

Pachydiscus (Pachydiscus) hornbyense JONES, 1963, and *P. (P.) catarinae* (ANDERSON & HANNA, 1935) (Cretaceous, Campanian: Ammonoidea), Pacific Realm marker fossils in the Western Interior Seaway of North America

by W. James KENNEDY & William A. COBBAN

Abstract

Pachydiscus (P.) hornbyense JONES, 1963, previously known only from Hornby Island, British Columbia, occurs in the Upper Campanian *Baculites jenseni* or lowest Maastrichtian *Baculites eliasi* zone of Garfield County, Montana, the *B. compressus* or *B. cuneatus* zone of Pennington County, South Dakota, and by inference, the *B. compressus* zone of Rosebud County, Montana. *P. (P.) catarinae* (ANDERSON & HANNA, 1935), originally described from Lower California, Mexico, and also known from Fresno and Diabolo Counties, California, occurs in the Upper Campanian *Exiteloceras jenneyi* zone of Pueblo County, Colorado. The presence of these Pacific Realm ammonites in the United States Western Interior indicates an easterly migration route into the Interior from the Pacific Realm, complementing published evidence for westward migration of Gulf Coast and Western Interior species into the Pacific Realm.

Key-words: Biogeography, Cretaceous, Campanian, Ammonoidea, *Pachydiscus*, USA.

Résumé

Pachydiscus (P.) hornbyense JONES, 1963 qui n'était connu jusqu'à présent que dans l'île d'Hornby en Colombie Britannique (Canada), est présent dans la zone à *Baculites jenseni* du Campanien supérieur ou dans la zone à *B. eliasi* de la base du Maastrichtien, dans le comté de Garfield au Montana, dans la zone à *B. compressus* ou à *B. cuneatus* dans le comté de Pennington au Dakota du Sud, et, par induction, dans la zone à *B. compressus* dans le comté de Rosebud au Montana. *P. (P.) catarinae* (ANDERSON & HANNA, 1935) décrit à l'origine sur base de matériel provenant de la "Baja California" au Mexique et également signalé dans les comtés de Fresno et Diabolo en Californie se rencontre dans la zone à *Exiteloceras jenneyi* dans le comté de Pueblo au Colorado. La présence de ces ammonites du Domaine pacifique dans le "Western Interior" des Etats Unis indique une voie de migration vers l'est en direction du "Western Interior" à partir du Domaine pacifique. Cela s'ajoute aux preuves, déjà publiées, d'une migration vers l'ouest dans le Domaine pacifique, d'espèces de la "Gulf Coast" et du "Western Interior".

Mots-clefs: Biogéographie, Crétacé, Campanien, Ammonoidea, *Pachydiscus*, USA.

Резюме

Pachydiscus (P.) hornbyense JONES, 1963, ранее известный лишь на острове Хорнби, Британская Колумбия, залегает в *Baculites jenseni* Верхнего Кампана или в *Baculites eliasi* самого нижнего Мاستрихта в округе Гарлфилд, Монтана, в

зоне *B. compressus* или *B. cuneatus* округа Пеннингтон, Южная Дакота, и, по аналогии, в зоне *B. compressus* округа Розбуд, Монтана. *P. (P.) catarinae* (ANDERSON & HANNA, 1935) изначально описанный как происходящий из Нижней Калифорнии, Мексика, а также известный как происходящий из округов Фресно и Диаболо, Калифорния, залегает в зоне *Exiteloceras jenneyi* Верхнего Кампана, округа Пуэбло, Колорадо. Присутствие этих аммонитов тихоокеанской области в «Western Interior» США указывает на существование миграционного восточного потока внутрь материка с морского побережья. Эти данные дополняют опубликованные доказательства миграции аммонитов с побережья Мексиканского залива и из «Western Interior» на запад, в тихоокеанскую область.

Ключевые слова: биogeография, Мел, Кампанский ярус, Ammonoidea, *Pachydiscus*, США.

