THE ATRYPOID BRACHIOPOD GENUS *CARINATINA* IN LATE EMSIAN (LATEST EARLY DEVONIAN) STRATA OF THE SHELLABARGER LIMESTONE, DENALI NATIONAL PARK AND PRESERVE, SOUTH-CENTRAL ALASKA

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Abstract—We here describe and establish the new species *Carinatina connorsi* n. sp. of the distinctive atrypoid brachiopod genus *Carinatina*, from the late Emsian (latest Early Devonian) age Shellabarger Limestone of the Shellabarger Pass area, Denali National Park and Preserve, Talkeetna C-6 quadrangle, south-central Alaska. In addition, another species of *Carinatina*, *C.* sp. is also described from the same beds as *C. connorsi* n. sp. The host formation (Shellabarger Limestone) forms the oldest stratigraphic interval within the Mystic sequence of the Farewell terrane. The fauna of this interval is biogeographically distinctive and shows closest affinities with coeval fauna of the Kolyma region of northeastern Russia and elsewhere in Eurasia.

INTRODUCTION

In this paper we report the first published occurrence of the distinctive Lower-Middle Devonian atrypoid brachiopod genus *Carinatina* from Alaska. Brachiopods are both diverse and abundant in a late Emsian (latest Early Devonian) age stratigraphic interval earlier established as the Shellabarger Limestone by the same authors (Blodgett et al., 2022) from the Shellabarger Pass area, Denali National Park & Preserve, Talkeetna C-6 quadrangle, south-central Alaska. A number of papers have previously appeared (Baranov and Blodgett, 2022; Blodgett, 1998; Blodgett and Boucot, 1999; Blodgett et al., 1997, 2002, 2021, 2022; Garcia-Alcalde and Blodgett, 2001) on the brachiopods from this unit which is minimally 38.7 m (127 ft) thick and composed of lime mudstone and wackestone. It is our aim in the near future to complete the description of the entire extensive brachiopod fauna and point out its distinctive paleobiogeographic affinities.

In recent years, the concept that nearly all of Alaska, as well as much of the western Cordillera of North America, is composed of numerous, discrete accreted tectonostratigraphic (or lithotectonic) terranes (Coney et al., 1980; Jones et al., 1981, 1982, 1986, 1987; Silberling et al., 1992, 1994; Nokleberg et al., 1994) has come into general acceptance within the scientific community. The only exception to this is the triangular area of east-central Alaska, more or less bounded on the northwest by Porcupine River, to the west by the Cretaceous flysch belt of the Kandik Basin, and to the southwest by the Yukon River. This region, which includes the Nation Arch, represents a continuation of Precambrian and Paleozoic rocks exposed further east in the Ogilvie Mountains of the Yukon Territory.

GEOLOGIC SETTING

The specimens described here are from the Mystic Subterrane of the Farewell terrane of southwestern and west-central Alaska. It was originally described (Jones et al., 1981) as a separate tectonostratigraphic entity of full terrane rank. More recently, Decker et al. (1994) recognized that the Mystic, as well as the Nixon Fork and Dillinger terranes, were genetically related and all were reduced in rank to subterranes of a larger terrane, termed the Farewell terrane (Fig. 1). Gilbert and Bundtzen (1984) considered the Dillinger and Mystic terranes, each of whose type sections were close to one another, to represent a single stratigraphic succession of Paleozoic to Triassic age, preferring to the term "sequence" to each. They considered the underlying Dillinger sequence to be a Cambrian to Lower Devonian deep-water succession followed depositionally by the Mystic sequence – consisting of laterally variable Devonian to Triassic? shallow-water to nonmarine sedimentary rocks with intrusive and extrusive mafic and ultramafic rocks. The close stratigraphic relationship between the Dillinger and Mystic sequence (or subterranes) was supported by stratigraphic studies by Blodgett and Gilbert (1992) to the southwest in the Lime Hills 1:250,000 scale quadrangle. The Nixon Fork subterrane, defined originally as a full-rank terrane by Patton (1978), represents a predominately shallow-water carbonate platform, mostly laterally equivalent to deeper water Cambrian to Lower Devonian rocks of the Dillinger subterrane (Blodgett, 1983; Blodgett and Gilbert, 1983; Bundtzen and Gilbert, 1983; Gilbert and Bundtzen, 1983).

