Dinosaur Nests Reinterpreted

Evidence of Eggs Being Laid Directly into Rising Water under Conditions of Stress

Walter R. Barnhart*

Abstract

Supposed nests of dinosaur eggs are examined for indications that they were laid under normal subaerial conditions. It is shown that when representative clutches of eggs are examined from numerous sites worldwide, they were all laid into a watery environment in which sedimentation was often actively taking place. This leads to the conclusion that dinosaur nests, as they are presently found, cannot represent normal living environments for the dinosaurs and instead show life existed at the survival level under highly stressed conditions. These conditions are consistent with egg laying taking place during a worldwide flood.

Introduction

In the effort by creationists to understand the geological record and its relationship to the Flood/post-Flood boundary, no part of the fossil record has created more of a problem than the occurrence of dinosaur eggs throughout strata attributed to the Mesozoic (Garner, 1996, pp. 101–5; Johns, 1997, p. 321; Oard, 1997, pp. 145–6; 1999, p. 4; Robinson, 1998, pp. 61–3). Many questions seem to revolve around rapidly rising Flood waters on the one hand and the apparently slow processes indicated by *in situ* dinosaur egg "nesting" sites. These questions arise because a first look at *in situ* "nests" of dinosaur eggs leads to the assumption that their occurrence must represent significant periods of time without attendant wave action from the global Flood. This time could vary from days to months for the needed nest building, incubation of the eggs, and attendant "brooding" by the parent dinosaur as well as the postulated rearing of young in the nesting location. This has caused some authors to feel that the apparent time period implied by such *in situ* nests must have occurred either prior to the Flood or after it, and therefore they consign these strata and those above or below them to the pre- or post-Flood period.

In this paper I take a second look at these nest structures and the attendant evidence, attempting to determine if the eggs were deposited on existing soil horizons in a normal life cycle period of the parent, or if the eggs were laid on the accreting ground surface during existing Flood conditions (even if that ground was concurrently covered with a shallow layer of water). If the eggs were laid into a watery environment, this would demonstrate that the gravid females were laying eggs under abnormal, highly stressed conditions which might be typical of the Noahic Flood. Such conditions would compel immediate abandonment and preclude any post-depositional manipulation of the egg clutches, or "brooding" by the female dinosaur parent.

A Brief History

Dinosaur eggs are found in abundance in several locations around the world. The first to be noted were in France in 1859 and again in 1869 (Buffetaut and LeLoeuff, 1994, pp. 31–32). Popular knowledge of the occurrence of dinosaur eggs came about through the discoveries made in 1923 by the American Museum of Natural History on their expedition to Mongolia. This discovery also popularized the image we have of dinosaur egg nests (see Figure 1). In more recent years, additional finds in these two locations, plus significant finds in Romania (Grigorescu, et al., 1994), India (Sahni, et al., 1994), Argentina (Oard, 1999, p. 3), Uruguay (Faccio, 1994), and the Rocky Mountains of North America (Hirsch, 1994) have added substantially to the data available for research. In these locations, the eggs have appeared in clutches of several different configura-

*Walter R. Barnhart, M.S.
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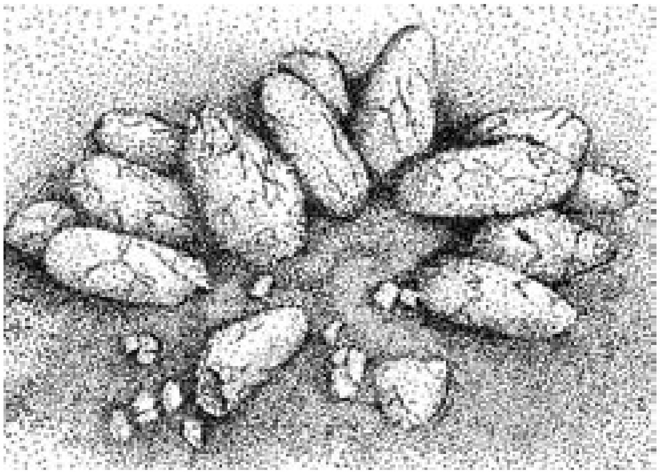

Figure 1. *Protoceratops(?)* egg nest from Mongolia, inverted as prepared and displayed. (Redrawn from drawing, Moratalla and Powell, 1994, p. 42, Figure 3.8).

tions, often referred to in the literature as "nests," but also singly and as scattered shell fragments distributed locally over large regions. One egg with embryo was even found inside the skeletal remains of a hadrasaur (Hirsch 1994, p. 138), while another egg with an embryonic ornithischian dinosaur was found preserved in fully marine conditions of the chalk in Alabama. It is theorized that the egg dropped from the 'bloated and floating body of a gravid female' (Ensign, 2002, p. 8).

The mere occurrence of eggs is assumed to show that all dinosaurs were oviparous (Paul, 1994, p. 247). Among modern reptiles, both oviparity and viviparity are known (Packard, et al., 1997, p. 75). Some evidence will be mentioned which suggests the same was true in the dinosaurs. (Ovoviviparity in the dinosaurs is beyond the scope of this paper and will be taken up another time.) Among fossil reptiles, the ichthyosaurs are recognized as being viviparous and it is necessary to consider that embryo development may have been already well underway when some dinosaur eggs were deposited.

Types of Nests

Dinosaur egg clusters occur in several arrangements which have been termed nests. Mikhailov, et al. (1994, p. 110) note,

> Three basic modes of nesting can be distinguished from the dinosaur egg sites in Mongolia: a typical underground (hole) nest . . . and two types of mound nests, where the nest is built out of sand or vegetation.

By contrast, Moratalla and Powell (1994, p. 38) identify worldwide,

> . . . two main types: clutched (nest) and linear. Moreover, the clutched type can be subdivided on the basis of how the eggs were distributed into concentric circles, spirals or inverted cones. The linear type also occur in different patterns of parallel rows or arcs.

From Mongolia, the mound nests are presumed to have been

> . . .made of vegetation, then after burial and decay of the nest material the eggs would fall over and the pressure of the overlying sediment would flatten each egg perpendicularly to its long axis (Mikhailov, et al., 1994, p. 111).

This implies burial possibly after hatching but certainly prior to decomposition of the vegetation and crushing of the eggs, although compaction of the vegetation and crushing of the egg in the vertical position seems more likely. The nests called sand nests, by contrast, presume the eggs were laid so as to be supported in a vertical position by the sand and therefore preserved in a vertical or subvertical position (Mikhailov, et al., 1994, p. 112).

There is considerable disagreement concerning the dinosaurs' ability to attain the complex, regular, geometric arrangements found in egg clutches. Mikhailov, et al. admit, "It is not believed that the female manipulated the eggs into position" (1994, p. 111). Speaking of clutches containing several concentric circles of subvertical eggs alternating with a covering of soil around the mounds, however, Moratalla and Powell state that a pattern of two parallel linear rows of eggs ". . . suggests that the eggs were rearranged by the female after egg laying" (1994, p. 41). Based on the common occurrence of regular geometric arrangements of eggs, they suggest that these animals had the capability for recognizing geometrical patterns (Moratalla and Powell, 1994, p. 44). This is not a presumption based on any extant reptile. Yet the regular, geometric patterns do exist, so the *a priori* speculation is that the dinosaur manipulated the eggs on a dry substrate to attain these patterns.

