

ARTICLE

FOSSIL POINT (LAKE CLARK NATIONAL PARK & PRESERVE):
ALASKA'S "JURASSIC PARK" FOR MIDDLE JURASSIC INVERTEBRATE FOSSILS

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ABSTRACT—The Fossil Point area on the south side of Tuxedni Bay is situated within Lake Clark National Park & Preserve in south-central Alaska. This aptly named topographic feature contains one of the most productive marine invertebrate fossil sites known in Alaska. Two formations, the Fitz Creek Siltstone and overlying Cynthia Falls Sandstone, both elements of the Tuxedni Group, are present in exposures at Fossil Point. The rich and well preserved invertebrate fauna was recognized during the nineteenth century when the area was previously part of Russian America. Eichwald (1871) provided some of the first descriptions and illustrations of Jurassic fauna from Fossil Point and elsewhere in Alaska. The inoceramid bivalves described by him are now assigned to the genus *Retroceramus* (Blodgett, 2012). Four inoceramid species were established by Eichwald, and there has been considerable debate subsequently by paleontologists as to the validity of these species or whether or not they merely represent ecological variants belonging to one or two species. The Middle and Upper Jurassic fauna exposed in Tuxedni Bay indicate a major global climatic cooling event. The Middle Jurassic Tuxedni Group and overlying Chinitna Formation faunas represent warmer water (probably subtropical to warm temperate) compared to the succeeding fauna of the Upper Jurassic Naknek Formation representing cool water (probably cool temperate) typified by a boreal fauna consisting predominantly of the bivalve *Buchia*. Recommended future work would include producing a measured section and obtaining detailed biostratigraphic collections for the purpose of better documenting the fauna, establishing the morphological variability of the component species and describing the remaining accompanying invertebrate taxa that have not been documented to date. Hence, Fossil Point provides an excellent laboratory to study dramatic climatic change within the middle part of the Mesozoic.

INTRODUCTION

Fossil Point is a prominent headland located along the south side of Tuxedni Bay on the west side of Cook Inlet, south-central Alaska (Figs. 1). The Middle Jurassic strata exposed at Fossil Point (Fig. 2) have long been known for their extremely prolific fossil invertebrate marine fauna. Knowledge concerning the cornucopia of fossil materials available here extends back to the final days of Russian America, in what is today Alaska. A significant fossil collection was made by the Russian mining engineer Peter Doroschin and sent to the Russian capital at St. Petersburg, where they were ultimately studied and described by Eichwald (1871) (Fig. 3). Eduard von Eichwald (1795–1876) described many important Jurassic fossils from Alaska. His material was collected when Alaska was still part of the Russian Empire. Eichwald was one of Russia's early and preeminent paleontologists. He was of German ancestry and was born in present-day Latvia, but spent much of his later career in St. Petersburg. Most of his scientific articles were written in German, but appeared in various Russian publications.

Fossil Point has long been known to Cook Inlet fishermen who would fish in Tuxedni Bay. Extensive fossil collecting has taken place at Fossil Point by private fossil collectors (Rock, 1980), and fossil specimens from Fossil Point are on display in various businesses in the cities of Homer and Anchorage. The most common megafossils found at Fossil Point belong to the widespread plexus of early inoceramid bivalves which are characteristic of

Alaska's Middle Jurassic strata, both in southern Alaska as well as the Arctic Coastal Plain (Imlay, 1955, 1965). These early members of the family Inoceramidae were formerly referred to the genus *Inoceramus*, but more recently have been transferred to a separate new genus *Retroceramus*, established by Z. V. Koshelkina based on her studies of Middle Jurassic Siberian faunas. Among the earliest named species of the genus were four species established by Eichwald (1871) from the area of Tuxedni Bay on the west side of Cook Inlet (see Figures 4–8 for examples). These four species (all originally assigned to the genus *Inoceramus*) are: *Retroceramus porrectus* (Eichwald, 1871) (Fig. 4); *R. ambiguus* (Eichwald, 1871) (Fig. 5); *R. eximius* (Eichwald, 1871) (Fig. 6); and *R. lucifer* (Eichwald, 1871) (Fig. 7).

As noted above, Eichwald's Alaskan inoceramid specimens were collected in and around Tuxedni Bay on the west side of Cook Inlet. They are especially common at the aptly named Fossil Point along its south shore, where they are the most easily recognizable fossils found in exposures at the locality (Fig. 2). The inoceramids from Fossil Point and Tuxedni Bay are referenced in several publications, including Dall (1896), Hyatt (1896), Stanton and Martin (1905), Martin and Katz (1912), Martin (1926), Moffit (1927), Detterman (1963), and Detterman and Hartsock (1966). Similar inoceramids are found in coeval strata of the Iniskin Peninsula south of Tuxedni Bay (Blodgett and Tainter, 2013). Ralph W. Imlay (1908–1989) is regarded as the foremost expert on Alaska's Jurassic fossils and