Until several years ago, most prior interpretations of the gross lithostratigraphy and faunal affinities of the best-studied terrane, the Nixon Fork terrane, had indicated either fragmentation from or lithic continuity with northwestern Canada (Blodgett, 1983; Churkin et al., 1984; Blodgett and Clough, 1985; Rohr and Blodgett, 1985). Newly acquired biogeographic data from Emsian (Late Early Devonian) strata of the Farewell terrane, along with reconsideration of the affinities of the faunas and floras of other time intervals, indicate that this

FIGURE 1. Index map of Alaska, showing location of Shellabarger Pass.

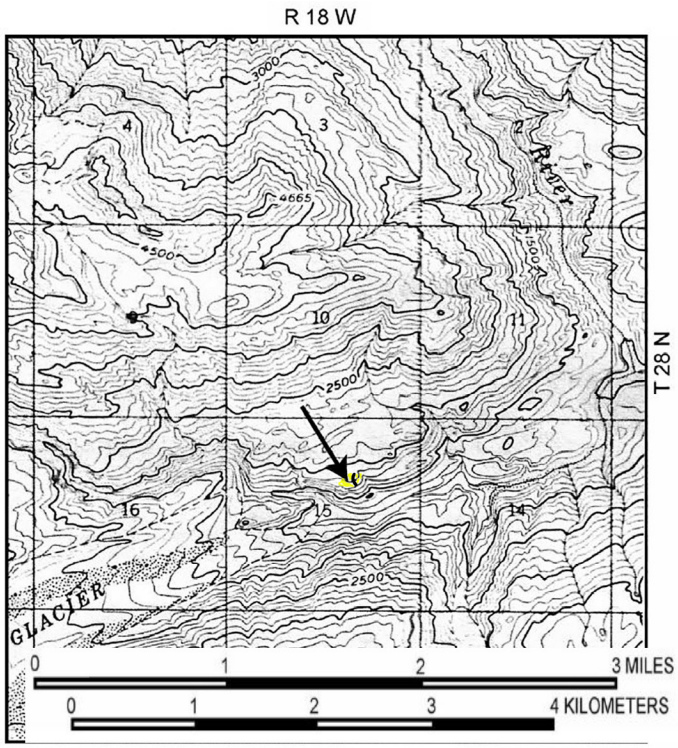

FIGURE 2. Map showing location of the Late Early Devonian (Emsian) age Shellabarger Limestone in Shellabarger Pass, Denali National Park & Preserve, Talkeetna C-6 quadrangle, south-central Alaska. Outcrop shown in yellow color surrounding the measured type section. Line indicates measured section. Base of section located at its north end.

continental margin sequence originated by rifting away from the Siberian continent, rather than northwestern North America (Blodgett and Brease, 1997, Blodgett, 1998, Blodgett et al., 2002). Recent past and on-going study of Emsian and Frasnian age fauna has emphasized their paleobiogeographic affinities and implications (Blodgett, 1998; Blodgett and Boucot, 1999; Blodgett and Brease, 1999; Blodgett et al., 2002, 20022; Hodges and Blodgett, 2019a, 2019b).

SYSTEMATIC PALEONTOLOGY

Repository: – The brachiopod specimens described in this paper are deposited at the Alaska Geologic Materials Center (prefix AKGMC), Anchorage, Alaska.

