later whorls, height gradually increases so that at a diameter of about 90 mm whorl height equals or exceeds whorl breadth; venter broadly and evenly rounded; flanks rounded on early whorls, becoming flat on later whorls; greatest whorl breadth just above evenly rounded umbilical shoulder; umbilical wall rounded and overhanging.

Ornamentation on early whorls at diameters less than about 30 mm is apparently lacking, but well-preserved specimens are not available to verify this. At a diameter of about 35 mm, umbilical tubercles and short radial ribs are present; at a diameter of about 45 mm, ornamentation consists of numerous fairly closely spaced radial primary ribs that rise from umbilical tubercles, together with intercalated secondary ribs that rise just above the umbilical shoulder (pl. 32, fig. 4). Both primary and secondary ribs cross the venter with only slight diminution in strength and with little anterior projection. One or 2 secondary ribs are intercalated between each primary rib. This ornamentation persists to a diameter of about 80 mm, where it begins to weaken and umbilical tubercles disappear (pl. 33, figs. 4, 6, 7). Ribs first become weak on the umbilical area and then on the flanks and ventral region. Large specimens are smooth with the exception of weak growth striae and irregular indistinct riblets that cross the venter with anterior projection (pl. 32, figs. 2, 6).

Pachydiscus (*P.*) *hornbyense* has previously been misidentified as *P.* (*P.*) *ootacodensis*, from which it differs by having well-developed umbilical tubercles as well as primary and secondary ribs on the early whorls. *P.* (*P.*) *hornbyense* also tends to have a slightly larger umbilicus, but the whorl sections of the two species are essentially similar (fig. 19). Kossmat (1898, p. 100; in Whiteaves, 1903, p. 41) indicated that the Vancouver specimens identified as *P.* (*P.*) *ootacodensis* differed from the typical Indian forms mainly by having more closely spaced ribs. This interpretation was based on examination of two specimens, both of which probaly were obtained from Hornby Island. One specimen in the Hector Collection in the British Museum (Nat. History) has never been figured; the other, identified as number 14, was illustrated by both Whiteaves (1903 pl. 46, fig. 1) and Usher (1952, pls. 19, 20). A plaster cast of this specimen is figured in this report in plate 32, figure 2. This specimen clearly shows the closely spaced primary and secondary ribs characteristic of *P.* (*P.*) *hornbyense*, but umbilical tubercles are not visible. Some of the ribs on the last whorl show a slight thickening suggestive of weakened tubercles; possibly, the lack of tubercles on inner whorls may be due to destruction of the umbilical shoulder during preparation of the umbilicus, although this is not apparent from Usher's photograph. In other features of ornamentation, Whiteaves' specimen agrees with the holotype of *P.* (*P.*) *hornbyense;* and as both specimens were obtained from the same locality, it seems possible that they are conspecific.

Plaster casts of two specimens illustrated by Usher (1952, pl. 17, figs 1–5) as *Pachydiscus ootacodensis* are figured in this report in plate 32, figures 3–5, and plate 33, figures 2, 3, 7. These specimens both from Hornby Island, clearly show the umbilical tubercles and numerous closely set primary and secondary ribs, features which distinguish *P. hornbyense* from *P. ootacodensis* (compare with pl. 32, fig. 1).

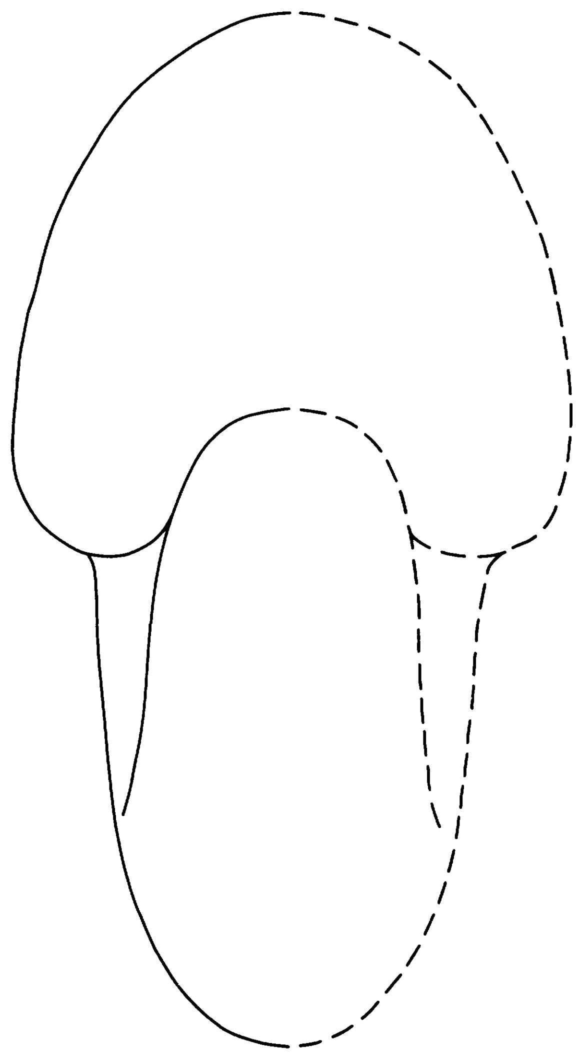


FIGURE 19.—Section of *Pachydiscus* (*Pachydiscus*) *hornbyense* Jones, n. sp. Holotype USNM 131209 from USGS Mesoyoic loc. M398, northwest side of Hornby Island, British Columbia. Dashed lines represent reconstructed portion. × 1.

Pachydiscus hornbyense is intermediate between the genera *Pachydiscus* and *Anapachydiscus*. Its whorl section is more inflated than is usual for *Pachydiscus* s. s., but it is somewhat more compressed than for *Anapachydiscus*. In general, *P. hornbyense* seems to be most closely related to the inflated group of pachydiscids which includes *P. ootacodensis*, *P. colligatus* Binkhorst, *P. obermuleri* Collignon, and other species. It is herein considered as belonging to *Pachydiscus* s. s., but future work may show the desirability of distinguishing this entire group as a separate subgenus.

Measurements (mm)

Specimen	Diameter	Height	Breadth	Ratio of breadth to height	Width of umbilicus	Umbilicus, percent of diameter
USNM 131210	57	26	32	1.23	16	28.5
Do	78+	34+	43	1.2	20	25.5
USNM	120	67	34×2	1.0	28	23.5
GSC 10051[1]	91	36.5	37.3	1.0	23.7	26
GSC 5850	126	64	63	.98	29	23

[1] Calculated from percentages given by Usher, 1952, p. 85

Holotype: USNM 131209.

Type locality: USGS Mesozoic loc. M394. Northwest side of Hornby Island, British Columbia, on wave cut platform.

Figured specimens: USNM 131209, 131210; GSC 5850, 10051, 10052.

Stratigraphic position: Lambert formation of Nanaimo group.

Subgenus NEODESMOCERAS

Neodesmoceras Matsumoto, 1947, Kyushu Univ., Repts. Dept. Geol., Fac. Sci., v. 2, no. 1, p. 39 (*in* Japanese, fide Matsumoto and Saito, 1954, p. 88). See Matsumoto, 1951, Paleont. Soc. Japan, Trans. Proc., N.S., no. 1, p. 24, for English description).

Type species (original designation): *Pachydiscus* (*Neodesmoceras*) *japonicus* Matsumoto, 1947.

This subgenus includes pachydiscids characterized by a compressed whorl section and by poorly developed ornamentation.

Pachydiscus (Neodesmoceras) obsoletiformis, Jones, n. sp.

Plate 26, figures 1, 4–8; plates 27, 28; text figures 20, 22*A*

Shell discoidal, compressed, moderately umbilicate; whorl height greater than whorl breadth; flanks on early whorls gently rounded with maximum breadth just below midflank; flanks on latter whorls become nearly flat and slightly convergent with maximum breadth just above umbilical shoulder; venter evenly rounded with a tendency to flatten on body whorl. Umbilicus shallow with subvertical wall and rounded shoulder.

Ornamentation is nearly obsolete except for slightly flexiradiate subcostae or growth lines; an occasional irregular, narrow, pinched rib on the septate part of the shell; and very broad, widely spaced, bulgelike swellings on the body chamber of some, but not all, specimens. These swellings begin at the umbilical shoulder and disappear just above midflank (pl. 27). The internal mold is smooth.

The suture line (fig. 20) is complex, with a massive thick-stemmed asymmetrical first lateral saddle and a deep trifid narrow first lateral lobe. This suture differs from that of *Pachydiscus* (*Pachydiscus*) *kamishakensis* by being more massive and less deeply incised.

Pachydiscus (*Neodesmoceras*) *obsoletiformis* differs from other species of *Neodesmoceras* by having a more compressed whorl section with flattened subparallel flanks and a larger umbilicus. For comparison, whorl sections of *N. japonicus* Matsumoto, *N. catarinae* (Anderson and Hanna, 1935) from Baja California, *N. mokotibense* Collignon from Madagascar, *N. obsoletiformis* from Alaska, as well as *Pachydiscus subcompressus obsoletus*, are shown on figures 21 and 22. *P. subcompressus obsoletus* has a similar whorl section but better developed ornamentation than *N. alaskensis*.

Measurements (mm)

Specimen	Diameter	Height	Breadth	Ratio of breadth to height	Width of umbilicus	Umbilicus, percent of diameter
USNM						
131200	210	89	66	0.74	59	28
131198	50	23	17	.74	---	---
Do	67	31	23	.74	---	---
Do	109	50	18.5×2	.74	27	25
131201	---	37	27	.73	---	---
Do	141	61	45	.73	34	24
17	46	21	17	.81	12	26
Do	61	27	21	.78	16	26
Do	72	32.6	25	.77	18.5	26
Do	86	39	30	.77	22	25.6
***Neodesmoceras japonicus*[1]**						
Holotype	327	165	133.4	0.80	70.1	21.4
Do	212.5	99	76.6	.77	44.6	21
Do	143.9	72.1	50.8	.70	30.5	21.2
Paratype	285	135	114.5	.85	54	19
Do	187	95.3	75.5	.79	---	---
Do	---	83	67	.81	---	---
***Pachydiscus subcompressus obsoletus*[2]**						
GH 9460	180	---	---	---	---	---
Do	129.5	58.5	39.5	0.67	29	22.4
Do	86.7	40.8	29.2	.71	25.25	22.3

[1] Matsumoto and Saito, 1954, p. 91.
[2] Matsumoto, 1954, p. 289.

Holotype: USNM 131200.

Type locality: USGS Mesozoic loc. M565.

Figured specimens: USNM 131198, 131200, 131201.

Number of specimens: 10.

Collecting localities: Matanuska Valley–Nelchina area: USGS Mesozoic loc. 24860, 24873, M565, M566, M1033. Cape Douglas area: USGS Mesozoic loc. 25856, 25857.

Stratigraphic position: Upper part of member 3 of Matanuska formation. Kaguyak formation. *Pachydiscus kamishakensis* zone.

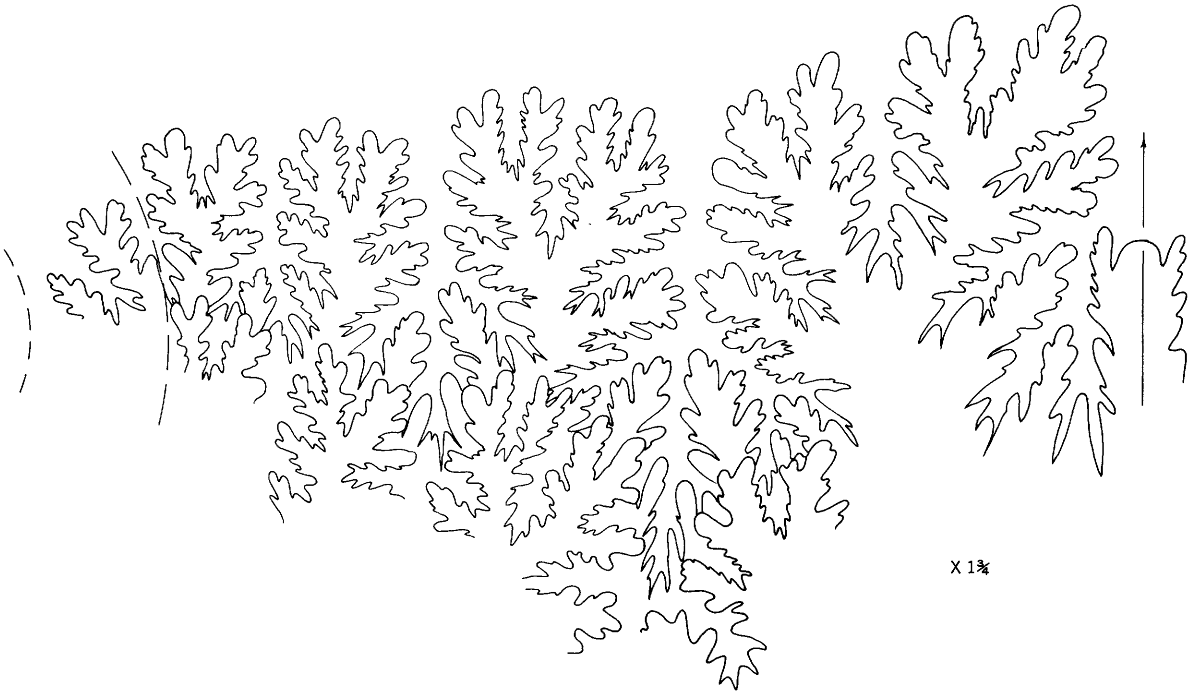


FIGURE 20.—Suture line of *Pachydiscus (Neodesmoceras) obsoletiformis* Jones, n. sp. Holotype USNM 131200 from USGS Mesozoic loc. M565. X 1¾.

Genus CANADOCERAS Spath

Canadoceras Spath, L. F., 1922. Royal Soc. South Africa Trans., v. 10, pt. 3, p. 125.

Type species (original designation): *Ammonites newberryanus* Meek 1858.

The generic characters of *Canadoceras* have been adequately described by Matsumoto (1954, p. 290; 1959b, p. 52), so only a brief summary is presented here. The shell is large, discoidal, and relatively compressed; the umbilical width is fairly narrow to moderate (20 to 38 percent of diameter); the flanks are flattened or gently inflated; and the venter is moderately or narrowly rounded. Ornamentation consists of prominent primary ribs with umbilical bullae, intercalated secondary ribs, and strong periodic constrictions. The suture line is of the usual pachydiscid type, with deeply incised narrow-stemmed saddles and lobes.

Canadoceras newberryanum (Meek)

Plate 36, figures 1–5, 7–10

1858 [1857]. *Ammonites newberryanus* Meek, Albany Instit. Trans., v. 4, p. 47.

1959. *Canadoceras newberryanum* (Meek). Matsumoto, Kyūshū Univ., Mem. Fac. Sci., ser. D, Spec. v. 1, p. 53. (See Matsumoto's paper for complete synonymy.)

Canadoceras newberryanum (Meek), characterized by relatively compressed whorl section, fairly narrow rounded venter, and strong forward-curving ribs, as well as umbilical tubercles and constrictions, is fairly rare in southern Alaska, being found in abundance only in the Chignik Bay area, Alaska Peninsula. One specimen from the Nelchina area is available in the Shell Oil Co. collection in Seattle, Wash. (SOC loc. T1335).

