A RE-EVALUTATION OF TRIASSIC INVERTEBRATE TYPE SPECIMENS OF CRATON-BOUND STRATA FROM THE LOWER PART OF THE GLENN SHALE, YUKON-CHARLEY RIVERS NATIONAL PRESERVE, EAST-CENTRAL ALASKA

ROBERT B. BLODGETT[1], VINCENT L. SANTUCCI[2], HOWARD R. FELDMAN[3] and VALERYI V. BARANOV[4]

[1]Consulting Geologist, 2821 Kingfisher Drive, Anchorage, Alaska 99502, email: robertbblodgett@gmail.com; [2]Senior Paleontologist, National Park Service - Geologic Resources Division, 1849 C Street, NW, Room 2644, Washington, D.C. 20240, email: vincent_santucci@nps.gov; [3]Biology Department, Touro University, 227 W. 60th Street, New York, New York 10023, email: feldspar4@optonline.net; [4]Diamond and Precious Metals Institute, Siberian Division, Russian Academy of Sciences, pr. Lenina 39, Yakutsk, 677000, Russia, email: baranowvalera@yandex.ru

Abstract—James Perrin Smith in 1927 (U.S. Geological Survey Professional Paper 141) described and established 11 species of megainvertebrate fossils from Triassic strata that are today referred to the lower part of the Glenn Shale (Brabb, 1969) in the Charley River Quadrangle, east-central Alaska. These rocks are all within the Yukon-Charley Rivers National Preserve (YUCH), established in 1978 as a national monument but redesignated a national preserve in 1980. Geologically the preserve is situated on a structural prong that represents the northwesternmost part of the ancient North American (Laurentian) continent. The fossil taxa described from the Glenn Shale include three brachiopod species (*Rhynchonella blackwelderi* n. sp., *Spiriferina yukonensis* Smith, and *Dielasma chapini* Smith); five bivalves species (*Halobia cordilleriana* Smith, *Pecten* (*Entolium*) *yukonensis* Smith, *Eumorphotis nationalis* Smith, *Lima martini* Smith, and *Pleurophorus overbecki* Smith), two ammonoids (*Cladiscites martini* Smith and *Nathorstites alaskanus* Smith) and one nautloid (*Germanonautilus brooksi* Smith). We present Smith's original line drawings of these species, along with recent photos obtained of Smith's same type specimens from YUCH. We noted some minor discrepancies exist between the original drawings by Smith and the modern photographs. We provide some slight generic reassignment, as well as summary history of the occurrences of these taxa since they were first established. This fauna is of great interest to paleobiogeographers as it provides a glimpse into a high mid-latitude fauna (equivalent to Fauna C of Silberling, 1985) and has similarities to coeval fauna from the Canadian Arctic Islands and the Shublik Formation on the Arctic Coastal Plain of northern Alaska. The fauna lacks warm-water taxa such as colonial scleractinian corals and the hydrozoan genus *Heteratstridium*. The Glenn Shale invertebrate fauna probably represent warm temperate to cool in temperature, which stands in strong contrast to the diverse Upper Triassic faunas of Alaska's accreted terranes of central and southeastern Alaska. Further research and collecting in the fossil-rich lower portion of the Glenn Shale will undoubtedly result in a more robust representation of species.

INTRODUCTION

Yukon-Charley Rivers National Preserve (YUCH) was originally proclaimed a national monument on December 1, 1978. The monument was soon redesignated a national preserve on December 2, 1980. The preserve is located along the Canadian border in east-central Alaska where it protects 185 km (115 mi) of the 2,897 km (1,800 mi) long Yukon River. The entire Charley River basin is within the preserve, consisting of 142 km (88 mi) of one of the most spectacular wild rivers in Alaska. Numerous historic cabins and other structures found within YUCH preserve the history of the Yukon River during the 1898 gold rush. An earlier attempt to summarize the paleontological and geological framework for YUCH was made by the National Park Service in 2011 (Santucci et al., 2011).

In terms of geological resources, the area around Yukon-Charley Rivers National Preserve (YUCH) is one of the most thoroughly investigated geologic regions in the NPS within Alaska. Early investigations extend well back into the last decade of the 19th century and the first decade of the 20th century. Notable geologic studies from this interval include McConnell (1890), Spurr (1898), Collier (1903), Brooks and Kindle (1908), Gilmore (1908), and Quakenbush (1909). Cairnes (1914a, 1914b) from the Geological Survey of Canada published the results of his geologic mapping along the Alaska-Yukon boundary area between the Yukon and Porcupine rivers. Subsequently, the work of John B. Mertie, Jr. outlined the geological framework for YUCH, his work covering rocks of all ages, including the sedimentary rocks north of the Tintina fault, and the polymetamorphosed rocks of the Yukon-Tanana Upland south of the fault.

References pertaining to the regional geologic mapping within the boundaries of YUCH include: Brabb (1962 − Charley River quadrangle); (Brabb and Churkin (1964 − Charley River quadrangle; 1965 − Eagle D-1 quadrangle; 1969a − Charley River quadrangle [colorized]); Dover (1992 − SE Charley River quadrangle); Cairnes (1914a, b − boundary strip area along Alaska-Yukon boundary); Dover and Miyaoka (1988 − Charley River quadrangle); Foster (1976 − Eagle quadrangle), Mertie (1930, 1933, 1937 and 1942); Miyaoka (1990 − SE Charley River quadrangle); and Van Kooten et al. (1997 − parts of Charley River and Eagle quadrangle).

Triassic strata are widely exposed in the craton-bound portion of YUCH, notably in the Charley River A-1, A-2, A-3, B-2 and B-3 1:63,000 scale quadrangle, situated in the eastern portion of YUCH. These consist of Middle and Upper Triassic strata of the lower part of the Glenn Shale, established by Brabb (1969), which overlies the Permian age Takhkandit Limestone. The lower part is separated from the upper part of the Glenn Shale (primarily Lower Cretaceous) by a significant hiatus, with Jurassic strata and fossils being notably missing, except for a few occurrences of the bivalve *Otapiria* in lowermost Jurassic strata.

The Glenn Shale is primarily composed of a gray to black carbonaceous shale, and is suggested to be 1,500 m (4,000 ft) thick. Two unconformities have been recognized within the Glenn Shale. The lower portion of the Glenn Shale is