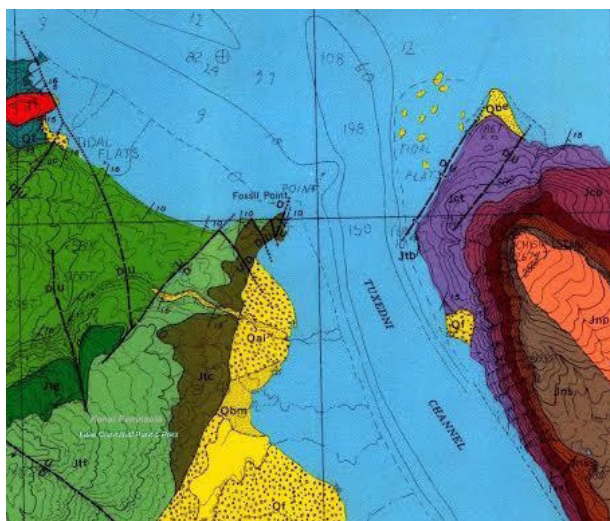


FIGURE 1. Geological map of part of the western side of Cook Inlet showing Fossil Point, Tuxedni Bay, and Chisik Island (modified from Magoon et al., 1976). The strata at Fossil Point are assigned to the Cynthia Falls Sandstone of the Tuxedni Group (shown in brown), to the west of which are adjacent to outcroppings of the Fitz Creek Siltstone (shown in light-green color) of the Tuxedni Group.

recognized only two of Eichwald's species as being taxonomically valid, with the remaining two being regarded as merely synonyms or variants. However, Russian paleontologists have regarded these four species as all being viable for biostratigraphic and taxonomic studies. In light of their great prominence in faunas of the Middle Jurassic, it seems timely for a renewed effort to systematically collect these forms from throughout the stratigraphic section exposed at Tuxedni Bay in order to better chronicle their variability, taxonomic validity, and stratigraphic significance. A direct comparison to the original specimens used by Eichwald is obvious, and not a daunting task, as this material is deposited in St. Petersburg, Russia.

STRATIGRAPHIC SUCCESSION AT FOSSIL POINT

Two lithostratigraphic formations are exposed at Fossil Point, the Fitz Creek Siltstone and overlying Cynthia Falls Sandstone (Fig. 1). Both units are considered to be of middle Bajocian (early Middle Jurassic) age and are recognized to be distinct formations within the Tuxedni Group. Figure 9 shows the stratigraphic succession within the Tuxedni Group and their relationship with the underlying Talkeetna Formation and overlying Chinitna Formation.

FITZ CREEK SILTSTONE OF TUXEDNI GROUP (MIDDLE BAJOCIAN)

The Fitz Creek Siltstone was named by Detterman (1963), replacing the informal terms "lower siltstone member of the Tuxedni Formation" of Kirschner and Minard (1949) and the "siltstone member of the Tuxedni

Formation" of Imlay (1953). The formation was named for Fitz Creek, the principal stream on the Iniskin Peninsula to the south of Tuxedni Bay. The type section is located along Tonnie Creek on the Iniskin Peninsula. Detterman and Hartsock (1966) stated that the sections of this formation ranged in thickness from 198 to 380 m (650 to 1,280 ft), with the type section being 332 m (1,090 ft) thick. The contact with the underlying Gaikema Sandstone was stated by these authors as conformable in all sections. The contact with the overlying Cynthia Falls Sandstone was noted to be sharp and usually conformable in most areas, with the exception of the area just north of Hickerson Lake where the contact is locally unconformable. The formation crops out on both the Iniskin Peninsula and to north as far as the south shore of Tuxedni Bay, where it terminates at Fossil Point. Detterman in Poulton et al. (1992) describes the formation as thin-bedded dark gray siltstone with limestone concretions, minor thin sandstone, with a thickness ranging from 150 to 390 m (492 to 1,279 ft).

Fauna

The marine invertebrate fauna (Table 1) of the Fitz Creek Siltstone has long been noted as being abundantly fossiliferous and it has by far the most diverse fossils of all the formations which comprise the Tuxedni Group. For the first time in the stratigraphic record, ammonites play a more prominent role in the fauna than bivalves, which dominated the underlying Red Glacier Formation and Gaikema Sandstone. This difference was attributed by Detterman and Hartsock (1966) to the different environments indicated by the dominance of siltstone in the lower units, as opposed to sandstone in the overlying Fitz Creek and Cynthia Falls.

Detterman and Hartsock (1966) noted that the most common bivalves in the formation are *Inoceramus* (= *Retroceramus* in this instance) and *Pleuromya*. The *Retroceramus* found in the Fitz Creek is *R. ambiguus* (Eichwald), which is different than the common retroceramids founds in the older beds. They also commented that the *Pleuromya* is a smooth type, in contrast to the coarsely ribbed forms found in the older beds of the Tuxedni Group. Other abundant but less common bivalves are *Trigonia*, *Parallelodon*, *Pecten*, *Camptonectes*, and *Astarte*. Descriptions of ammonites from the Fitz Creek Siltstone are found in Imlay (1964).