Introduction

The Campanian ammonite faunas of the United States Western Interior seaway are typically made up of two elements: predominantly endemic taxa, and a minority of immigrant taxa. The former have recently been recognized from scattered occurrences in the Gulf Coast and Atlantic Seaboard (e.g. KENNEDY & COBBAN, 1994, 1997; COBBAN & KENNEDY, 1994; KENNEDY, JOHNSON & COBBAN, 1995), and western Europe (KENNEDY, 1993; HANCOCK & KENNEDY, 1993; KENNEDY & JAGT, 1995; KENNEDY & BILOTTE, 1995). We had previously assumed that immigrants into the interior seaway came via a southeasterly route through the Gulf Coast, but recent records suggest that east-west migration was also possible. These include the presence of *Didymoceras hornbyense* (WHITEAVES, 1895), a species originally described from Hornby Island, British Columbia, in the Upper Campanian Coon Creek Tongue of the Ripley Formation in Tennessee (COBBAN & KENNEDY, 1994).

We have recently seen specimens of *Nostoceras (Nostoceras) hyatti* STEPHENSON, 1941, *N. (N.) helicinum* (SHUMARD, 1861), and *Didymoceras draconis* (STEPHENSON, 1941), from the San Diego area, California. These are all Upper Campanian species best known from the Atlantic Seaboard and Gulf Coast regions (COBBAN,