Evidence from Amniotic Eggs

The amniotic egg is thought to have freed tetrapods from having to reproduce in water by protecting the developing embryo from desiccation in a subaerial environment (Carpenter, et al., 1994, p. 4).With the description of dinosaur eggs as amniotic, however, we are identifying them as air breathing organisms. Dinosaur eggs studied by electron scanning micrography have shown varied pore systems which provided gas exchange rates with the environment which vary from eight times the gas exchange rate of bird eggs up to hundreds of times greater (Faccio, 1994, p. 52). This high gas exchange rate is presumed to be necessary for the rapid growth rate suggested for dinosaur embryos,

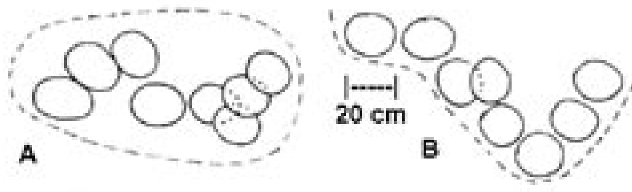

Figure 2. The first clutch of eggs from Rousset, France, to be drawn as a nest by Kérourio in 1981. A. Plan view. B. Vertical section. (Redrawn from diagram, Cousin, *et al.*, 1994, p. 69).

however it would also make the embryo highly susceptible to drowning if the egg is submerged in water. Even a few minutes of submerging a chicken egg will drown the embryo, and it would be reasonable to assume the same to be true for dinosaur eggs. Indeed, it is likely the pattern of breakage found in the shells of dinosaur eggs was the result of a literal explosion of the shell caused by increasing internal hydrostatic pressure as they rapidly absorbed water. This water absorption would drown the embryo.

Evidence that Dinosaurs Were under Stress while Laying Eggs

The occurrence of dinosaur egg clutches in nests are based on two popular images: Figure 1 is the popularly displayed clutch of *Protoceratops(?)* eggs found in Mongolia in 1923, and Figure 2 is a nest of titanosaur eggs found north of Rousset-sur-Arc, France, in 1981. The careful researcher looks beyond the popular images of nests as presented for the general public and past the physical arrangement of what is seen as he makes an effort to understand what was happening at the time the eggs were being deposited. This understanding will allow speculation as to what the conditions were when the gravid female laid her eggs.

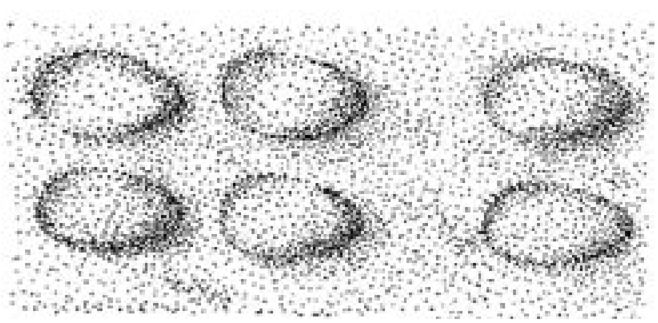

Figure 3. Theropod eggs deposited in two parallel rows, from Montana, United States. (Redrawn from diagram, Moratalla and Powell, 1994, p. 41. Figure 3.7).

From Montana's Two Medicine Formation in a greenish-grey mudstone with occasionally abundant caliche Horner and Currie (1994, p. 312, as cited in Moratalla and Powell, 1994, p. 41) labeled as a nest, the linear pattern of *Troodon(?)* eggs found in two parallel rows, as shown in Figure 3. Pairing of eggs in nests is relatively common and can be seen in several examples including clutches of Protoceratopsidae from Mongolia (see Figure 4). Mikhailov, et al. note, The eggs are often preserved in pairs, possibly as a result of the simultaneous action of both oviducts and the gluing together of the eggs with a mucous secretion (1994, p. 99).

But in referring to the clutch in Figure 3, Moratalla and Powell say, "This pattern suggests that the eggs were rearranged by the female after egg laying" (1994, p. 41). Part of their reasoning for attributing the eggs to theropods is that the shortened forelimbs could be suitable for egg maneuvering.

Does a regular pattern of eggs indicate dinosaur manipulation? A look at Figure 3 with the greater but uniform gap between the pairs of eggs on the right suggests that the eggs were merely dropped, not manipulated. The even distance between pairs of eggs suggests a mechanical determination consistent with their exiting the oviducts in pairs. The mechanical nature of the layout is emphasized by Mikhailov, et al. (1994, p. 99) when they state concerning the eggs of Mongolia, "The eggs are often preserved in pairs, possibly as a result of the simultaneous action of both oviducts and the gluing together of the eggs with a mucous secretion." Paired eggs would then be a sign of stress on the gravid female which resulted in her effort to rid herself of the encumbering

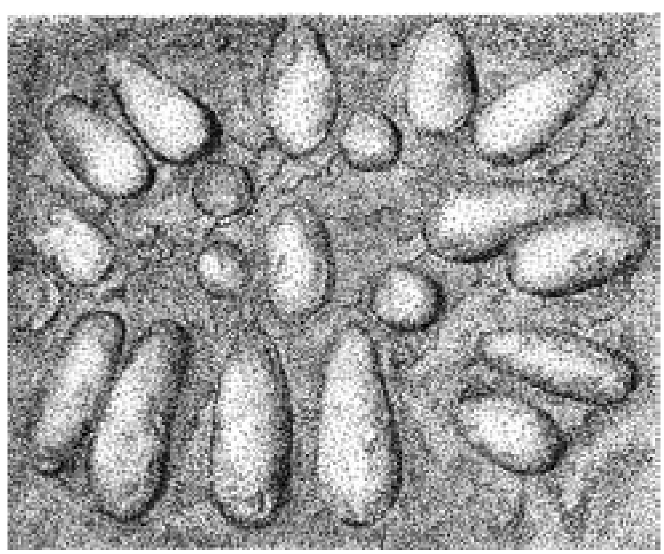

Figure 4. Protoceratopsid eggs from Mongolia. (Redrawn from photo, Mikhailov, et al., 1994, p. 102. Figure 7.12A).

eggs as rapidly as possible. The eggs would not have been manipulated into this pattern, but instead simply fell and were allowed to remain where they fell in the linear pattern as she continued moving forward laying the eggs.

No example of simultaneous function of both oviducts can be found in extant reptiles. The reptile which lays the most eggs in a single clutch is the green sea turtle which lays over 200 round eggs into the same excavated sand nest. While on the beach, the female turtle is subject to predation, yet it deposits its eggs one at a time. Because the eggs are round and the cloaca appears fairly loose, it may be possible that two eggs could exit together, but they have never been observed to do so. The design is restricted to one round egg pushing its way through the canal at a time.

All known birds follow the same pattern, and the design of the tapered bird egg allows the smaller end to push its way through the cloaca first, expanding the opening as gently as possible for the larger, more voluminous end. Working from the pattern of extant reptiles and birds to reconstruct the design of the dinosaurs' soft tissue would lead to the conclusion that dinosaurs exhibited no significant difference in design. This comparison is reinforced because all dinosaur eggs believed to have been laid in pairs are elongated eggs, tapered towards one end, designed to function in the same way as bird eggs, opening the cloaca as gently as possible. Further, it is reasonable to speculate that the laying of two eggs simultaneously may have been an indication of injury which permitted or even caused it to take place.

Multiple Nests Attributed to Different Years May Belong to the Same Clutch

Figure 5 shows three eggs from Lérida, Spain, with the rock surface splitting through the presumed equator of two eggs (based on the size of the eggs) and the top or bottom of a third egg I have labeled number 1. The eggs are attributed to a titanosaur, a Sauropod, and the larger one measures about 24 cm by 29 cm. In the photograph, the rock surface gives every indication of being a cleavage plane and therefore, as demonstrated by Julien, et al. (1998, p. 220), a surface of deposition delineated by a change between fine and coarse sand, the end of one pulse of sediment. The original photograph showed three ovals of white egg shell in a dark matrix of stone. In the photograph it is not possible to tell if egg 1 is above or below the level of eggs 2 and 3. Because its elevation overlaps eggs 2 and 3 by approximately half of their circumference, the overlapping distance would be approximately the same for either situation. For this evaluation, I will assume egg 1 is below eggs 2 and 3.