Age

The Fitz Creek ammonite fauna is correlative with the *Otoites sauzei* and *Stephanoceras humphriesianum* zones of northwestern Europe. Imlay (1964) and Detterman and Hartsock (1966) both indicate a middle Bajocian age for the Fitz Creek ammonite fauna. Imlay (1982, 1984) also gave a middle Bajocian age for this formation.

Biogeographic affinities

As noted previously Imlay (1964) considered the middle Bajocian faunas of the Tuxedni Group to have their closest affinities (generically and specifically) with coeval

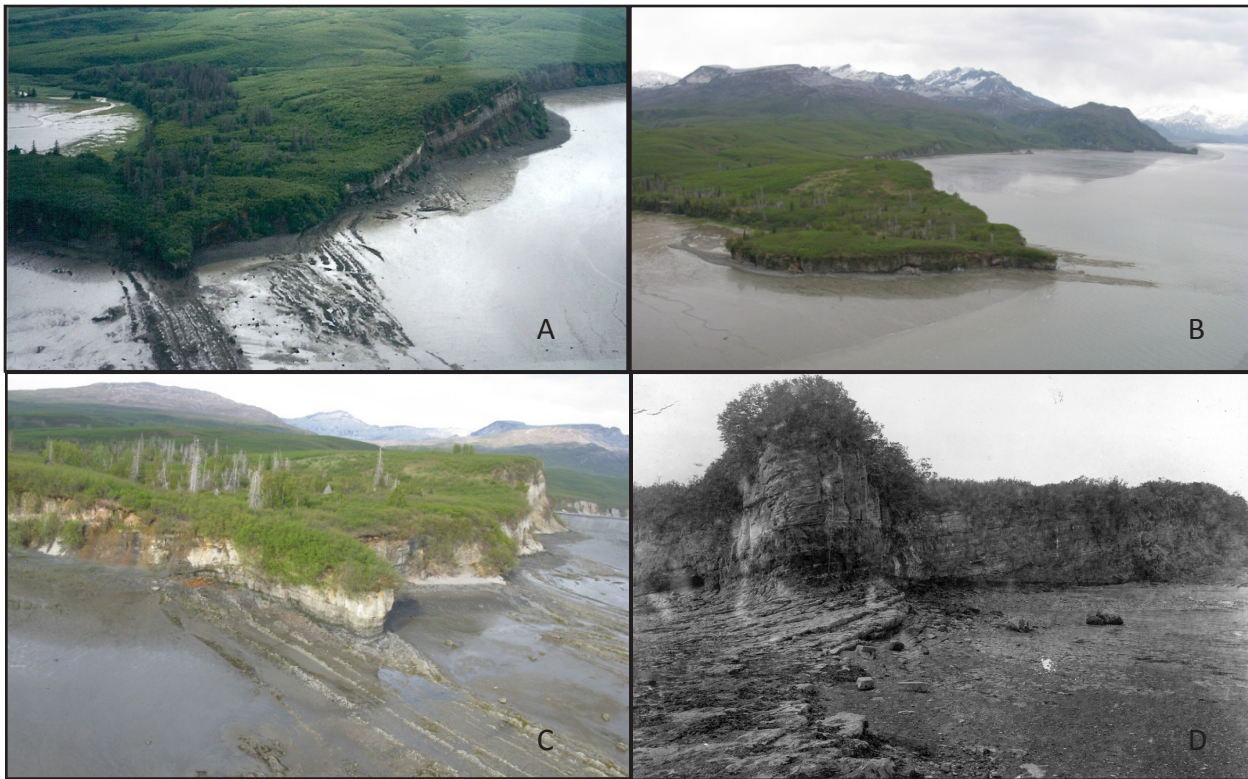


FIGURE 2. Various views of Fossil Point. **A**, Aerial view from the northeast; **B**, More distant aerial view from north-northeast; **C**, Closer aerial view from northeast.; **D**, Historical photo taken by C. W. Purington in 1896 of the prominent headland at Fossil Point (compare with modern view in right-center of Fig. 2C). This same photo appears as Plate LVIII in Dall (1896). Figures 3A–3C courtesy of Richard G. Stanley, U.S. Geological Survey, Menlo Park, California.

faunas known from other parts of the Pacific coast from Alaska to California, rather than with those of the same age known from the western interior of Canada and the U.S.