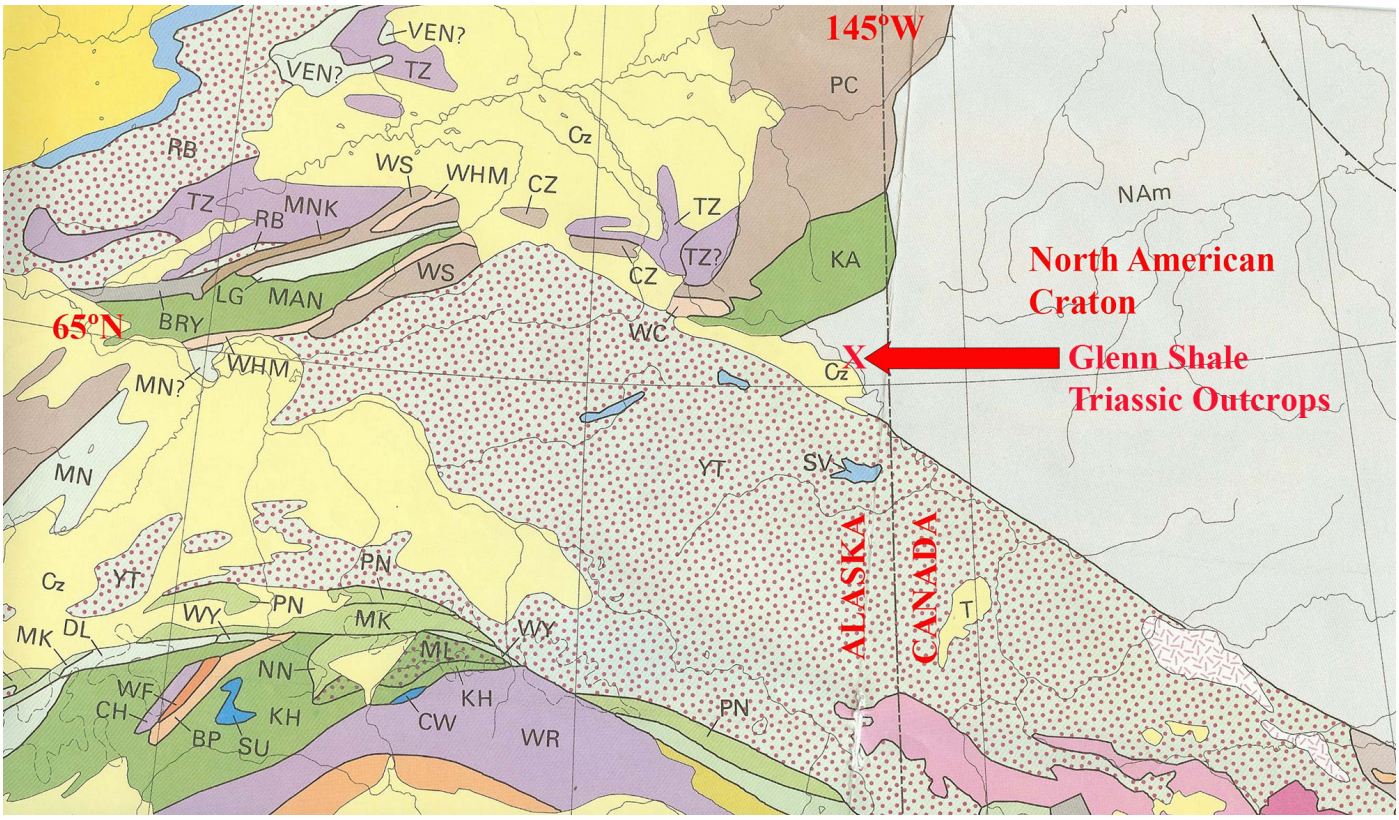


FIGURE 1. Map showing location of area of outcrops of the lower part (Triassic) of the Glenn Shale in east-central Alaska at the western-most edge of the North American craton. X marks the primary area of Triassic outcrops (mouth of Nation River area, Trout Creek, Michigan Creek). Map modified from Silberling et al. (1994).

approximately 120 m (390 ft) thick and is exposed along the Yukon River and along Trout Creek. These rocks contain a rich, diverse Middle and Late Triassic (late Ladinian to Norian) age marine invertebrate fauna including rhynchonellid, spiriferid, and terebratuloid brachiopods; nuculid and pectenid pelecypods (*Halobia* and *Monotis*); ammonoids and nautiloids. Higher in the section, the remains of the pelecypod *Otapiria* indicate an Early Jurassic age. The crinoid *Pentacrinus subangularis* var. *alaska* of Early Jurassic age has been reported nearby from the same beds. Lower Cretaceous beds are also recognized in the formation and include both Berriasian and probable Valanginian age *Buchia*. The long time span and great thickness of this formation suggests that future detailed mapping will probably result in a much finer segregation of stratigraphic units within the Glenn Shale.

The National Park Service is currently compiling a comprehensive paleontological resources inventory of the fossil fauna and flora of YUCH. The lower Glenn Shale is among the geologic strata that will be evaluated in the YUCH paleontological resource inventory. The robust bivalve, ammonoid, nautiloid and brachiopod fauna provides an important glimpse into the composition of a relatively high-latitude Triassic biota within the northwestern-most corner of the area that at that time comprised cratonic North America. Primary references to the megafauna include the works of Smith (1927), Kummel (1953), Silberling (1963), Grant-Mackie and Silberling (1990), Silberling *et al.* (1997), and McRoberts (1997). Study of the radiolarian fauna was undertaken by Robinson (1989) and Robinson and Pessagno (1998). It is our intent to greatly amplify our knowledge of the fossil biota from YUCH, including potential ichthyosaurs (one rib has previously been collected from the lower Glenn Shale). Expanded knowledge of the diversity of the macroinvertebrate fauna of the lower part of the Glenn Shale will be most useful for comparing and contrasting North American mid-latitude cratonic Late Triassic biotas with those from nearby accreted terranes such as Wrangellia (south-central Alaska) and the Lewes River Group of the Stikinia terrane (from Whitehorse area of the Yukon Territory). The two paleontologists who studied the Glenn Shale invertebrate fossil faunas include James Perrin Smith (1864-1931) and Norman J. Silberling (1928-2011) (Fig. 2).

REVIEW OF GLENN SHALE TRIASSIC HOLOTYPES

The three brachiopod species established by Smith (1927) from the lower part of the Glenn Shale are illustrated here: *Spiriferina yukonensis* Smith (Fig. 3), *Rhynchonella blackwelderi* (Figs. 4A-F) and *Dielasma chapini* Smith (Figs. 4G-L). Smith (1927) illustrates a species that he refers to as *Dielasma chapini*. The shell of this genus does not fit the morphology of the genus *Dielasma,* rather it is comparable to the genera *Tibetothyris* or *Rhaetina*, both Triassic forms. Generally, in the Paleozoic *Dielasma* specimens are very often rectimarginate and somewhat elongate. However, in the Mesozoic this genus became more sulcate, unisulcate or sulcisulcate. In the Treatise (Jin et al., 2006, p. 2029-2030) described *Dielasma* from the upper Permian, Pössneck, Thuringia, Germany as follows: "small to large, elongate oval to subpentagonal in outline, generally dorsibiconvex, narrowly domed to keeled, and ventral valve flatly convex to medially concave; anterior commissure uniplicate to sulciplicate; beak ridges rounded; foramen permesothyrid small

FIGURE 3 (facing page). *Spiriferina yukonensis* Smith, 1927. Holotype, USNM 74202. **A-B,** line drawings of the holotype in ventral and dorsal views (from Smith, 1927, Pl. CI, figs. 13-14). **C-D,** same views as before, but in color (original specimen housed in USNM). **E,** oblique ventral view to better show the nature of sulcus. Original specimen housed in USNM; scale bar = 10 mm