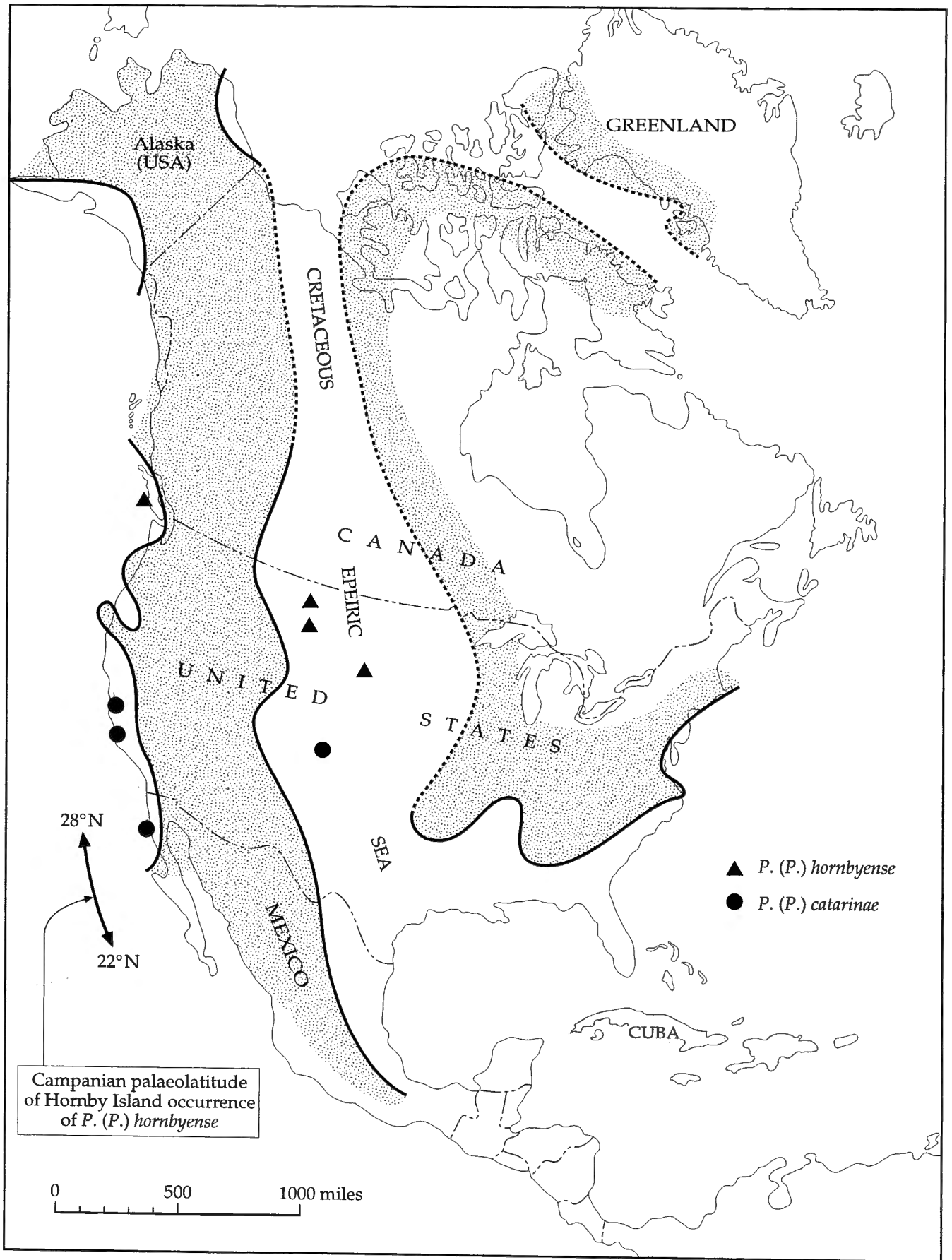


Fig. 1 — Palaeogeographic map of North America during Campanian time (modified after GILL & COBBAN, 1966).

1974; KENNEDY & COBBAN, 1993), with the first two also known from Western Europe (e.g. HANCOCK & KENNEDY, 1993). *N. (N.) hyatti* occurs as a rarity in the *Baculites jenseni* zone of the Pierre Shale of Huerfano County, Colorado (KENNEDY, COBBAN & SCOTT, 1992), and *D. draconis* in the *Baculites cuneatus* zone of Middle Park, Grand County, Colorado. *Exiteloceras jenneyi* (WHITFIELD, 1877), best known from the northern part of the Western Interior, but also known from the New Jersey/Delaware boundary (KENNEDY & COBBAN, 1997) was also able to migrate southwards, and is known from Colombia in South America (KENNEDY in FÖLLMI, GARRISON, RAMIREZ, ZAMBRANO-ORTIZ, RAMIREZ, KENNEDY & LEHNER, 1992).

We document here the first evidence of migration of Pacific Realm ammonites into the northern part of the Western Interior Seaway (Fig. 1). This takes the form of, firstly, the occurrence of specimens of *Pachydiscus (Pachydiscus) hornbyense* JONES, 1963 (p. 38, pl. 32, figs. 2-6; pl. 33; text-fig. 10) in the Upper Campanian *Baculites jenseni* or *B. eliasi* zone (Fig. 2) of the Bearpaw Shale south of Fort Peck in Garfield County, in northeastern Montana (Pl. 1, figs. 1-3), in the *B. compressus* or *B. cuneatus* zone Pierre Shale of Pennington County, South Dakota, and in the inferred *B. compressus* zone Pierre Shale in Rosebud County, Montana (Pl. 2). *P. (P.) hornbyense* was previously known only from the Lambert Formation of the Nanaimo Group in British Columbia (Fig. 1).

The second Pacific Realm migrant is *P. (P.) catarinae* (ANDERSON & HANNA, 1935), a specimen of which is known from the *Exiteloceras jenneyi* zone of the Pierre Shale of Pueblo County, Colorado (Pl. 1, Figs. 3, 4). This species was originally described from near Santa, Caterina Landing, Baja, Lower California, Mexico and subsequently recorded from near Coalinga, Fresno County, and Puerto Creek in Diabolo County, California (Fig. 1).

Conventional palaeogeographic maps (e.g. WILLIAMS & STELCK, 1975; CHRISTENSEN, 1993; SMITH, SMITH & FUNNELL, 1994 and references therein) also show a seaway extending north-northwest to northern Alaska. But as JONES (1963) noted, there is a lack of faunal similarity, apart from the present records. It must also be noted that the present latitude of the British Columbia records of *P. (P.) hornbyense* may be well to the north of their original site of deposition as a result of post-Cretaceous plate tectonic activity. WARD, HURTADO, KIRSCHVINK & VEROSUB (1997) have shown the Campanian-(?)Maastriichtian sediments of Hornby Island to retain a stable remnant magnetism that indicates the Insular Superterrains of which they are a part originally lay at an Upper Cretaceous palaeolatitude of 25 ± 3 degrees north, equivalent to that of present-day Baja, California. Given the evidence for southerly migration out of the Gulf Coast and Western Interior into the Pacific Realm during the Upper Campanian, we take the view that this is more likely to have been the route taken by the present specimens of both *P. (P.) hornbyense* and *P. (P.) catarinae*.