Order Atrypida Rzhonsnitskaya, 1960
Suborder Davidsoniidina Copper, 1996
Superfamily Davidsonioidea King, 1850
Family Carinatinidae Rzhonsnitskaya, 1960
Genus *Carinatina* Nalivkin, 1930

Type species: *Orthis arimaspas* Eichwald in von Buch, 1840

***Carinatina connorsi* n. sp.**
Fig. 5

Description: The shell is medium-sized (length 32-40 mm), oval, slightly transversely elongated, with rough dichotomizing and intercalating ribs, slightly convex. The hinge edge is straight and equal to the greatest width of the shell. The ventral valve is most convex in the umbilical region and most concave in

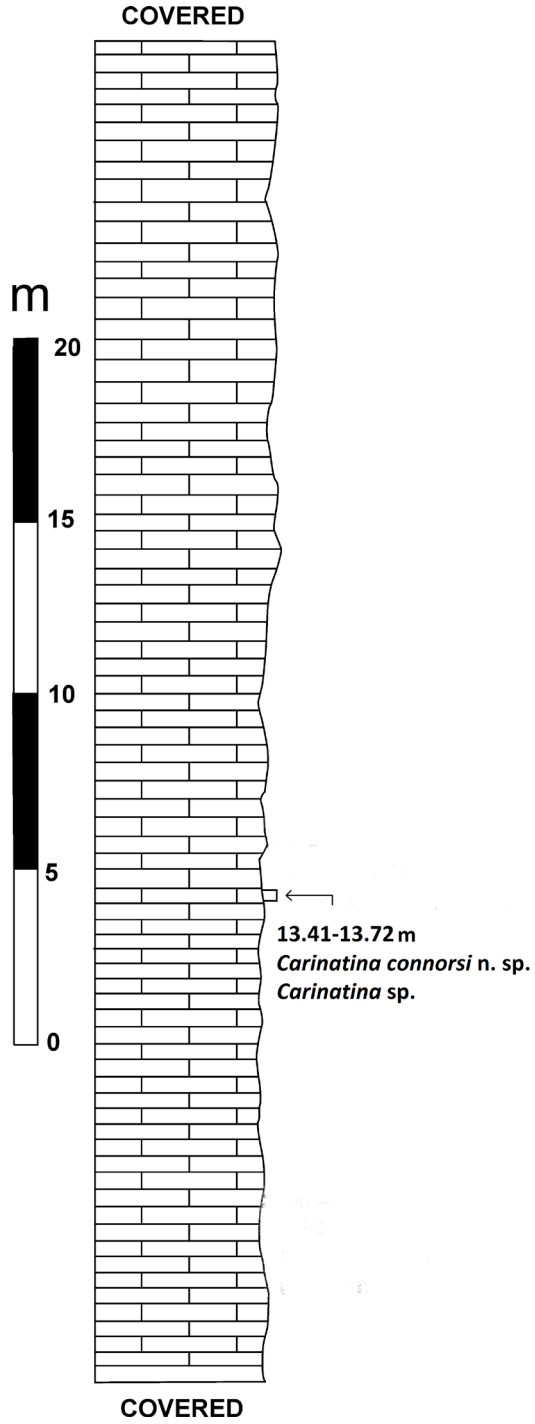

FIGURE 3. Measured type section of the Shellabarger Limestone. Situated at a single isolated limestone outcrop, it constitutes the oldest Devonian interval within the Dl unit of Reed and Nelson (1977, 1980). It forms the oldest stratigraphic interval within the Mystic sequence of Gilbert and Bundtzen (1984). This outcrop is situated on the eastern side of a small hillock situated near the center of the NE¼, SW¼, NE1/4, sec. 15, T28N, R18W, Talkeetna C-6 1:63,360 scale quadrangle, latitude 62°31'21"N., longitude 152°35'32" W. The measured section of the outcrop indicates a minimum thickness of 38.7 m (127 ft) of lime mudstone and wackestone for the unit (Blodgett et al., 2021). Top of measured section is at the south. Location of *Carinatina connorsi* n. sp. and *Carinatina* sp., both described here at 44-45 feet (13.41-13.72 m) above the base of section is indicated.