Specimens of *Canadoceras newberryanum* from both Vancouver Island and California show a considerable range in morphologic variation, as was pointed out by Usher (1952b, p. 66) and Matsumoto (1959b, p. 55). This is particularly true in regard to number and prominence of ribs, degree of compression of the whorl section, and width of umbilicus. Chignik Bay specimens likewise are variable, but the wide range in degree of compression of the whorl section is due in part to slight crushing and flattening of many of the specimens. Matsumoto (1959b, p. 55) suggested that some of the Chignik Bay specimens might better be referred to *C. kossmati* Matsumoto (1954, p. 295, pl. 13, figs. 1a, b; pl. 14, figs. 1, 2; pl. 15, fig. 1; pl. 16, figs. 1–3, text figs. 18–25, 27), which differs from *C. newberryanum* by having a less compressed whorl section and a more broadly rounded venter on large specimens.

This difference seems to be minor but may be of subspecific importance, as suggested by Matsumoto (1959b, p. 55). Several specimens from SOC M176, Chignik Bay, have very inflated early whorls with straight, nearly rectilinear ribs and a broad venter. Later whorls are only moderately compressed and seem to fall within the range of variation exhibited by typical specimens of *Canadoceras newberryanum*. More specimens will have to be examined before the proper allocation of these inflated forms can be decided.

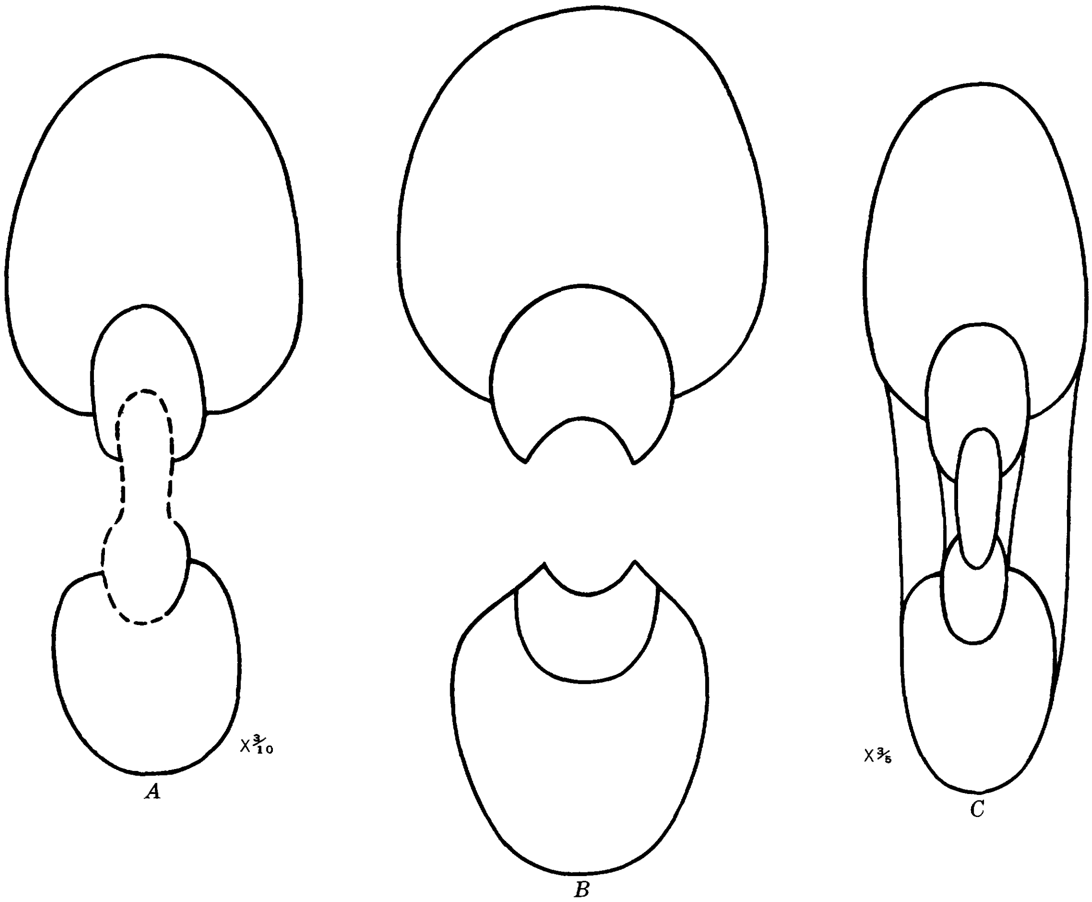


FIGURE 21.—Sections of species of *Pachydiscus Neodesmoceras*. *A*, *P.* (*N.*) *Japonicum* Matsumoto and Saito; *B*, *P.* (*N.*) *Mokotibense* Collignon; *C*, *Pachydiscus subcompressus obsoletus* Matsumoto.

Measurements (mm)

Specimen	Diameter	Height	Breadth	Ratio of breadth to height	Width of umbilicus	Umbilicus percent of diameter
USNM 131214	71	31	26	0.84	19	27
USNM 131213	26	12	11.6	.97	6	23
UC 12490	----------	27	21	.78	----------	----------
3	84	36	29.5	.82	22	26.5
4	32.5	14	5.8×2	.83	8	24.5
SOC M139	49	20	20	1.0	----------	----------
M131	110	42	39	.93	35	32
M342a	----------	34	25	.74	----------	----------
b	115	48	33+	.69+	32	28
c	----------	53	45	.85	----------	----------
d	220	95	35×2	.74	60	27
Do	----------	62	52	.84	----------	----------
SOC M176	----------	36	16×2	.89	----------	----------
Do	----------	10	12.8	1.28	----------	----------
Do	13	6	7	1.16	----------	----------
Do	----------	20	20	1.0	----------	----------
Do	----------	36	31	.86	----------	----------
Do	----------	41	38	.88	----------	----------
SOC T1335	68	28	26	.93	21	31
USNM 12394 [1]	57	24.8	ca. 24.8	1.0	17.8	31
USNM 20146 [2]	76	32	29	.90	22	29
USNM 23009 [2]	91	37	34	.92	27	29.5
5 [3]	94	37	33	.89	29	31

[1] Holotype. Measurements from Matsumoto, 1959b, p. 54.
[2] Specimens from USGS Mesozoic loc. 398, Chico Creek, Calif.
[3] From USGS Mesozoic loc. 19469, Sucia Island, Wash.

Holotype: USMN 12394.

Type locality: "Komooks", Vancouver Island; exact locality unknown.

Figured specimens: USMN 131213, 131214. UC 12490.

Number of specimens: 12.

Collecting localities: Chignik Bay. USGS Mesozoic loc. 13481, 13483, 25702, 25704, 25705, 25706, 25707; SOC–M131, –M138 –M139, –M342. Matanuska valley–Nelchina area, SOC T–1335.

Stratigraphic position: Lower part of member 3 of Matanuska formation. Chignik formation. *Inoceramus schmidti* zone.

Canadoceras yokoyamai (Jimbo)

Plate 36, figure 6; plate 37

1894. *Pachydiscus yokoyamai* Jimbo, Palaeontologische Abhandl., v. 6 [N.F. 2], no. 3, p. 31, pl. 2, figs. 3, 3a, 3b.

1954. *Canadoceras yokoyamai* (Jimbo). Matsumoto, The Cretaceous System in the Japanese Islands, App., p. 302, pl. 13, figs. 2a, b; pl. 17, figs. 1a, b; text fig. 26.

1959. *Canadoceras yokoyamai* (Jimbo). Matsumoto, Kyūshū Univ., Mem. Fac. Sci., ser. D, Spec. v. 1, p. 56, pl. 12, figs. 1a–c; pl. 13, figs. 1a–c, 2; pl. 14, figs. 1a, b; pl. 15, figs. 1a–c. (See Matsumoto's paper for complete synonymy.)

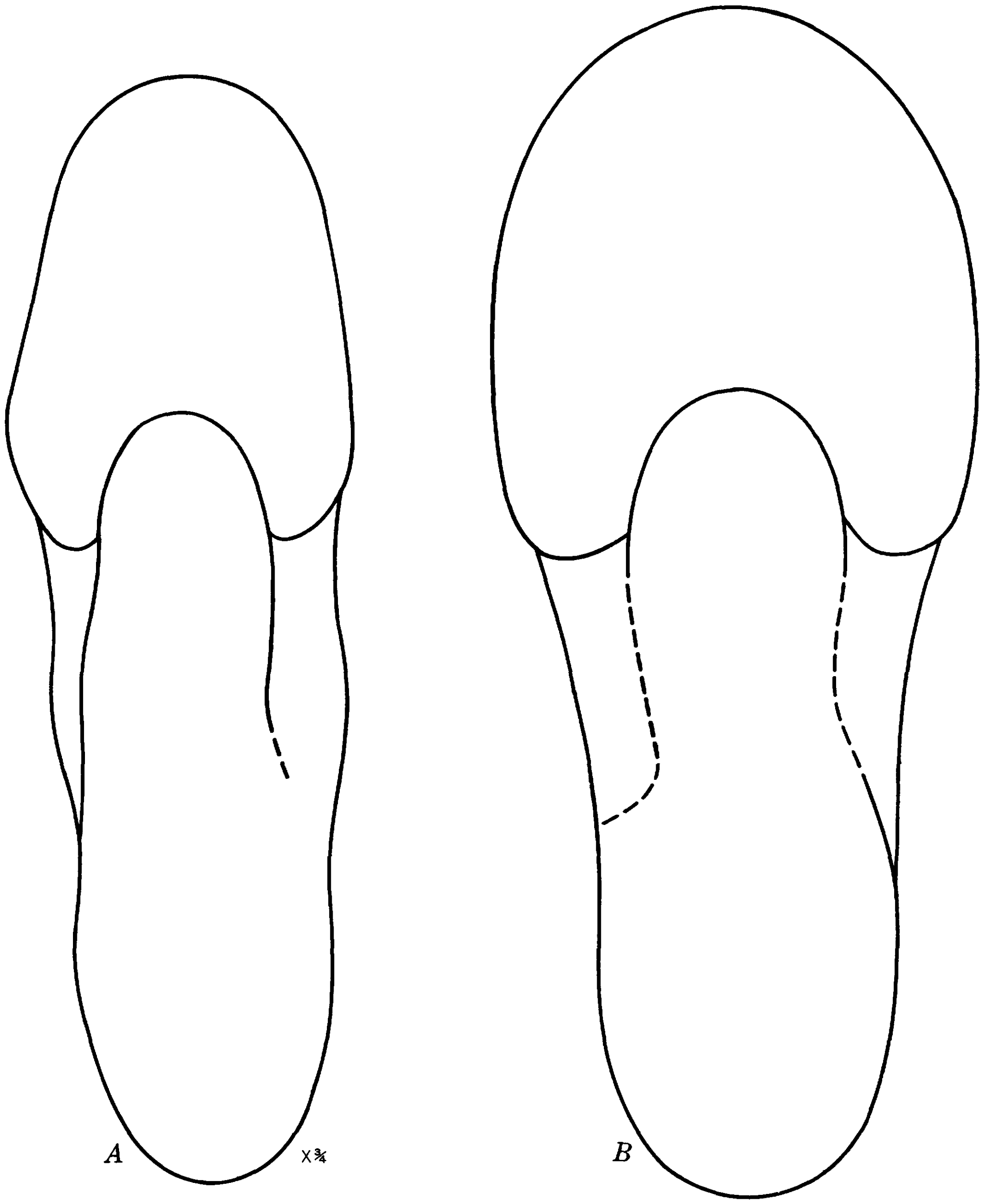


FIGURE 22.—Sections of species of *Pachydiscus* (*Neodesmoceras*). *A*, *P.* (*N.*) *obsoletiformis* Jones n. sp; *B*, *P.* (*N.*) *Catarinae* (Anderson and Hanna).

Only one specimen of *Canadoceras yokoyamai* is in the Survey's collection from Alaska, and this is from USGS Mesozoic locality 5580, Herendeen Bay, Alaska Peninsula. This specimen shows the relatively inflated whorl section and coarse ribs characteristic of *C. yokoyamai*, but its umbilicus is slightly wider than is usual for Japanese specimens. Matsumoto (1959b, p. 57) has shown that some specimens of *Canadoceras yokoyamai* from the Cretaceous of California also have a wide umbilicus; so this difference probably is not significant.

Canadoceras multisulcatum (Whiteaves. 1903, p. 349, pl. 50; Usher, 1952, p. 81, pl. 16, figs. 1–4; pl. 31, fig. 8) is similar in whorl shape to *C. yokoyamai*, and Matsumoto (1959b, p. 57, 58) considered the former species to be a synonym of the latter. However, based on an examination of a plastolectotype and two topotype specimens from Northwest Bay, Vancouver Island, *C. multisulcatum* seems to have consistently finer and more irregular ribbing than does *C. yokoyamai*. This difference may only be of subspecific importance, but it seems to be sufficient to differentiate the two forms.

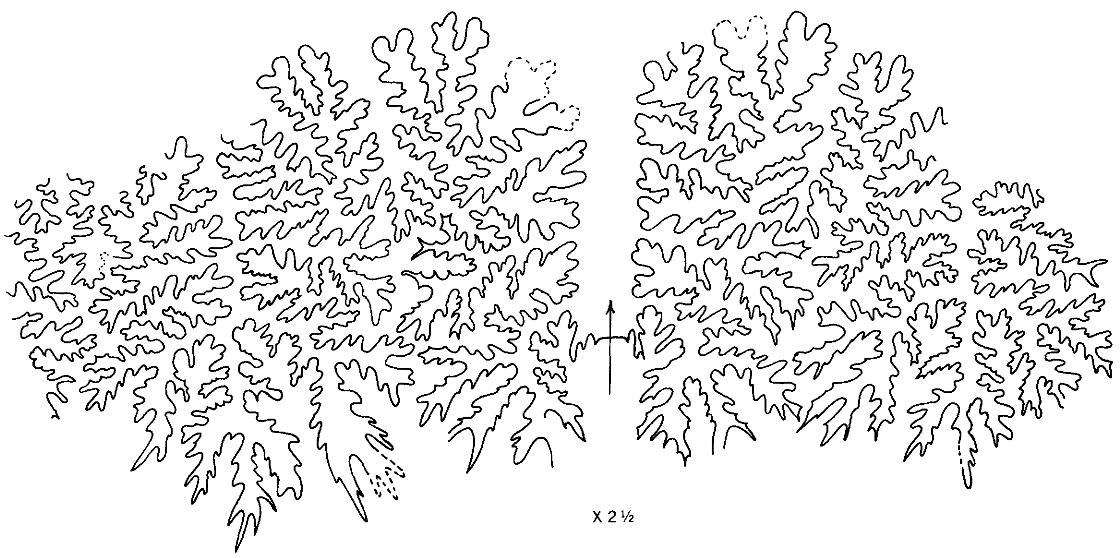


FIGURE 23.—Suture line of *Anapachydiscus nelchinensis* Jones, n. sp. Holotype, USNM 131212, from USGS Mesozoic loc. 24217. Whorl height of 34 mm. × 2½

Measurements (mm)

Specimen	Diameter	Height	Breadth	Ratio of breadth to height	Width of umbilicus	Umbilicus, percent of diameter
USNM 131215	171	71	69	0.97	56	33
Do	----------	43	44	1.0	----------	----------
Do	----------	65	64.5	.99	----------	----------
GT I-103 [1]	44	17	20	1.1	13	29
GT H5182 [1]	119.2	54.1	56	1.0	27.5	23
UC 14938 [2]	203	85.5	77.5	.90	60.7	30
LSJU 8532 [2]	ca. 160	63	62	.98	49	31
	115	44	44.5	1.01	37.8	32
	ca. 85	34.6	35.5	1.02	28.4	33
LSJU 8528 [2]	120	52.4	53.5	1.02	31.8	26
Comparison with *Canadoceras multisulcatum* (Whiteaves)						
GSC 5856 [3]	190	84	78	0.93	53	28
USGS M400 [4]	162	70	35×2	1.0	47	29

[1] Holotype. Matsumoto, 1954, p. 303.
[2] Matsumoto, 1959b, p. 56.
[3] Lectotype. Usher, 1952, p. 81.
[4] Topotype from USGS Mesozoic loc. M400, Northwest Bay, Vancouver Island, B.C.

