

# Tusoteuthis longa: North Dakota's 80 Million-Year-Old Giant Squid

by John W. Hoganson

## Introduction

Occasionally I am asked if I have ever found a fossil that I cannot at the time identify. This doesn't happen very often, but maybe more often than I care to admit. The discovery of the gladius of the giant squid, *Tusoteuthis longa*, was one of those fossils (Hoganson, 2009a). In 2002, during one of our public fossil digs at the Pembina Gorge site a large, odd shaped cylindrical fossil was found in the Late Cretaceous (about 80-million-year-old) Pierre Shale. The fossil appeared to be a piece of petrified wood because of its branch-like shape and faintly preserved concentric layering in cross section. But the Pierre Shale was deposited in a shallow marine environment where petrified wood is generally not found. Further excavation revealed that the fossil was the remains of a rare giant squid (fig. 1).

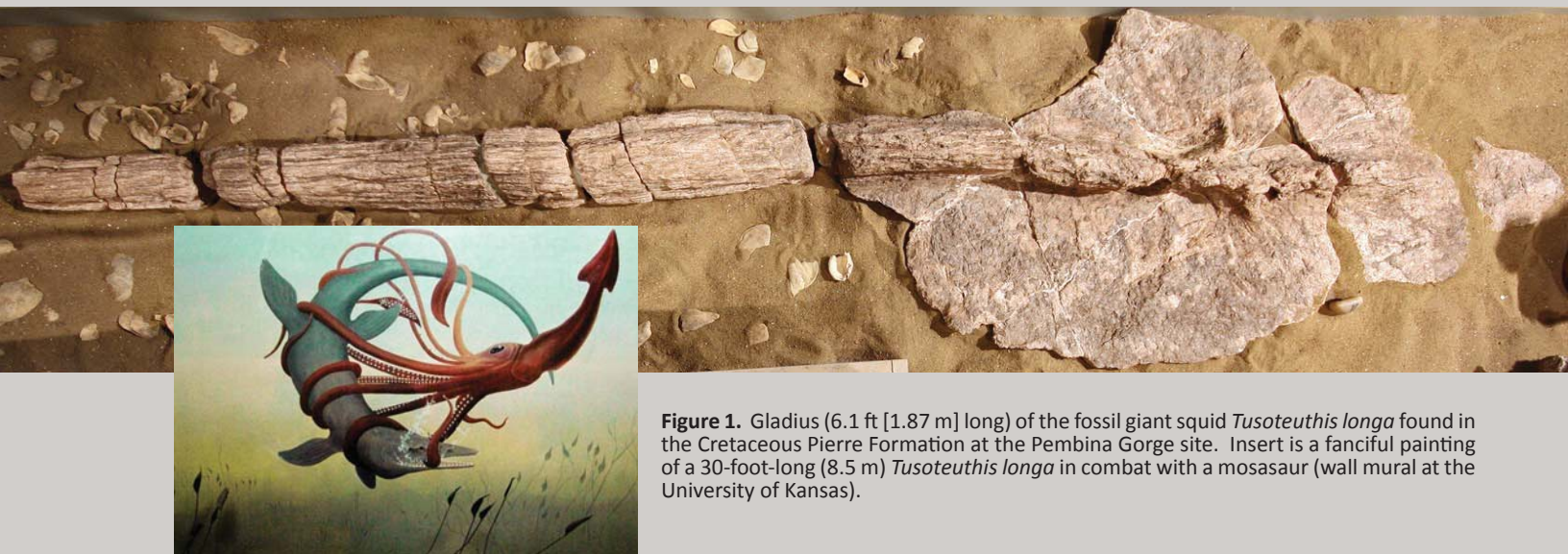
In 1996, the Ralph Werven family was hiking in the beautiful and pristine area of northeastern North Dakota called the Pembina Hills when they discovered mosasaur (large marine reptile) remains weathering out of the Cretaceous (Campanian) Pierre Formation (fig. 2). Unfortunately, these fossils were along a hillside road and unauthorized expansion of that road devastated the site before excavation of the fossils was possible. While that road construction destroyed the original mosasaur remains, additional fossils were unearthed, prompting a multiyear search for fossils at the site. From 2000 through 2002, public fossil digs as part of the North

Dakota Geological Survey's public fossil dig program, were conducted at this Pembina Gorge site and studies continue there to this day (fig 3).