Systematic palaeontology

Family Pachydiscidae SPATH, 1922

Genus and Subgenus *Pachydiscus* ZITTEL, 1884

Type species: *Ammonites neubergicus* HAUER, 1858, p. 12, pl. 1, figs. 1-3; pl. 2, figs. 1, 2, by subsequent designation by DE GROSSOUVRE, 1894, p. 177.

Pachydiscus (Pachydiscus) hornbyense JONES, 1963
(Pl. 1, Figs. 1-3; Pl. 2)

1903 *Pachydiscus otacodensis* (STOLICZKA); WHITEAVES, p. 340, pl. 46, fig. 1; text-fig. 20.

1952 *Pachydiscus otacodensis* (STOLICZKA); USHER, p. 85, pl. 17, figs. 1-5; pl. 18; pls. 19, 20.

1963 *Pachydiscus (Pachydiscus) hornbyense* JONES, p. 38, pl. 32, figs. 2-6; pl. 33; text-fig. 19.

1997 *Pachydiscus* cf. *hornbyense*; LARSON, JORGENSEN, FARRAR & LARSON; unnumbered fig. on p. 61.

TYPE

Holotype is in the U.S. National Museum of Natural History (USNM n° 131209), the original of JONES, 1963, pl. 32, fig. 6, from the Lambert Formation of the Nanaimo Group, beach platform on the northwest side of Hornby Island, British Columbia.

DESCRIPTION

Black Hills Institute of Geological Research Inc. (BHI) 4140 (Pl. 1, Figs. 1-3) is a crushed phragmocone 76 mm in diameter. Involute, whorl section slightly depressed, umbilical shoulder broadly rounded. Inner flanks convex, outer flanks convergent, ventrolateral shoulders and venter broadly rounded. First half of outer whorl bears twelve narrow, distant ribs, separated by very wide interspaces. Ribs more or less regularly alternately long and short; long ribs with or without feeble bullae; shorter ribs arise low on flank. Ribs straight and prorsiradiate on flanks, projected forwards and slightly concave on ventrolateral shoulders, thickening and feebly convex over venter. Interspaces between ribs with delicate riblets and growth lines. Ribbing crowds at adapical end of specimen.

BH1 4139 (Pl. 2) is an undeformed specimen, septate to 230 mm diameter. A short section of the adapical end of the body chamber is preserved. Coiling involute, with $U = 18\%$ of the diameter, deep, with a feebly convex umbilical wall; umbilical shoulder broadly rounded. Whorl section compressed; whorl breadth to height ratio 0.88. Inner flanks broadly rounded, outer flanks convergent; venter broadly rounded. Inner flanks of inner whorls ornamented as in previous specimen. Inner flank of outer phragmocone whorl smooth. Low, broad, concave ribs strengthen across the outer flank, and cross the venter in a broad convexity on the first half of the outer whorl, but decline progressively with increasing diameter, leaving the adapertural end of phragmocone and adapical end of body chamber smooth.

Suture highly complex, with deeply incised lobes and saddles; typical for genus.

Cretaceous Stages and Western Interior informal substages		Western Interior ammonite zones
Maastrichtian (part)	Upper (part)	<i>Jeletzkytes nebrascensis</i> <i>Hoploscaphites nicolletii</i> <i>Hoploscaphites birkelundi</i> <i>Baculites clinolobatus</i> <i>Baculites grandis</i> <i>Baculites baculus</i> <i>Baculites eliasi</i>
	Lower	<i>Baculites jenseni</i> ▲ <i>Baculites reesidei</i> <i>Baculites cuneatus</i> ▲ <i>Baculites compressus</i> <i>Didymoceras cheyennense</i> <i>Exiteloceras jenneyi</i> ● <i>Didymoceras stevensoni</i> <i>Didymoceras nebrascense</i> <i>Baculites scotti</i> <i>Baculites reduncus</i> <i>Baculites gregoryensis</i> <i>Baculites perplexus</i> <i>Baculites sp. (smooth)</i> <i>Baculites asperiformis</i> <i>Baculites maclearni</i> <i>Baculites obtusus</i> <i>Baculites sp. (weak flank ribs)</i> <i>Baculites sp. (smooth)</i> <i>Scaphites hippocrepis</i> III <i>Scaphites hippocrepis</i> II <i>Scaphites hippocrepis</i> I <i>Scaphites leei</i> III
Campanian	Upper	
	Middle	
	Lower	

● *Pachydiscus (P.) catarinae* (ANDERSON & HANNA, 1935)

▲ *Pachydiscus (P.) hornbyense* JONES, 1963

Fig. 2 — Western Interior Campanian ammonites zones.

