EVIDENCE FOR A TRIASSIC KRAKEN

Unusual Arrangement of Bones at Ichthyosaur State Park in Nevada

by Mark A. S. McMenamin

Did a giant kraken drag nine huge ichthyosaurs back to its lair in the Triassic era, where their fossil remains are found today? The author of this hypothesis tells why he thinks so.

Courtesy of Mark McMenamin

Shonisaurus *ichthyosaur vertebral disks at the Berlin-Ichthyosaur State Park in Nevada, arranged in curious linear patterns with almost geometric regularity. The arranged vertebrae in this Specimen-U resemble the pattern of sucker discs on a cephalopod tentacle, with each vertebra strongly resembling a coleoid sucker.*

The Triassic Kraken hypothesis, presented to the Geological Society of America at its October annual meeting in Minneapolis (McMenamin and McMenamin 2011), generated an enormous amount of attention on Internet media, immediately after the Society's press release announcing the discovery.

Nine gigantic ichthyosaurs are preserved in a rock layer belonging to the Shaly Limestone Member of the Luning Formation at the Ichthyosaur State Park in Nevada. Geological analysis of this fossil site had shown it to be a deep water deposit (Holger 1992), thus invalidating Camp's (1980) original hypothesis that the fossil bed represented an ichthyosaur mass-stranding event. Holger's (1992) study left unexplained, however, how it came to be that nine giant *Shonisaurus* ichthyosaurs sequentially accumulated at virtually the same spot on the Triassic sea floor.

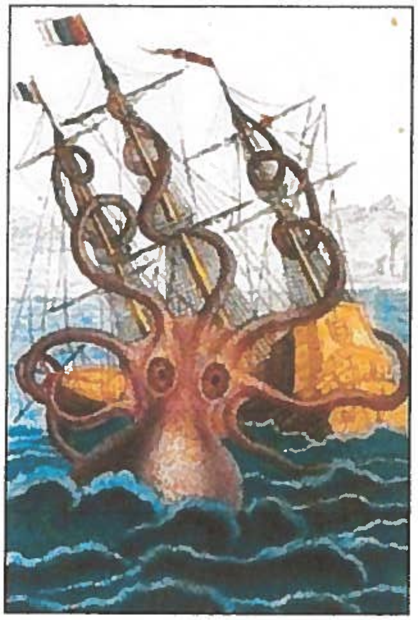
This paleontological conundrum was crying out for an unconventional new approach to attempt to solve the problem. McMenamin and McMenamin (2011) hypothesized that the nine gigantic ichthyosaur fossils were captured and transported by a gigantic cephalopod ("a Triassic kraken"), that killed the marine reptiles and then dragged their carcasses back to its lair. The giant cephalopod then proceeded to arrange the bones of its victims into almost geometric patterns, some of which resemble the sucker arrays on cephalopod tentacles.

A YouTube video from the Seattle Aquarium, showing a Pacific Octopus attacking and killing a shark, lent widespread credence to the hypothesis. To date, nearly 250 news and analysis articles on the subject have appeared online.

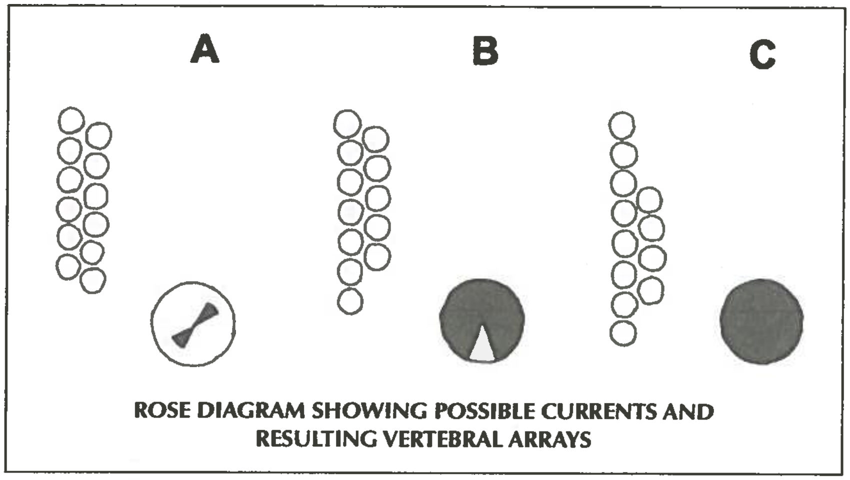
The Triassic Kraken hypothesis is in fact an extension of the great Seilacherian research program (named for the renowned German paleontologist Adolf "Dolf" Seilacher) that sees trace fossils as fossilized behavior. Once alerted to the new hypothesis, Seilacher seemed intrigued by the Triassic kraken and noted that the bone arrangement has indeed "never been observed at other localities."

Seilacher remarked that Jurassic ichthyosaur skeletons in Germany, which may provide analogous examples, occur in stagnant basin strata devoid of sea floor animals. Such sites received most of their sediment via muddy turbidity currents. (A turbidity current is a dilute underwater mudslide that forms a deposit called a turbidite.) Ammonite fossils at these sites are, on occasion, current-aligned in an otherwise quiet water setting in a body of stagnant water.

