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Dinosaur nesting ground from the Early Jurassic fluvial deposits, Holy Cross Mountains (Poland) — reply and new evidence

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In their discussion, Karol Sabath, Marcin Machalski and Jerzy Lefeld claim, that in their opinion spherical objects described in my paper (G. Pieńkowski, 1998) should not be interpreted as strongly altered "post-egg structures". They believe that they should be interpreted rather as redeposited ferruginous nodules.

With due respect, I reject a "nodule scenario" and I maintain, that my interpretation is justified. At first, let me comment on the arguments put forward by K. Sabath, M. Machalski and J. Lefeld.

THE SHAPE, SIZE, AND ARRANGEMENT OF THE STRUCTURES

To shake my interpretation, the Authors claim that "Even at first glance it is obvious that some rounded bodies on the slab were omitted from the schematic drawing." and "...the objects shown as of approximately the same size on the drawing (e.g. those labelled A–D, G. Pieńkowski, 1998, on pl. III, fig.1), actually do show pronounced size differences." The Authors included a drawing to support their opinion. The drawing shows alleged differences between the photo and my original drawing (G. Pieńkowski, 1998, pl. III, fig. 1).

However, the drawing included by my Opponents is incorrect. It is very difficult to trace an accurate drawing from a photograph without referring to the original specimen. In result, the drawing presented by the Authors ignores important fragments of the objects and includes other structures, which do not exist at all or represent obvious mud clasts (presence of the mud clasts was reported in my paper — G. Pieńkowski, 1998, fig. 4). To correct the erroneous drawing presented by the Authors, I present a correction (Fig. 1), which shows where the Authors drawing is incorrect. It is a pity, that the Authors did not refer to the original slab, which is still fully accessible. After completing of the studies, it will be included into the Institutes Museum collection. The Authors also claim, that in "another specimen", shown to them by Gerard Gierliński, they could not see any regularity in size and shape of other rounded objects. However, the slab shown to the Authors by Gerard Gierliński represents the left part of the same slab pictured in my paper! No wonder, that seeing a small surface with mud clasts and splitting surfaces, the Authors came to their conclusion that the structures should be irregular. However, one has to distinguish the peculiar structures under question from obvious mud clasts, artifacts and small nodules, which occur in the same place. To sum up, it is not truth, that the objects under question are irregular in shape and arrangement — the latter regards only the rounded, spherical objects. In the second part of this discussion, I will put forward some new evidence showing that the regularity in size, shape and arrangement is observed in more objects.

ASSOCIATION WITH SAUROPOD FOOTPRINTS

I agree that association with sauropod footprints can not be treated as a proof for the egg origin of the objects under

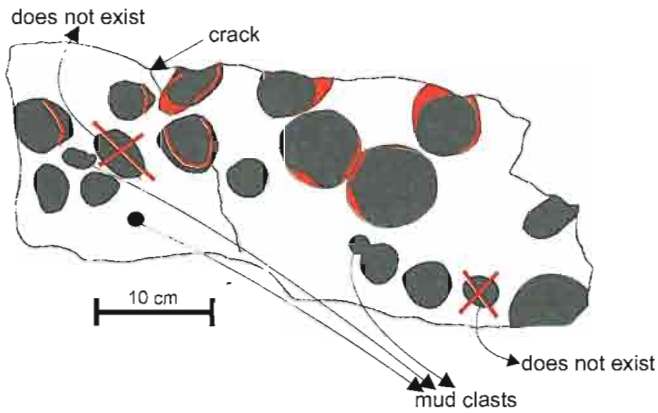

Fig. 1. Correction of the drawing presented by K. Sabath *et al.* (1999)

Red spots mark omitted side surfaces of the structures or spliced fragments of infillings; red lines cut off the exaggerated parts or shadows, two objects do not exist at all, three smallest objects represent obvious mud clasts

discussion. I mentioned the presence of sauropod footprints as a fact, which indirectly supports my interpretation.

EMBRYONIC REMAINS

I disagree that the figs. 6 and 7 from my paper (G. Pieńkowski, 1998) are "inconclusive" or "ladder-like" structures are clearly visible. Phosphorus occurs only in a trace amount, but despite the artificial Au peak its presence can be confirmed. The presence of calcium is crucial — I mentioned in my paper that calcium is totally absent from the Sołtyków outcrop and other Lower Jurassic outcrops in the Holy Cross Mountains. Its presence in such a quantity inside the fibrolamellar chalcedone structures is a phenomenon which requires explanation. In my opinion, remnants of skeletal elements provide the best explanation of this phenomenon.