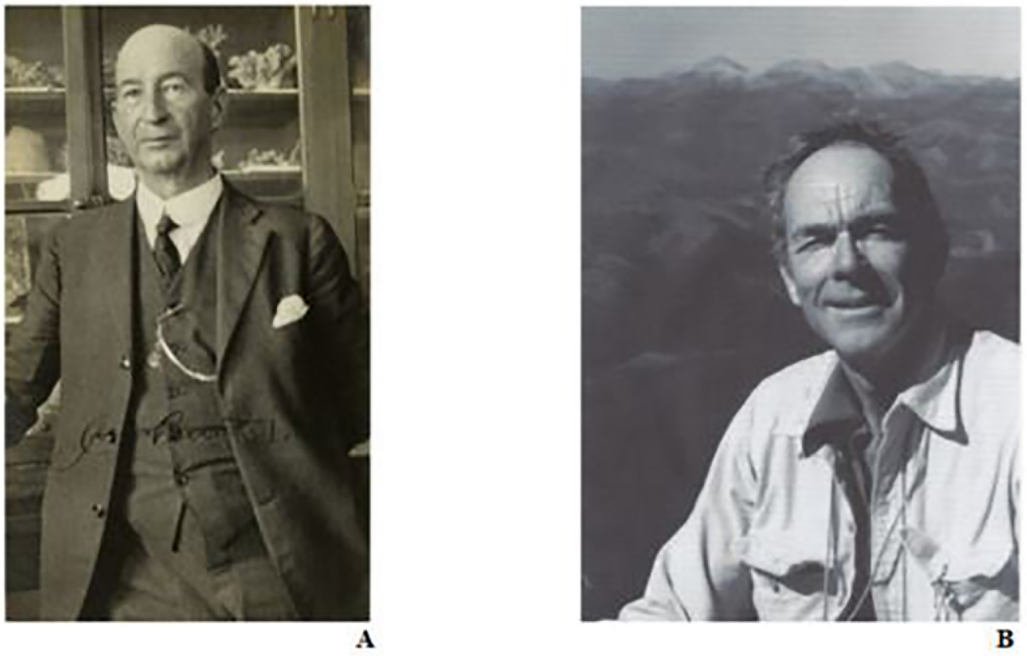
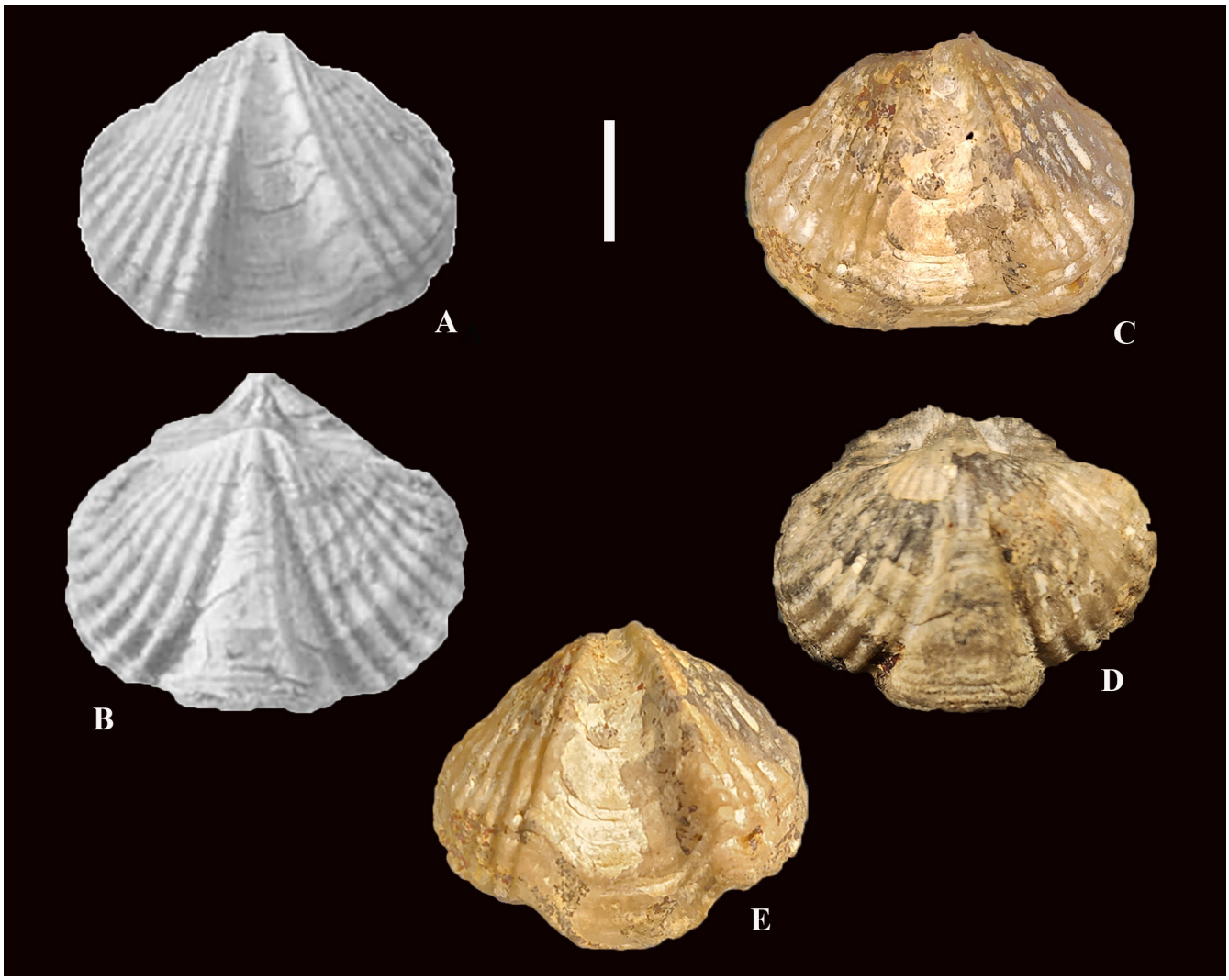


FIGURE 2. Two renowned Triassic paleontologists whose studies in the Triassic of Alaska, Californian and Nevada led to the conceptualization of accreted terranes in western North America. **A,** James Perrin Smith (1864-1931), renowned Stanford University paleontologist. **B,** Norman J. Silberling (1928-2011), USGS paleontologist/stratigrapher, earlier with Stanford University.