Considering the eggs in light of the possible sequence of events which occurred during their laying (Figure 6), egg 1 was laid and prior to the time eggs 2 and 3 were laid, approximately 12 to 15 cm of sediment, (half the diameter of egg 1), were deposited. Moratalla and Powell (1994, pp. 41, 45) suggest that when different layers of eggs are present, they may have belonged to different years with an annual return to the nesting site. That would indicate the first egg laid remained on the ground half exposed, yet unbroken, for a full season while the 12 to 15 cm of sand washed in around the egg. For the first egg laid to remain whole and in a position for it to have been cleaved in this manner with eggs 2 and 3, however, it would have needed to be totally buried in its own layer of sediment. It is unreasonable to assume it might have lain half exposed at the surface of the ground for a full year and survived unbroken during the ovipositing of eggs 2 and 3.

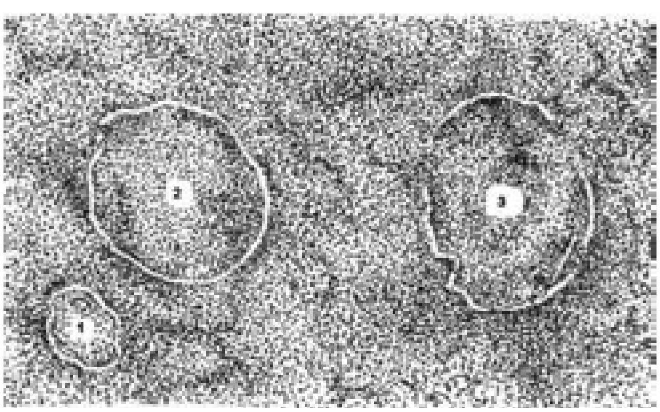

Figure 5. Cross section of Titanosaur eggs as exposed on cleavage plain. Right egg approximately 24 x 29 cm. (Redrawn from photograph, Moratalla and Powell, 1994, p. 40, Figure 3.4).

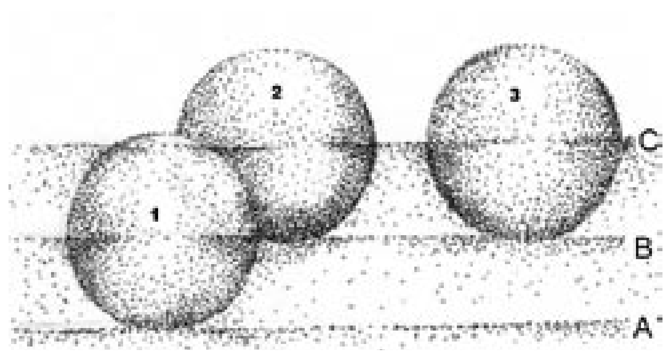

Figure 6. My own sketch showing projected elevation of eggs in Figure 5 with suggested sediment surfaces at the time the eggs were oviposited. Surface A at the bottom was sediment top when egg 1 was laid. Surface B (middle surface) at 12–15 cm higher than A was sediment top when eggs 2 and 3 were laid. Surface C (top surface) is the cleavage plain across which eggs are exposed in Figure 5.

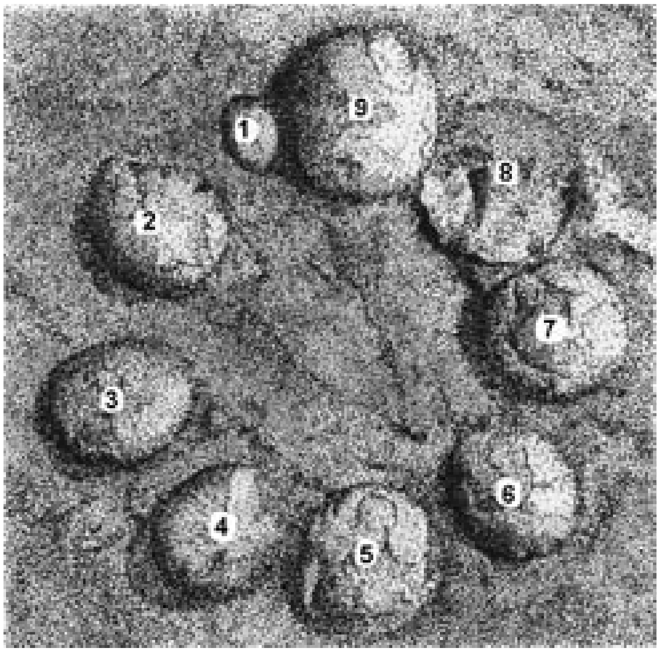

Figure 7. Clutch of *Spherolithus chiongchiungtingensis* from Laiyang, China, 8–10 cm by 7–8 cm, spherical and slightly ellipsoid. (Redrawn from photograph, Mikhailov, et al., 1994, p. 96, Figure 7.7B).

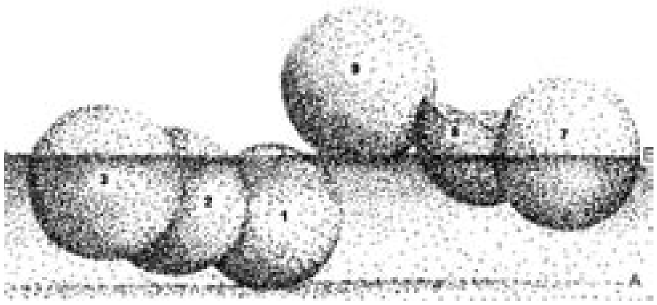

Figure 8. My view of a cross section of a portion of Figure 7 showing eggs in relationship to top of sediment at time egg laying began and ended. Height from the lower surface (A) to surface B would be 5–6 cm to engulf egg 1.

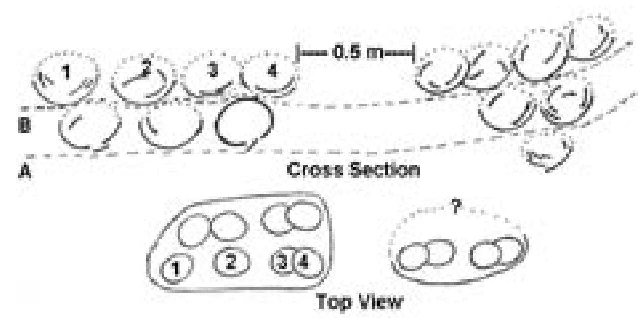

Figure 9. Juxtaposition of two clutches of eggs from Hateg Basin, Romania. Each clutch occurs in two or more separate levels of sediment. Top view shows arrangement of paired eggs to numbers 1–4. (Redrawn from diagram, Grigorescu, et al., 1994, p. 78, Figure 6.4). Note that the numbering of eggs is my own.

Based on the arrangement of eggs in the photograph, egg 1 was laid along (possibly with an as yet unexposed egg as a pair) into an accumulating sediment, then 10 to 15 cm of sediment accumulated around it while eggs 2 and 3 were clearing the oviduct either singly or as a pair. It is reasonable to assume that the time required for this was a matter of minutes.

A rate of sediment deposition of 10 to 15 cm within a few minutes indicates a significant rate most easily visualized as occurring with moving water covering the nesting site.

Is this trio of titanosaur eggs unusual? Figure 7 shows another example. These eggs from China are significantly smaller, being 7 to 8 cm in diameter. They are believed to belong to a hadrosaur, although no body fossils were found in association (Mikhailov, et al., 1994, p. 99). Here the gravid female seems to have wobbled as she crouched to lay these 9 eggs. While there is no pairing, there is a stair-stepping of the eggs visible around the circle. The laying order appears to be from number 1 to number 9. During the time it took to lay the 9 eggs, 5 to 6 cm of sediment accumulated (Figure 8). This is less than half the accumulation of sediment around the titanosaur eggs, and apparently it occurred over a significantly longer span of time, possibly several minutes. Both examples indicate that the females involved were laying their eggs into moving water of such a depth that it may have covered the eggs completely. This is rather different than the sub-aerial environment which is normally associated with tranquil egg laying.

An even more spectacular example of sedimentation can be seen in Figure 9. These eggs are all about the same size as those in Figure 7, being between 5.6 and 7.5 cm long, as reconstructed. The authors, Grigorescu, et al., (1994, p. 77) comment,

> As indicated by their distribution in the rocks, the subspherical eggs were apparently lying in linear rows, each egg located close to another. The eggs were arranged vertically in two closely superposed levels each containing two groups of two, three or four eggs. The groups were spaced about a half meter from one another. The left and right superposed groups may represent two contemporaneous clutches deposited by the same female or they may belong to two clutches laid in two different years.... On the right

> side, large isolated fragments of another egg were found beneath the first row.