CYNTHIA FALLS SANDSTONE OF TUXEDNI GROUP (LATE MIDDLE BAJOCIAN)

The unit was first recognized as the Cynthia Falls Member of the Tuxedni Formation by Kellum (1945) and was later raised to formational status by Detterman (1963) within his Tuxedni Group which he concurrently raised from formation to group status. The Cynthia Falls Sandstone was considered by Detterman to be 180 to 210 m (600 to 700 ft) thick. The type section was designated as being on Tonnie Creek, and was named after Cynthia Falls, a prominent waterfall on Hardy Creek on the Iniskin Peninsula. The formation consists mainly of massive to thick bedded coarse-grained greenish-gray graywacke-type sandstone, interbedded with lesser, thick layers of pebble-cobble conglomerate and arenaceous siltstone (Detterman, 1963). Graded bedding was also noted as being present in the sandstone (Detterman and Hartsock, 1966). Detterman in Poulton et al. (1992) described the unit as being composed of medium to thick bedded greenish gray sandstone with few conglomerate beds, containing very few fossils, and indicated its thickness to be ca. 200 m (660 ft.). The contacts were also stated by Detterman

(1963) to be conformable with the underlying and overlying formations. However, Detterman and Hartsock (1966) noted that the lower contact with the Fitz Creek Siltstone is conformable and sharp except near Hickerson Lake, where a slight angularity was said to exist. In addition, they indicated that the upper contact with the overlying Twist Creek Siltstone is conformable throughout most of its areal extent. The exception to this occurs in an area in the southwestern Iniskin Peninsula, where the Twist Creek is removed, and the Bowser Formation unconformably overlies the Cynthia Falls Sandstone. The areal extent of the Cynthia Falls Sandstone starts at the southern terminus near the southwestern edge of the Iniskin Peninsula, proceeding NNE and terminating at the its northernmost exposure at Fossil Point on the south shore of Tuxedni Bay.

Fauna

The fossil fauna from the Cynthia Falls Sandstone (Table 1) is limited in diversity, being somewhat devoid of molluscan remains. The ammonites *Chondroceras* and *Stephanoceras* suggest correlation with the European standard ammonite zone of *Stephanoceras humphriesianum* (Imlay, 1964:B14; Detterman and Hartsock, 1966). The few bivalves found in the formation included faunal elements suggesting links with the underlying Fitz Creek Siltstone. Ammonites from this formation were described in Imlay (1964), who noted that few ammonites were found

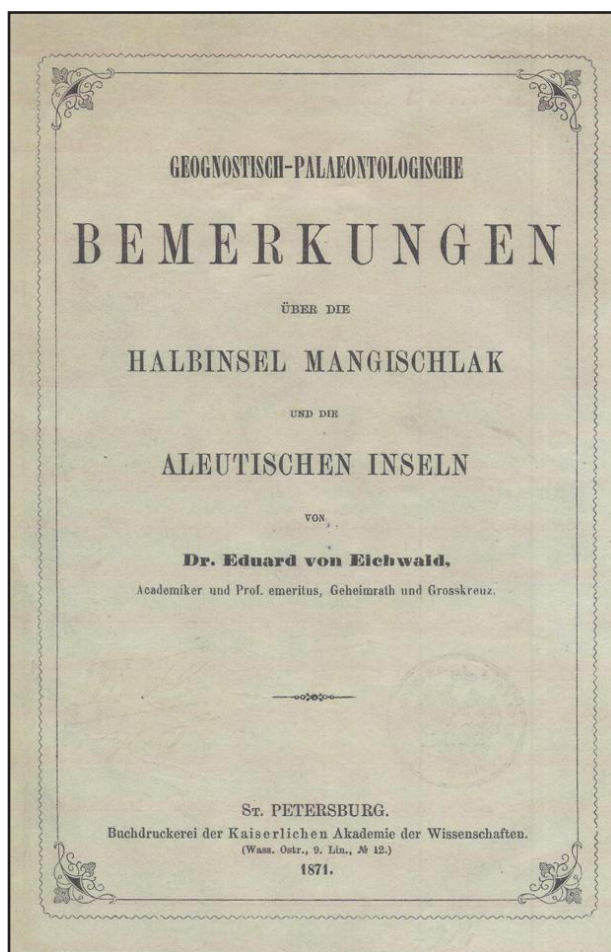


FIGURE 3. Cover of Eichwald's 1871 classic paper in which the first taxonomic descriptions of marine invertebrates from Fossil Point were made.

in the formation, but the genera and species present are identical with those in the underlying Fitz Creek Siltstone, indicating a similar age.

Age

The Cynthia Falls Sandstone has been cited as being of late middle Bajocian age (Imlay, 1982; Imlay, 1984).