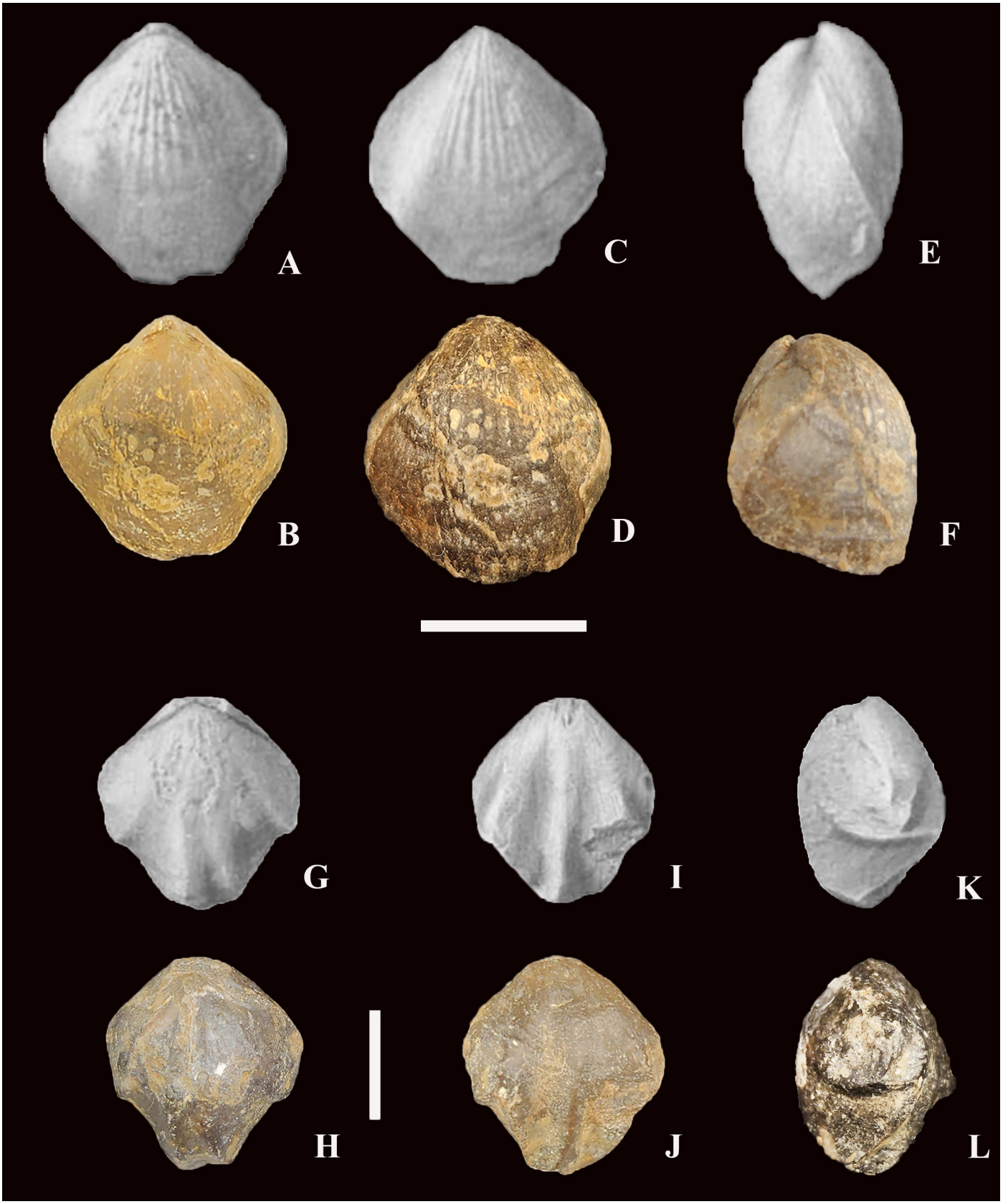


FIGURE 4. **A-F,** *Rhynchonella blackwelderi* Smith, 1927. A, C, E, dorsal, ventral and lateral views of original line drawing. B, D, F, dorsal, ventral and slightly oblique lateral views of the same holotype specimen. Holotype, USNM 74204. [originally illustrated in Smith, 1927, Pl. CII, figs. 1-3.]. Scale bar = 10 mm. **G-L,** *Dielasma chapini* Smith, 1927. G, I, K, dorsal, ventral, and lateral views of original line drawing of holotype. H, J, L, dorsal, ventral, and lateral photographic views of the same holotype specimen. Holotype, USNM 74205. [originally illustrated in Smith, 1927, Pl. CI, figs. 4-6]. Scale bar = 10 mm.

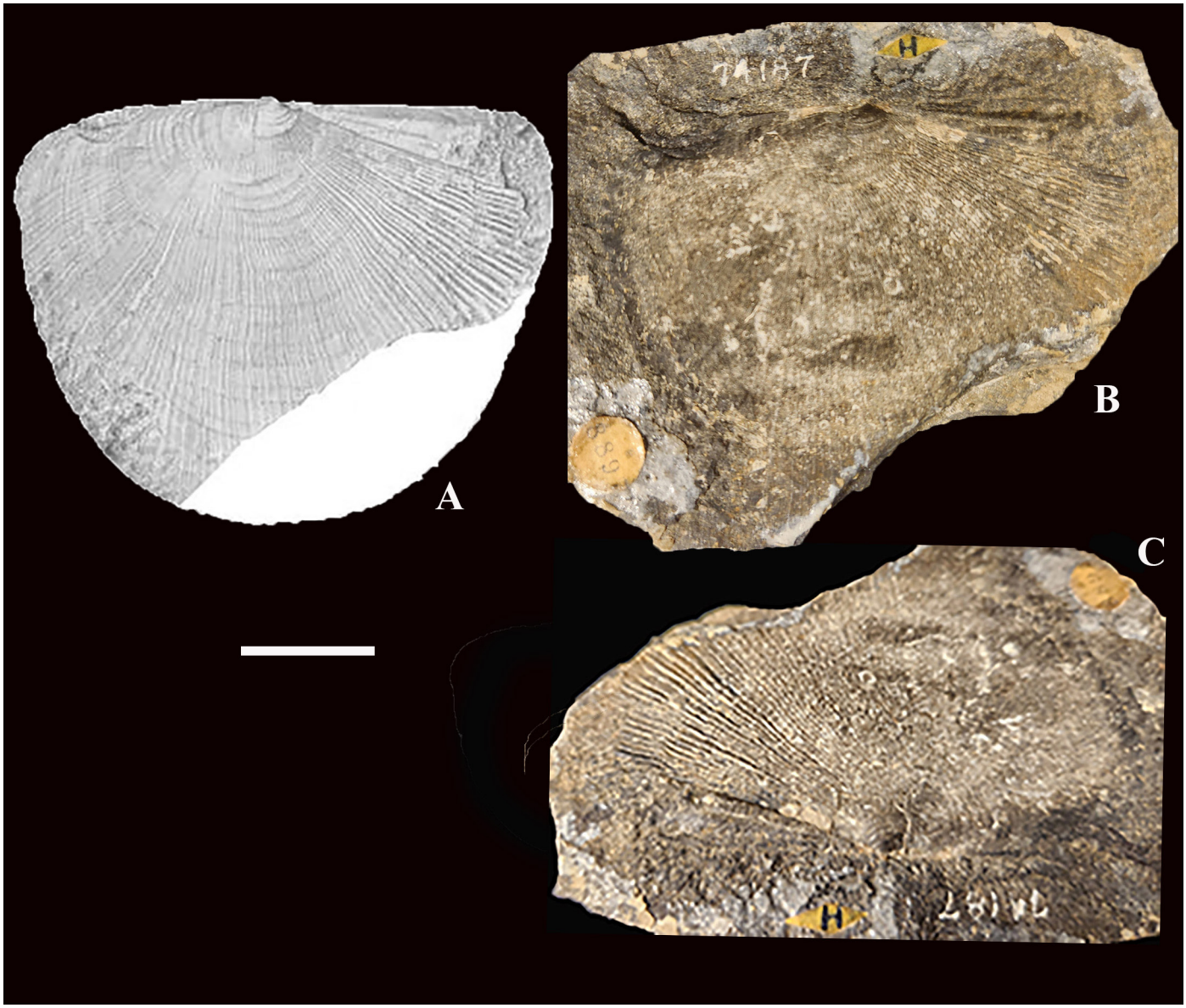


FIGURE 5. *Halobia cordilleriana* Smith, 1927. Holotype, USNM 74187 [originally illustrated in Smith, 1927, Pl. XCIX, fig. 2]. **A,** line drawing from Smith 1927. **B,** external mold of holotype specimen kept at the USNM. **C**, counterpart specimen. Scale bar = 20 mm. This is one of the most significant bivalve species in the Glenn Shale Formation (in upper Carnian age beds) of east-central Alaska.

to large often labiate, symphytium often hidden." Feldman (2017) describes a new species of *Tunethyris* from the Triassic of Israel (Anisian-Ladinian) that externally closely resembles Paleozoic forms of *Dielasma* but differs in its sulcation; it has a sulciplicate anterior commissure. *Rhaetina* (Waagen, 1883) from the Rhaetian of the eastern Alps resembles Smith's *Dielasma chapini* in that they both are medium to large and strongly sulciplicate. However, Smith's specimen has a relatively flat dorsal valve. A more favorable possibility is that Smith's specimen is a *Tibetothyris* (Treatise, Part H, p. 2032, 2035, fig. 1343) or a close relative. Jin et al. (2004) describe *Tibetothyris* as follows: "medium sized, pentagonal, biconvex, anterior commissure sulciplicate to bisulcate; beak short, erect ….foramen circular, permesothyrid." However, to determine whether Smith illustrates a true *Dielasma* one must make serial sections of several specimens for comparison with the internal morphologies of the known specimens of the genera noted above.