So far, several hundred fossils have been recovered. Most of these fossils are disarticulated, isolated skeletal parts of several vertebrate taxa. They are encrusted and impregnated with gypsum and are poorly preserved. Vertebrate taxa found include mosasaurs (*Plioplatecarpus*, mosasaur indet.), fish (*Enchodus*, *Xiphactinus*, *Stratodus*), plesiosaurs(?), and birds (*Hesperornis regalis*). Only one invertebrate fossil, *Tusoteuthis longa*, has been discovered at this site (Hoganson, 2009a, 2009b).

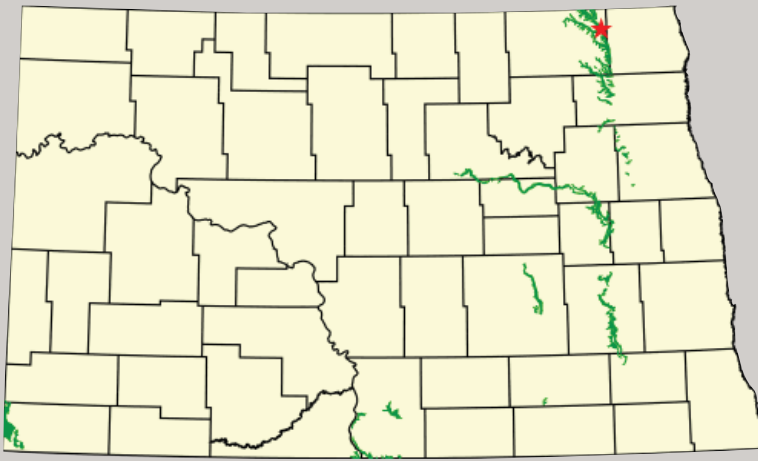
## Location and stratigraphy of the Pembina Gorge Site

The Pembina Gorge site is located near Walhalla in Cavalier County, northeastern North Dakota not far from the Canadian border (fig. 2). In northeastern North Dakota rivers and streams have eroded through the veneer of glacial drift to expose Cretaceous marine rocks represented by several formations. Along the Little North Pembina River isolated outcrops of the Carlile, Niobrara, and Pierre Formations are present. The contact between the Niobrara Formation and Pembina Member (basal member) of the Pierre Formation, is well-defined after exposure by road construction activity at the Pembina Gorge site in this valley (fig. 3). The Niobrara Formation is a calcareous claystone. The Pembina



**Figure 1.** Gladius (6.1 ft [1.87 m] long) of the fossil giant squid *Tusoteuthis longa* found in the Cretaceous Pierre Formation at the Pembina Gorge site. Insert is a fanciful painting of a 30-foot-long (8.5 m) *Tusoteuthis longa* in combat with a mosasaur (wall mural at the University of Kansas).





**Figure 2.** Outcrop map of the Pierre Formation (in green) showing location (star) of the Pembina Gorge site in northeastern North Dakota.

Member is a carbonaceous (containing abundant disseminated fish skeletal debris) black shale with numerous bentonite (altered volcanic sediment) layers at the base. The contact between the Niobrara and Pierre Formations is at the base of the bentonites (fig. 3). These bentonites are equivalent to the Ardmore bentonite succession and are about 80 million years old (Bertog et al., 2007). The *Tusoteuthis longa* gladius specimen was recovered from the upper part of the bentonite sequence.

#### The fossil giant squid, *Tusoteuthis longa*

Squids have a bone-like, hard support structure, referred to as a pen or gladius (latin word for sword), located in their mantle (torso) – the area of the body behind the head that contains muscles and organs. In a way, the gladius functions like a backbone providing structural support for the animal and a place for muscle

attachment. But unlike a backbone, the gladius consists of chitinous material not bone. The gladius in squids is similar to the cuttlebone in the related cuttlefish. (Chalky cuttlebone is sold at pet stores for use in birdcages. Parakeets and other birds use the cuttlebone for sharpening their beaks and as a calcium supplement.) Squids are invertebrate animals in the Class Cephalopoda (Greek for “head foot” – referring to the arms that appear to emerge from the head region) that also includes octopuses, cuttlefish, and chambered nautilus. Cephalopods are one of the groups of mollusks (clams and snails are other mollusks). Most mollusks have shells, and the gladii of squids are internal shells. Most squids have eight arms and two long tentacles and because of this are referred to as decapodiforms. In contrast, octopuses only have eight arms and are octopodiforms. Octopuses also do not have an internal shell and can therefore squeeze through small openings. Today, there are several hundred species of squids that live in the world’s oceans. *Tusoteuthis longa* is believed to have been similar to the living giant squid *Architeuthis dux*. The gladius found at the Pembina Gorge site in 2002 is roughly six feet (1.87 m) long (fig. 1)!