PALEOCLIMATIC IMPLICATIONS OF SOUTHERN ALASKAN MIDDLE AND UPPER JURASSIC INVERTEBRATE FAUNAS

Imlay (1965) in his presidential address to the Paleontological Society gave considerable discussion to the prominence of inoceramid (most now placed in the genus *Retroceramus*) bivalves in Middle Jurassic faunas of Alaska, standing in stark contrast to their total absence from Upper Jurassic faunas of Alaska! Inoceramids also disappear at the same time from faunas of the Canadian Arctic Islands and Northeast Russia (Kolya region), and in all the above-mentioned regions appear to ecologically be replaced by bivalves belong to the genus *Buchia*. This absence coincides with a marked reduction in overall fau-

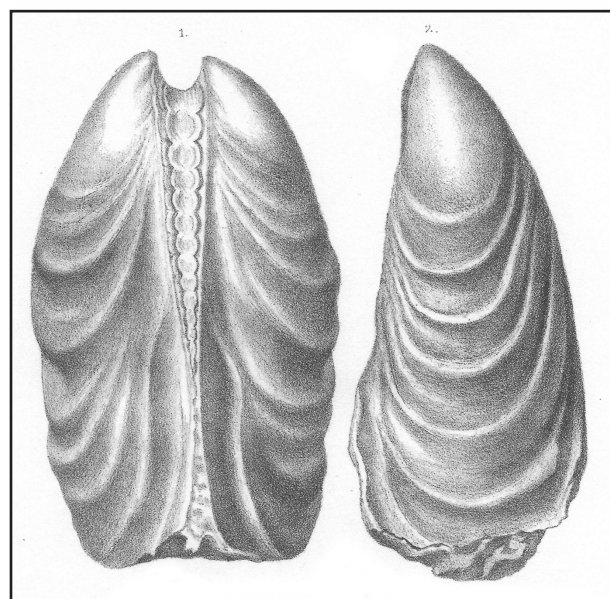


FIGURE 4. *Retroceramus porrectus* (Eichwald, 1871) (originally named *Inoceramus porrectus*). Eichwald (187:191) reported this species from the entrance to Tuxedni Bay ("Einfahrt in die Bucht Tukusitnu"), corresponding to the exposures directly at Fossil Point on the south side of the bay.

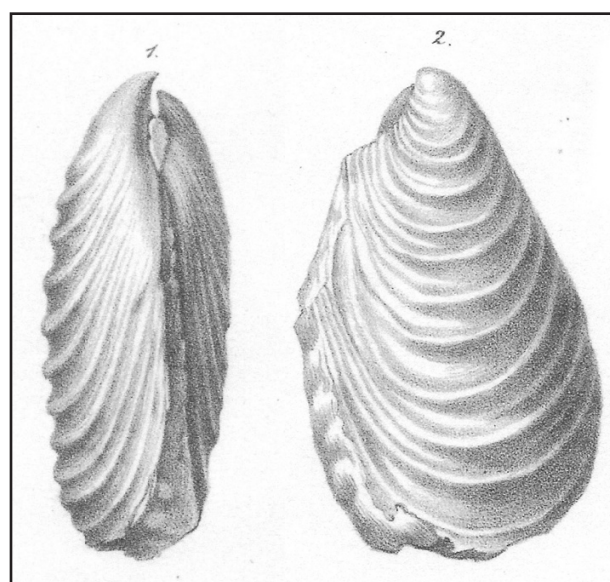


FIGURE 5. *Retroceramus ambiguus* (Eichwald, 1871) (originally named *Inoceramus ambiguus*).

nal diversity in the same regions, most likely indicating a major interval of global cooling (resulting in a heightened global climatic gradient) at this time. These areas were situated at that time very close to the North Pole. Inoceramids abruptly reappear in great abundance in southern Alaska during the latter part of the Early Cretaceous in the Herendeen Formation (Hauterivian-Barremian) on the

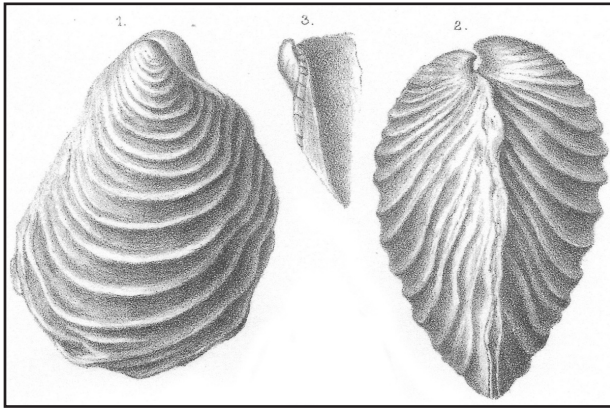


FIGURE 6. *Retroceramus eximius* (Eichwald, 1871) (originally *Inoceramus eximius*).