FIGURE 4. Outcrop of the upper part of the type section of the Shellabarger Limestone (Late Early Devonian) in Shellabarger Pass (view looking east-northeast). The two people in the photo are Pam Sousanes (NPS) (left) and one of the authors, Robert B. Blodgett (on right).

the anterior half. At the anterior edge it is limited by a round concentric ridge. The beak is small, sharp and straight. The area is triangular, narrow, with a wide, closed triangular delthyrium, at the apex of which there is an oval foramen. The apical angle is about 130–140°. The fold is rounded, keeled, more pronounced in the umbonal part and widening towards the anterior edge. The dorsal valve is more convex than the ventral valve, with a distinct sinus widening towards the anterior margin. The lateral slopes flatten towards the edges. The concentric groove corresponding to the concentric ridge of the ventral valve is weakly expressed. The surface of the shell is covered with coarse rounded ribs, the number of which at the anterior edge is about 31–33. Towards the anterior margin, the ribs dichotomize and intercalate, and on the ridge of the ventral valve they split into 3–4 striae. There are 4 primary ribs on the fold, which can dichotomize towards the anterior edge. In the sinus, on each side of the central rib there is one lateral rib. The surface of the shell is covered with frequent thin concentric growth lines. The internal structure has not been studied.

Comparison: *Carinatina connorsi* n.sp. from the late Emsian Shellabarger Limestone of Denali National Park,west-central Alaska closely approaches *Carinatina lowtherensis* Johnson and Boucot from the late Emsian Disappointment Bay Formation, Canadian Arctic Islands, Yukon Territory, and east-central Alaska but differs in being slightly less transverse (having sharp angular cardinal margins) and in having a slightly more rounded ventral and dorsal shell outlines. In addition it is also slightly thinner in thickess. *C. connorsi* n. sp. differs from the type species of the genus, *C. arimaspa* (Eichwald, 1840), (Copper, 2002, p. 1446, fig. 980.1a–g) by a flattened shell, flatter ventral and dorsal valves, a long straight hinge edge coinciding with the largest shell width, narrow and long ventral area, wide delthyrium overgrown with deltidial plates. Photos of *C. arimaspa* (Eichwald) from the Malobachatsky horizon (Pragian) of the Kuznetsk basin, are given by R.E. Alekseeva (1962), differs from the type species by a straight hinge edge and probably belongs to another species. This was also noted by M.A. Rzhonsnitskaya (1975, p. 142). *C. connorsi* n. sp. differs from the *C. arimaspa* described by Rzhonsnitskaya from the Eifelian (currently the Emsian) of the Kuznetsk Basin and the Urals in its larger size, long straight hinge margin, fused deltidial plates and oval foramen. A.N. Khodalevich (1951, p. 86) describes fused deltidial plates and a small foramen in the Uralian *C. arimaspus*. *C. connorsi* n. sp. differs from *C. signifera* (Schnur), described in the publications of Khodalevich (1951), Alekseeva (1962), and *C. praesignifera* Rzonsnitskaya, 1968, found in the articles of Breivel and Breivel (1977), Sapelnikov and Mizens (1981), Mizens and Sapelnikov (1982), Mizens (1984) with thin ribs and a large number of them, a long hinge edge equal to the greatest width of the shell.

Occurrence: This new species is known only from late Emsian strata of the Shellabarger Limestone, established earlier in Shellabarger Pass, Talkeetna C-6 1:6 3,360 scale quadrangle, south-central Alaska. The genus is widely reported at a number of localities in the Old World Realm (Copper, 2002) in strata ranging in age from Pragian-early Givetian, but is most common in Eurasia (notably Siberia), Europe, and North Africa. The genus in North America is restricted to northwest Laurentia in the Emsian, notably the Canadian Arctic Islands (Johnson, 1975, Johnson and Boucot, 1972), Yukon Territory (Lenz, 1977; Perry, 1979, 1984; Perry and Lenz, 1978), as well as Laurentian craton-bound part of east-central Alaska (Blodgett, 1978). It is interesting to note no occurrences are in the Great Basin (Nevada) further to the south during the Early and Middle Devonian (Johnson and Klapper, 1990).