Holotype: GT I–103.

Type locality: "Tsiptaushibets, a branch of the Tumbets, Kitami province, Hokkaido" (Matsumoto, 1959b, p. 56).

Figured specimen: USNM 131215 from USGS Mesozoic loc. 5580.

Collecting locality: Herendeen Bay Area: USGS Mesozoic loc. 5580.

Stratigraphic position: Chignik formation, Herendeen Bay. *Inoceramus schmidti* zone.

Genus ANAPACHYDISCUS Yabe and Shimizu

Anapachydiscus Yabe and Shimizu, 1926, Imp. Acad. Japan Proc., v. 2, no. 4, p. 172.

Type species (original designation): *Pachydiscus* (*Parapachydiscus*) *fascicostatum* Yabe and Shimizu, 1921.

Anapachydiscus includes species characterized by large size, by very depressed whorls throughout all stages of growth, and by a fairly narrow umbilicus. Ornamentation is usually weak, consisting of umbilical tubercles and radial ribs. Early whorls may be constricted, and one species, *A. naumanni* (Yokoyama), bears constrictions on later whorls.

Representatives of this genus in Japan are most common in rocks of Santonian age, but in California and Madagascar they are abundant in rocks of Campanian age (Matsumoto, 1954, p. 273; 1959b, p. 38; Besairie and Colligon, 1956, p. 45, 46). In Alaska, only a few specimens are known from Campanian rocks of the Matanuska Valley–Nelchina area.

Anapachydiscus nelchinensis Jones, n. sp.

Plate 32; plate 35, figures 4, 7–9; text figure 23

Shell large, inflated; whorls depressed, breadth greater than height, lunate in cross section with broadly rounded venter, inflated flanks, rounded umbilical shoulder and sloping umbilical wall; greatest whorl breadth just above umbilical shoulder.

Ornamentation very weak, consisting of a few low irregular pinched umbilical bullae and radial ribs which rise on the umbilical wall and extend to about midflank; these ribs number 6 to 9 per whorl. Interbullate area, upper flanks, and venter ornamented only with slightly sigmoidal growth lines on outer layer of shell; internal mold smooth. On large specimens (pl. 34, fig. 1, 2) ornamentation consists of irregular low broad bulges which rise on the umbilical shoulder and extend to above midflank. Ornamentation on early whorls at whorl height less than about 15 mm not known.

External suture line (fig. 23) consists first of three, later of four, massive deeply cut saddles and narrow lobes. First lateral lobe extremely narrow and slightly longer than ventral lobe.

Anapachydiscus nelchinensis n. sp. differs from other species of *Anapachydiscus* by being nearly smooth throughout all stages of growth and by lacking well-developed ribs and umbilical tubercles on early whorls. *A. steinmanni* (Paulcke, 1907, p. 64 [230], pl. 18, figs.1, 1a) from Lago Amargo, Patagonia, has a nearly identical whorl section but differs from *A. nelchinensis* by having strong ribs on the early whorls and weak primary and secondary ribs on the later whorls. *A. naumanni* (Yokoyama, 1890, p. 187, pl. 19, fig. 6; pl. 22, fig, 1) has a more depressed whorl section, coarser ornamentation, and is constricted. *A. fascicostatus* (Yabe and Shimizu) is closely related but has better developed ribs and tubercles.

Measurements (mm)

Specimen	Diameter	Height	Breadth	Ratio of breadth to height	Width of umbilicus	Umbilicus, percent of diameter
USNM 131212 (Holotype)	67	27	36	1.32	18	27
Do	----------	20	27	1.34	----------	----------
Do	91	37	47	1.28	24	26.5
USNM 131211	----------	80	95	1.18	----------	----------

Holotype: USNM 131212.

Type locality: USGS Mesozoic loc. 24217, Matanuska Valley–Nelchina area.

Figured specimens: USNM 131211, 131212.

Number of specimens: 5.

Collecting localities: Matanuska Valley–Nelchina area: USGS Mesozoic loc. 8586, 24217, 25386.

Stratigraphic position: Member 3 of Matanuska formation. Probably lower to perhaps middle part of member, but upper limit not positive. Loc. 25386 definitely in Zone of *Inoceramus schmidti.* Localities 8586 and 24217 in upper part of Zone of *Inoceramus schmidti* or lowermost Zone of *Pachydiscus kamishakensis.*

Genus PATAGIOSITES Spath

Patagiosites Spath, L. F., 1953, Falkland Islands Dependencies Survey, Sci. Rept. 3, p. 38.

Type species (original designation): *Ammonites patagiosus* Schluter, 1867.

The original diagnosis (Spath, 1953, p. 38) of *Patagiosites* is as follows:

> "Pachydiscid, with Puzosid features still evident. Deep constrictions presisting to adult, but ornamentation (umbilical ribs or tubercles and then long or short, peripheral or lateral ribs) becoming feeble or disappearing altogether. About eight constrictions per whorl, destinctly projected forward at middle of broadly arched periphery. Intermediate ribs very irregular or faint, Suture-line unknown, of Puzosid type and almost certainly less advanced than that of *Anapachydiscus* or *Pachydiscus* s. s."

Ammonites patagiosus is known from three specimens, two figured by Schlüter (1867, pl. 4, figs. 4, 5; fide Spath, 1953, p. 38) and one figured by Schlüter (1872, pl. 20, figs. 7, 8). Schlüter's paper of 1867, which contains a figure of the lectotype, designated by Spath (1953, p. 39) as plate 4, figure 4, is unavailable to this writer, so the following remarks are based only on Schlüter's specimen illustrated in 1872 (pl. 20, figs. 7, 8). This specimen, which is somewhat deformed, has a depressed whorl section, inflated flanks, and a broadly rounded venter. Constrictions are deep, prorsiradiate, and projected on the venter. Three to 5 irregular ribs are present between successive constrictions. In whorl shape, both this species and *Patagiosites amarus* (Paulcke, 1907, pl. 17, fig. 5) from Patagonia, show a strong similarity to *Anapachydiscus.* Matsumoto (1954, p. 294; 1959b, p. 60), however, postulated a closer relationship to *Canadoceras,* but this seems difficult to accept for the inflated round-whorled forms that include the type species, although it may be true for a group of compressed species known from California, Japan, and Alaska. *Patagiosites,* as now understood, may thus be a polyphyletic genus.

Patagiosites alaskensis Jones, n. sp.

Plates 38–40; plate 41, figures 1, 3, 7, 9; text figures 24, 25

Shell discoidal, compressed, attaining large size, fairly narrowly umbilicate; flanks subparallel, gently inflated to nearly flat; venter evenly rounded; umbilical shoulder abruptly rounded, umbilical wall sloping; greatest whorl breadth above umbilical shoulder in lower one-third of flanks.

Ornamentation consists of deep periodic constrictions and irregular weakly to moderately developed ribs. Constrictions, which number 5 to 7 per whorl, rise at the umbilical seam and are strongly projected backward on crossing the umbilical wall but bend forward on the umbilical shoulder and cross the flanks with a slightly prorsiradiate course. At the ventrolateral shoulder they again bend forward and cross the venter with slight to moderate projection. On early whorls, constrictions are bordered on both sides by prominent ridges. At large shell diameters, both the ridges and the constrictions become progressively weaker and finally disappear.

Ribs rise on the umbilical shoulder or umbilical wall and run about parallel to the constrictions on the flanks and venter, where they tend to weaken. Development of the ribs is variable, not only from specimen to specimen, but also between the different growth stages of a single individual. Early whorls may be smooth (pl. 41, fig. 7) or have quite prominent ribs. (pl. 39). On middle growth stages (pl. 38), ribs are invariably present, but they tend to be irregularly developed. At large shell diameters (pl. 40; pl. 41, figs. 1, 8), ornamentation becomes obsolete and consists of broad shallow poorly defined constrictions and low bordering ridges. Umbilical tubercles are lacking at all stages of growth.

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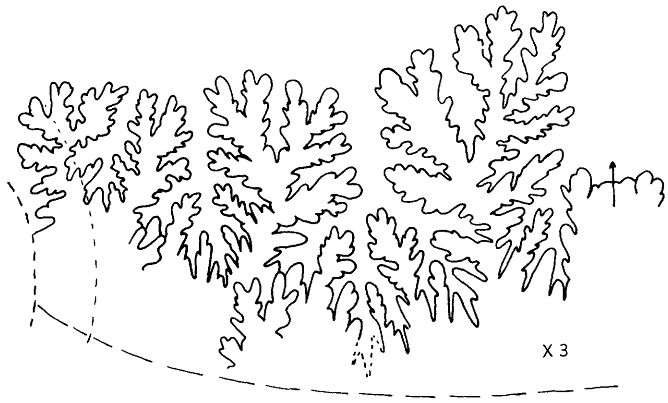

FIGURE 24.—Suture line of *Patagiosites alaskensis* Jones, n. sp. Paratype USNM 131216 from USGS Mesozoic loc. 24861. Dashed line marks position of constriction. Whorl height of 20 mm. X 3.

The suture line (figs. 24 and 25) is typical of pachydiscids and includes finely and deeply cut thin-stemmed saddles and narrow deep lobes. The first lateral lobe is slightly deeper than the ventral lobe.

Patagiosites alaskensis n. sp. differs from *P. patagiosus* (Shlüter) primarily by having a much more compressed whorl section, with flatter flanks and a larger umbilicus. Ornamentation of the two species, however, is generally similar. *Patagiosites amarus* (Paulcke, 1907, p. 61, pl. 17, fig. 5), from south Patagonia, and *P.* cf. *P. amarus* (Spath, 1953, p. 39, pl. 10, fig. 7), from Graham Land, Antarctica, differ from the Alaskan species by having a more inflated whorl section with rounded flanks and stronger ornamentation with well-developed umbilical bullae on some of the major ribs.

Patagiosites arbucklensis (Anderson, 1958, p. 223; see Matsumoto, 1959b, p. 60, pl. 16, fig. 1; pl. 17, figs. 1, 2, for a discussion of Anderson's species) is somewhat more inflated than the Alaskan species and also has well-developed umbilical tubercles, more prominent ribs, and less conspicuous constrictions.

Patagiosites alaskensis is closely related to *P. compressus* (Matsumoto, 1954, p. 310, pl. 20, figs. 1–3) from the Maestrichtian of Japan. Unfortunately, published information concerning this species is insufficient for an adequate specific diagnosis; the only figured specimens are either small or fragmentary. In general shell form, the two species seem to be fairly similar, although the Japanese species is somewhat more compressed. (See measurements.) Also, the umbilical wall of *P. compressus* is described (Matsumoto, 1954, p. 310) as gently sloping in early growth stages and perpendicular in later stages; in contrast, *P. alaskensis* has a subvertical umbilical wall in early stages and a sloping wall in later stages. *P. compressus* also differs by having more prominent ribs, at least in early growth stages, and by having more prominent umbilical bullae on ribs that border constrictions.

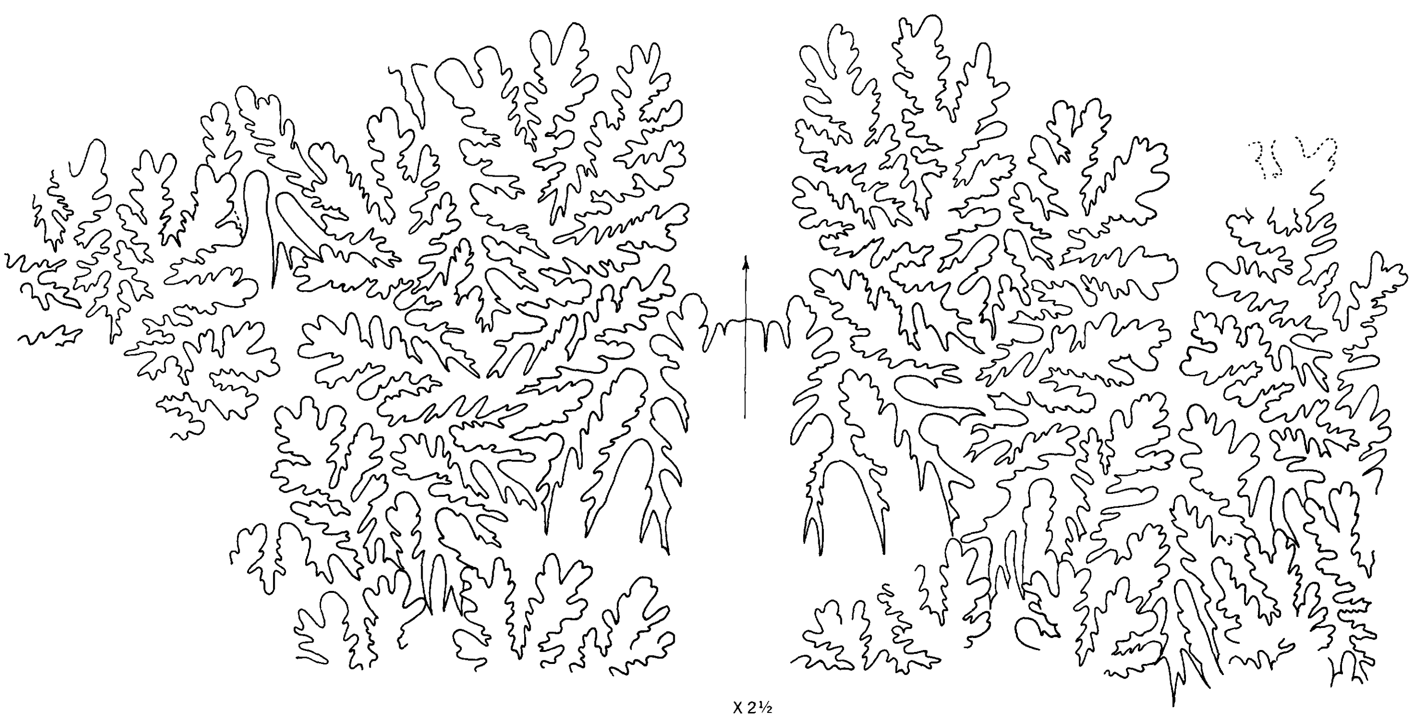

FIGURE 25.—Suture line of *Patagiosites alaskensis* Jones, n. sp. Paratype USNM 131216 from USGS Mesozoic loc. 24861. Whorl height of 48 mm. X 2½.