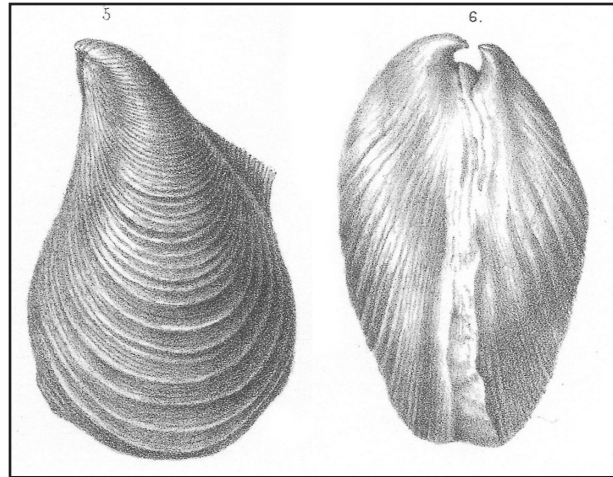


FIGURE 7. *Retroceramus lucifer* (Eichwald, 1871) (originally *Inoceramus lucifer*).



FIGURE 8. A *Retroceramus* specimen collected by Minerals Management Service (now Bureau of Ocean Energy Management - BOEM) geologists from Fossil Point at Tuxedni Bay. This specimen is now deposited at the Geologic Materials Center (GMC) in Eagle River, Alaska. Photograph by Jean A. Riordan and Robert B. Blodgett.

Alaska Peninsula and its lateral equivalent, the Nelchina Formation in the southern Talkeetna Mountains. This seems to coincide with a significant climatic warming event when marine faunas of these regions become more diverse.

Another bivalve group which almost completely disappears in the Upper Jurassic of Alaska is the trioniid bivalves. One the last species reported from the Jurassic occurs in the Callovian (uppermost Middle Jurassic) strata

of the Chinitna Formation on Chisik Island in Tuxendi Bay, immediately east of Fossil Point (Fig.11).

PALEONTOLOGICAL RESOURCE MANAGEMENT AND PROTECTION

Fossil Point is administered by the National Park Service (NPS) within Lake Clark National Park and Preserve. Lake Clark National Monument was first established in 1978. The monument was reauthorized Lake Clark National Park and Preserve through the Alaska National Interests Lands Conservation Act (ANILCA) in 1980.

The management of the paleontological resources at Fossil Point presents a number of challenges. As a coastal fossil locality, Fossil Point is subjected to a variety of natural processes including sea currents, tides, storms and long-term changes in sea level. Additionally, this well-known fossil locality appears to have been visited by private fossil collectors and hobbyists for many years (Rock, 1980). There are anecdotal references and a few private fossil collections which designated specimens from Fossil Point, Alaska. These references appear to have occurred principally in the past prior to NPS administration of Fossil Point. There is evidence that suggests that some unauthorized fossil collecting has been undertaken at Fossil Point after Lake Clark National Monument was established as a unit of the NPS in 1978.

According to NPS laws, regulations and policies, the collection of fossils in parks without a permit is prohibited. These regulations and policies associated with paleontological resources apply on federally owned lands and waters, on lands and waters that are administered by the NPS pursuant to a written instrument or over which the NPS holds a less-than fee interest, and in waters subject to the jurisdiction of the U.S. up to the mean high water line, regardless of the ownership of the submerged lands (Brunner et al., 2010).



TABLE 1. Taxa identified in the Fitz Creek and Cynthia Falls formations. Compiled from Imlay (1964) and Detterman and Hartsock (1966).