A further unfigured fragment, USNM 499023 may belong to *P. (P.) hornbyense*; it is inferred to be from the *Baculites compressus* zone of the Pierre Shale 15 km (9 mi.) east, and 3.3 km (2 mi.) south of Ingomar, Rosebud County, Montana, in the N1/2, T.9N., R.36E. It is a wholly septate fragment with a maximum preserved whorl height of 119 mm and a whorl breadth to height ratio of 0.96. The dorsum shows impressions of sharp distant ribs, as in BHI 4140 at a comparable diameter; the outer whorl is completely smooth.

DISCUSSION

The present specimens differ in no significant respects from the holotype and topotypes from Hornby Island. Of other *Pachydiscus (Pachydiscus)* species known from the Campanian of the United States Western Interior, *P. (P.) arkansanus* (STEPHENSON, 1941) (COBBAN & KENNEDY, 1991, p. F2, pl. 1, fig. 4; pls. 2-4; text-fig. 2) is much more closely and coarsely ribbed, ribbing persisting to a diameter where *P. (P.) hornbyense* has lost its ribbing. *P. (P.) cf. oldhami* (SHARPE, 1855) (COBBAN & KENNEDY, 1991, p. F1, pl. 1, figs. 1-3; text-fig. 1) is a compressed species, with crowded ribs.

OCCURRENCE

Upper Campanian, Lambert Formation of the Nanaimo Group, Hornby Island, British Columbia. In the U.S. Western Interior, there are specimens from the Bearpaw Shale, *Baculites jenseni* or *B. eliasi* zone, Garfield County, Montana; *B. compressus* or *B. cuneatus* zone of the Pierre Shale of Pennington County, South Dakota; *B. compressus* zone inferred, Rosebud County, Montana.

Pachydiscus (Pachydiscus) catarinae (ANDERSON & HANNA, 1935)
(Pl. 1, Figs. 4, 5)

- 1928 *Pachydiscus catarinae* ANDERSON; p. 238, pl. 9 (*nomen nudum*).
1935 *Parapachydiscus catarinae* ANDERSON & HANNA; p. 19, pls. 1, 2; pl. 3, figs. 1-3.
1958 *Parapachydiscus catarinae* (ANDERSON & HANNA); ANDERSON, p. 224, pl. 58, fig. 2.
1997 *Pachydiscus catarini* LARSON, JORGENSEN, FARRAR & LARSON; unnumbered figure on p. 61.

References

- ANDERSON, F.M., 1928. Late Cretacic fossils from Lower California. *Pan American Geologist*, **50**: 283-284.
ANDERSON, F.M., 1958. Upper Cretaceous of the Pacific Coast. *Geological Society of America Memoir*, **71**: xi + 378 p.
ANDERSON, F.M. & HANNA, G.D., 1935. Cretaceous geology of Lower California. *Proceedings of the California Academy of Sciences*, (4), **23**: 1-34.
CHRISTENSEN, W.-K., 1993. *Actinocamax cobbani* n.sp. from

TYPE

Holotype is no. 4245 in the collections of the California Academy of Sciences, from the Upper Campanian near Catarina Landing, Lower California, Mexico, refigured by ANDERSON, 1958, pl. 58, fig. 2.

DESCRIPTION

USNM 486635 is a phragmocone 215 mm in diameter, with the following dimensions in millimeters: diameter: 213.0(100); whorl breadth (Wb): 92.6(43.5); whorl height (Wh): 101.0 (47.0); Wb:Wh: 0.91; umbilicus 51.9(24.4). Coiling involute, 68% of the previous whorl covered. Umbilicus small: 24.4% of the diameter, deep, with convex wall and more narrowly rounded umbilical shoulder. Whorl section compressed, with whorl breadth to height ratio 0.91, inner flanks convex, outer flanks convergent, ventrolateral shoulders and venter broadly rounded. Ornament consists of distant weak ribs, strong, straight, prorsiradiate on inner to middle flanks of outer whorl, flexing forward, concave and weakening across outer flanks and ventrolateral shoulders, weak and broadly convex across venter. Occasional shorter intercalated ribs present on outer flank and venter. Imperfectly exposed suture with deeply incised lobes and saddles, typical for genus.