Co-author Valeryi Baranov makes the following observation in comparing Smith's brachiopod holotypes with Norian-Rhaetian species noted by Dagys (1965). *Rhynchonella blackwelderi* Smith, 1927 is very close to the species *Piarorhynchia dubia* Dagys, 1965 from the Norian-Rhaetian deposits of northeastern Russia, differing only in a smaller shell thickness. In the Norian-Rhaetian beds of northeastern Russia, A.S. Dagys (1965) described representatives of two species of the genus *Spiriferina*: *S. viligensis* Dagys, 1965 and *S. asiatica* Dagys, 1965. *Spiriferina yukonensis* Smith, 1927 is closest to the second species in terms of shell shape, number of ribs, shape of the sinus and fold, but differs in having a more isometric shell. Representatives of the genus *Dielasma* in the Upper Triassic of northeast Russia are not detected.

By far, the most cited bivalve species established by Smith (1927) is *Halobia cordillerana* Smith, 1927 (Fig. 5), which is widely distributed throughout much of western North America. McRoberts (2011, p. 633), noted that "….this species has a broad distribution in similar-aged strata in North America and northeastern Asia (e.g. McRoberts, 1993, 1997)." In addition, he noted "the holotype comes from the south bank of the Yukon River, Alaska about 0.75 km north of the Nation River, Alaska

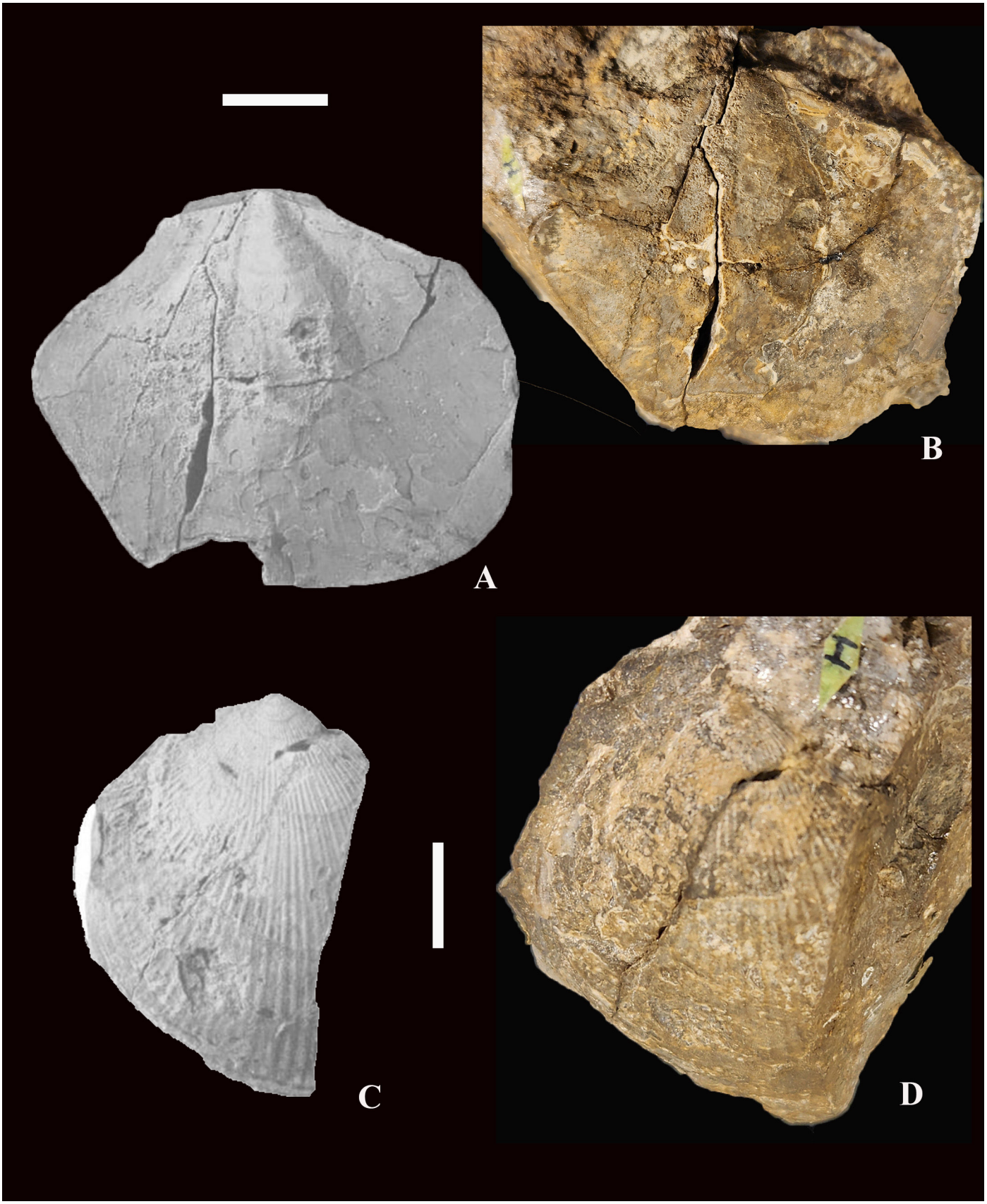


FIGURE 6. **A-B,** *Pecten* (*Entolium*) *yukonensis* Smith, 1927. Holotype, USNM 74199. [originally illustrated in Smith, 1927, Pl. CI, fig. 9]. A, Original line drawing from Smith, 1927, B, holotype specimen kept in the USNM. **C-D,** *Lima martini* Smith, 1927. Holotype, USNM 74200 (originally illustrated in Smith, 1927, Pl. CI, fig. 11], C, Original line drawing from Smith, 1927 D, photo of holotype specimen keep in the USNM. Scale bars = 20 mm.