Later excavation revealed four additional eggs in a row, lined up behind eggs 1, 2, 3, 4 in Figure 9. Excavation was not continued to reveal if any other eggs were paired. The pairing of the eggs may be the result of both oviducts working simultaneously, as discussed earlier, and while the female may not have had any control over this action, it would deposit the greatest number of eggs in the shortest time.

Grigorescu, et al. (1994, p. 86) continue:

> The eggs themselves appear to have been buried superficially in fine sandy sediments, which were then rapidly overlain by a thick blanket of coarse sediments.

In a lithographic cross section, the authors show the egg bed as occurring in the upper portion of one meter thick stratified "pinkish, silty marls with calcretes and plant rootlets" grading into "red massive, silty mudstone.... This is sandwiched between a coarse, poorly cemented, grayish sandstone below, and a three meter thick layer of "grayish, poorly cemented cross-bedded conglomerate" (Grigorescu, et al., 1994, p. 77). Although Grigorescu, et al. suggest that the multiple layers may have even been laid down in successive years, they also state as quoted above, … buried superficially … then rapidly overlaid by a thick blanket of coarse sediments (Grigorescu, et al., 1994, p. 86). The stratigraphy suggests that the lower grayish sandstone and the pinkish silty marls may have been deposited by the decreasing velocity of the same wave front. It was in the short span of the ensuing lowered energy waves that the two dinosaurs crouched in near tandem to deposit their eggs. One was slightly earlier than the other and both may have swayed in the current. In the time it took for each to lay her 7 to 8 eggs, or pairs of eggs, 2 or 3 bedding surfaces of sand had collected about their feet and caused the eggs to appear stacked in a "nest" formation. In this instance, the bedding surfaces were retained and the excavators were able to recognize and identify each egg in relationship to the layers. As the wave increased in depth and energy, the females were driven on by the arrival of the conglomerate, an indication of a higher energy wave.

In Figure 10 we see what can only be called a laying field of sauropod eggs. This grouping is from France, but Sahni, et al. (1994, p. 220) give less detailed diagrams of sauropod laying sites in India which he describes as "roughly circular groups," with one nest site covering about 5000 square meters. In Figure 10 the area covered is about 50 square meters. About half of the eggs lay in arcs of from 1.3 m to 1.7 m in radius. In the description of this site, Cousin, et al. (1994, p. 68) suggest this distance represents the turning radius of the sauropod, and the differences represent different sized individuals. The remaining eggs occur in localized clusters or individually. Figure 11 represents a cross section at FG 11 in Figure 10, where two arcs and a cluster overlap (Cousin, et al., 1994, p. 67). We can see

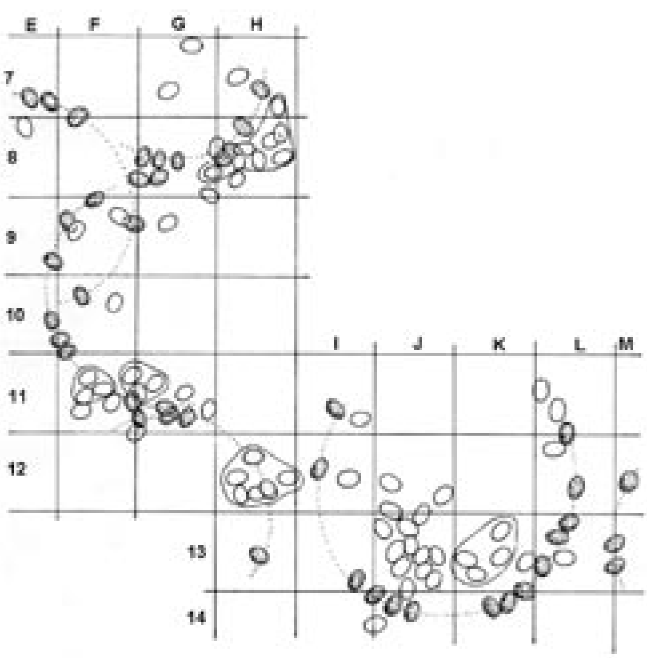

Figure 10. Sauropod eggs from Rennes-Le-Chateau, France. Eggs 15–17 cm x 18–25 cm, arcs 1.3–1.7 meter radius. Shown as originally grouped in nest on 1 meter grid (Watté, et al., 1986; Watté, 1989). All eggs distributed over 35 cm vertically are shown grouped on same plane. (Redrawn from diagram, as cited in Cousin, et al., 1994, p. 71, Figure 5.16).

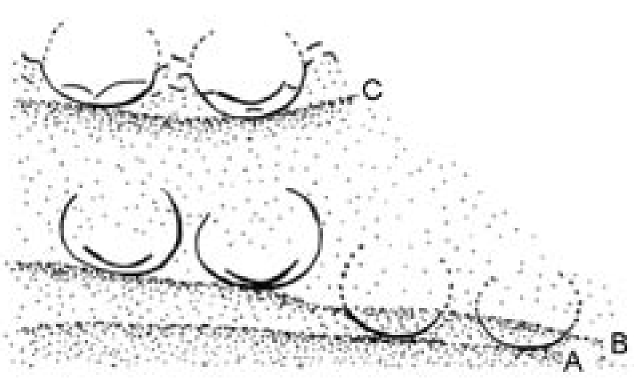

Figure 11. Is this a case of three superimposed egg levels of three separate clutches of eggs, or one clutch laid into accumulating sediment at three different levels of sediment? Cross section through Figure 10 at FG 11. From Rennes-le-Chateau, France. Total height is less than 35 cm. (Redrawn from diagram, Cousin, et al. 1994, p. 72, Figure 5.18, labeling changed).

that the eggs occur on at least three levels within this site. Since all of the eggs are of the same basic sauropod type, Cousin, et al. conclude that those eggs in more distinct clusters and outside the prescribed arcs may belong to a different sauropod species. They suggest *Rhabdodon priscus* for the clumped clusters and *Hypselosaurus priscus* for the arcuate clutches. While the attribution to two separate species of parentage may be possible, no physiological or morphological differences in the eggs are cited, only the depositional difference in pattern.

Figure 11 shows the cluster occurring at the lowest sedimentary level with the two arcs above it. While there is not nearly enough information provided to know if this type of arrangement is generally true, it may be an indication of increasing stress during the egg-laying episode. All of the eggs may have been laid by the same species, with those members of the herd which arrived first being able to pause in one place to drop their eggs. There may have been no standing water on the ground at that time and only a shallow, firmer mud as suggested by the lowest level of eggs in Figure 11, which may have been laid into a very thin layer of sediment. But as one group of females finished or were frightened onward in their escape from the Flood waters, the next group moved into the region as water began to flow across the ground. The middle layer of eggs appears to be deposited into an accumulating mud. The arcuate pattern shows no preferential direction and might represent females entering the location from diverse directions or in pronounced agitation. This agitation may be the direct cause of the arcs. The females were too stressed to stand still and instinctively swung around to view approaching trouble or respond to wave noise.