Measurements (mm)

Specimen	Diameter	Height	Breadth	Ratio of breadth to height	Width of umbilicus	Umbilicus, percent of diameter
1	52	21	16	0.76		
Do	65	26	20	.77	20	31
Do	81	34	25	.74	24	30
2	91	41	31	.76		
3	279	114	77+	.675+	84	30
Do		87	66	.76		
Do		80	60	.75		
USNM 131216	64	25	19	.76	21	33
Do	81	33	25	.76	27	33.4
Do	170	69	27×2	.78	54	32
Do		52	38	.73		
4		39	30	.77		
USNM 131218	278	118	80	.68	83	30
Do	373	162	108	.67	105	28
H3831 [1]	13.9	6.1	5.1	.83-.84	4.0	28.7
H3830 [1]	69.0	29.2	17.2	.59	23.8	34.5
H3832 [1]	150.0	61.3	31.7	.52	74	31.3

[1] Measurements of *P. compressus* (Matsumoto, 1954, p. 310).

Holotype: USNM 131218.

Type locality: USGS Mesozoic loc. M560.

Figured specimens: USNM 131216, 131217, 131218.

Number of specimens: 14.

Collecting localities: Matanuska valley–Nelchina area: USGS Mesozoic loc. 24214, 24861, 24870, 24871, 25327, M551, M552, M560.

Stratigraphic position: Upper part of member 3 of Matanuska formation. *Pachydiscus kamishakensis* zone.

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INDEX

[Italic numbers indicate descriptions]

PLATES 6–41

PLATE 6

[All figures natural size except as indicated]

FIGURES 1–8. *Neophylloceras ramosum* (Meek) (p. 22).

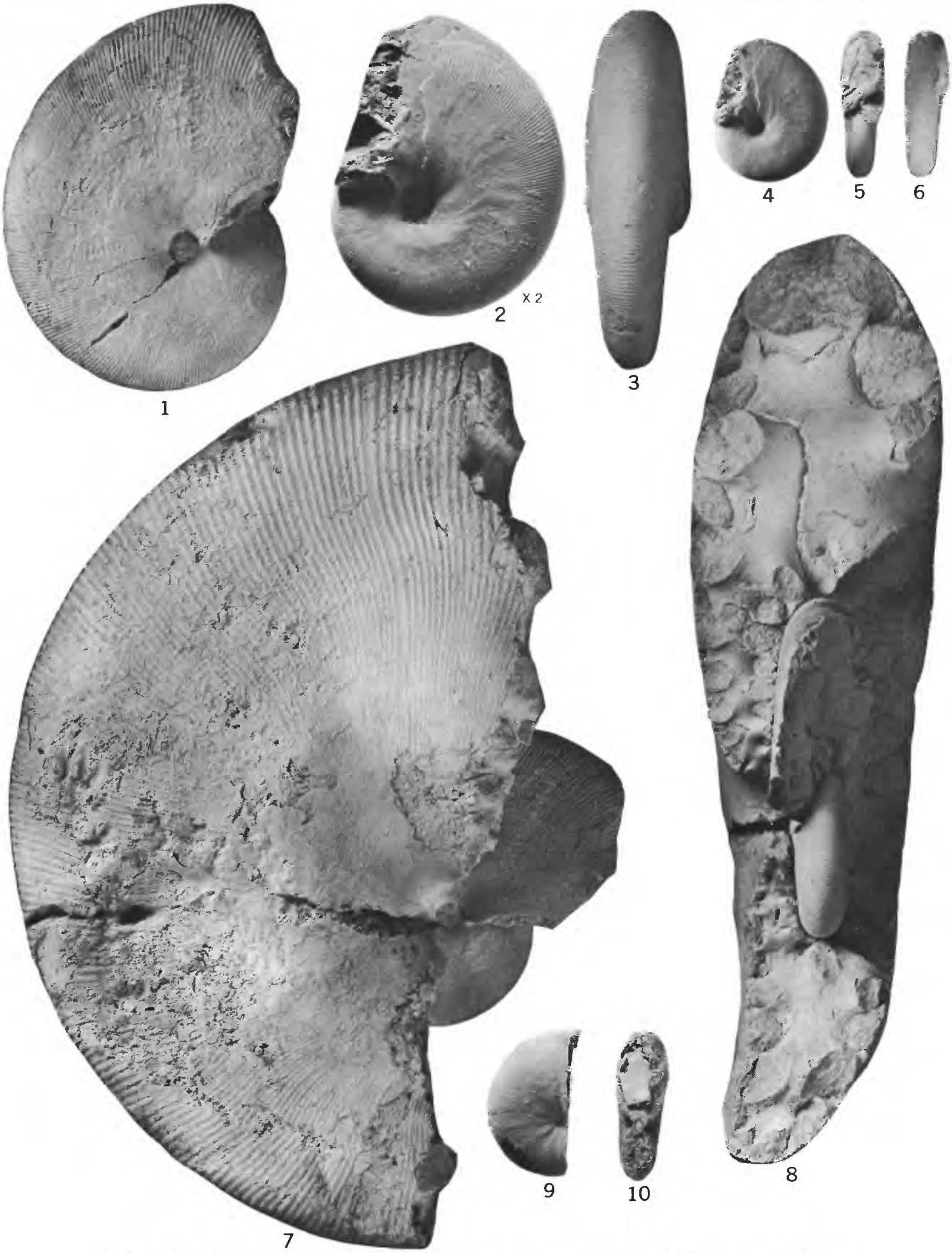
1, 3. Side and back views of inner whorls of plesiotype USNM 131172 from USGS Mesozoic loc. M562.

2, 3, 5, 6. Side, front, and back views of plesiotype USNM 131173 from USGS Mesozoic loc. 25325; fig. 2 × 2.

7, 8. Side and front view of plesiotype USNM 131172.

9–10. *Neophylloceras hetonaiense* Matsumoto (p. 23).

Side and front views of plesiotype USNM 131174 from USGS Mesozoic loc. 8562.



NEOPHYLLOCERAS RAMOSUM (MEEK) AND *N. HETONAIENSE* MATSUMOTO

PLATE 7

[All figures natural size except as indicated]

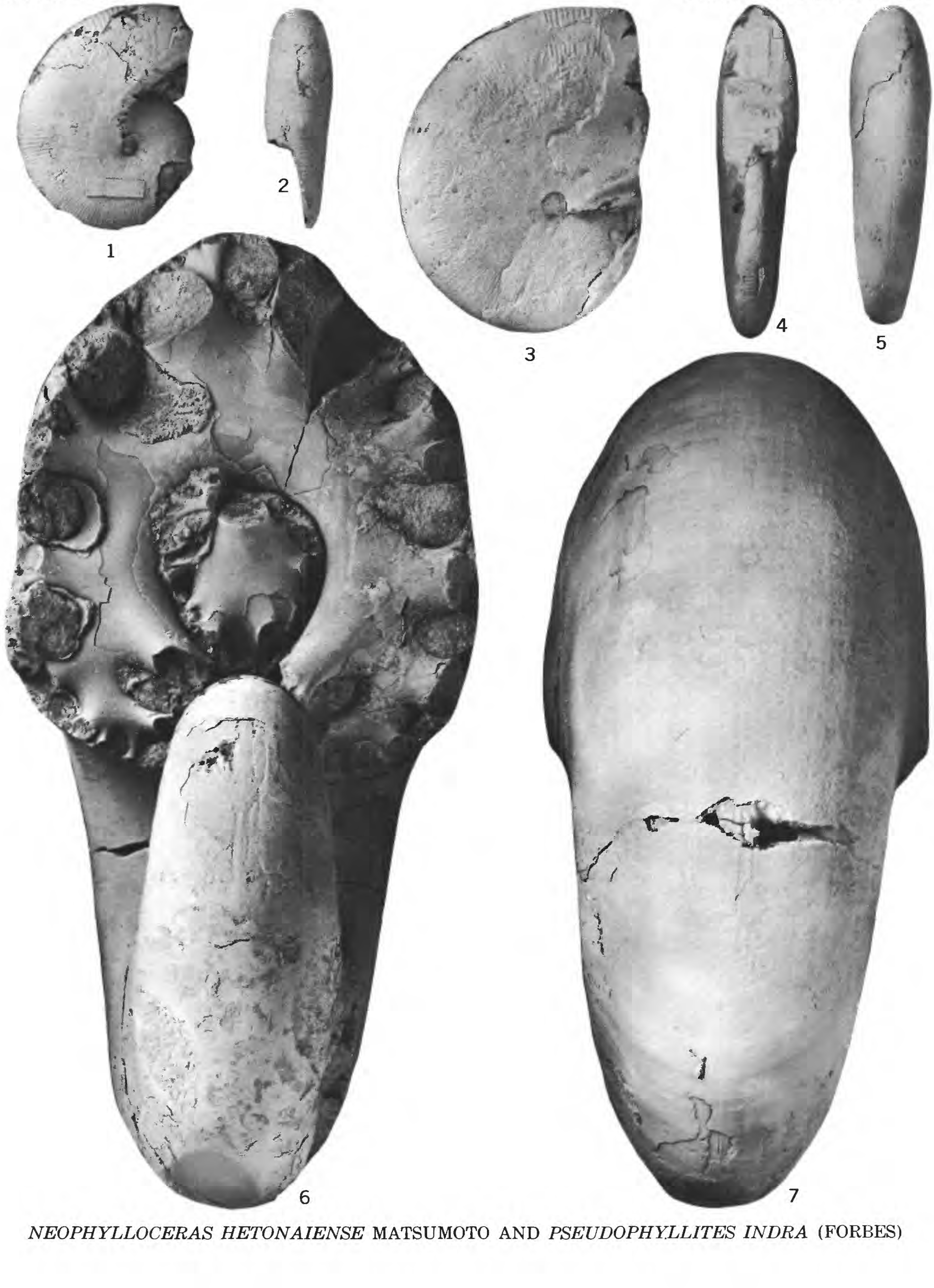
FIGURES 1–5. *Neophylloceras hetonaiense* Matsumoto (p. 23)

1, 2. Side and back views of plesiotype USNM 131175 from USGS Mesozoic loc. 24861.

3, 4, 5. Side, front, and back views of slightly crushed plesiotype USNM 131176 from USGS Mesozoic loc. 24861.

6–7. *Pseudophyllites indra* (Forbes) (p. 25).

Front and back views of plesiotype USNM 131177 from USGS Mesozoic loc. M562.



NEOPHYLLOCERAS HETONAIENSE MATSUMOTO AND *PSEUDOPHYLLITES INDRA* (FORBES)

PLATE 8

[All figures natural size except as indicated]

FIGURES 1–4. *Pseudophyllites indra* (Forbes) (p. 25).
1, 2, 4. Side, front, and back views of inner whorls of plesiotype USNM 131177.
3. Side view of outer whorl of plesiotype USNM 131177 from USGS Mesozoic loc. M562.

1

2

3

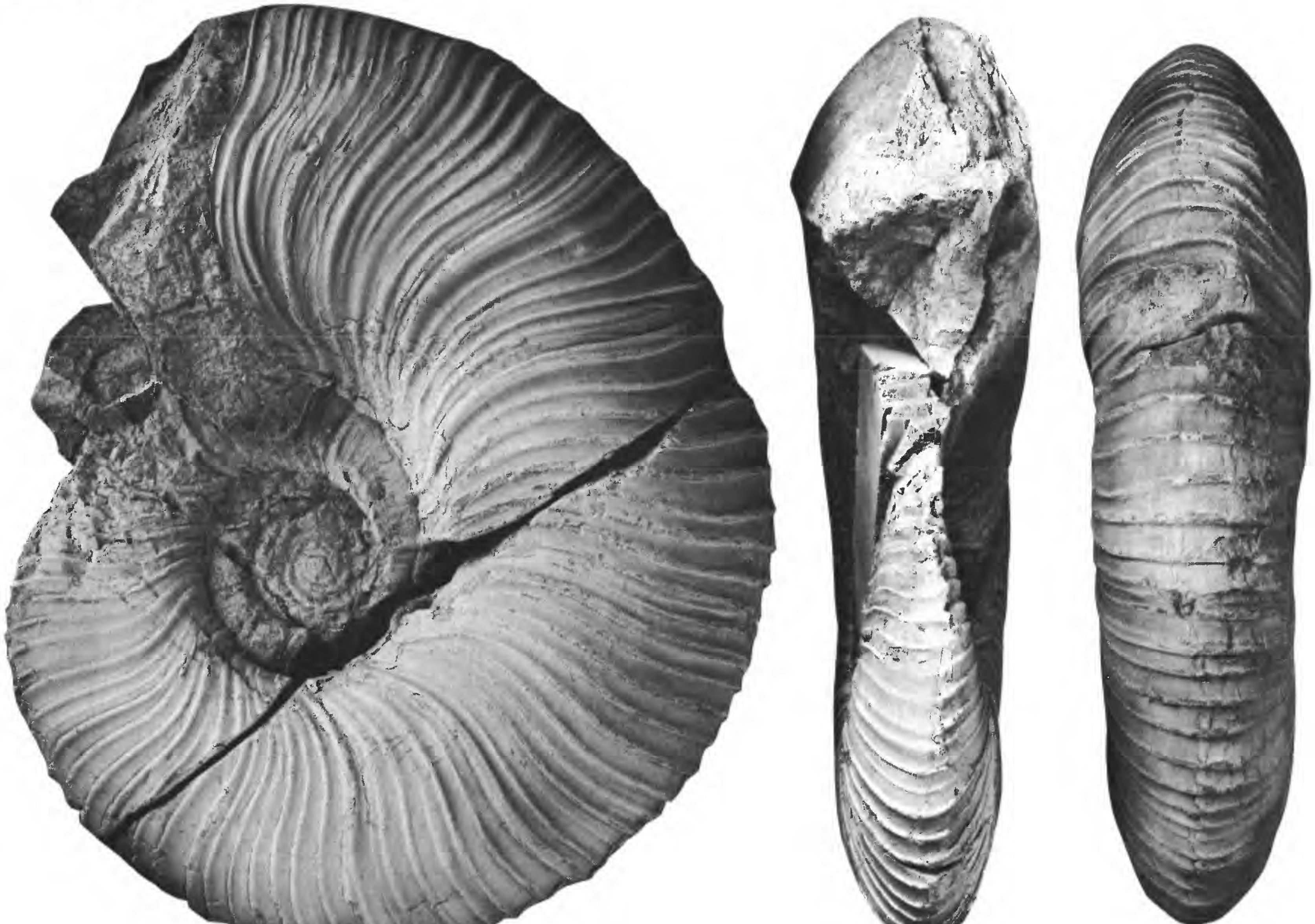
4

PSEUDOPHYLLITES INDRA (FORBES)

PLATE 9

[All figures natural size except as indicated]

FIGURES 1–3. *Gaudryceras tenuiliratum* Yabe (p. 26).
Side, front, and back views of plesiotype USNM 131178 from USGS Mesozoic loc. 24861.