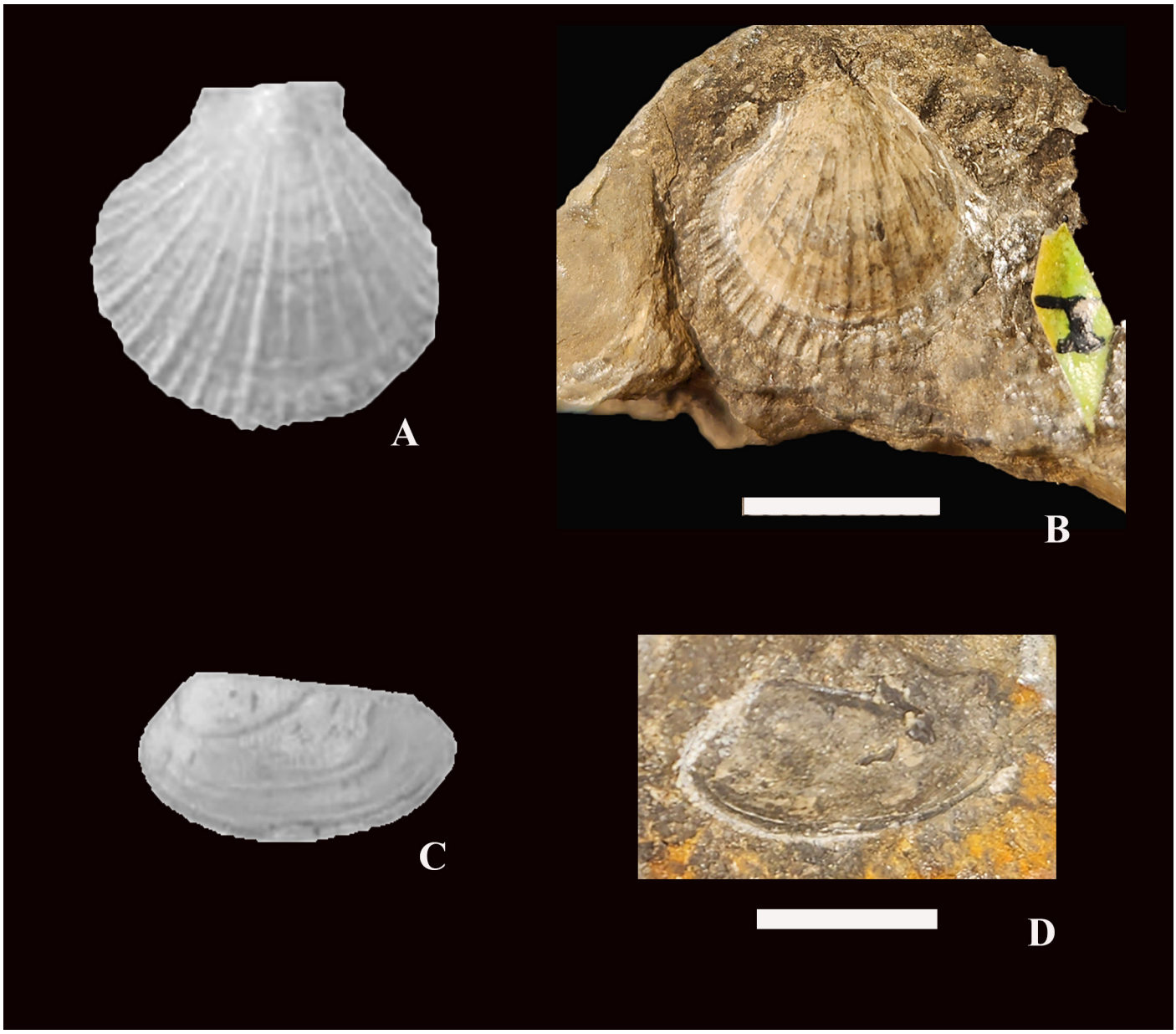


FIGURE 7. **A-B,** *Eumorphotis nationalis* Smith, 1927. Holotype, USNM 74201 [originally illustrated in Smith, 1927, Pl. CII, fig. 12]. Scale bar = 10 mm. A is original illustration from Smith, 1927 and B is actual specimen kept in the USNM. **C-D,** *Pleurophorus overbecki* Smith, 1927. Holotype, USNM 74203 (originally illustrated in Smith, 1927, Pl. CI, fig. 15]. C is the original illustration in Smith, 1927 and D is the actual specimen kept in the USGS collections. Scale bar = 10 mm.

(USGS Mesozoic loc. 8897). Although the age of this locality was originally described as Carnian, the original descriptions by Martin (1916) and Smith (1927) note the absence of co-occurring tropitid ammonoids that are known to occur, together with "*H. superba*" of Smith (1927), approximately 3-4 meters stratigraphically below the type locality (USGS Mesozoic loc. 8896). Demonstrable *G. cordilleranus* Zone with *Monotis subcircularis* Gabb, 1864, occurs from USGS Mesozoic loc. 8898 approximately 100 m above the type locality. Although it is possible that the type locality is uppermost Carnian, its morphology and interpolated position is more consistent with an early Norian age."

In the Pardonet Formtion of northeast British Columbia, McRoberts (2011, p. 633) recognized the species as common in the lower Norian *S. kerri* and middle Norian *M. columbianus* Zones. New publications citing its widespread occurrence include McRoberts et al., (2001) from the lower and middle Norian of the North Slope of Arctic Alaska (Arctic Alaska terrane) and from Kuiu Island (Alexander terrane) of southeast Alaska. Other bivalves established by Smith from the Glenn Shale include *Pecten* (*Entolium*) *yukonensis* Smith, 1927 (Fig, 6A-B), *Lima martini* Smith, 1927 (Fig. 6C-D), *Eumorphotis nationalis* Smith, 1927 (Fig. 7A-B), and *Pleurophorus overbecki* Smith, 1927 (Fig. 7C-D). Two ammonoid species were established by Smith (1927) and included *Cladiscites martini* Smith, 1927 (Fig. 8A-D) and *Nathorstites alaskanus* Smith, 1927 (Fig. 9A-C). In addition, he also established a new nautiloid species, *Germanonautilus brooksi* Smith, 1927 (Fig. 10A-D). It should be noted that Tozer (1994, p. 304) concluded that the ammonoid *Cladiscites martini* is better referred to the genus *Sphaerocladiscites*.