Seilacher wonders, first, are there fossils of seafloor animals associated with the Nevadan ichthyosaur bones? Second, even an entirely soft-bodied cephalopod



The kraken, a colossal octopus, in an 1801 Century drawing by Pierre Dénys de Montfort, based on descriptions by French sailors.



would still need a horny jaw, and assuming that it was not destroyed by bacteria, might it still be possible to find a fossil of its beak? Third, why did the bones near the critical Specimen-U bi-serial vertebral array remain undisturbed, and could the arrangement possibly be due to compaction?

Possible Comparisons

The strata of the *Shonisaurus*-bearing Shaly Limestone Member of the Luning Formation in Nevada might very well be compared to the famous Jurrasic fossil beds near Holzmaden, Germany, but they might also be compared to the muddy strata appearing as parallel-bedded lime mudstones of Lefkara, southern Cyprus. Stow (2006) interprets the Cypriot strata as alternating between distal turbidites and open-water sedimentation (pelagites) in a deep-water slope to basinal setting.

Referring to the Cypriot strata, Stow (2006, p. 179) notes that "the distinction between turbidite and pelagite is often very difficult to make ... as is the case here."

Similar considerations would apply to the Shaly Limestone Member of the Luning Formation. In any case, the sedimentology of the Shaly Limestone Member is in close accord with a deeper-water setting. Essentially the same depositional setting is inferred for *Shonisaurus* specimens of Hound Island, southeastern Alaska (called the deep-water Facies 2 by Adams [2009]). Sediment analysis at the Nevada park indicates that the site was deep, and that local marine depth had been increasing right up to the time that the bones were buried (Silberling 1959).

We can now confidently rule out a shallow water environment for the Berlin Ichthyosaur fossil site. Turbidite flows can undoubtedly align ammonite remains, as seen in Germany and elsewhere, but whether or not such deep water flows could arrange large, dense ichthyosaur bones into bi-serial accumulations seems highly unlikely.

Furthermore, the bi-serial vertebral array in Specimen-U is in a hydrodynamically unstable arrangement, *regardless* of inferred current direction.

A simple geometrical proof demonstrates the hydrodynamic instability of the bi-serial array at Berlin Ichthyosaur State Park with regard to currents fast enough to displace ichthyosaur vertebrae. Case A is the most hydrodynamically stable. For the sake of discussion, we will consider north to be at the top of the image. Only currents from the northeast and the southwest, of sufficient force to displace ichthyosaur vertebral centra (a relatively dense bone type, shaped like a hockey puck), have much chance of displacing the bones, and only the ones on the ends of the array are in much danger of thus being displaced.

The rose diagram shows a narrow band of competent currents, with the center of the diagram representing the strongest currents and the perimeter of the diagram representing the weakest currents that could move a vertebral centra.

Case B has a dangling vertebral centra on its bottom end, hence it is safe from displacement only from a relatively narrow wedge of current directions that come from north of the array and would flow around the array like currents moving along the streamlined body of a fish. In this case the dangling vertebra is roughly streamlined like the tail of the fish.

Case C is the array actually seen at Berlin Ichthyosaur as Specimen-U. With dangling vertebrae at both ends, any competent current (be it from turbidity current influx, shelf-edge contour currents, etc.), from any direction, is going to displace one or more of the bones; hence the entire rose diagram is filled in.

Hence, it is virtually impossible that currents arranged the bi-serial array seen in Specimen-U. This demonstration considers currents that are linear in terms of their trajectory. Non-linear currents, such as swirling currents or gyres, would be even less likely to form the bi-serial array seen in case C (Specimen-U).

Probability of Displacement

This demonstration can also be given in terms of probabilities. The probability of displacement (PD), or tendency to displacement, by currents in a random set of directions, in Case A, is approximately PD = 60/360 = 1/6 = 0.167 = 17 percent. The probability of displacement in Case B is PD = 320/360 = 8/9 = 0.889 = 89 percent. The probability in Case C, the actual case, is PD = 1.0 = 100 percent.

Once again, the probability that currents assembled the Nevada array is vir-

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An exhibit at the Berlin-Ichthyosaur State Park where visitors can view an exposed bone bed surface.

tually zero. Even in the unlikely event of two spiral current bores, of the type known to be responsible for forming elongate grooves, called flute casts, on the sea floor, that happened to converge along a center line to push material to the boundary between the spiraling currents (analogous to the converging circulation cells in the Sargasso Sea), Case C would still be impossible because we would expect the dangling vertebrae on both ends of the pattern to align along a boundary line (or line of symmetry along the long axis), and what we see instead is that they are displaced to the left side.

Thus, there is virtually no possibility that currents formed Case C. The triangular neck vertebra on one end of the Specimen-U array is in a particularly precarious position, with only one point of contact with an adjacent centra and two corners of the triangle exposed to torque by current flow. The likelihood of the neck vertebra being displaced by current is particularly high, especially considering its position on one end of the Specimen-U array.