TAXON	FITZ CREEK FORMATION	CYNTHIA FALLS FORMATION	TAXON	FITZ CREEK FORMATION	CYNTHIA FALLS FORMATION
BRACHIOPODA			<i>Chondroceras cf. C. defonti</i> (McLearn)	X	
Rhynchonellid	X	X	<i>Chondroceras allani</i> (McLearn)	X	X
Brachiopods			<i>Chondroceras cf. C. allani</i> (McLearn)	X	
Brachiopoda indet.	X		<i>Chondroceras cf. C. oblatum</i> (Whiteaves)		X
GASTROPODA indet.	X		<i>Chondroceras sp.</i>	X	X
BIVALVIA			<i>Normannites sp.</i>	X	X
<i>Grammatodon</i> sp.	X	X	<i>Normannites (Itinsaites) crickmayi</i> (McLearn)	X	X
<i>Cucullaea</i> sp.	X		<i>Normannites (Itinsaites) cf. N. (I.) crickmayi</i> (McLearn)	X	X
<i>Parallelodon</i> sp.	X		<i>Normannites (Itinsaites) itinsae</i> (McLearn)	X	
<i>Pinna</i> sp.	X		<i>Normannites (Itinsaites) cf. N. (I.) variabilis</i> Imlay	X	
<i>Retroceramus ambiguus</i> (Eichwald)	X		<i>Normannites (Itinsaites) itinsae</i> (McLearn)	X	
<i>Retroceramus</i> sp.	X	X	<i>Normannites (Itinsaites) cf. N. (I.) variabilis</i> Imlay	X	
<i>Oxytoma</i> sp.	X		<i>Stephanoceras sp.</i>	X	X
<i>Pteria</i> sp.	X		<i>Stephanoceras (Skirroceras) kirschneri</i> Imlay	X	
<i>Ostrea</i> sp.	X		<i>Stephanoceras? sp.</i>	X	
<i>Trigonia</i> sp.	X		<i>Stemmatoceras cf. S. palliseri</i> (McLearn)	X	
<i>Pecten</i> sp.	X		<i>Stemmatoceras tuxedniense</i> Imlay	X	
<i>Camptonectes</i> sp.	X		<i>Stemmatoceras ursinum</i> Imlay	X	
<i>Lima</i> sp.	X		<i>Stemmatoceras sp. juv.</i>	X	
<i>Pleuromya</i> sp.	X		<i>Teloceras itinsae</i> (McLearn)	X	
<i>Goniomya</i> sp.	X		<i>Teloceras. aff. T. itinsae</i> (McLearn)	X	
<i>Pholadomya</i> sp.	X		<i>Zemistephanus richardsoni</i> (Whiteaves)	X	
<i>Astarte</i> sp.	X		<i>Zemistephanus cf. Z. richardsoni</i> (Whiteaves)	X	
<i>Lucina</i> sp.	X		<i>Zemistephanus carlottensis</i> (Whiteaves)	X	X
<i>Plagiostoma</i> sp.	X		<i>Zemistephanus? sp.</i>	X	
<i>Mytilus</i> sp.		X	Ammonoidea indet.		X
AMMONOIDEA			BELEMNOIDEA indet.	X	
<i>Phylloceras</i> sp.	X				
<i>Macrophylloceras</i> sp. indet.	X				
<i>Macrophylloceras</i> sp. undet. A	X				
<i>Macrophylloceras</i> sp. undet. B	X				
<i>Calliphylloceras</i> sp.	X				
<i>Holcophylloceras costasparsum</i> Imlay	X				
<i>Holcophylloceras cf. H. costisparsum</i> Imlay	X				
<i>Holcophylloceras</i> sp. juv.	X				
<i>Sonninia tuxedniensis</i> Imlay	X				
<i>Sonninia cf. S. tuxedniensis</i> Imlay	X				
<i>Strigoceras cf. S. languidum</i> Buckman	X				
<i>Lissoceras bakeri</i> Imlay		X			
<i>Lissoceras</i> sp.	X				
<i>Oppelia stantoni</i> Imlay	X				
<i>Chondroceras defonti</i> (McLearn)	X	X			

In order to more fully assess the natural and anthropogenic impacts to the paleontological resources at Fossil Point, the establishment and implementation of a monitoring strategy at the locality is warranted using best practices (see Santucci and Koch, 2003; Santucci et al., 2009). An initial assessment of the fossil locality should include a consideration of the wide range of factors that may influence the condition and stability of the area. The initial assessment will represent the baseline information from

which a monitoring protocol could be established for Fossil Point. Paleontological resource monitoring at Fossil Point will provide data and information that will enhance the management and protection of a world renowned fossil locality.

CONCLUSIONS

The early Middle Jurassic strata exposed at Fossil Point provides some of the earliest named and illustrated