DISCUSSION

Compressed whorl section and widely separated ribs distinguish *P. (P.) catarinae* from all other *Pachydiscus (Pachydiscus)* recorded from the Campanian of the U.S. Western Interior Seaway.

OCCURRENCE

Upper Campanian, Catarina Landing, Baja, Lower California, Mexico; near Coalinga, Fresno County, California; Puerto Creek, Diablo County, California. *Exiteloceras jenneyi* zone of the Pierre Shale, in the NE1/4, sec. 23, T.18S; R.64W., Pueblo County, Colorado.

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the Coniacian of Montana and Wyoming and the occurrence of Late Cretaceous belemnites in North America and Greenland. *Journal of Paleontology*, **67**: 434-446.

COBBAN, W.A., 1974. Ammonites from the Navesink Formation at Atlantic Highlands, New Jersey. *U.S. Geological Survey Professional Paper*, **845**: 21 p.

COBBAN, W.A. & KENNEDY, W.J., 1991. *Pachydiscus* (Ammonoidea) from Campanian (Upper Cretaceous) rocks in the Wes-

- tern Interior of the United States. *U.S. Geological Survey Bulletin*, **1985**: F1-F4.
- COBBAN, W.A. & KENNEDY, W.J., 1994. Upper Cretaceous ammonites from the Coon Creek Tongue of the Ripley Formation at its type locality in McNairy County, Tennessee. *U.S. Geological Survey Bulletin*, **2073-B**: B1-B12.
- FÖLLMI, K.B., GARRISON, R.E., RAMIREZ, P.C., ZAMBRANO-ORTIZ, F., KENNEDY, W.J. & LEHNER, B.L., 1992. Cyclic phosphate-rich sequences in the upper Cretaceous of Colombia. *Palaeogeography, Palaeoclimatology, Palaeoecology*, **93**: 151-182.
- GILL, J.R. & COBBAN, W.A. 1966. The Red Bird section of the Upper Cretaceous Pierre Shale in Wyoming. *U.S. Geological Survey Professional Paper*, **393-A**: 73 p.
- GROSSOUVRE, A. de, 1894. Recherches sur la craie supérieure, 2, Paléontologie. Les ammonites de la craie supérieure. *Mémoires du Service de la Carte Géologique détaillée de la France*. Imprimerie Nationale, Paris, 264 p. (misdated 1893).
- HANCOCK, J.M. & KENNEDY, W.J., 1993. The high Cretaceous ammonite fauna from Tercis, Landes, France. *Bulletin de l'Institut royal des Sciences naturelles de Belgique, Série Sciences de la Terre*, **63**: 149-209.
- HAUER, F. von, 1858. Ueber die Cephalopoden aus den Gosauschichten. *Beiträge zur Paläontologie von Oesterreich*, **1**: 7-14.
- JONES, D., 1963. Upper Cretaceous (Campanian and Maastrichtian) ammonites from southern Alaska. *U.S. Geological Survey Professional Paper*, **432**: 55 p.
- KENNEDY, W. J., 1993. Campanian and Maastrichtian ammonites from the Mons Basin (Belgium). *Bulletin de l'Institut royal des Sciences naturelles de Belgique, Série Sciences de la Terre*, **63**: 99-131.
- KENNEDY, W.J. & BILOTTE, M., 1995. A new ammonite fauna from the sub-pyrenean Campanian (Upper Cretaceous). *Geobios*, **28**: 359-370.
- KENNEDY, W.J. & COBBAN, W.A., 1993. Ammonites from the Saratoga Chalk (Upper Cretaceous), Arkansas. *Journal of Paleontology*, **67**: 404-434.
- KENNEDY, W.J. & COBBAN, W.A., 1994. Upper Campanian ammonites from the Mount Laurel Sand at Biggs Farm, Delaware. *Journal of Paleontology*, **68**: 1285-1305.
- KENNEDY, W.J. & COBBAN, W.A., 1997. Upper Campanian (Upper Cretaceous) ammonites from the Marshalltown Formation-Mount Laurel Sand boundary beds in Delaware. *Journal of Paleontology*, **71**: 62-73.