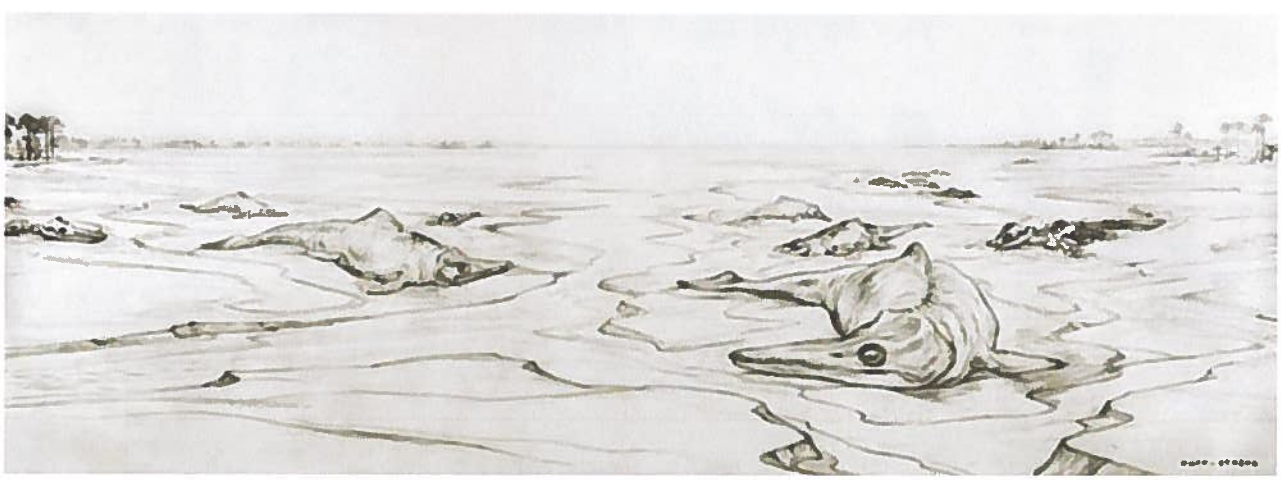
Each individual disc in the array is embedded into the matrix, and there are no associated external casts of nearby discs, therefore no discs were removed from the array subsequent to fossilization.

Seafloor Animal Fossils

The question of *in situ* seafloor animal fossils in association with the Nevadan bones is an important one. Sea floor animal fossils are rare at the site, although some brachiopods and/or halobiid bivalves have been reported from this horizon in the Luning Formation. No trace fossil burrows are known from the Fossil House Quarry, but in the absence of sandy turbidite layers to cast the underlying traces, these would not be expected to fossilize.

The depositional setting may have been one that experienced reduced oxygen levels, as some organic matter is visible in the rock thin sections. The environment, however, was evidently not greatly anoxic, because the mudstones and micrites are light in color. Modern vampire squids (*Vampyroteuthis*) are able to thrive at dissolved oxygen levels as low as 3 percent.

Giant Cretaceous squids (such as *Tusoteuthis*), reaching lengths of up to 11 meters, are assigned to the vampire squids because of similarities in the shape of their pen (gladius) to that of *Vampyroteuthis*. Thus, somewhat reduced oxygen levels would not necessarily have posed a significant challenge for the hypothesized Triassic Kraken, although we do not know exactly what



Drawing of ichthyosaurs by William Huff, depicting Charles Camp's 1980 hypothesis that they were stranded at the site in low tide. A later study showed, however, that this was a deep water site, invalidating the Camp hypothesis.

The Berlin-Ichthyosaur State Park in Nevada is also home to a 19th Century ghost town and an abandoned mine.

type of cephalopod this creature represented. Interestingly, the question of anoxic versus aerobic conditions and the Holzmaden, Germany strata are still a topic of debate.

The kraken would have indeed required hard jaws, and plans are under way to search the Luning Formation for such remains. There is a possibility for success in this effort, as a calcareous nodule from Wakkaweenbetsu Creek, Hokkaido, Japan has already produced an enormous Cretaceous cephalopod upper jaw assigned to the species *Yezoteuthis giganteus* by Tanabe et al. (2006).

With a search image now in hand, the chances of finding a giant cephalopod beak in the Luning Formation are dramatically enhanced. Modern octopi will kill sharks and use their beaks to pluck the flesh off of the shark's remains, leaving behind a cartilaginous vertebral column that rather resembles the long, relatively intact ichthyosaur vertebral columns seen at Berlin Ichthyosaur State Park.

Regarding the question of sediment compaction, the process can certainly lead to "bed parallel alignment and more close-spaced packing" (Stow 2006, p. 102) of the particles of fine sediment. Compaction processes would tend to flatten the orientation of vertebral discs, especially if they rested on a relatively resistant, hard, smooth surface. However, compaction processes do not appear to be capable of causing discs to move laterally to form an organized bi-serial array.

In conclusion, the Triassic Kraken hypothesis has survived all tests to date, including the current displacement probability test performed here, and is thus the leading explanation for the otherwise unexplained arrangement of ichthyosaur bones at Berlin Ichthyosaur State Park in Nevada.

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