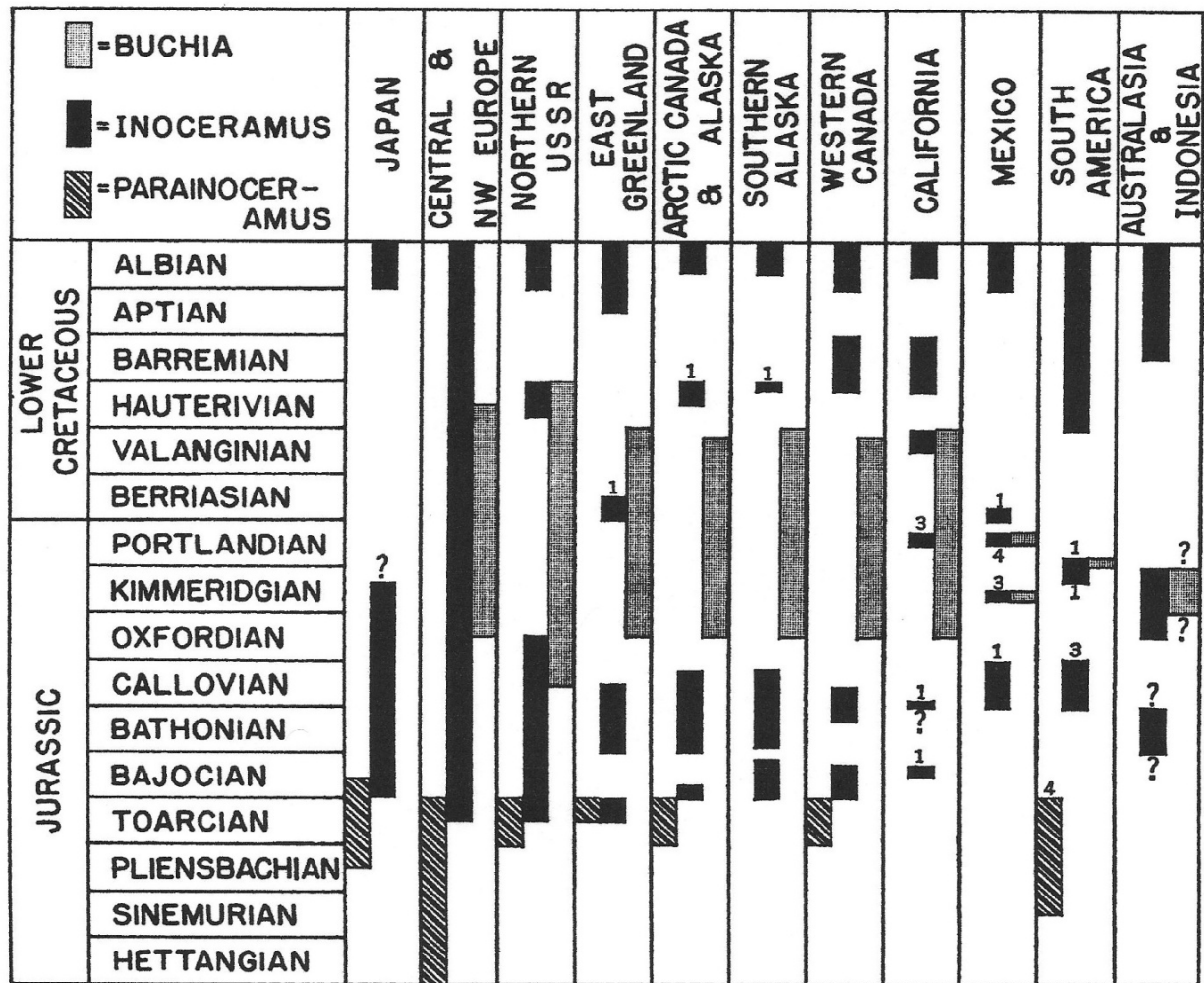


FIGURE 10. Diagram from Imlay (1965) showing the stratigraphic distribution of selected invertebrate groups during the Jurassic and Lower Cretaceous. The inoceramid bivalves (shown in black; also including the genus *Retroceramus*) are conspicuously absent from the Upper Jurassic (Oxfordian–Portlandian) and lower Lower Cretaceous (Berriasian–Valanginian) of both southern Alaska and arctic Canada/arctic Alaska.

fossils from this time interval in western North America. Despite the naming and illustration of the beautiful large inoceramid (*Retroceramus*) bivalve species represented here (Figs. 4–8), most of the accompanying fauna remains undocumented either in illustration or description. This report illustrates the need to undertake a comprehensive study of the invertebrate species present at Fossil Point. Such an undertaking would enable the development of complete faunal lists and photo documentation for each species, plus some formal taxonomic studies including the paleoflora and potential vertebrate fossils. One primary objective will be a review of the inoceramids described to date to determine their proper stratigraphic order, ecological associations, variability and taxonomic validity. As the original Alaskan inoceramid types utilized by Eichwald are now deposited in St. Petersburg, Russia, a direct comparison to the originals is obvious, and a close working

relationship with Russian specialists or even a visit to the host museum for their study may be in order.

ACKNOWLEDGEMENTS

We extend our thanks to R. G. Stanley, U.S. Geological Survey, Menlo Park, California, for his helpful discussion related to the geology of Fossil Point and the Tuxedni Bay area and kindly sharing his photographs from Fossil Point. Additional thanks is given to S. Prien of the ARLIS Interlibrary Loan office, Alaska Resources Library & Information Services (ARLIS), Anchorage, Alaska, for her assistance in obtaining hard-to-find paleontological references pertinent to our work on the Middle Jurassic fauna at Fossil Point. We also extend our appreciation to the National Park Service staff in Alaska, Guy Adema, Linda Stromquist and Jeff Shearer, for their support of paleontological resource stewardship in the Alaska parks.

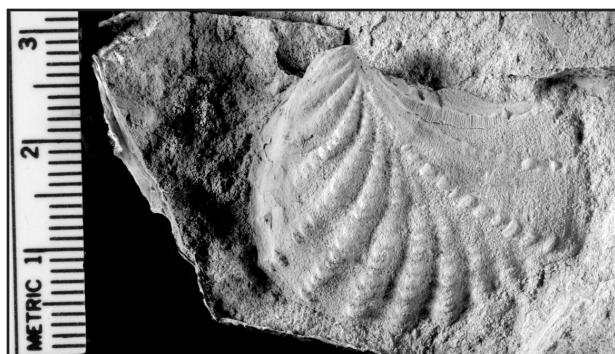


FIGURE 11. A trigoniid bivalve from the uppermost Middle Jurassic (Callovian) Chinitna Formation on Chisik Island, Tuxedni Bay, Cook Inlet region, south-central Alaska. NPS photo.

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