The cephalopod *Tusoteuthis longa* was first described by Logan (1898) from the fossils found in the Niobrara Formation of Kansas. Nicholls and Isaak (1987) extended the geographic and temporal range of this taxon through description of fossils from the Pembina Member of the Pierre Formation in Manitoba, Canada. Although more than twice as large, the North Dakota specimen (NDGS 241) is similar to the *Tusoteuthis longa* (MDM Q77.O2.O7) specimen described and illustrated by Nicholls and Isaak (1987). The North Dakota *Tusoteuthis longa* fossil gladius, the first discovered in the state, may be the largest ever found.



**Figure 3.** Pembina Member of the Pierre Formation exposed along a road cut at the Pembina Gorge site. Light layers are bentonites. Niobrara Formation is exposed below the bentonite layers.

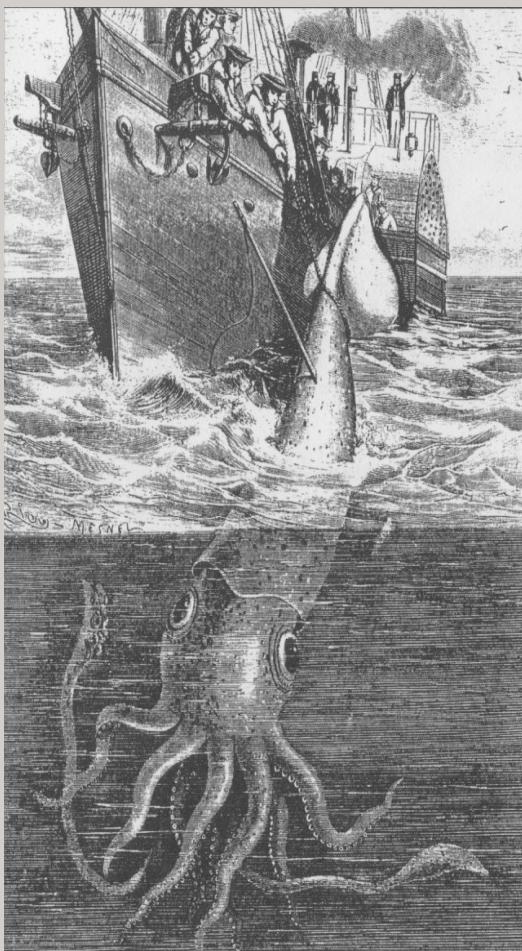
#### How big was *Tusoteuthis longa* and what were its life habits?

Because we only find gladii preserved as fossils and these fossils are extremely rare, we know very little about the size and life habits of *Tusoteuthis longa*. *Tusoteuthis longa* was similar to the living giant squid *Architeuthis*. Realizing the danger of becoming too speculative, perhaps we can gain insight about the 80-million-year-old squid found in North Dakota by comparison to *Architeuthis*. However, very little is also known about *Architeuthis* even though this squid grows to lengths of 45 feet (14 m) or perhaps even longer! The giant squid *Architeuthis* has been known since ancient times because carcasses of these animals have been found washed ashore and they have been observed by fisherman at sea (fig. 4). The giant squid is believed to be the sea monster in ancient stories such as the kraken (figs. 5 and 6) in Norwegian mythology. Historic accounts of *Architeuthis* extend back to Aristotle in the 4th century B.C. and Pliny the Elder in the 1st century A.D. (Ellis, 1998). Giant squids have been portrayed as grotesque monsters in classic works of fiction such as Herman Melville’s