1 2 3

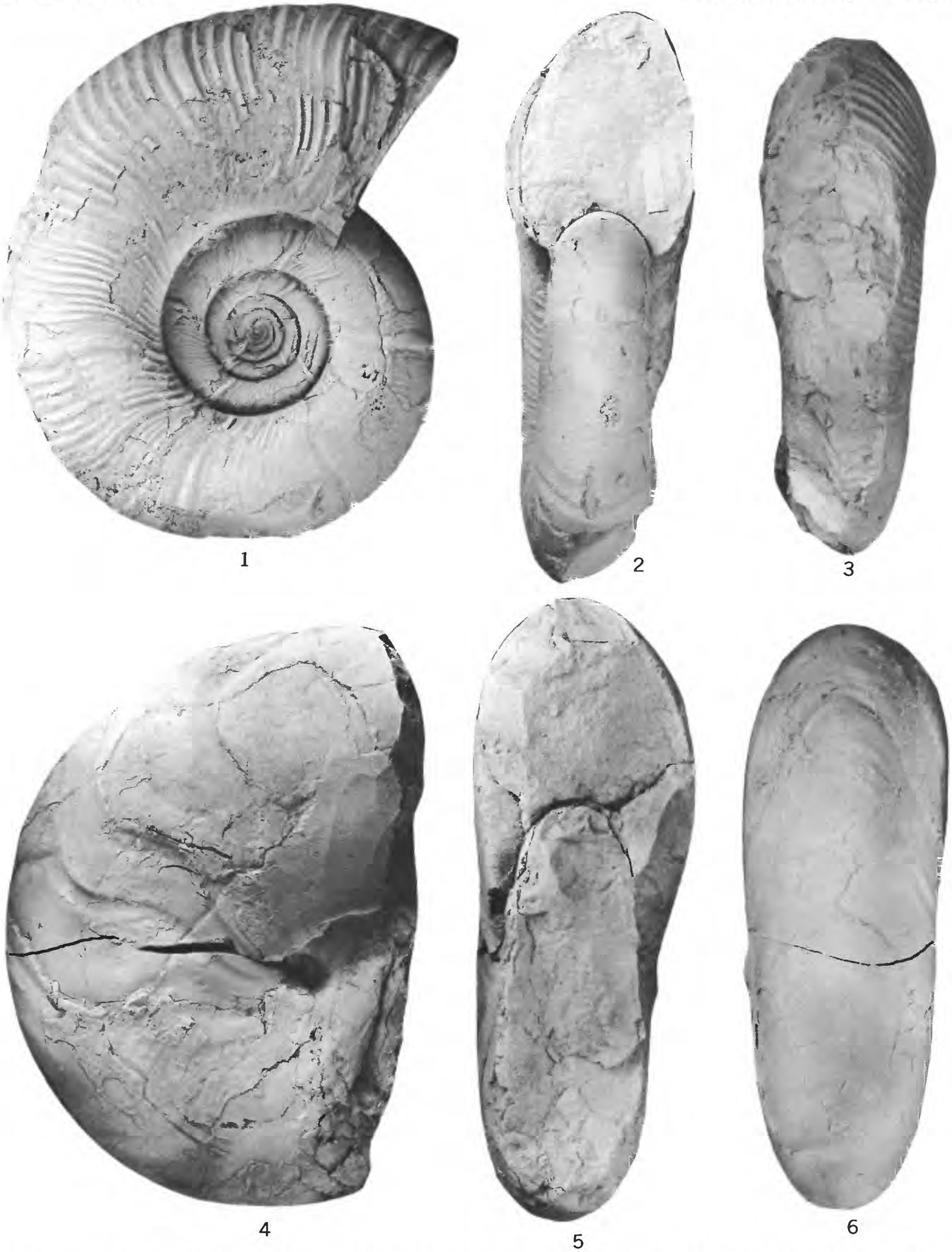
GAUDRYCERAS TENUILIRATUM YABE

PLATE 10

[All figures natural size except as indicated]

FIGURES 1–3. *Gaudryceras tenuiliratum* Yabe (p. 26).
Side, front, and back views of plesiotype USNM 131179 from USGS Mesozoic loc. 24209.

4–6. *Desmophyllites phyllimorphym* (Kossmat) (p. 34).
Side, front, and back views of plesiotype USNM 131180 from USGS Mesozoic loc. 24227.



GAUDRYCERAS TENUILIRATUM YABE AND *DESMOPHYLLITES PHYLLIMORPHUM* (KOSSMAT)

PLATE 11

[All figures natural size except as indicated]

FIGURES 1–3. *Baculites occidentalis* Meek (p. 28).
Side, dorsal, and ventral views of plesiotype USNM 131181 from USGS Mesozoic loc. M565.


1


2


3

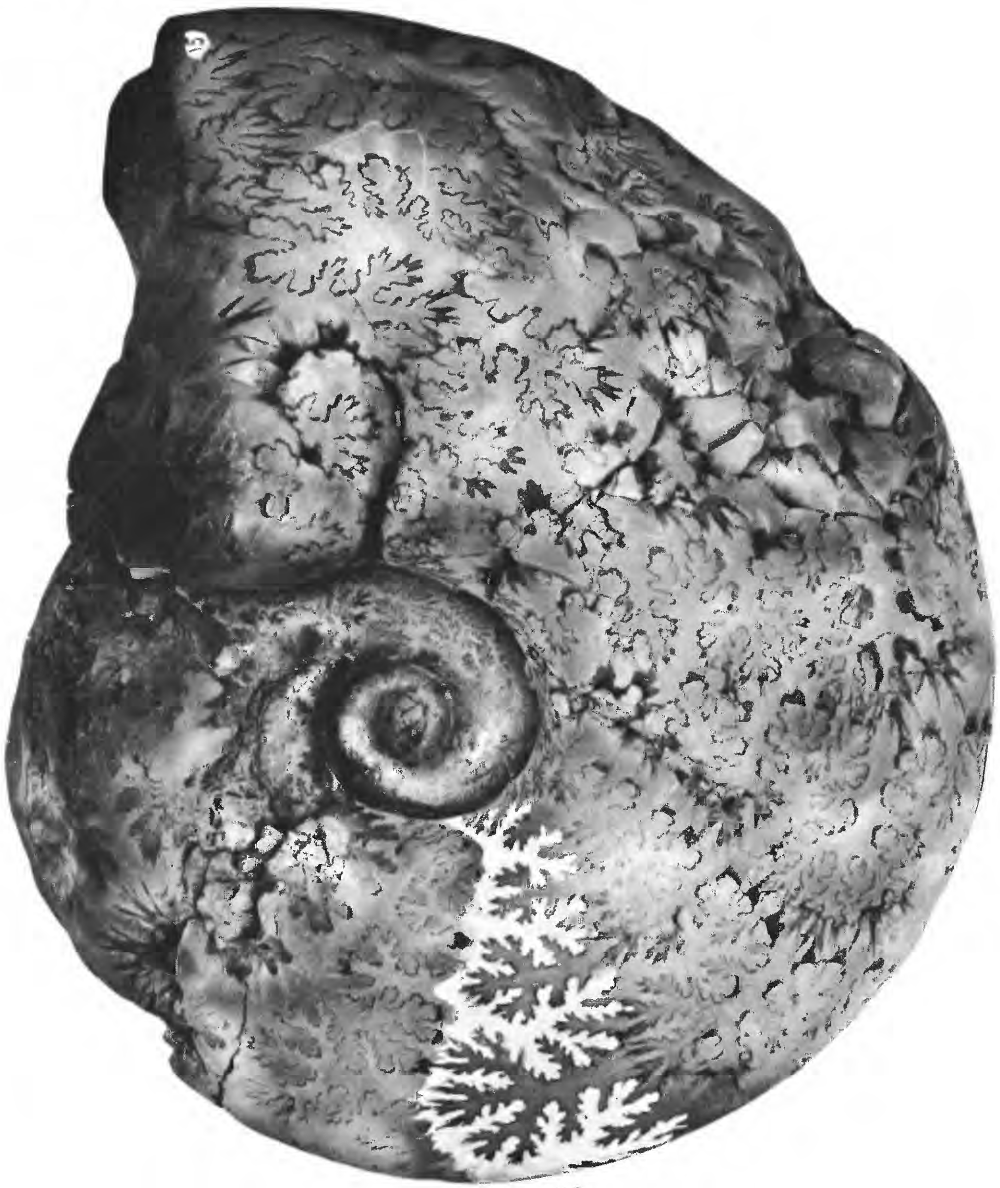
BACULITES OCCIDENTALIS MEEK

PLATE 12

[All figures natural size except as indicated]

FIGURES 1, 2. *Pachydiscus* (*Pachydiscus*) *hazzardi* Jones, n. sp. (p. 36).
Side and front view of paratype USNM 131182 from Union Oil Co. loc. JCH 1754, Kaguyak Bay; exact position unknown. × 2/3.

667-159 O - 63 - 4



1 X 2/3

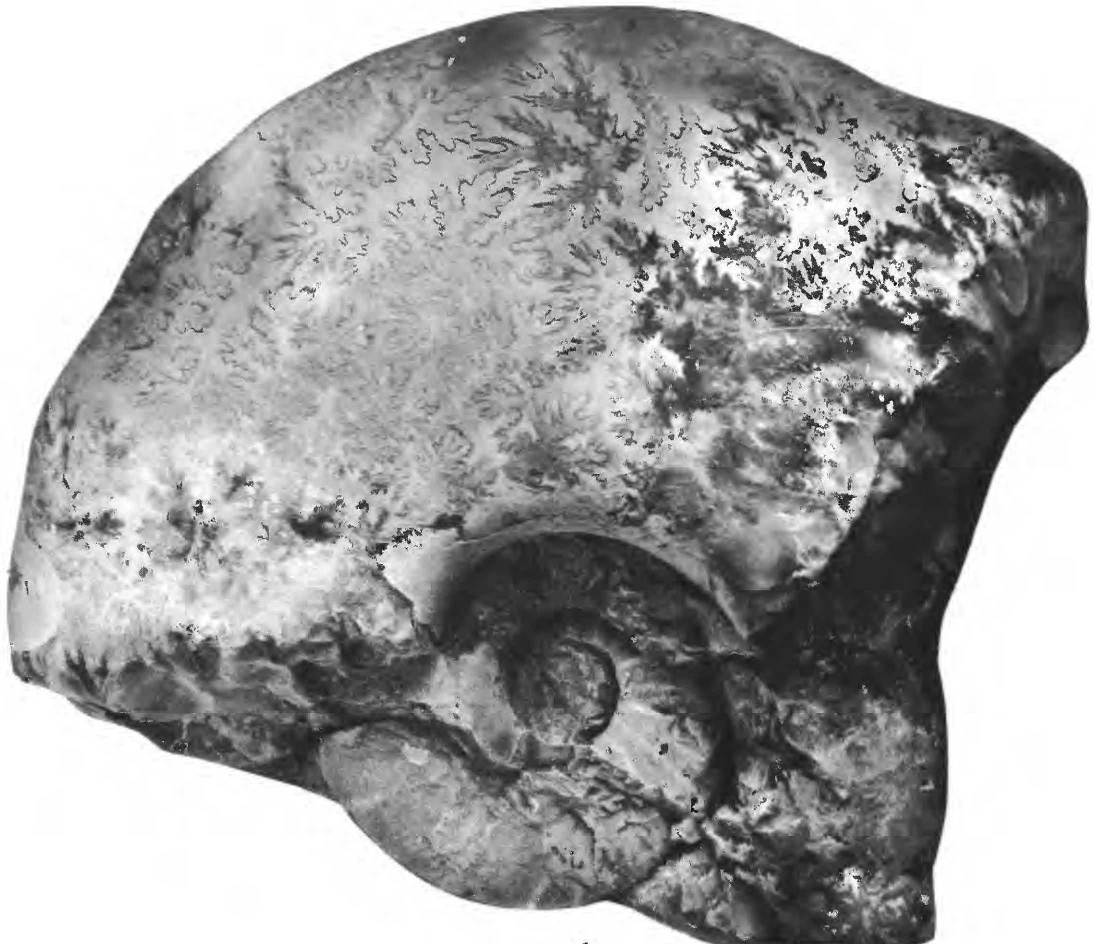
2 X 2/3

PACHYDISCUS (PACHYDISCUS) HAZZARDI JONES, N. SP.

PLATE 13

[All figures natural size except as indicated]

FIGURES 1, 2. *Pachydiscus* (*Pachydiscus*) *hazzardi* Jones, n. sp. (p. 36).
Paratype USNM 131183 from Union Oil Co. loc. JCH 1753.



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PACHYDISCUS (PACHYDISCUS) HAZZARDI JONES, N. SP.

PLATE 14

[All figures natural size except as indicated]

FIGURES 1, 2. *Pachydiscus* (*Pachydiscus*) *hazzardi* Jones, n. sp. (p. 36).
Side and back views of same specimen figured on plate 13. Paratype USNM 131183 from Union Oil Co. loc. JCH 1753.

1

2

PACHYDISCUS (PACHYDISCUS) HAZZARDI JONES, N. SP.

PLATE 15

[All figures natural size except as indicated]

FIGURES 1–3. *Pachydiscus* (*Pachydiscus*) *hazzardi*? (p. 36).

Side, front, and back view of figured specimen USNM 131184 from USGS Mesozoic loc. 25856; intermediate between *P.* (*P.*) *hazzardi* and *P.* (*P.*) *kamishakensis* Jones, n. sp. × 3/4.

PACHYDISCUS (PACHYDISCUS) HAZZARDI?