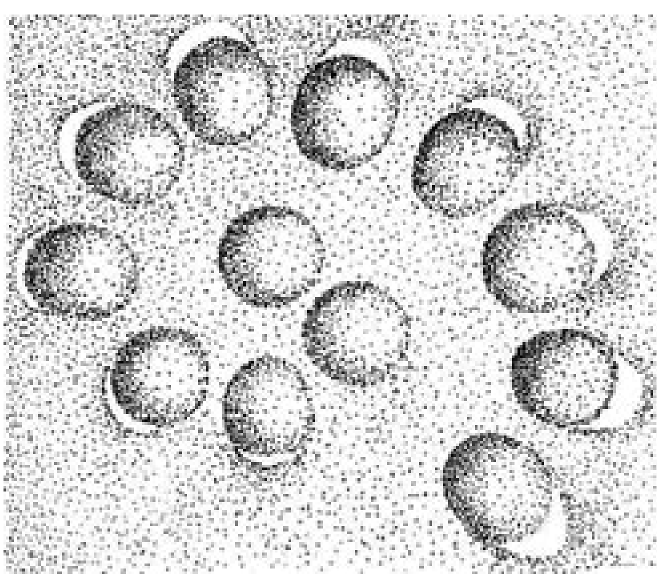

Figure 12. ***Orodromeus*** **eggs from Montana, United States. Clutch of eggs all tilted toward a common point above center egg. (Redrawn from drawing, Moratalla and Powell, 1994, p. 44, Figure 3.11).**

Further Evidence Eggs Were Laid in Wet Mud of Rising Waters

If Figure 4 is compared to the very orderly arrangement of the clutch in Figure 12, attributed to another ornithischen, *Orodromeus*, the spiral nature of Figure 4 can be discerned. The ornithischen eggs of Figure 12 seem to have been emitted from a common point in a constantly varied direction outward with enough force that a firm, viscous mud enveloped each egg independently and “froze” it into the arrangement and direction it was sent. Had either of these clutches been laid onto dry sand, as some have attributed them (Mikhailov, et al., 1994, p. 102), it is hard to imagine enough force to cause them to penetrate the sand and not be crushed. The eggs in Figure 4 do seem to have been laid into ground which was of an uneven viscosity. The eggs in the center are fully buried and seem to be essentially vertical. The eggs in the lower portion of the Figure landed on less viscous ground and were unable to penetrate and therefore fell over. This lowered viscosity might reflect an obstruction below the surface, a change in the character of the cementing agent which was hardening unevenly, or dewatering. Those eggs in the upper and right outer ring appear to have landed in mud adequately viscous to maintain their orientation while not penetrating deeply. There does appear to be some paired orientation of the eggs in this clutch.

Figure 12 is so perfectly arranged, it is difficult to imagine how it could be produced by the simple physical actions

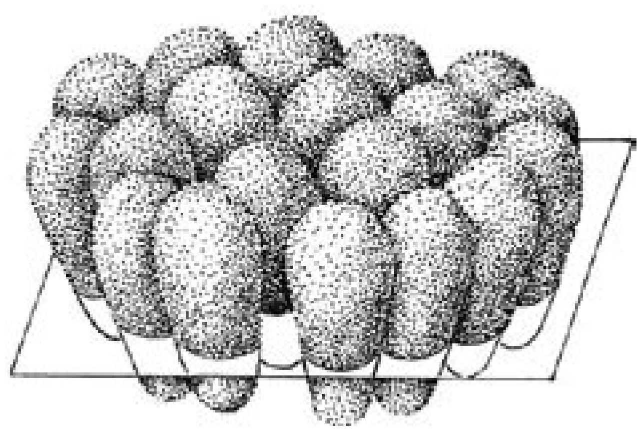

Figure 13. ***Elongatodithus*** **eggs typical clutch structure, large end up, tilted outward. (Redrawn from diagram, Mikhailov, et al., 1994, p. 93, Figure 7.4G).**

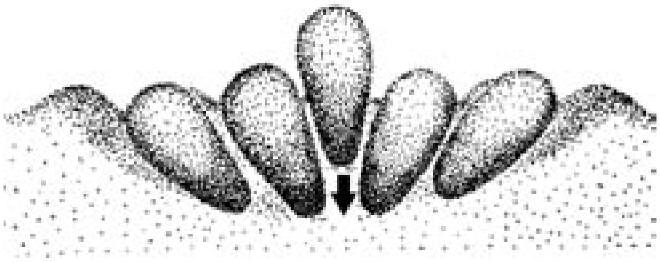

Figure 14. My idea of how elongated eggs would produce a pushed up nest edge as they drop into low viscosity substrate.

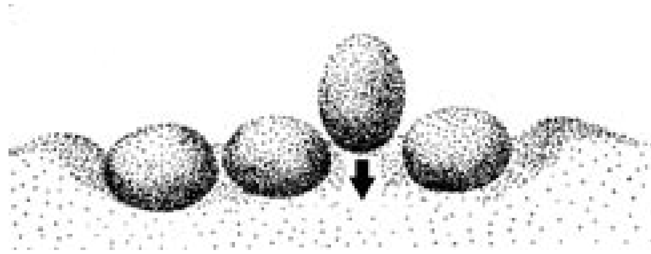

Figure 15. My idea of how subspherical eggs would produce a pushed up nest edge as they drop into low viscosity substrate.

of the gravid female. In fact, some kind of internal anatomy may be necessary to send each egg out of the cloaca in a different direction to produce the spiral pattern. While the mechanism to produce the spiral is elusive, the fact that the orientation is presented seems to be an artifact of being laid into mud, not dry sand.

A second type of vertical or subvertical arrangement of elongated eggs also occurs in Mongolia and elsewhere. These clutches are identified as elongatodithid, and are identified where the top of each egg points outward in different directions (see Figure 13). Here, the description is often of the eggs being arranged in concentric circles (Mikhailov, et al., 1994, p. 113). But the concentricity might simply be an artifact of the random drop of the eggs into a highly viscous mud. While Figures 4 and 12 would be naturally produced if the eggs were laid from a common point but aimed in different directions, the clutch pattern in Figure 13 would take on this outward tilting form if the eggs were laid from a common point directly above the center of the clutch, and the eggs were each allowed to drop straight downward into highly viscous mud (see Figure 14). While the mud in Figures 4 and 12 needed to be thick enough for the implanted eggs to retain their original orientation, the mud in Figure 13 needs to be viscous enough so that as each new egg drops into the center of the clutch it would force the other eggs to float outwards. The smaller diameter on the lower end allowing the same thickness of mud between eggs at the bottom as well as the top, would automatically orient the larger upper end to point outwards. The natural clustering of eggs requiring the least amount of movement during the implanting process would naturally result, arranging the eggs in concentric circles.

The difference of cluster structure between Figures 4 and 13 then would be based on differences of internal structure or maternal motion during deposition and the viscosity of the mud. There would have been differences in the dinosaur species which laid the eggs, especially if one species exhibited a difference in internal body structure which produced the spiral pattern as seen in Figure 12. But it must be emphasized that neither of the two forms of egg clusters would have been preserved with such clarity unless they were deposited in wet mud. Simple covering by sediments after they were laid (see Figures 5, 6 and 9) would not have preserved the specific characteristics of each nest. While wet muds do not automatically require some standing water above the mud, it would preclude the laying of the eggs in a tranquil, dry, subaerial environment and increases the likelihood that these were not normal conditions for dinosaur egg laying.

Oard (1998, PP. 74–76) comments,

> There are only a few nests in the whole world, nests being defined as a bowl-shaped depression around the eggs. One of them is on the top of Egg Mountain (see [his] Figure 1).

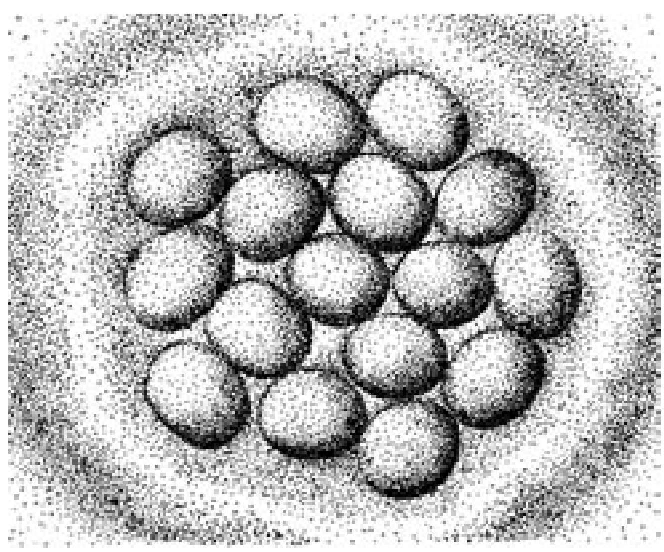

Figure 16. My idea of a subspherical nest as it would look in an aerial view with the nest edge as a natural result of the push-up formed when eggs drop into a low viscosity substrate.