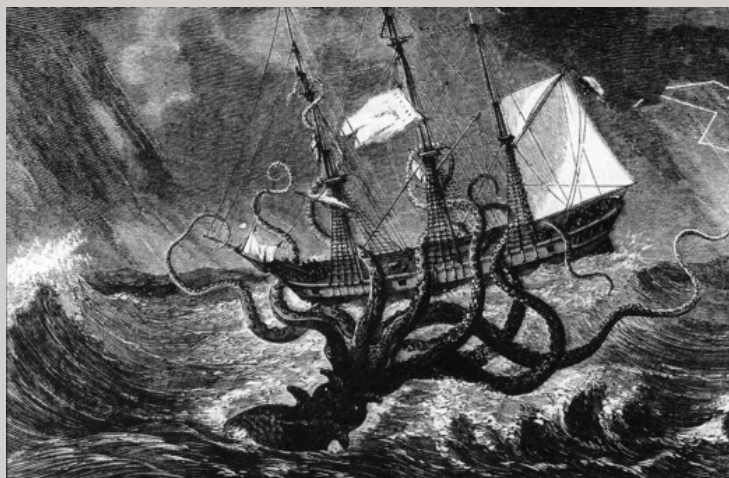
*Moby Dick* and Jules Verne's *Twenty Thousand Leagues Under the Sea* (fig. 7). More recently, this "terrible gigantic calamari" (Ellis, 1998) has been featured in the James Bond book *Dr. No* by Ian Fleming, and novel by Peter Benchley *The Beast*. A tentacled kraken also made a cameo appearance in the recently posthumously published swashbuckling novel *Pirate Latitudes*, by Michael Crichton. These myths and fictional accounts always exaggerate the capabilities and size of the giant squid.

Even though *Architeuthis* was named by the Danish scientist Jepetus Steenstrup in 1856, it was remarkably not photographed in its natural habitat until 2004 – two years after the *Tusoteuthis longa* fossil was found in North Dakota. *Architeuthis* was not captured on video until 2006! One reason for this is *Architeuthis* lives in marine waters at great depth, perhaps 1,600 to 2,000 feet (490 to 610 m) and deeper. In recent years, more information



**Figure 4.** The *Alecote* attempting to capture a giant squid *Architeuthis* off Tenerife in 1861. Illustration from Harper Lee's *Sea Monsters Unmasked*, 1884.

about the giant squid has been obtained from specimens caught in nets during commercial fishing in deep water. The largest *Architeuthis* specimens recorded are about 45 feet (14 m) long (mantle length about 6.6 feet [2 m]), mantle plus arm length about 16 feet (5 m). The long tentacles provide the remaining length. They can weigh up to about one ton and are among the largest animals in the world. The gladius of our *Tusoteuthis* specimen is



**Figure 5.** Drawing of an imaginary kraken seizing a ship by French naturalist Pierre Denis de Montfort in 1802.

6.1 feet (1.87 m) long. Nesic et al. (1985) determined that the length of *Architeuthis* can be calculated by multiplying the length of the mantle by 440 percent. If we can be so presumptuous as to use this method with our fossil *Tusoteuthis* specimen (6.1 feet x 440 percent) we can infer that the animal was 28 feet (8.2 m) long, although the mantle would be longer than the gladius so our *Tusoteuthis* was perhaps 35 feet (10.7 m) long.

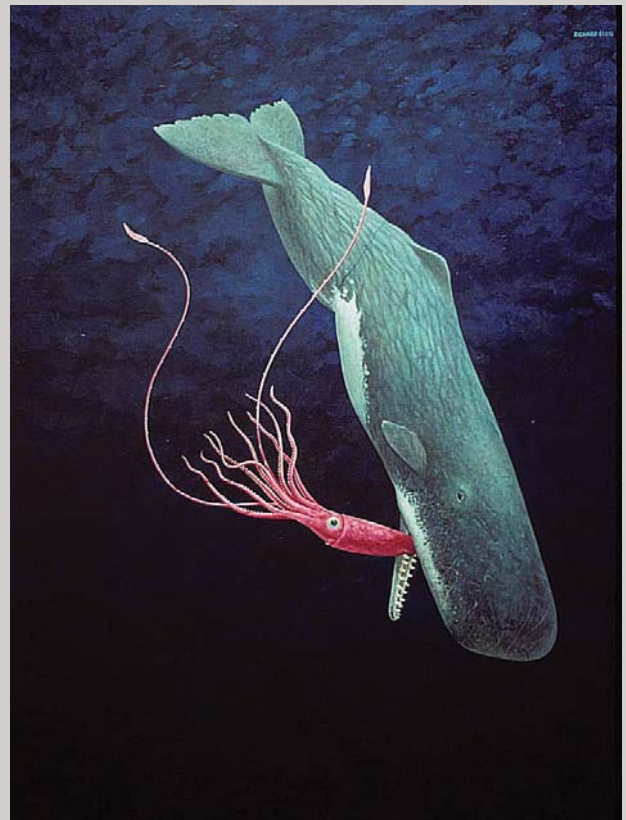
The living giant squid is a deep water, solitary predator. Prey is secured by the long, grasping tentacles and brought to the mouth where it is macerated by a chitinous parrot-like beak. The radula, a chitinous ribbon covered with backward pointing rudimentary teeth, further processes food and forces it into the throat. Little is known about the diet of these giant squids, but fish and perhaps other squids are likely prey. I assume that *Tusoteuthis longa* fed in a similar way and also ate fish. Fossils of several kinds of fish are found with *Tusoteuthis* which indicates that there was abundant prey. The living giant squid has huge eyes, up to about 12 inches (30 cm) in diameter (largest eyes of all animals) because they live in deep water where there is little light. This is problematic in our comparison of *Tusoteuthis* to the living giant squid because our fossil was found in rocks that were deposited in relatively shallow water. So did *Tusoteuthis* live in shallower water than the living giant squid or was the fossil washed into the shallow water area?