PALEOCLIMATIC INTERPRETATION

This fauna is of great interest to paleobiogeographers as it

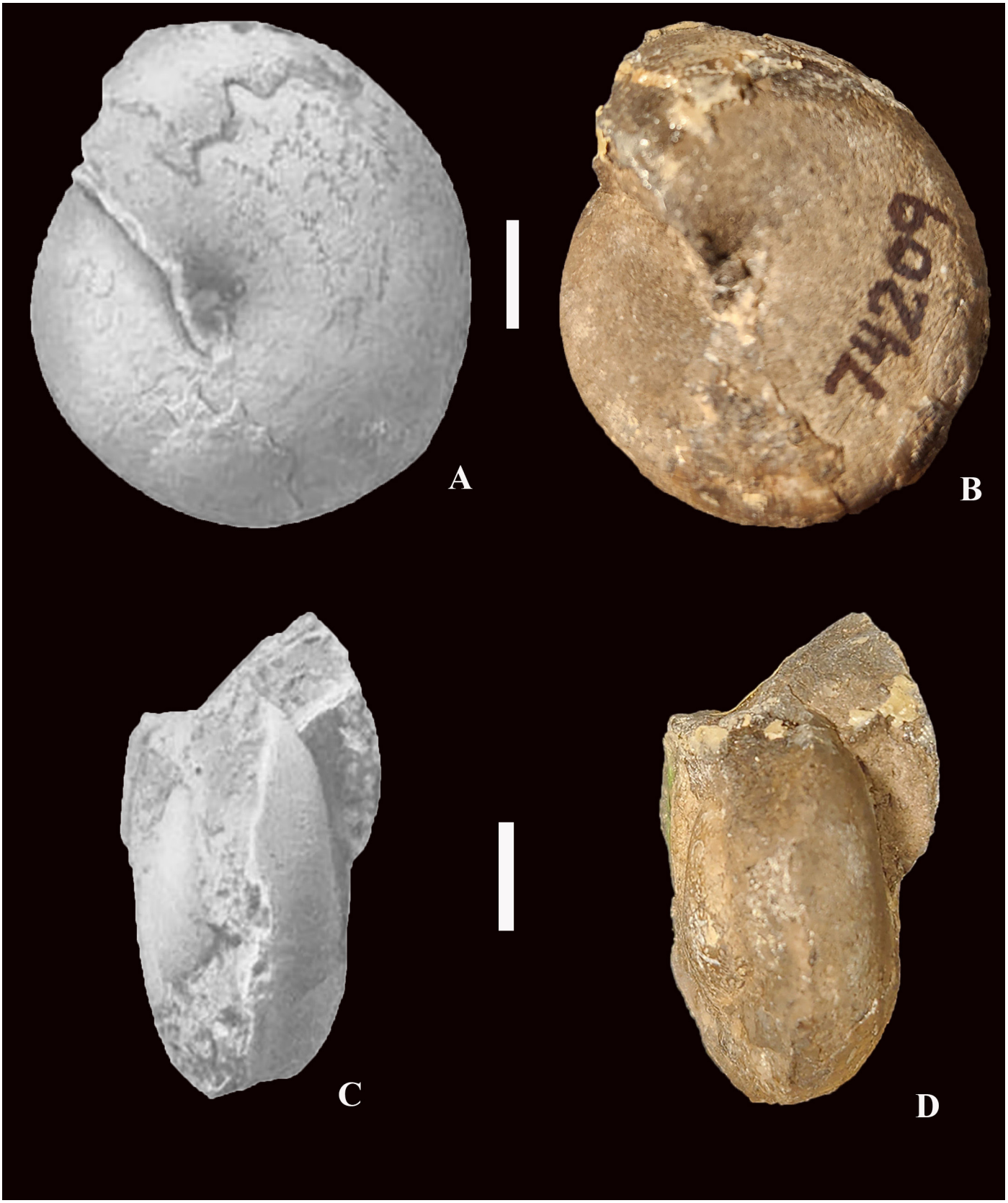


FIGURE 8. *Cladiscites martini* Smith, 1927. Holotype, USNM 74209 [originally illustrated in Smith, 1927, Pl. CII, figs. 17-18.]. **A-B,** lateral views, A, line drawing of holotype from Smith, 1927, photo of holotype specimen kept in USNM; C-D, side views. **C,** line drawing of the holotype from Smith, 1927; **D,** photo of the holotype kept in the USNM. It seems some artistic license is visible in the reconstruction in view D. Scale bars = 20 mm.

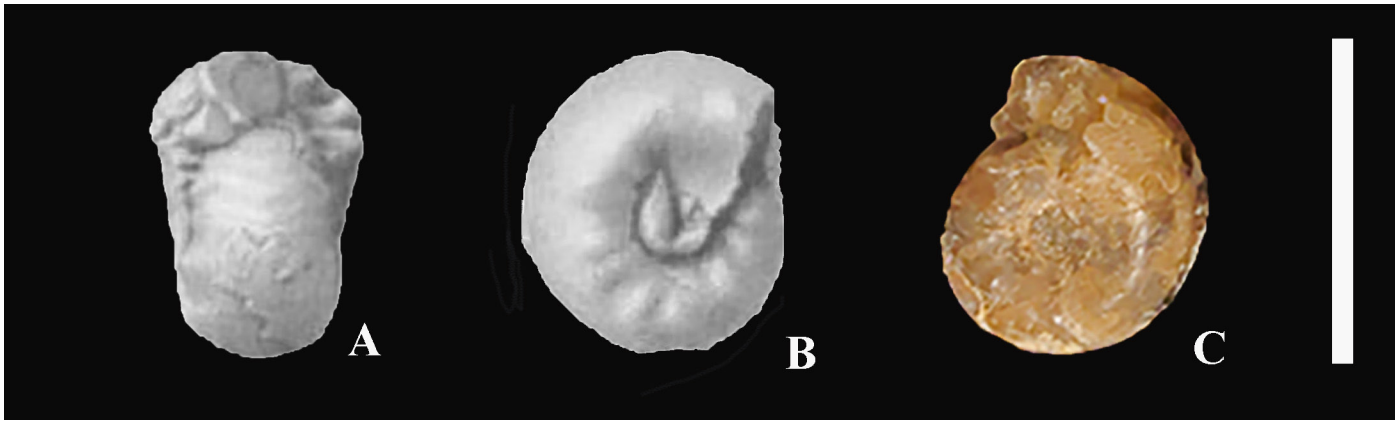


FIGURE 9. *Nathorstites alaskanus* Smith, 1927. Holotype 74207 [originally illustrated in Smith, 1927, Pl. CII, figs. 11-13]. **A-B,** line drawings of holotype from Smith, 1927. **C,** photo of holotype specimen kept in the USNM. Scale bar = 10 mm.