His Figure 1 shows another type of nest, a cluster of eggs surrounded, at least partially, by a ridge of the bedding substrate. If a dinosaur had excavated a depression with its foot and then laid its eggs into the bowl, this is the type of structure that would be expected. But must such a ridge have been produced by excavation? My sketches in Figures 14 and 15 illustrate that such a ridge could have been produced by the dropping of the eggs into a low viscosity substrate. Such a method would produce a cluster which, as Figure 16 shows, would have superficially mimicked the eggs being laid into an excavated depression. The difference would be an excavated nest would have a level cleavage plain under the ridge continuous with the surrounding surface level.. Other indications would need to be examined to determine whether the substrate was viscous or dry when the eggs were oviposited. Several questions remain. Are the eggs on top of the substrate or partially submerged as if floating? Does the ridge form a parting plane with the substrate below? Does the top of the pushup show a continuous texture (a bedding plane cleavage) on its surface with the surrounding stratae?

Evidence from the First Nest Reinterpreted in Terms of a Standing Water Model

The American Museum of Natural History's expedition to Mongolia in 1923 located the first recognized nests of dinosaur eggs (Andrews, 1927). Positioned near skeletal elements of *Protoceratops*, the eggs were assumed to belong to that group and were described by van Straelem in 1925 as *Protoceratops(?) andrewski* (as cited in Moratalla and Powell, 1994, p. 37). Mikhailov, et al. (1994, pp. 110–112) note that the nest was prepared upside down because the eggs always lay with the more pointed end downward. This method produces a much more spectacular museum display as the upper ends of the eggs generally have been crushed or weathered away, and only the lower portion remains. It is assumed that the upper end mostly was destroyed by the hatching window (discussed later). In Figure 1 the bottoms of the eggs . . . are slightly crushed, thus exaggerating their width (Carpenter, et al., 1994, p. 8). The eggs of the nest were identified by Sabath in 1991 as occurring in pairs, a condition thought to be due to both oviducts participating in egg laying (as cited by Carpenter, et al., p. 9).

Figure 17 gives my projected cross section view of the clutch in Figure 1 as it might have appeared when laid. The eggs are inclined with the pointed end outward and generally are thought to have been buried in sand. But the arrangement could have been more easily produced by the dropping of the eggs into a highly viscous sand slurry. The first eggs floated outward and are preserved in a more horizontal position. The final eggs were probably the more vertical ones which were held in this more upright position by the compression created by the more horizontal eggs or decreasing viscosity of the fluidized sand due to dewatering. It would be difficult to imagine the eggs being laid onto dry sand, even soft, dry sand, in such a manner that they were able to become embedded and maintain their final arrangement. Dropping the eggs from a single point onto the top of dry ground might be expected to form a cluster like Figure 18. Additionally, when we compare them to tapered bird eggs, we recognize that the taper could be a design element to keep rolling eggs in an open nest, not buried at all (Figure 19).

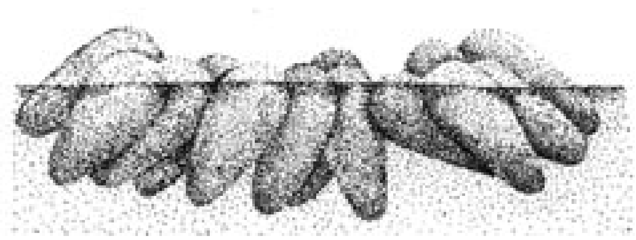

Figure 17. My rendering of *Protoceratops(?)* egg nest from Mongolia, redrawn from Figure 1 to show *in situ* cross sectional arrangement when laid. Appearance is of eggs floating in a high viscosity solution.

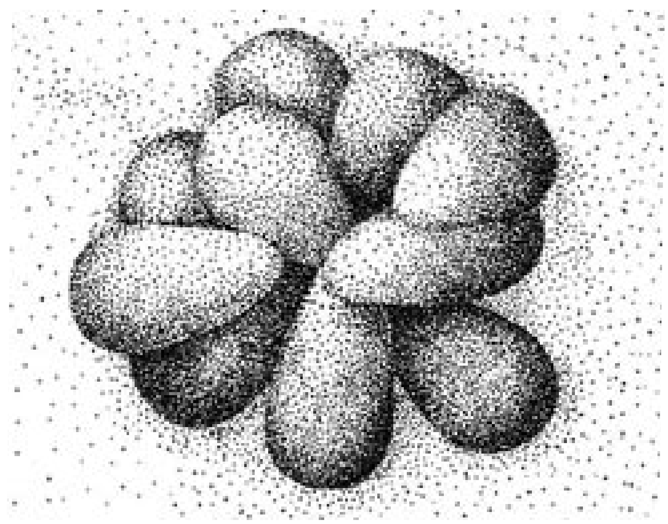

Figure 18. My idea of how the *Protoceratops(?) egg* clutch of Figure 17 might be expected to pile up if laid onto a dry substrate.

The other cluster of eggs to shape the popular concept of dinosaur nests is the one described by Kénourio in 1981 from Rousset-sur-Arc, France (Cousin, et al., 1994, pp.

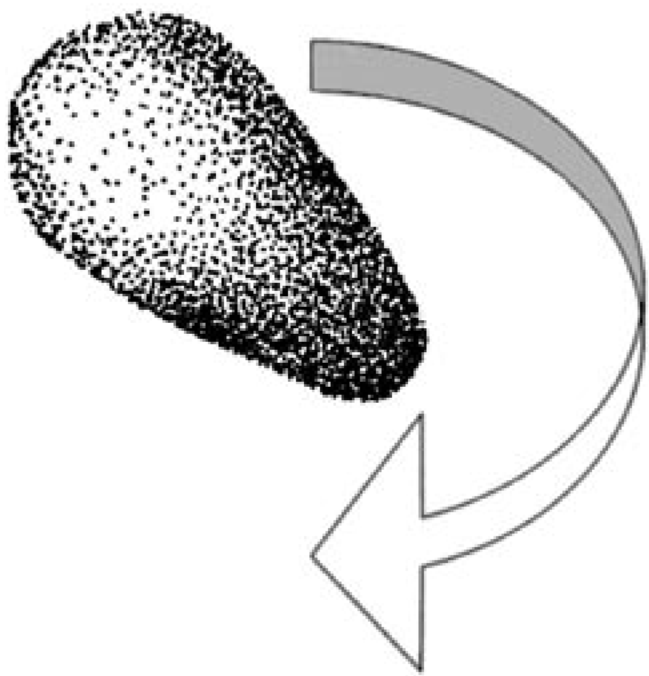

Figure 19. Tapered eggs are designed to encourage them to remain in a nest by rolling around, so as not to require burying.

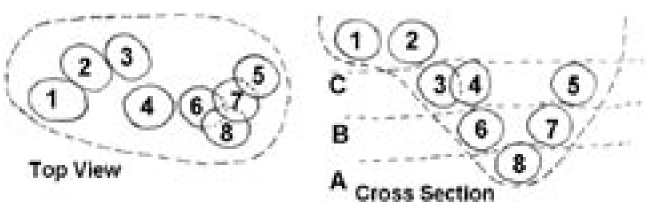

Figure 20. Kérourio's nest drawn to show possible occurrence of eggs in different sediment layers following comments of Cousin, et al. (1994, pp. 63–64). Lettering of possible divisions by layer and numbering of eggs (1–8) is my own.