Material: Two articulated specimens, holotype AKGMC-59 and paratype AKGMC-60, both from 44-45 feet (12.41-13.72 m) above the base of the measured section.

Etymology: This new brachiopod species is named in honor of Timothy B. Connors in recognition of his 25 years of contributions to National Park Service geology and paleontology.

Types: Holotype AKGMC-59 and paratype, AKGMC-60, both from 44-45 feet (13.41-13.72 m) above the base of the measured section.

Measurements: Holotype (AKGMC-59), 31 mm wide and 27.5 mm in length. Paratype (AKGMC-60), 40 mm wide and 30 mm in length.

Carinatina sp.
Fig. 6

Description: The shell is of medium size (width 32 mm), oval, slightly transversely elongated, with coarse ribs that dichotomize and intercalate in the anterior direction, and is plano-convex. The hinge edge is straight and short. The greatest width is located in the middle of the length. The ventral valve is flat with a median elevation in the posterior part. At the leading edge it ends in a poorly preserved concentric ridge. The top of the head has not survived. The area is triangular. The delthyrium is not wide, and covered in the lower part by a delthyrial plate; in the upper part it is not preserved. Also, the form of the foramen has not been established. The apical angle is about 145°. The fold is round, low, clearly defined only in the posterior half, and flattens anteriorly. The dorsal valve is more convex than the ventral valve, with a small sinus expanding towards the anterior edge. The side slopes are inclined at an angle of 45°. The shape of the beak has not been determined. The concentric groove is poorly preserved. The surface of the shell is covered with coarse rounded ribs, the number of which at the anterior margin is about 40. Towards the anterior margin, the ribs dichotomize and intercalate, and on the ridge of the ventral valve they split into 4–5 striae. The ribs on the fold are not preserved. In the sinus in the umbilical region, one narrow rib appears on either side of the central rib, which widens and dichotomizes towards the anterior edge, and another rib is inserted. The surface of the shell is covered with thin concentric growth lines. The internal structure has not been studied.