- KENNEDY, W.J., COBBAN, W.A. & SCOTT, G.R., 1992. Ammonite correlation of the uppermost Campanian of Western Europe, the U.S. Gulf Coast, Atlantic Seaboard and Western Interior, and the numerical age of the base of the Maastrichtian. *Geological Magazine*, **129**: 497-500.
- KENNEDY, W.J. & JAGT, J.W.M., 1995. Lower Campanian heteromorph ammonites from the Vaals Formation around Aachen, Germany, and adjacent parts of Belgium and the Netherlands. *Neues Jahrbuch für Geologie und Paläontologie, Abhandlungen*, **197**: 275-294.
- KENNEDY, W.J., JOHNSON, R.O. & COBBAN, W.A., 1995. Upper Cretaceous ammonite faunas of New Jersey. *Geological Association of New Jersey*, **12**: 24-55.
- LARSON, N.L., JORGENSEN, S.D., FARRAR, R.A. & LARSON, P.L., 1997. Ammonites and other cephalopods of the Pierre Seaway. Geoscience Press, Tucson. xi + 148 p.
- SHARPE, D., 1853-57. Description of the fossil remains of Mollusca found in the Chalk of England. I. Cephalopoda. *Palaeontographical Society Monographs*, 68 pp. , 27 pls. 1-26, pls. 1-10 (1853); 27-36, pls. 11-16 (1855); 37-68, pls. 17-27 (1857).
- SHUMARD, B.F., 1861. Descriptions of new Cretaceous fossils from Texas. *Transactions of the Academy of Sciences of St. Louis*, **1**: 590-610.
- SMITH, A.G., SMITH, D.G. & FUNNELL, B.M., 1994. Atlas of Mesozoic and Cenozoic coastlines. Cambridge University Press, Cambridge, New York and Melbourne. ix + 99 p.
- SPATH, L.F., 1922. On the Senonian ammonite fauna of Ponderland. *Transactions of the Royal Society of South Africa*, **10**: 113-147.
- STEPHENSON, L.W., 1941. The larger invertebrates of the Navarro Group of Texas (exclusive of corals and crustaceans and exclusive of the fauna of the Escondido Formation). *University of Texas Bulletin*, **4101**: 641 p.
- USHER, J.L., 1952. Ammonite faunas of the Upper Cretaceous of Vancouver Island, British Columbia. *Bulletin of the Geological Survey of Canada*, **21**: 1-182, pls. 1-30.
- WARD, P.D., HURTADO, J.M., KIRSCHVINK, J.L. & VEROSUB, K.L., 1997. Measurements of the Cretaceous paleolatitude of Vancouver Island: consistent with the Baja-British Columbia hypothesis. *Science*, **77**: 1642-1645
- WHITEAVES, J.F., 1895. Notes on some fossils from the Cretaceous rocks of British Columbia, with descriptions of two species that appear to be new. *Canadian Record of Science*, **6**: 313-318.
- WHITEAVES, J.F., 1903. On some additional fossils from the Vancouver Cretaceous, with a revised list of the species therefrom. *Geological Survey of Canada Mesozoic Fossils*, **1**: 309-409.
- WHITFIELD, R.P., 1877. Preliminary report on the paleontology of the Black Hills, containing descriptions of new species of fossils from the Potsdam, Jurassic, and Cretaceous formations of the Black Hills of Dakota. United States Geographical and Geological Survey of the Rocky Mountain Region. 49 p.
- WILLIAMS, G.D. & STELCK, C.R., 1975. Speculations on the Cretaceous palaeogeography of North America. *Geological Association of Canada Special Paper*, **13**: 1-29.
- ZITTEL, K.A. von, 1884. Handbuch der Paläontologie, 1, Abt. 2; Lief. 3, Cephalopoda. R. Oldenbourg, München und Leipzig, p. 329-522.