63–64). He described it as containing 8 eggs which defined a cone 70 cm deep with an upper opening of 70 cm wide by 120 cm long (see Figure 20). Kérourio failed to do any further excavation because the matrix was too hard. He did note a large number of additional isolated eggs. Cousin, et al., themselves, point out that "...the matrix filling the nest cannot be differentiated from the surrounding sediment..." and further propose that the eggs may belong partly to multiple clutches located on different levels. In the cross section (assuming it accurately portrayed what was found) it is possible to draw strata lines between eggs 2 and 3, eggs 5 and 6, and eggs 7 and 8. This could place them into a situation exactly like what was observed in the clusters of eggs from Romania in Figure 9. Or they could be part of a larger grouping as seen in the arcs of Figure 10 and accentuated by the small cross-section taken from it in Figure 11. In this possibility, the large number of additional isolated eggs might indicate that the eggs lying on four different levels define four arcuate rows. The comments of Cousin, et al., taken at face value, would suggest that the nest excavated and illustrated by Kérourio has no characteristics to define it as a single clutch of eggs, and therefore this widely cited example of a nest lacks any characteristics to define it as a nest except the limited excavation of the site. At best the nest should be considered an artifact of the excavation and at worst a case of the paleontologist selecting his fossils to supply support for his preconceived ideas.

Evidence for Stress Conditions Shown by Broken Eggs

In searches for dinosaur eggs, it is extremely rare, if ever, that a completely unbroken egg is located. The shells of most eggs are extremely fractured and spacially displaced. While many eggs exhibit *in situ* fragmentation, intrastratal reworking due to dewatering, and soft sediment deformation, some fragmentation is of such a regular pattern that it raises questions as to its cause.

A careful examination of Figure 9 reveals a regular pattern of breakage. The diagram appears to be done carefully, and the tops of all eggs except one are open. The majority of the displaced pieces inside the lower shell are lying with the concave surface upwards.

Much is made in the literature of "hatching windows" occurring in buried eggs. Almost any time the top of the egg is broken and displaced, it is assumed that the hatchling moved the hatching window when emerging from the egg. This is used as an indication that the eggs lay there in that position long enough for the embryo to develop, emerge from the egg, and desert the nesting site. It is the prolonged span of time for these events which is the crux of the questions about dinosaur eggs and a rapid Flood burial. Because reptile eggs must remain in the same orientation during their entire period of incubation for the young to emerge alive, it is considered unlikely that they could have been transported and still have hatched.

While "hatching windows" do not occur in all clutches of eggs (see Figures 4, 7 and 12 for clutches without "hatching windows"), they often do occur and when they do, they occur in most eggs of the clutch. The occasional egg in a clutch which does not contain a "hatching window" is re-

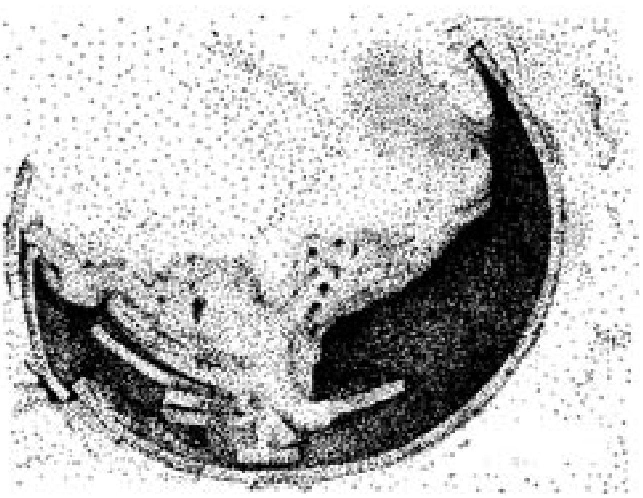

Figure 21. One of cluster of eggs ascribed to Sauropoda, based on large size, from Soriano, Uruguay (redrawn from photograph, Faccio, 1994, p. 49, Figure 4.2,C).

ferred to as infertile. Cousin, et al. (1994, p. 63) conclude, concerning the egg sites in France, the presence of eggs presupposes the presence of beasts, and the presence of beasts presupposes the presence of fertile eggs. Furthermore, they . . . suggest that the hole in the egg is the 'hatching window,' which would indicate that the egg had hatched.

The "hatching windows" most often occur in the top of eggs but may be found on a side or even on the bottom. Openings vary in size from very small to more than the top half of the egg shell. Furthermore, often the piece of shell which came out of the "hatching window" is preserved in the bottom of the shell with its concave surface oriented upwards.

Figure 21, showing a titanosaurid egg from Uruguay, is an unusually clear example. Faccio (1994, p. 48) describes the site: The top of the eggs are [*sic*] broken, while the lower portions are well preserved. The fragments were situated with their internal (concave) surfaces facing upwards.

Eggs Probably Opened while Full of Yoke and Albumen

When the concave surface of the displaced shell faces upward, it would seem to preclude breaking being associated with the hatching of an embryo. Had the embryo hatched at full term the young dinosaur would have filled the shell. When a hatching window was created, the shell would have fallen outward because there would have been no room inside the egg. Once the young had exited the egg, then parts of the shell might have collapsed back into the base of the egg due to attaching membranes, but these pieces would have experienced a random chance of falling concave or convex side upwards. Only when the egg is still full of liquid, not embryo, would pieces of shell float downward in a concave side upward preferential direction. This gives strong reason to believe that the breaking open of the eggshells happened while they were still full of yoke and albumen rather than a developed embryo. Under these circumstances, breakage could have been caused by physical or environmental forces such as pedogenesis or dewatering and the subsequent compression of the sedimentary layers rather than the hatching of young.

Hatching Windows May Be in Bottoms of Broken Eggs

When a portion of the eggshell is left intact, it is most likely the geographic bottom of the shell. While this is most often taken to be a byproduct of the "hatching window" occurring in the upper portion of the shell, it is equally possible that the mud into which the egg was deposited dewatered rapidly or even paracontemporaneous cementation may have begun. Either of these might have provided preferential support to the lower section. When subsequent dewatering began from the weight of the ongoing sedimentary overburden, a disproportionately high pressure on the top of the egg which was not yet supported by a lithofied matrix would thus result in a more common crushing of the top of the egg.

In examining Figure 9 and the pattern of breakage, we see that the bottoms of all eggshells are essentially intact except for eggs 3 and 4. It is noteworthy that the one wholly intact egg (deemed infertile by some) occurs directly below eggs 3 and 4. Two conclusions can be drawn if eggs 3 and 4 broke in preference to the egg below them: 1) All eggs were laid at the same time as it is unlikely that an egg from a previous laying season would have retained greater strength to preferentially break two new eggs, and 2) If the breaks in the bottoms of eggs 3 and 4 and the lack of a break in the egg below them are not related to the hatching of young, then it is unlikely that any of the eggshell breaks are due to hatching of young.

Other Stress Conditions Causing Shell Breakage

The spherical shape of a calcareous egg shell is known for its remarkable strength and might successfully resist crushing by strong compression forces when they are distributed equally over its surface. Therefore, the original breaking of the shells may not have been caused by the dewatering of the substrate, but rather by absorption of water from the substrate.

Among extant reptiles, the crocodilian egg shell is known to be porous, allowing gases to diffuse freely between the enclosed embryo and the external environment. This is required to supply the needed oxygen for development. But along with the oxygen, a crocodilian egg also absorbs water which causes the leathery membrane to swell during the progress of normal incubation (Packard, et al., 1977, pp. 72–3). This same swelling is observed in the Chelonia (sea turtles) and Squamata (lizards) (Packard, et al., 1977, pp. 74–5). It is very pronounced in the American alligator, whose calcareous egg shells have been observed to be cracked when the nest was opened six weeks following oviposition. The same cracks were observed to be expanded two weeks later (Packard, et al., 1977, p 77). Water intake is observed to take place in a wide variety of reptile eggs for up to 14 days, whether the eggs are fertile or not. After that, such uptake continues only in fertile eggs. Intake of water appears to be directly related to osmotic pressure as the rate increases with the temperature of the egg resulting from metabolic processes or substrate changes (Packard, et al., 1977, p. 79).