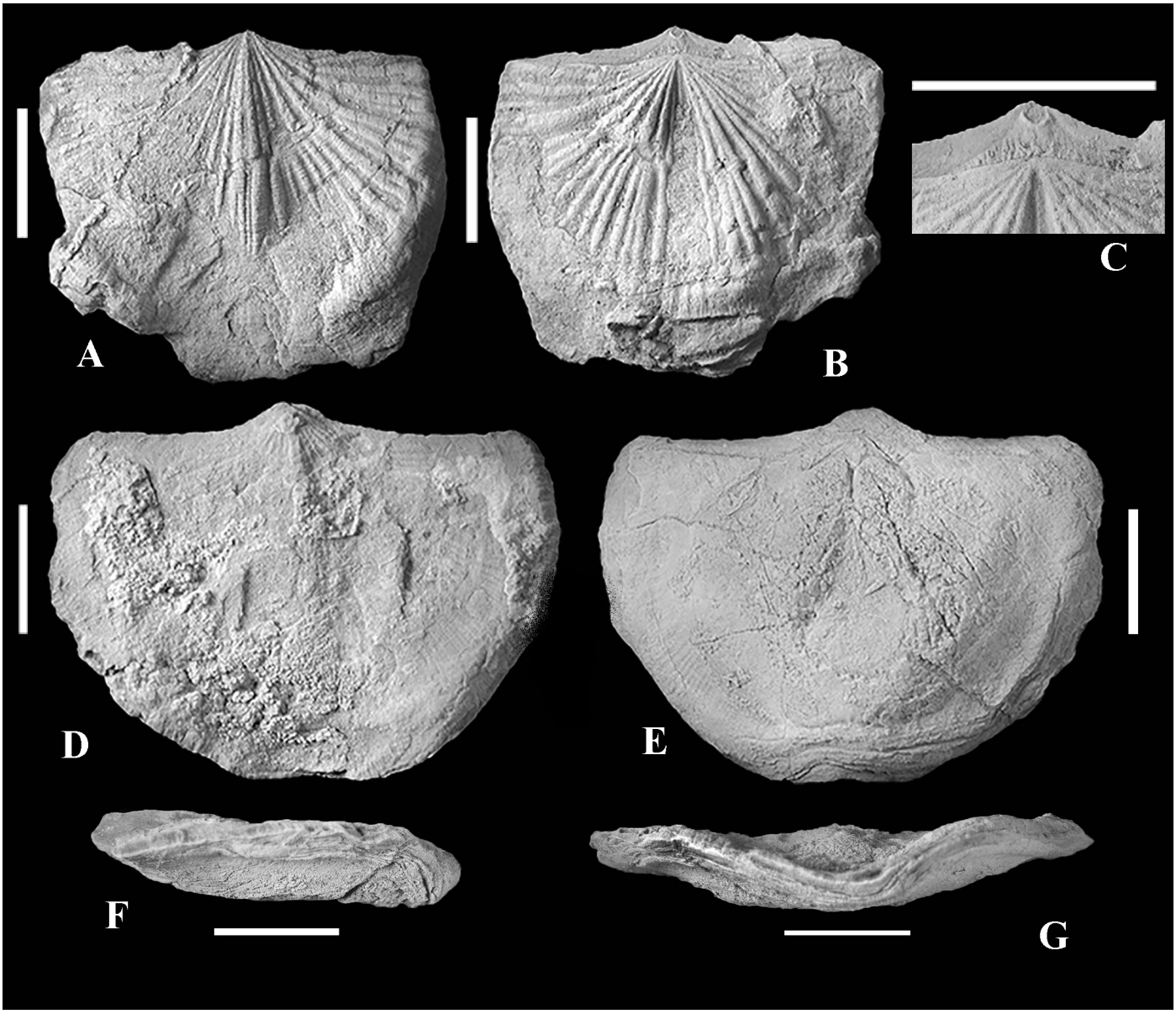

FIGURE 5. **A-E**, *Carinatina connorsi* n. sp. A-C, Holotype (AKGMC-59), ventral (A) and dorsal (B) views of an articulated specimen collected 44-45 feet (13.41-13.72 m) above the base of the measured section of the Shellabarger Limestone, Shellabarger Pass, Denali National Park & Preserve and Preserve, Talkeetna C-6 scale quadrangle, south-central Alaska. C is an enlarged view of hinge of the holotype specimen showing character of the delthyrial area. **D-G**, *Carinatina connorsi* n. sp., paratype (AKGMC-60), ventral, dorsal lateral and anterior views of highly weathered articulated specimen from same locality. Scale bar = 10 mm in all views.

Comparison: *Carinatina* sp. differs from *C. connorsi* n. sp. in having a more convex shell, a shorter hinge edge, and with the greatest width located in the middle, as well as a flat ventral and much more convex ventral valve, and a larger number of ribs. *Carinatina* sp. differs from *C. arimaspus* (Eichwald, 1840), described by Khodalevich (1951, p. 86) in having a larger size of the shell and the presence of coarser, and few ribs; it differs from *C. signifera* (Schnur, 1854), described by Alekseeva (1962, p. 153), in the presence of coarser ribs and their greater number (40 versus 120). Due to uncertainty of the complete character of this species, we leave it here in open nomenclature simply as *Carinatina* sp.