Young *Architeuthis* are vulnerable to sharks and other fish but at maturity they have few natural predators. Sperm whales (*Physeter macrocephalus*), "deep-diving dirigibles of death" (Ellis, 1998), are one of these predators. This is known because remains of giant squids, primarily indigestible beaks, are found in the stomach contents of these whales. Knowing this has also prompted writers to suggest great battles between whale and squid (fig. 8). Whales had not evolved yet when *Tusoteuthis longa* was inhabiting the Pierre Sea in North Dakota 80 million years ago. Did it have any natural enemies? It has been speculated that the huge marine reptiles called mosasaurs (also at times referred to as sea monsters) preyed on *Tusoteuthis*. An old, fanciful wall mural at the University of Kansas shows a mosasaur and *Tusoteuthis* in combat (fig. 1 and cover). Mosasaurs were as big as whales and were among the top predators that lived in the Pierre Sea so it is likely that they preyed on *Tusoteuthis*.

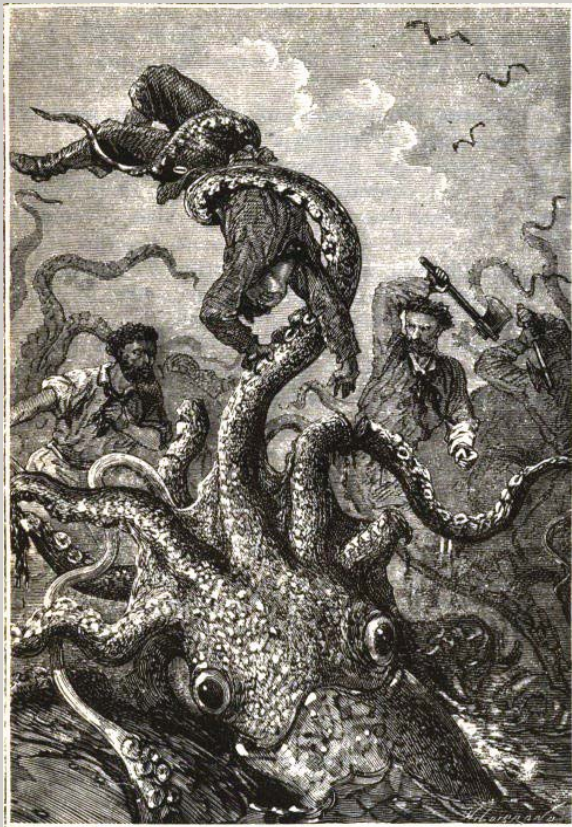




**Figure 6.** Pen and wash drawing by Pierre Denys de Montfort, 1801 from the descriptions of French sailors reportedly attacked by such a creature off the coast of Angola.



**Figure 8.** Painting by Richard Ellis of the sperm whale (*Physeter macrocephalus*) preying on the giant squid *Architeuthis*.



**Figure 7.** The crew of the *Nautilus* battling with the giant squid *Architeuthis* in Jules Verne's novel *Twenty Thousand Leagues under the Sea*. Illustration from the original version.

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