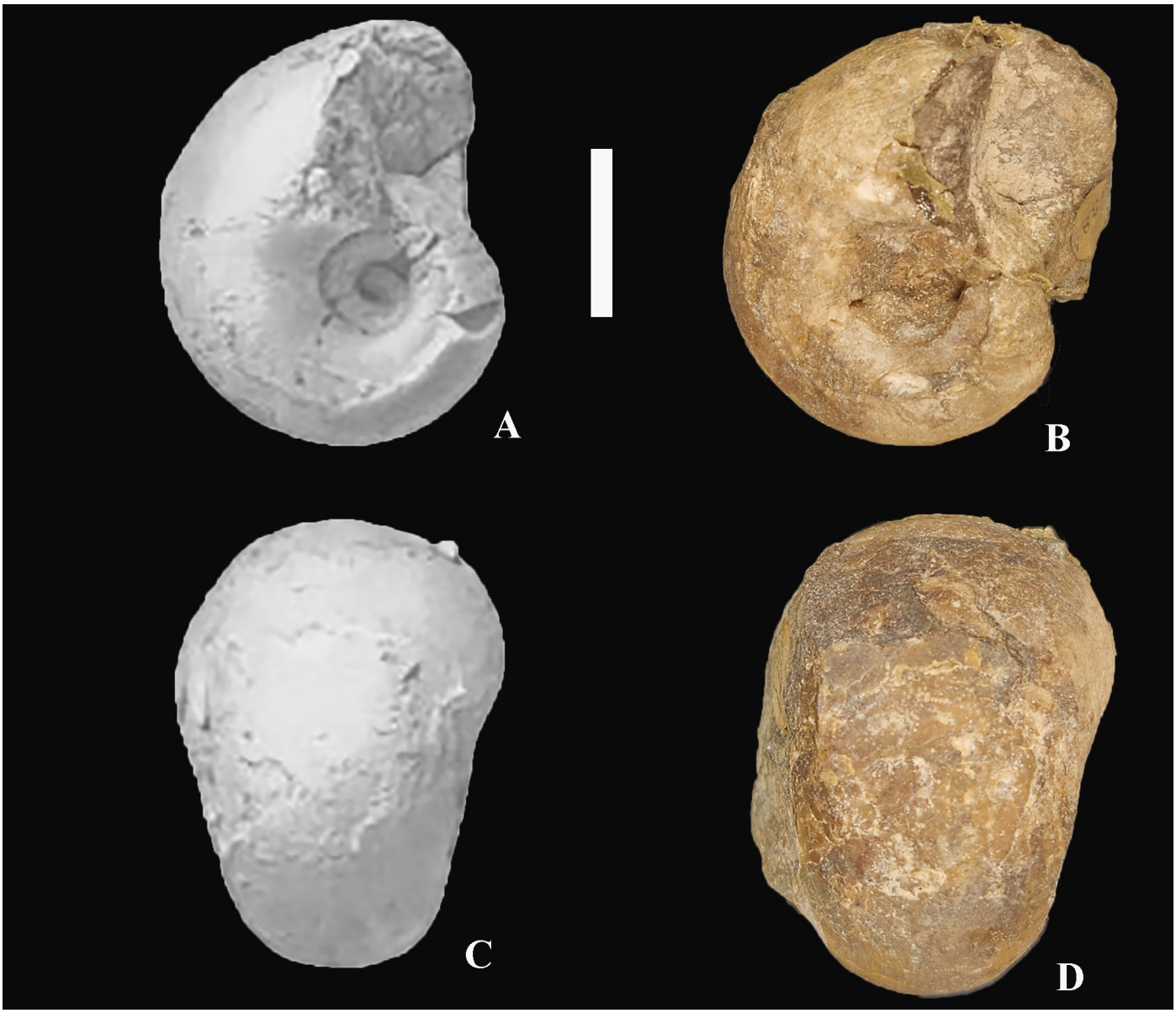


FIGURE 10. The nautiloid *Germanonautilus brooksi* Smith, 1927. Holotype, USNM 74206 [originally illustrated in Smith, 1927, Pl. CII, figs. 7-8.]. **A-B,** lateral views, A, line drawing of holotype from Smith, 1927, B, photo of holotype specimen kept in USNM; C-D, lateral view. **C,** line drawing of the holotype from Smith, 1927. **D,** photo of the holotype kept in the USNM. It seems some artistic license is visible in the reconstruction in view D. Scale bar = 20 mm.

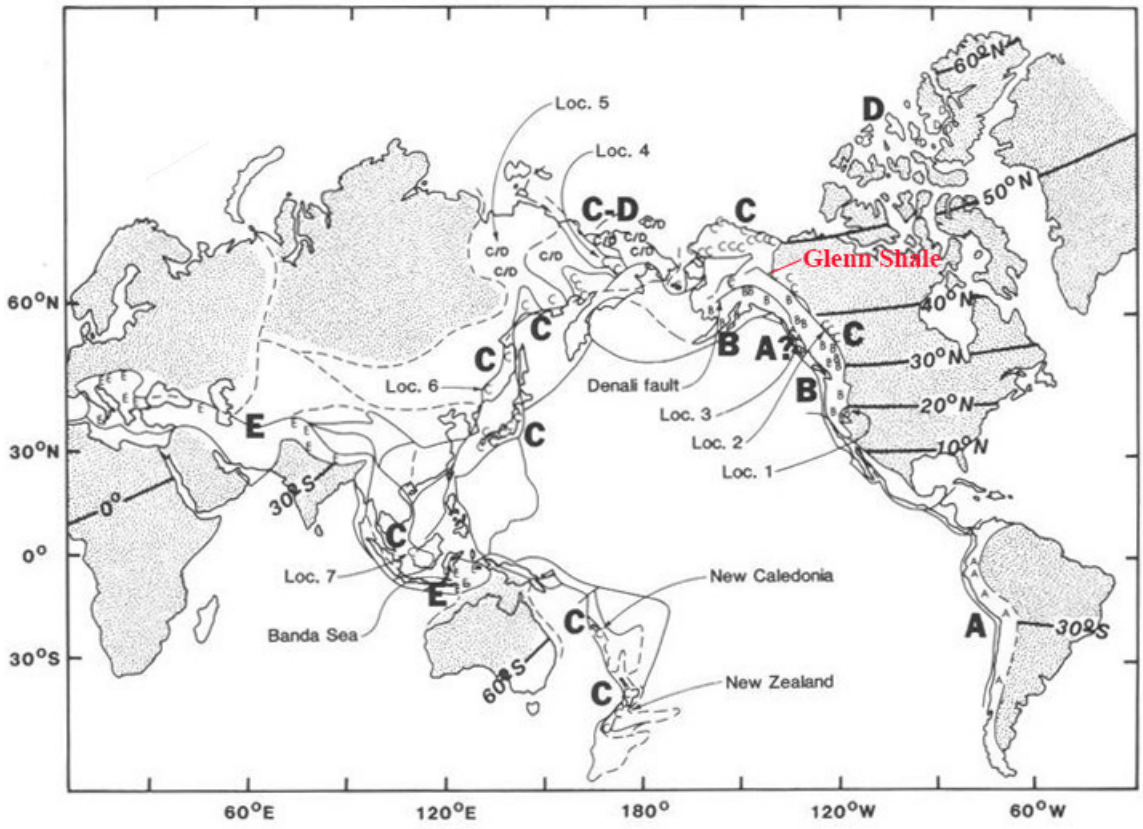


FIGURE 11. World distribution of *Monotis* faunas A through E (modified from Silberling, 1985). Position of the Glenn Shale exposures shown by red line.

provides a glimpse into a high mid-latitude fauna (equivalent to Fauna C of Silberling, 1985) and has similarities to coeval fauna from the Canadian Arctic Islands and the Shublik Formation on the Arctic Coastal Plain of northern Alaska. The fauna lacks warm-water taxa such as colonial scleractinian corals and the hydrozoan genus *Heteratstridium*. The Glenn Shale invertebrate fauna probably represents warm temperate to cool in temperature, which stands in strong contrast to the diverse Upper Triassic faunas of Alaska's accreted terranes of central and southeastern Alaska. Smith (1927, p. 12) commented that the Nation River fauna (i.e. Glenn Shale) also indicated lower temperatures than the equivalent age faunas of southern Alaska. He suggested similarities for some localities with the "*Dawsonites* fauna of British Columbia and of Bear Island in the Arctic Ocean."

Silberling (1970) noted that marine Triassic faunas of the northern part of Alaska had much in common with those along the Yukon River in east-central Alaska (i.e. the Glenn Shale) and the Canadian Arctic Archipelago and eastern Asia, but stood in strong contrast with the Triassic faunas from the accretionary southern Alaska and Pacific margin of North America. Silberling (1985, fig. 15) placed the Glenn Shale fauna with his mid-latitude *Monotis* C fauna between 40 and 50 paleolatitude and even slightly higher, showing linkage with coeval fauna of the same unit in Arctic Alaska (Fig. 11).

RECOMMENDATIONS FOR FUTURE STUDY

Future study of the lower part (Middle and Upper Triassic) of the Glenn Shale is highly recommended for both paleontologists and stratigraphers. The ease of access to the major outcrops by boat along the banks of the Yukon River and adjoining Nation River, downstream from the town of Eagle (headquarters of the Yukon-Charley Rivers Preserve), make this a relatively inexpensive field area by rural Alaskan standards. The Triassic portion of the Glenn Shale is relatively fossil rich and undoubtedly collection of new material will greatly augment the census of marine invertebrates, notably bivalves, gastropods, brachiopods and cephalopods. Even vertebrates have potential with one ichthyosaur bone from USGS Mesozoic locality 9387, collected by Elliot Blackwelder in 1915, which has not been described and is illustrated here for the first time (Fig. 12). Further detailed study of the microfauna, notable radiolarians, appears to be highly profitable (Robinson, 1989; Robinson and Pessagno, 1988; Dumitrica et al., 2010). Determination of the character of the contact with the upper part (Jurassic and Lower Cretaceous) of the Glenn Shale is critical, and it seems likely that further study indicates that the lower and upper parts of Brabb's formation deserve revision with the upper portion needing formal designation as a new, separate lithostratigraphic unit.

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FIGURE 12. Marine vertebrate bone (ichthyosaur) from USGS Mesozoic locality 9387. Scale bar = 40 mm (4 cm).

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