Many dinosaur eggs have a gas conductance value much higher than crocodilian eggs. If alligator eggs swell to the point of cracking their calcareous shells, it is reasonable to assume that dinosaur eggs would do the same but even faster. Figure 22 shows an egg from Jabalpur, India, which Sahni, et al. (1994, p. 221) report is of similar condition to all eggs at that site. As this egg appears to be of the same type as more solid eggs found in France and Uruguay, with a diameter of 18 to 20 cm, it is likely that it has expanded 2 to 8 cm in diameter. If the membrane swelled that much, then intense fracturing of the shell would result. Where less swelling took place, less fracturing (similar to Figure 9) of the shell would result. Intense fracturing of the shell might be an indication of high water temperature in the eggs of India which are all directly associated with the Deccan Basalts.

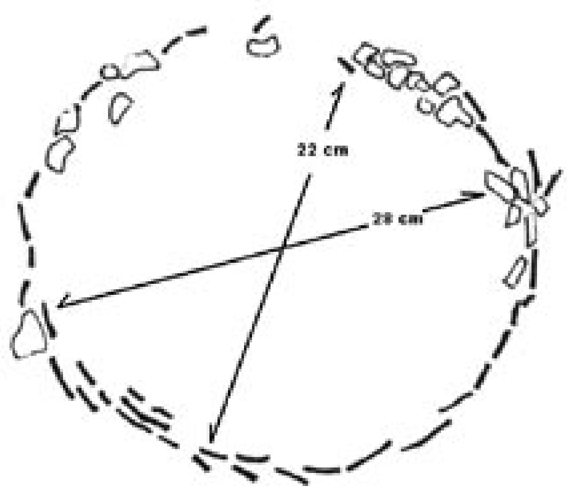

Figure 22. Titanosaurid egg, Jabalpur, India. Normally 18–20 cm diameter, *in situ* fragmentation typical of all eggs this locale. (Redrawn from drawing, Sahni, et al., 1994, p. 221, Figure 13.15).

Evidence of Stress Conditions from Scripture

The Hebrew term *mabbul* is used exclusively to refer to the Noahic Flood in Genesis, except for one use by King David in Psalm 29:10, "The Lord sitteth upon the flood." This has caused some to consider that the actions described previously in that psalm are a result of not just any flood, but the Noahic Flood. In this regard, the phrase, "He maketh the hines to calve" in verse 9 (KJV) has given translators some difficulty. (The New International Version translates it, "He twists the oaks.") The word translated "calve" carries the idea of causing it to happen out of season. In the vernacular, that would be referring to a natural abortion. A natural abortion certainly can be induced by stress. While the psalm was referring to a mammal, the occurrence of dinosaur eggs laid into wet sediments might be an example among reptiles of what this verse was citing for the mammal. The gravid female dinosaur retained the eggs in the oviducts because of the lack of a safe location to lay them. Later, in an effort to save her own life in the Flood's wave action, or as a response to the stress, she dropped them at the first contact with firm ground.

Another possibility is that some dinosaurs may have been functionally or at least partially ovoviviparous, normally retaining the eggs in the oviducts until they were partially or completely developed. At the onset of the Flood, some dinosaurs already may have contained eggs which had been developing for considerable time. If this were so, it would account for embryos of varied ages and sizes all the way up to hatchlings occurring in egg shells and associated with regions where broken shells are found. This is a matter for further research.

Concluding Comments

In discussing difficulties with dinosaur eggs and Flood models, Woodmorappe (1996, p. 285) once remarked on the validity of the premise that dinosaurs could not lay eggs under stressful conditions as "…something that we do not know and probably never will know."

By looking carefully at the eggs and their depositional environment, it is possible to determine some of the conditions under which the eggs were laid. In this article I have identified six indicators of dinosaur eggs routinely being laid under conditions of stress.

1. Eggs of the same laying episode are positioned at different levels as though they arrived on top of the sediment as it was being built up actively.
2. Eggs are positioned in the substrate as though their final positions were determined by the viscosity of wet sediments into which they were dropped.
3. Eggs are found arranged in such a way as to suggest that they were allowed to drop in the most expedient manner and then allowed to lie where they landed.
4. Eggs are found with their calcareous shells exploded by the absorption of water as though they were laid into water which was most likely hot.
5. Eggs are found with pieces of hatching windows lying inside the lower portion of the shells, usually with the concave surface upward, indicating breakage by causes other than the hatching of young and also indicating negligent treatment of the eggs when they were laid.
6. Eggs are found at multiple horizons having been laid under stressful conditions and indicating the desperate situation in which the gravid females found themselves.

Not all deposits of dinosaur eggs have been considered, but enough examples have been cited here to provide confidence that a second look will show that clutches were routinely laid under stressful conditions directly into wet sediments, which, in many cases, may have been covered with at least a shallow layer of water at the time.

Acknowledgements

I express thanks to the editorial staff and referees who helped greatly in shaping the text of this paper. A special thanks is extended to my wife for tireless hours transcribing and correcting my scribbles. Without her help this paper would never have been. Any errors are strictly my own. *Be exalted, O God, above the heavens, and thy glory over all the earth.*

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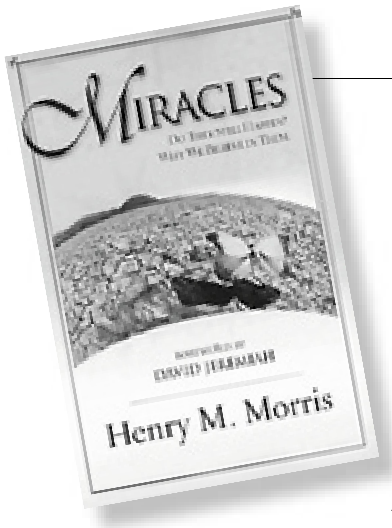

Book Review

Miracles by Henry Morris
Master Books, Green Forest, AR. 2003. 141 pages, $10.00

Dr. Morris explains that this book was motivated by a serious auto accident in which he and his wife were spared injury. Dr. Morris is skeptical of many modern miracles, but he has studied and spoken on the topic. True to his scientific engineering nature, Dr. Morris places miracles into three distinct categories. *Class* A miracles involve a temporary laying aside of either of the two most basic laws of nature, conservation of energy and the dissipation of energy. These are also called the First and Second Laws of Thermodynamics. Class A miracles are performed only by God who established the natural laws in the first place. Examples include the original creation *ex nihilo*, the dividing of the Red Sea (Exodus 14), changing water to wine (John 2), walking on water, the resurrection of Christ, and the new birth conversion experience within human hearts.

In the Morris view, *Grade B* miracles involve the providential ordering and timing of events within natural laws. They also include temporary alterations of natural rates of change. Grade B miracles include the Flood, the earthquake which freed Paul and Silas from prison (Acts 16), and also the avoiding or surviving of a serious accident. It is noticed that Grace B miracles often include the activity of angels and include specific answers to prayer. Dr. Morris suggests that evil angels may also perform B but not A miracles. Apparent A miracle activities by evil forces, as when Pharaoh's men turned wooden staffs into serpents (Exodus 7:8–13), are described as hallucinations or hypnotism (p. 92).

Dr. Morris surveyed all the biblical miracles and concludes that 38% are A category, 55% are godly B, and 7% are demonic B (p. 103). But far greater in occurrence then either A or B are *Grade C* miracles. There are the countless (but no less miraculous) answers to prayer which continue day by day in the lives of millions of believers worldwide (p. 134). The Morris miracle classification is somewhat similar to the distinct "classes" or "senses" of miracles which have been known to theologians since Augustine. A review of the traditional categories of miracles would have been helpful.

Dr. Morris expresses uncertainty in categorizing real, contemporary physical healings, whether in the A or B category. He describes modern "tongues speaking" as probably psychological and not at all miraculous (p. 53). Challenging political correctness, Dr. Morris describes the words of Islamic prophet Mohammed as demonically inspired (p. 83). This book describes many personal experiences of the Morris family. Dr. Morris has once again given his unique insights to an important topic, in this case miracles. His clear discussion will be helpful to many readers. Subject and scripture indexes are provided.

Don B. DeYoung
DBDeYoung@Grace.edu