PLATE 16

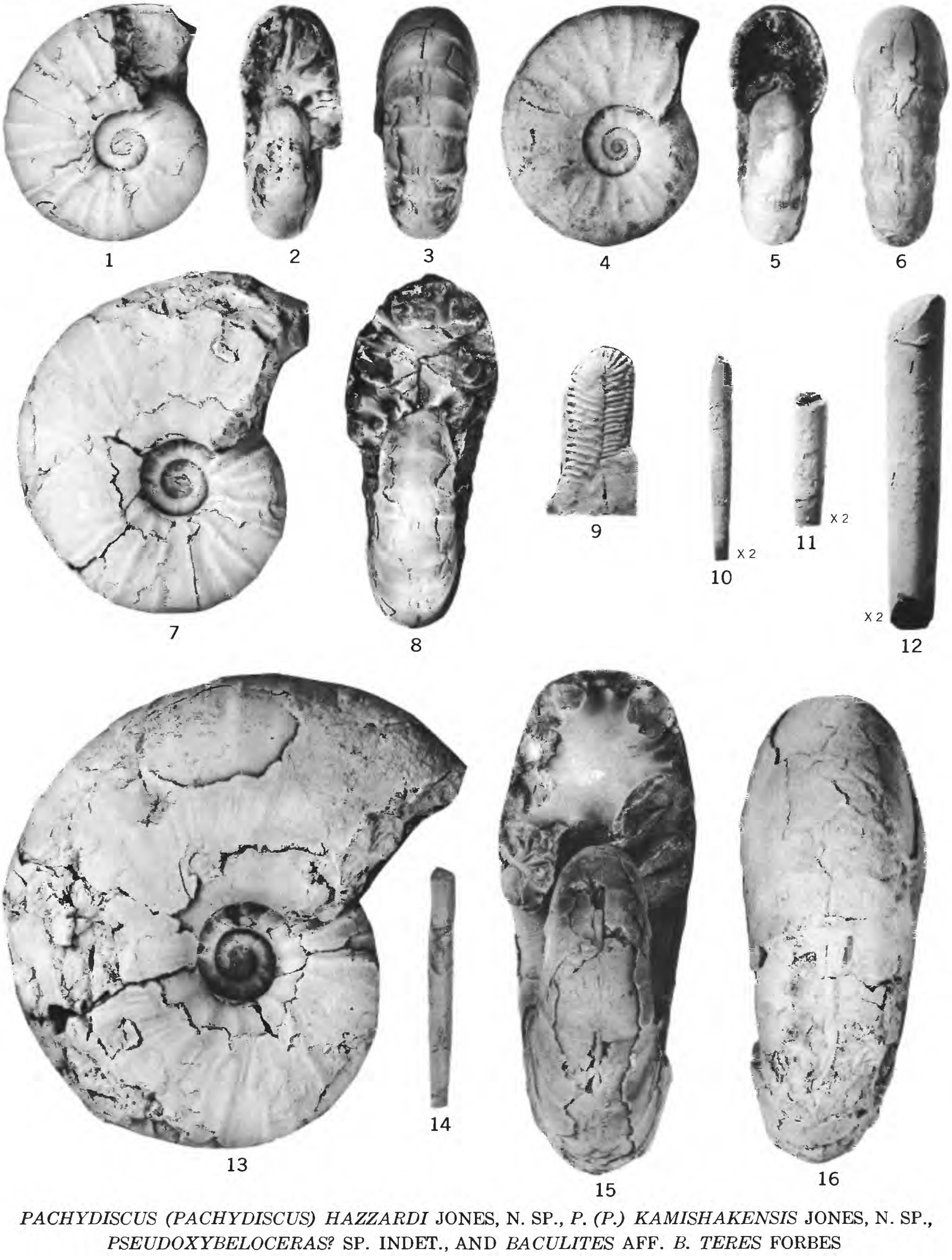
[All figures natural size except as indicated]

FIGURES 1–3, 7, 8, 13, 15, 16. *Pachydiscus (Pachydiscus) hazzardi* Jones, n. sp. (p. 36).
Holotype, USNM 131185 from Union Oil Co. loc. JCH 1754.
1–3. Side, front, and back views of inner whorls.
7, 8. Side and front views of same specimen with one-half whorl added, showing obsolescence of ornamentation.
13, 15, 16. Side, front, and back views of same specimen with another one-half whorl added.

4–6. *Pachydiscus (Pachydiscus) kamishakensis* Jones, n. sp. (p. 35).
Side, front, and back views of paratype USNM 131186 from USGS Mesozoic loc. M562. One-fourth whorl removed.

9. *Pseudoxybeloceras*? sp. indeterminate (p. 31).
Figured specimen, USNM 131187 from USGS M578.

10–12, 14. *Baculite* aff. *B. teres* Forbes (p. 29).
10. Figured specimen USNM 131188a from USGS Mesozoic loc. M558. × 2.
11. Figured specimen USNM 131188b from USGS Mesozoic loc. M558. × 2.
12. Figured specimen USNM 131188c from USGS Mesozoic loc. M558. × 2.
14. Figured specimen USNM 131189 from USGS Mesozoic loc. 582.



PACHYDISCUS (PACHYDISCUS) HAZZARDI JONES, N. SP., *P. (P.) KAMISHAKENSIS* JONES, N. SP., *PSEUDOXYBELOCERAS?* SP. INDET., AND *BACULITES* AFF. *B. TERES* FORBES

PLATE 17

[All figures natural size except as indicated]

FIGURES 1–6. *Pachydiscus* (*Pachydiscus*) *kamishakensis* Jones, n. sp. (p. 35).
1–3. Side, front, and back views of paratype USNM 131190 from Mesozoic loc. 16398.
4–6. Side, front, and back views of paratype USNM 131191 from USGS Mesozoic loc. M565. Front and back views with outer part of body chamber removed.


1


2


3


4


5


6

PACHYDISCUS (PACHYDISCUS) KAMISHAKENSIS JONES, N. SP.

PLATE 18

[All figures natural size except as indicated]

FIGURES 1, 2. *Pachydiscus* (*Pachydiscus*) *kamishakensis* Jones, n. sp. (p. 35).

Side and back view of paratype USNM 131192 from USGS Mesozoic loc. 25856. See plate 19 for views of front and other side.

1

2

PACHYDISCUS (PACHYDISCUS) KAMISHAKENSIS JONES, N. SP.

PLATE 19

[All figures natural size except as indicated]

FIGURES 1, 2. *Pachydiscus* (*Pachydiscus*) *kamishakensis* Jones, n. sp. (p. 35).
Side and front view of paratype USNM 131192 from USGS Mesozoic loc. 25856. See plate 18 for views of back and other side.

1

2

PACHYDISCUS (PACHYDISCUS) KAMISHAKENSIS JONES, N. SP.

PLATE 20

[All figures natural size except as indicated]

FIGURE 1. *Pachydiscus* (*Pachydiscus*) *kamishakensis* Jones, n. sp. (p. 35).
Side view of holotype USNM 131193 from USGS Mesozoic loc. 25856. See plate 21 for cross section and front view. × 2/3.

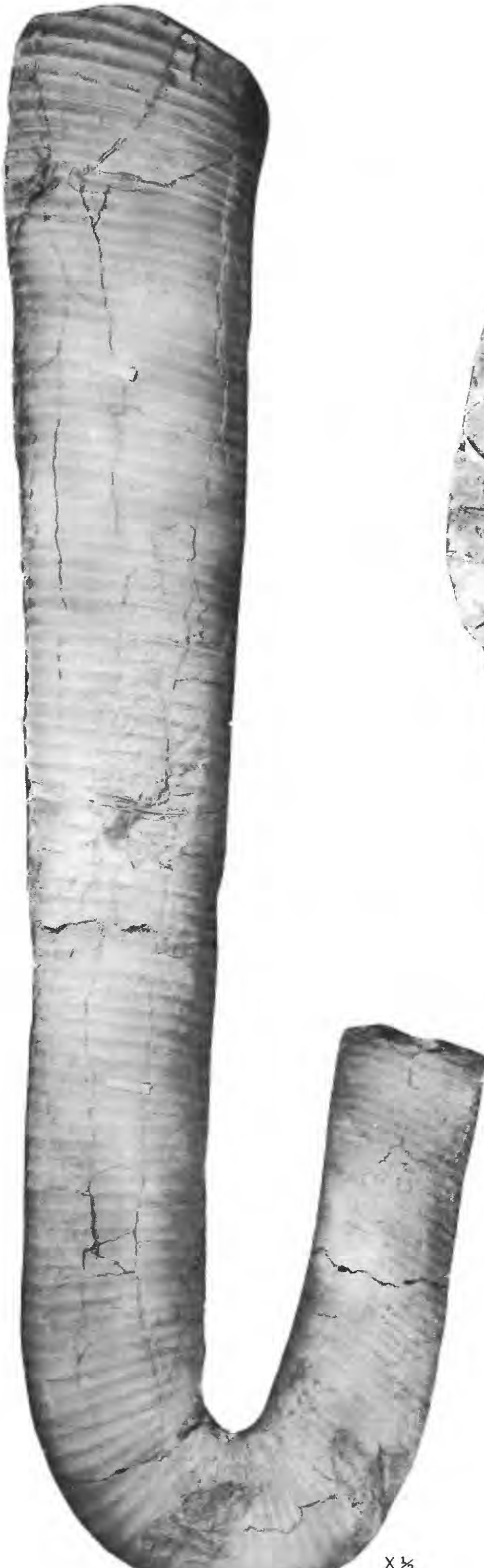
PACHYDISCUS (PACHYDISCUS) KAMISHAKENSIS JONES, N. SP.

PLATE 21

[All figures natural size except as indicated]

FIGURE 1. *Diplomoceras notabile* Whiteaves (p. 32).
Side view of plesiotype USNM 131194 from USGS Mesozoic loc. M562. × 1/2.

2, 3. *Pachydiscus* (*Pachydiscus*) *kamishakensis* Jones, n. sp. (p. 35).
Cross section and front view of holotype USNM 131193. × 2/3.



X ½

1

2 X⅔

X⅔

3

DIPLOMOCERAS NOTABILE WHITEAVES AND *PACHYDISCUS (PACHYDISCUS) KAMISHAKENSIS* JONES, N. SP.

PLATE 22

[All figures natural size except as indicated]

FIGURES 1, 2. *Pachydiscus* (*Pachydiscus*) *kamishakensis* Jones, n. sp. (p. 35).
Side and front view of paratype USNM 131195 from USGS Mesozoic loc. 25856. See plate 23 for back view. × 4/5.

PACHYDISCUS (PACHYDISCUS) KAMISHAKENSIS JONES, N. SP.

PLATE 23

[All figures natural size except as indicated]

FIGURE 1. *Didymoceras* aff. *D. hornbyense* (Whiteaves) (p. 30).
Side view of figured specimen USNM 131196 from USGS Mesozoic loc. 8587.

2. *Pachydiscus* (*Pachydiscus*) *kamishakensis* Jones, n. sp. (p. 35).
Back view of paratype USNM 131195. See plate 22 for side and front views. × 4/5.

3. *Ammonites cooperi* Gabb (p. 30).
Holotype UC12119 from Point Loma, southern California.

1 3 2 ×4/5

DIDYMOCERAS AFF. *D. HORNBYENSE* (WHITEAVES), *PACHYDISCUS (PACHYDISCUS) KAMISHAKENSIS* JONES, N. SP., AND *AMMONITES COOPERI* GABB

PLATE 24

[All figures natural size except as indicated]

FIGURE 1. *Pachydiscus* (*Pachydiscus*) *kamishakensis* Jones, n. sp. (p. 35).
Side view of very large paratype USNM 131197 from USGS Mesozoic loc. 25856. See plate 35, figures 1–3, 5, and 6, for figures of early whorls, and plate 25 for front and back views. × 2/5.

1

PACHYDISCUS (PACHYDISCUS) KAMISHAKENSIS JONES, N. SP.

667-159 O - 63 - 5

PLATE 25

[All figures natural size except as indicated]

FIGURES 1, 2. *Pachydiscus* (*Pachydiscus*) *kamishakensis* Jones, n. sp. (p. 35).
Front and back views of paratype USNM 131197. × 2/5.

X 2/5

1

X 2/5

2

PACHYDISCUS (PACHYDISCUS) KAMISHAKENSIS JONES, N. SP.

PLATE 26

[All figures natural size except as indicated]

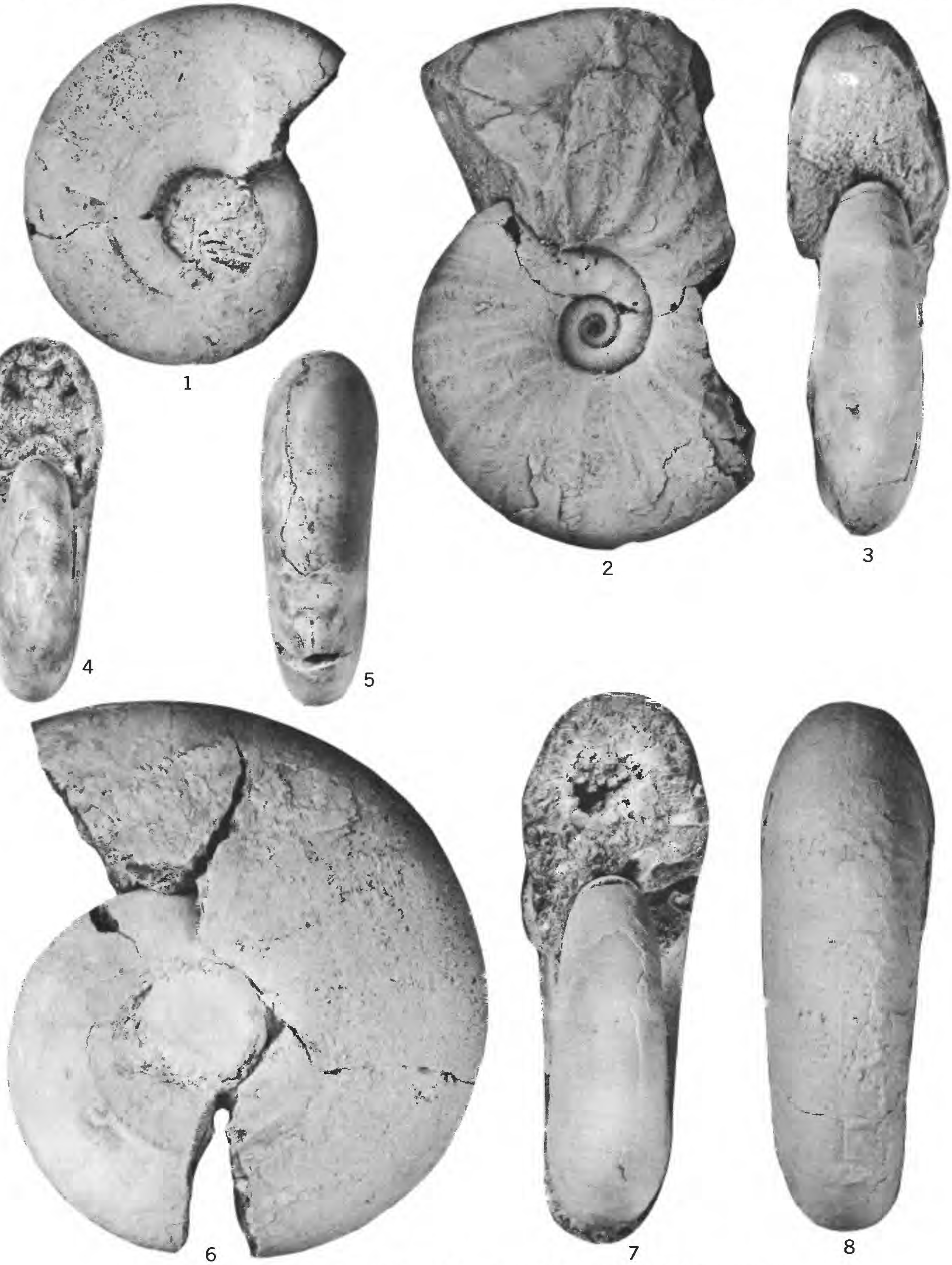
FIGURES 1, 4–8. *Pachydiscus* (*Neodesmoceras*) *obsoletiformis* Jones, (p. 40).

1, 4, 5. Side, front, and back views of paratype USNM 131198 from USGS Mesozoic loc. 24873.

6–8. Side, front, and back views of same specimen with one-half whorl added.

2, 3. *Pachydiscus* (*Pachydiscus*) *kamishakensis* Jones, n. sp. (p. 35).