Material: Only one articulated specimen (AKGMC-61), collected from 44-45 feet (13.41-13.72 m) above the base of the section is recognized.

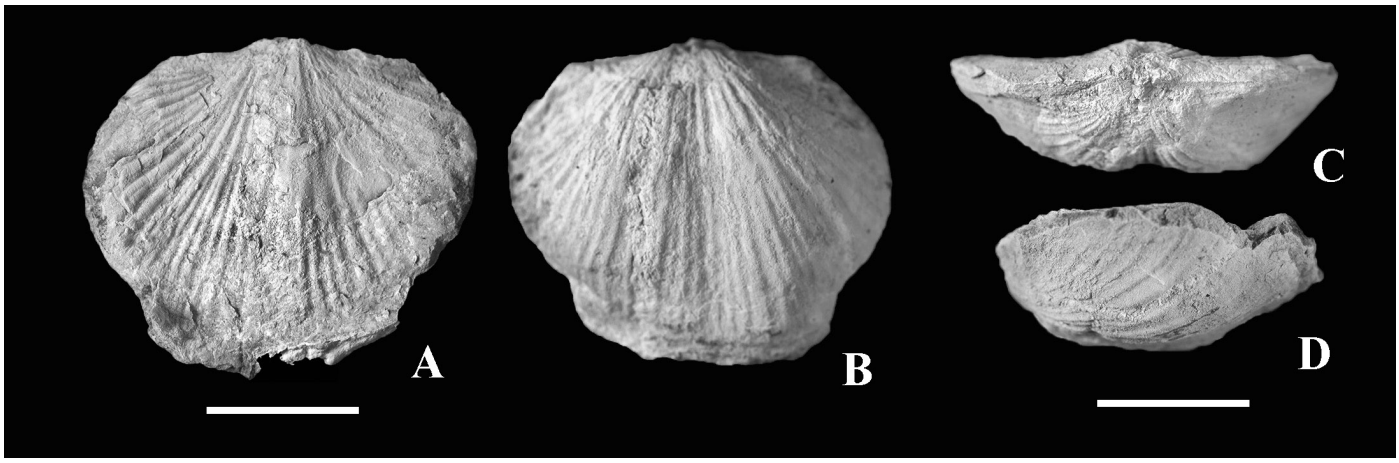

FIGURE 6. *Carinatina* sp. **A-D**. Ventral, dorsal, posterior and lateral views of a single articulated specimen (AKGMC-61) collected 44-45 feet (13.41-13.72 m) above the base of the measured section of the Shellabarger Limestone, Shellabarger Pass, Denali National Park & Preserve and Preserve, Talkeetna C-6 scale quadrangle, south-central Alaska. Scale bar = 10 mm in all views.

ACKNOWLEDGMENTS

Blodgett thanks the Committee for Research and Exploration of the National Geographic Society for providing funds in 1996 which permitted five days of fieldwork in the Shellabarger Pass area of south-central Alaska in late July of the same year. He also thanks Phil F. Brease (deceased) and Pam Sousanes of the U.S. National Park Service, Denali National Park, for able assistance in the field. Norman M. Savage, University of Oregon, Eugene, kindly identified the conodonts. Carl Bentley, helicopter pilot for Era Helicopters, capably got us into and out of the remote and beautiful area of the central Alaska Range. We are grateful to Dirk A. Bodnar (Murrieta, California) and Viktor I. Makoshin (Diamond and Precious Metals Geology Institute, Yakutsk, Russia) for their thoughtful reviews of this manuscript. Finally, we are indebted to Christopher L. Hodges (Sacramento State University, Sacramento) for his help in the formal drafting of several figures.