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Explanation of Plates

PLATE 1

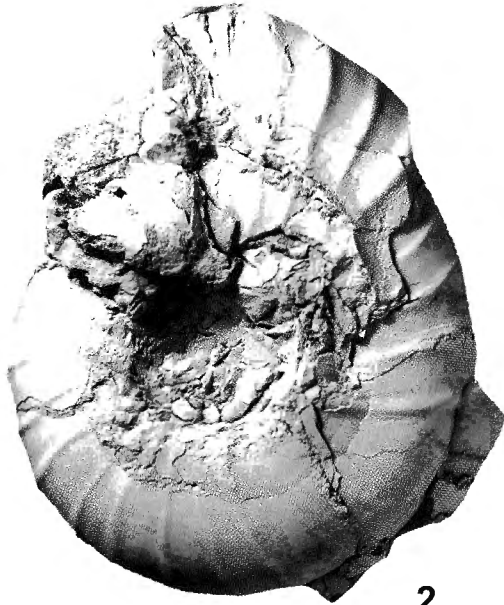
- Figs. 1-3 — *Pachydiscus (Pachydiscus) hornbyense* JONES, 1963. BH1 4140, Bearpaw Shale, Upper Campanian, *Baculites jenseni* or *B. eliasi* zone, south of Fort Peck, Garfield County, Montana. Figures are x 1.
- Figs. 4-5 — *Pachydiscus (Pachydiscus) catarinae* (ANDERSON & HANNA, 1935), USNM 486635, cast of a specimen from the Pierre Shale, Upper Campanian, *Exiteloceras jenneyi* zone, NE1/4 Sec. 23, T.18S, R.64W., Pueblo County, Colorado. Figures are reduced x 0.66.

PLATE 2

- Figs. 1, 2 — *Pachydiscus (Pachydiscus) hornbyense* JONES, 1963. BH1 4139, Pierre Shale, Upper Campanian, *Baculites cuneatus* or *B. compressus* zone, Elk Creek, Pennington County, South Dakota. Figures are x 1.



1



2



3



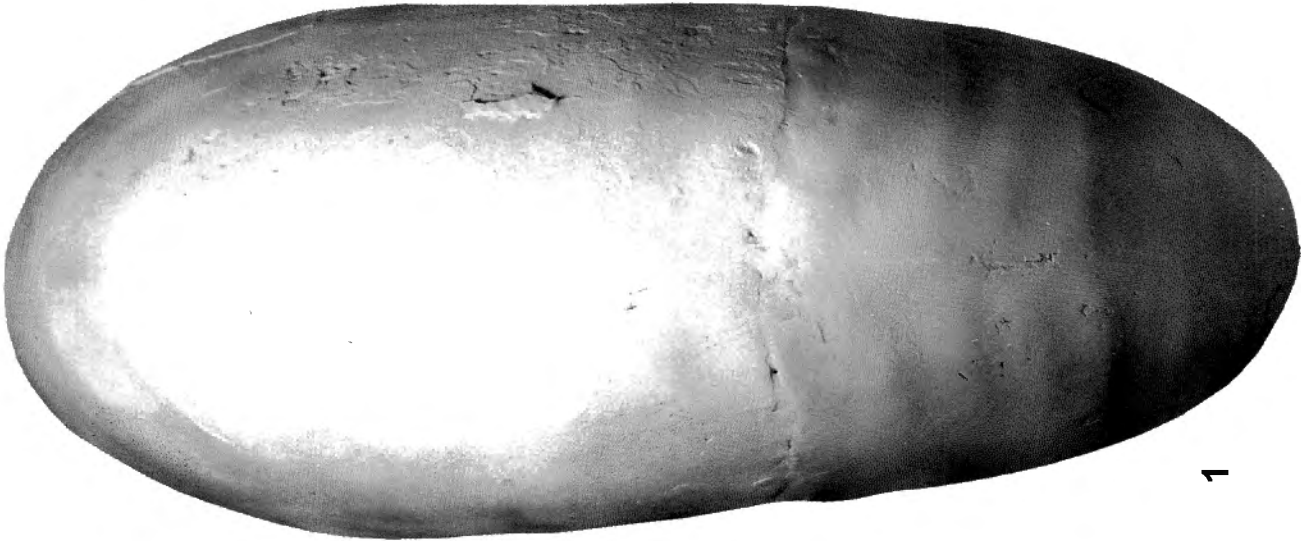
4



5



2



1

PLATE 2