Side and front view of paratype USNM 131199 from USGS Mesozoic loc. 16398, showing somewhat less prominent ribs than is usual for this species.



PACHYDISCUS (NEODESMOCERAS) OBSOLETIFORMIS JONES, N. SP.,
AND *P. (P.) KAMISHAKENSIS* JONES, N. SP.

PLATE 27

[All figures natural size except as indicated]

FIGURES 1–3. *Pachydisceras* (*Neodesmoceras*) *obsoletiformis* Jones, n. sp. (p. 40).
Side front, and back view of holotype USNM 131200 from USGS Mesozoic loc. M565. × 3/4

PACHYDISCUS (NEODESMOCERAS) OBSOLETIFORMIS JONES, N. SP.

PLATE 28

[All figures natural size except as indicated]

FIGURES 1–3. *Pachydiscus* (*Neodesmoceras*) *obsoletiformis* Jones, n. sp. (p. 40).
Side, front, and back views of paratype USNM 131201 from USGS Mesozoic loc. 25857

1 2 3

PACHYDISCUS (NEODESMOCERAS) OBSOLETIFORMIS JONES, N. SP.

PLATE 29

[All figures natural size except as indicated]

FIGURES 1–3, 13–16. *Pachydiscus* (*Pachydiscus*) *ootacodensis* (*Stoliczka*) (p. 38).

1–3. Side, front, and back views of plesiotype USNM 131202 from USGS Mesozoic loc. 16398.

13–15. Front, back, and side views of plesiotype USNM 131203 from USGS Mesozoic loc. 16398. See plate 31, figure 1, for view of other side.

16. Side view of plesiotype USNM 131204 from USGS Mesozoic loc. 25327. See plate 30 for front and back views.

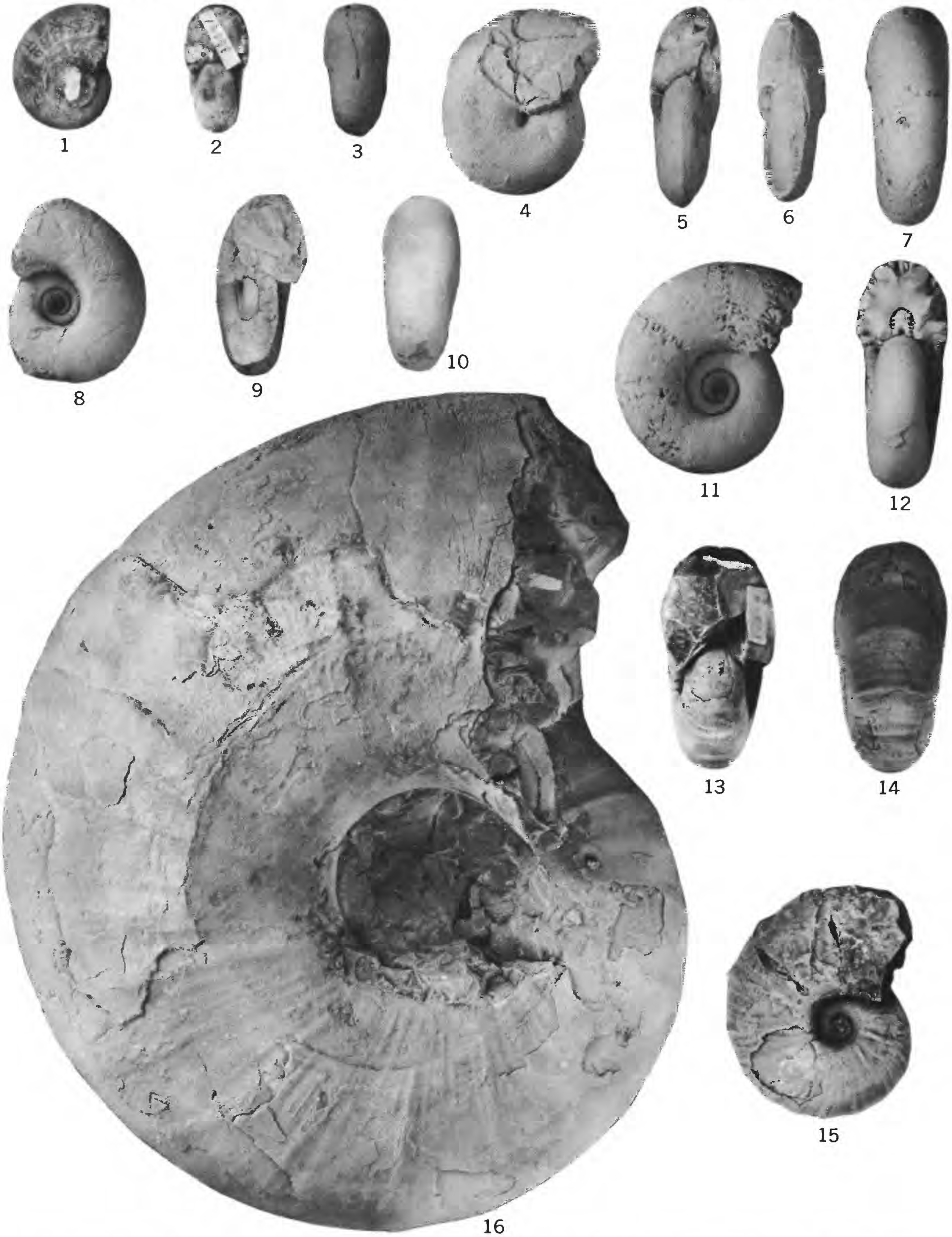
4–6. *Damesites hetonaiensis* Matsumoto (p. 34).

Side, front, and back views of plesiotype USNM 131205 from USGS Mesozoic loc. M552.

7–12. *Pseudophyllites indra* (Forbes) (p. 25).

7, 11, 12. Back, side, and front views of plesiotype USNM 131206 from USGS Mesozoic loc. M592.

8–10. Side, front, and back views of plesiotype USNM 131207 from USGS Mesozoic loc. M558.



PACHYDISCUS (PACHYDISCUS) OOTACODENSIS (STOLICZKA), DAMESITES HETONAIENSIS MATSUMOTO, AND *PSEUDOPHYLLITES INDRA* (FORBES)

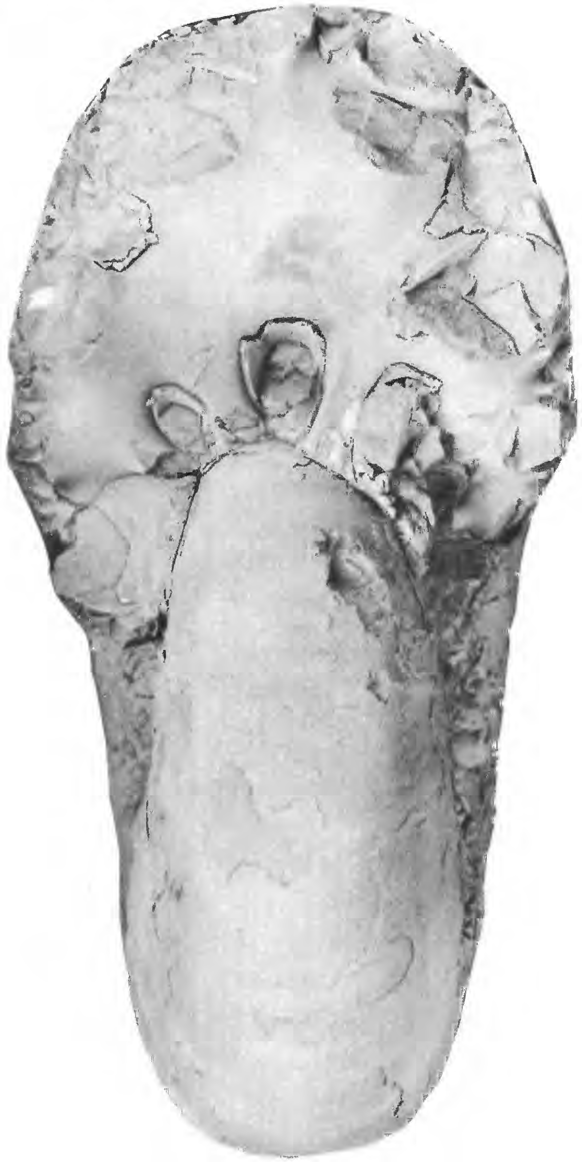
PLATE 30

[All figures natural size except as indicated]

FIGURES 1–3. *Pachydiscus* (*Pachydiscus*) *ootacodensis* (Stoliczka) (p. 38).

1, 2. Front and back views of plesiotype USNM 131204 from USGS Mesozoic loc. 25327. See plate 29, figure 16, for side view.

3. Back view of plesiotype USNM 131208 from USGS Mesozoic loc. 25856. See plate 29 for side and front views. × 1/2.


1


2


3 X½

PACHYDISCUS (PACHYDISCUS) OOTACODENSIS (STOLICZKA)

PLATE 31

[All figures natural size except as indicated]

FIGURES 1, 2. *Pachydiscus* (*Pachydiscus*) *ootacodensis* (Stoliczka) (p. 38).
Side and front view of plesiotype USNM 131208 from USGS Mesozoic loc. 25856. × 1/2


1 X½


2 X½

PACHYDISCUS (PACHYDISCUS) OOTACODENSIS (STOLICZKA)

PLATE 32

[All figures natural size except as indicated]

FIGURE 1. *Pachydiscus* (*Pachydiscus*) *ootacodensis* (Stoliczka) (p. 38).
Side view of USNM 131203 from USGS Mesozoic loc. 16398. See plate 29, figures 13–15, for other views.

2. *Pachydiscus* (*Pachydiscus*) *hornbyense*? (p. 38).
Plaster cast of *Pachydiscus ootacodensis* Whiteaves (1903, pl. 46, fig. 1) from Hornby Island, British Columbia, GSC 5850.

3-6. *Pachydiscus* (*Pachydicus*) *hornbyense* Jones, n. sp. (p. 38).
3–5. Plaster cast of *P. ootacodensis* Usher, (not Stoliczka), 1952, plate 17, figures 1–3. GSC 10052 from Hornby Island, British Columbia.
6. Side view of holotype USNM 131209 from USGS Mesozoic loc. M398, Hornby Island, British Columbia. See text-figure 19 for cross section.

PACHYDISCUS (PACHYDISCUS) OOTACODENSIS (STOLICZKA), P. (P.) HORNBYENSE?, AND *P. (P) HORNBYENSE* JONES, N. SP.

PLATE 33

[All figures natural size except as indicated]

FIGURES 1–7. *Pachydiscus* (*Pachydiscus*) *hornbyense* Jones, n. sp. (p. 38).

1, 4, 5, 6. Front, side, back, and side views of paratype USNM 131210 from USGS Mesozoic loc. M398, Hornby Island, British Columbia.

2, 3, 7. Plaster casts of *P. ootacodensis* Usher (not Stoliczka), 1952, plate 17, figures 4,5, GSC 10051. Hornby Island, British Columbia. Front, back, and side views.

PACHYDISCUS (PACHYDISCUS) HORNBYENSE JONES, N. SP.

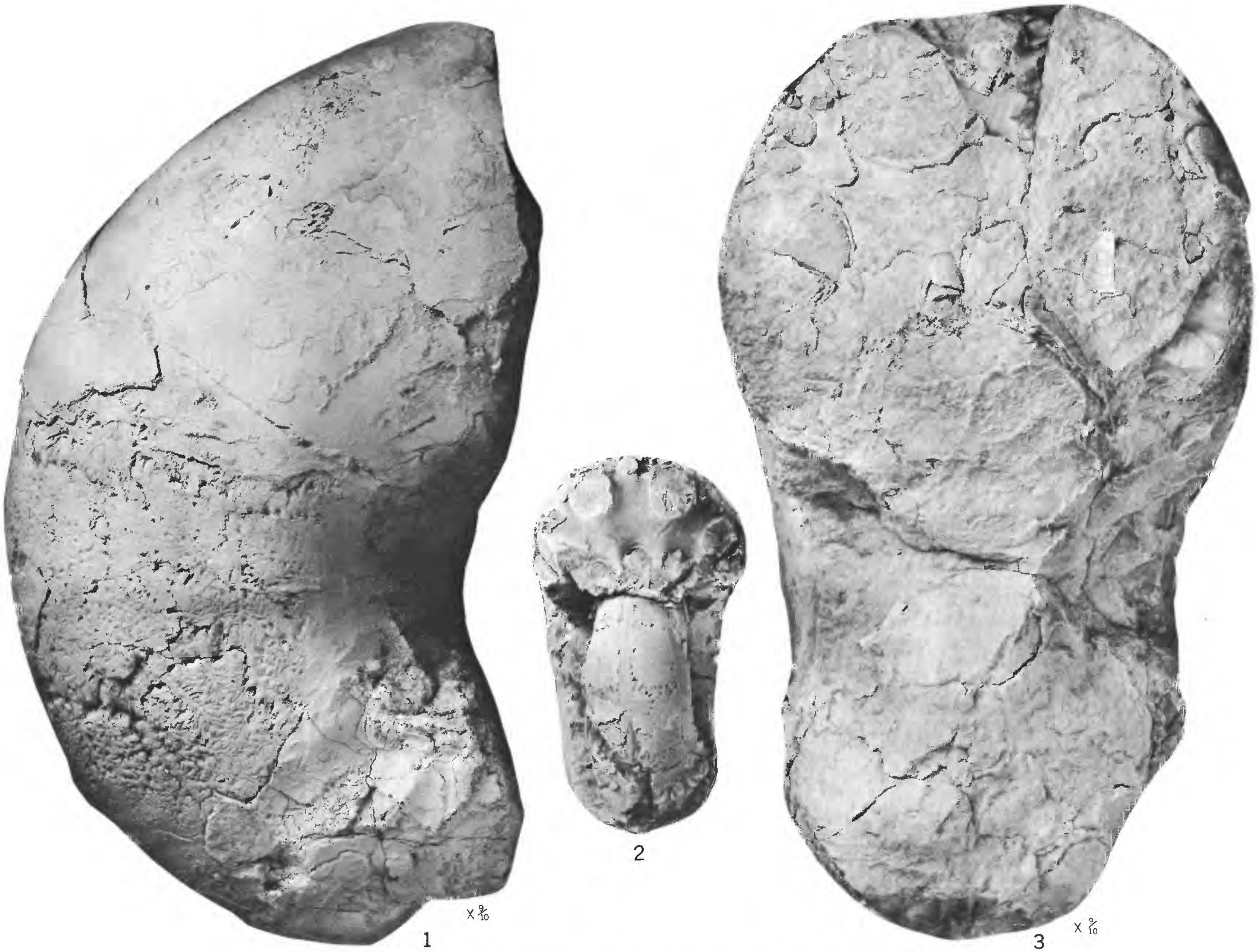
PLATE 34

[All figures natural size except as indicated]

FIGURES 1–3. *Anapachydiscus nelchinensis* Jones, n. sp. (p. 44).

1, 3. Side and front views of paratype USNM 131211 from USGS Mesozoic loc. 24217. × 9/10.

2. Front view of inner whorls of holotype, USNM 131212 from USGS Mesozoic loc. 24217. See plate 34 for other view.



ANAPACHYDISCUS NELCHINENSIS JONES, N. SP.