The research of Valeryi V. Baranov was carried out under the state order of the Institute of Geology of Diamond and Precious Metals of the Siberian Branch of the Russian Academy Sciences, project FUFG-2024-0005. This work greatly benefited from the recent (post-1995) collaborative efforts on the part of other paleontologists who have studied or made observations of our fossil collections from the Shellabarger Pass area. These include the following individuals: Jenaro L. Garcia-Alcalde (Oviedo, Spain, Devonian brachiopods), Alan E.H. Pedder (Sidney, British Columbia, Canada, deceased Devonian corals), Norman M. Savage (University of Oregon, Eugene, Devonian conodonts), and J. Keith Rigby, Sr. (Provo, Utah, deceased, Devonian sponges).

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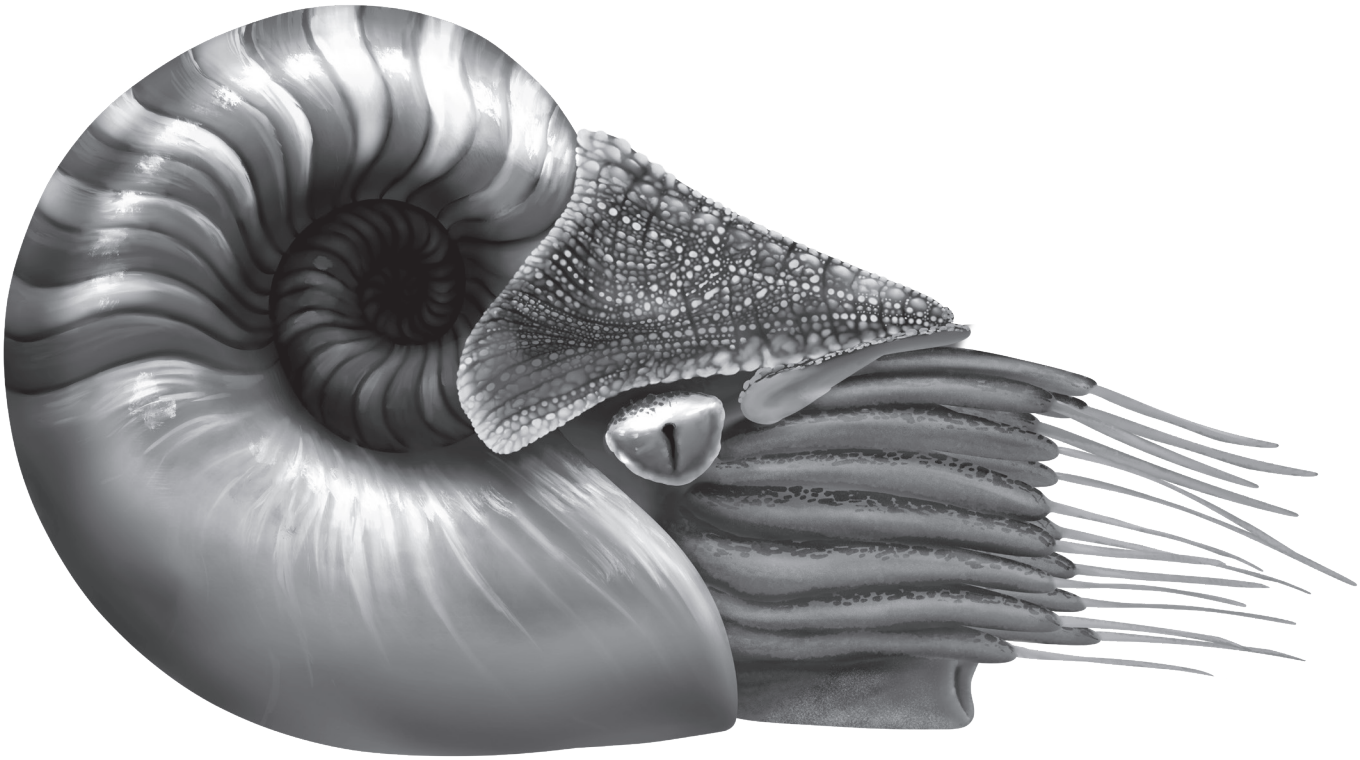
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