PLATE 35

[All figures natural size except as indicated]

FIGURES 1–3, 5, 6. *Pachydiscus* (*Pachydiscus*) *kamishakensis* Jones, n. sp. (p. 35).

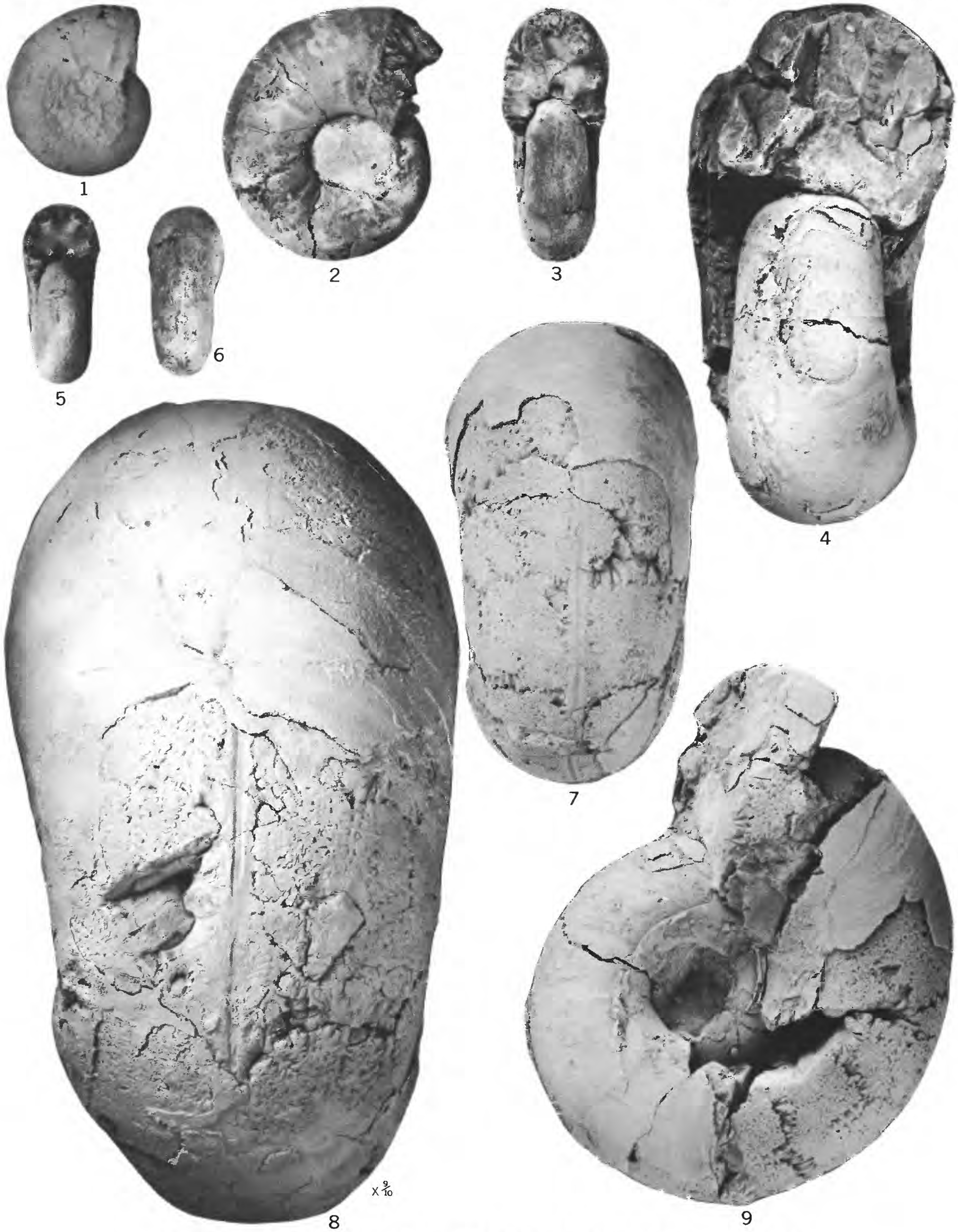
1, 5, 6. Inner whorls of large specimen USNM 131197 from USGS Mesozoic loc. 25856 shown on plate 24.

2, 3. Same specimen with one-half whorl added.

4, 7, 8, 9. *Anapachydiscus nelchinensis* Jones, n, sp. (p. 44).

4, 7, 9. Front, back, and side views of holotype USNM 131212 from USGS Mesozoic loc. 24217.

8. Back view of paratype USNM 131211. See plate 33 for side and front views. × 9/10.



PACHYDISCUS (PACHYDISCUS) KAMISHAKENSIS JONES, N. SP., AND *ANAPACHYDISCUS NELCHINENSIS* JONES, N. SP.

PLATE 36

[All figures natural size except as indicated]

FIGURES 1–5, 7–10. *Canadoceras newberryanum* (Meek) (p. 41).

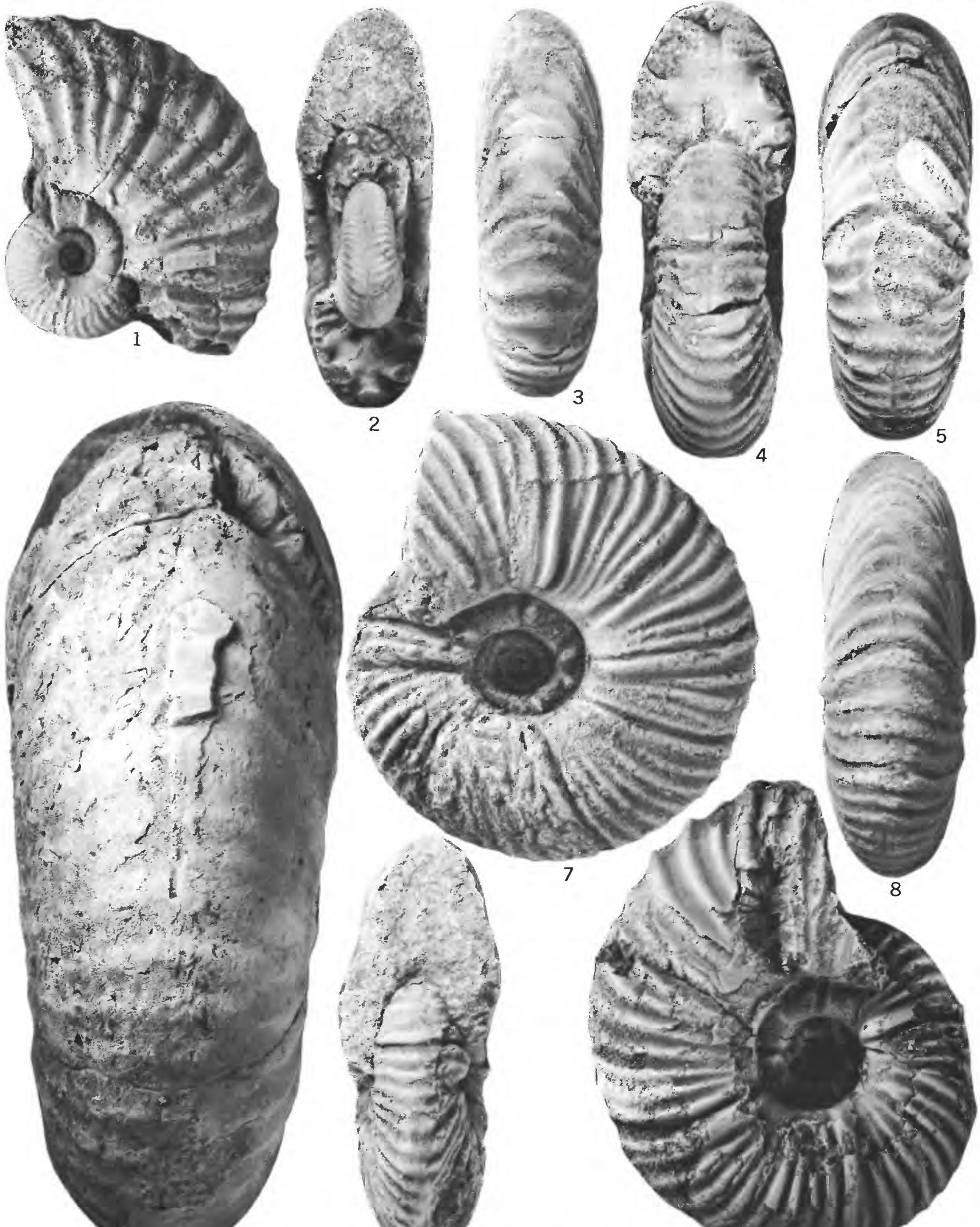
1–3. Side, front, and back views of plesiotype USNM 131213 from USGS Mesozoic loc. 25707.

4, 5, 10. Front, back, and side views of plesiotype UC12490, from Shell Oil Co. loc. M342.

7–9. Side, back, and front views of plesiotype USNM 131214 from USGS Mesozoic loc. 25707.

6. *Canadoceras yokoyamai* (Jimbo) (p. 42).

Back view of plesiotype USNM 131215 from USGS Mesozoic loc. 5580. See plate 37 for front and side views.



CANADOCERAS NEWBERRYANUM (MEEK) AND *C. YOKOYAMAI* (JIMBO)

667-159 O - 63 - 6

PLATE 37

[All figures natural size except as indicated]

FIGURES 1, 2. *Canadoceras yokoyamai* (Jimbo) (p. 42).
Side and front view of USNM 131215 from USGS Mesozoic loc. 5580.

1

2

CANADOCERAS YOKOYAMAI (JIMBO)

PLATE 38

[All figures natural size except as indicated]

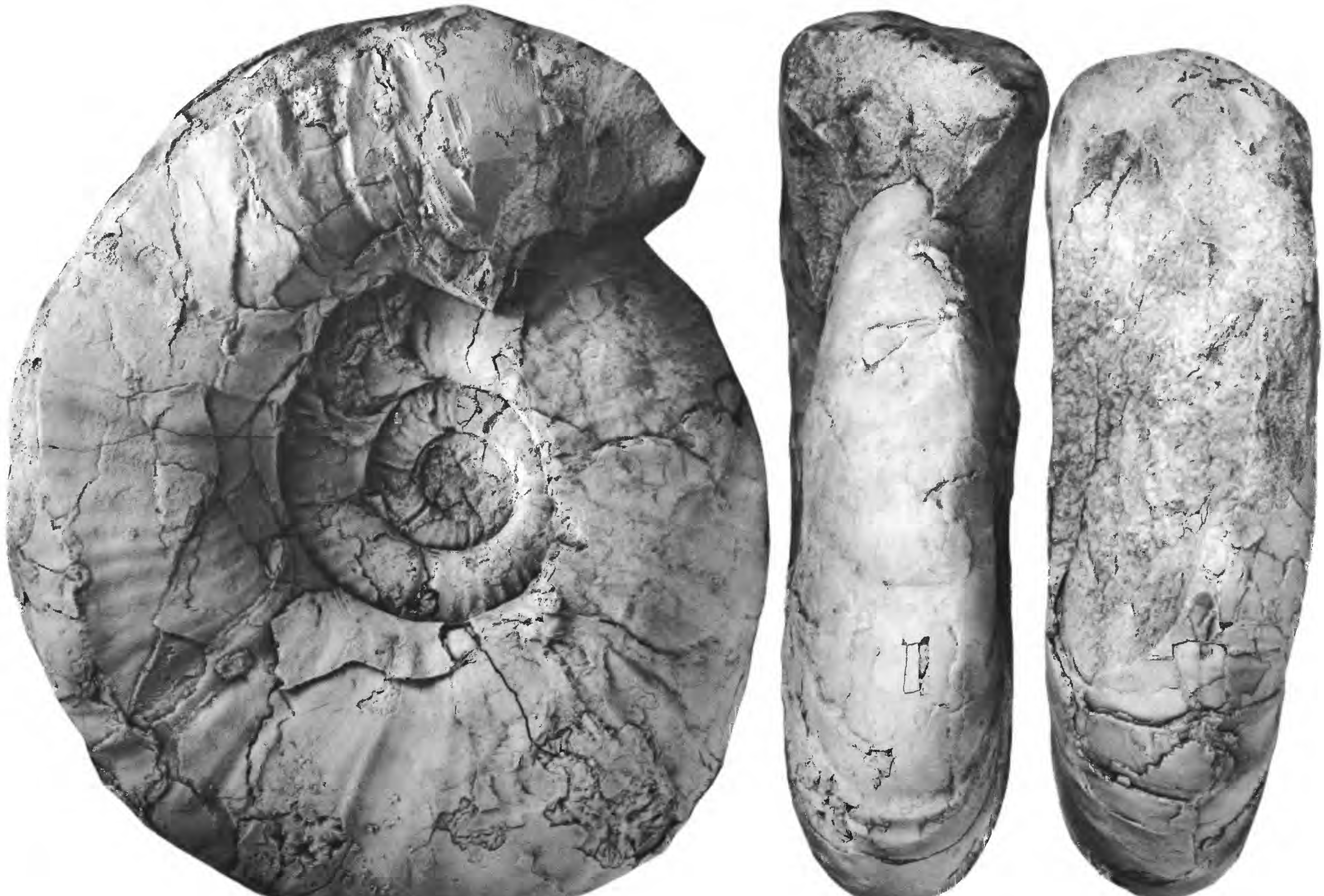
FIGURES 1–3. *Patagiosites alaskensis* Jones, n. sp. (p. 45).
Side, front, and back views of paratype USNM 131216 from USGS Mesozoic loc. 24861. See plate 41, figures 3, 7, for views of inner whorls.

PATAGIOSITES ALASKENSIS JONES, N. SP.

PLATE 39

[All figures natural size except as indicated]

FIGURES 1–3. *Patagiosites alaskensis* Jones, n. sp. (p. 45).
Side, front, and back views of paratype USNM 131217 from USGS Mesozoic loc. M560



1 2 3

PATAGIOSITES ALASKENSIS JONES, N. SP.

PLATE 40

[All figures natural size except as indicated]

FIGURES 1. *Patagiosites alaskensis* Jones, n. sp. (p. 45).

Side view of holotype USNM 131218 from USGS Mesozoic loc. M560. See plate 41 for front and back views. ×1/2.

X½

1

PATAGIOSITES ALASKENSIS JONES, N. SP.

PLATE 41

[All figures natural size except as indicated]

FIGURES 1, 3, 7–8. *Patagiosites alaskensis* Jones, n. sp. (p. 45).

1, 8. Front and back views of holotype USNM 131218 from USGS Mesozoic loc. M560 × 1/2.

3, 7. Side and back views of paratype USNM 131216 from USGS Mesozoic loc. 24861. See plate 38 for views of outer whorls.

2, 4–6. *Phyllopachyceras forbesianum* (d'Orbigny) (p. 24).

2, 5, 6. Side, front, and back views of plesiotype USNM 131219 from USGS Mesozoic loc. 16398.

4. Etched suture line of same specimen.

PATAGIOSITES ALASKENSIS JONES, N. SP., AND *PHYLLOPACHYCERAS FORBESIANUM* (D'ORBIGNY)

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