EGGSHELL REMAINS

Some parallel canals perpendicular to the chips surface are obvious (G. Pieńkowski, 1998, fig. 10). Thickness of the chips can be varied indeed and conclusive evidence proving the existence of eggshell have not yet been found. Therefore, in my paper I was very cautious in interpreting the SEM pictures of the clayey-chip like plates, claiming that such a supposition is highly hypothetical.

TAPHONOMICAL INTERPRETATION

I reject the "redeposited nodules" scenario, because of the following facts:

1. Most of the structures are infilled by a detrital, muddy or sandy material. Ferruginous substance is clearly secondary to the structures, it often does not form continuous coatings, but occurs in separated "cluster nodules" covering some local centres around the structures (Pl. I, Fig. 1). Lamination preserved in the structures (Pl. I, Figs. 1, 2) points to a detrital infilling of the voids. In my paper, I discussed a "mud clasts" scenario rather than a "nodule" scenario, because parallel lamination occurring in several objects under discussion would point to the mud clasts, not nodules. Even if the parallel lamination is present in the nodules, it must be inherited from the primary sedimentary rocks. Moreover, lamination observed in at least three different structures shows the same horizontal, geopetal orientation (after rotation against the tectonical tilt). Therefore, it is impossible to interpret them as redeposited mud clasts or nodules (one should expect chaotic orientation of the primary lamination in such a case). "Nodule" scenario was also rejected because most of the structure under discussion do not show typical features of nodules (Pl. I, Fig. 1). True nodules are quite frequent in the same outcrop and I include one photograph to show their typical concentric structure (Pl. I, Fig. 3). I wrote in my paper that ferruginous concretions could have been formed subsequently inside or around some of the objects under discussion (compare R. Cousin *et al.*, 1994, p. 68, figs. 5, 13).

2. Hard, redeposited ferruginous nodules should not reveal "semi-plastic" indents occurring at the contact with a neighbouring object (Pl. I, Fig. 1).

3. Redeposition in the case of larger, spherical objects is very unlikely because of their arrangement and regularity in size.

4. Redeposited nodules should be incorporated in the "event layer", while the structures under discussion are placed between two layers (G. Pieńkowski, 1998, fig. 11). The "flood event" layer covers the structures partly "submerged" in the underlying layer.

5. Concerning the taphonomical scenario, how can we explain presence of dense burrowings only inside the structures under discussion? It is obvious, that the burrowing organisms were attracted by the organic matter.

The Authors reversed two stages in my taphonomical scenario: the detrital material filled in the interior of the eggs (through pores and cracks, perhaps with the help of the burrowing organisms) before, not after the eggshell was totally dissolved and altered. Therefore, the structures preserved their spherical shape (although deformed by compaction). There is nothing unusual, that the embryonic remnants were preserved inside the decayed and infilled egg. Concerning the preservation of the eggs, some of them described in the previous papers are preserved in the form of collapsed structures, while some maintained their original shape (J. W. Kitchling, 1979; K. Sabath, 1991; L. M. Chiappe *et al.*, 1998).

NEW EVIDENCE

Current field studies provided new evidence supporting my interpretation. After exposing a larger surface, I found

several circular or arcuate groups of similar spherical structures (Pl. I, Figs. 4, 5). Coincidence? I doubt.

CONCLUSION

The discussion of my Opponents is adamant, but unfortunately offers little besides criticism. Concerning a "red herring" category, what appers to be "in red" is not a mythical "herring" but rather the drawing presented by the Authors. Nevertheless, the present discussion gave me a chance for better articulation and enhancement of my arguments. Also, new evidence could be put forward. Therefore, I am thankful to my Opponents and I am open to the future constructive and stimulating discussion.

The studies of the structures under discussion are still in progress. I agree, that at the present stage it is difficult to provide a strong, unequivocal proof, i.e. an eggshell or well-preserved embryonic remains. I admitted that fact in my paper. But it is also obvious, that different circumstantial evidence presented in my paper could help to exclude certain interpretations (like a "redeposited nodules scenario" and other "inorganic" scenarios) and point to some other, more probable explanations. I agree, that any interpretation based on circumstantial evidence can be controversial. However, I maintain my opinion that these structures can be **interpreted** as dinosaur "post-egg structures" and nests — I stress the word "interpreted". Instead of a "redeposited nodules scenario", I would rather ponder other alternatives of organic origin of those structures, for example coprolites. However, such interpretation is less likely (regularity in sphaerical shape and arrangement, taphonomical dilemma). Concerning strict "formal requirements" of any egg identification, the specialists belonging to the trace fossils working group, who have recently gathered in Denmark, have advised that eggs should be excluded from the trace fossils category and included to the genuine body fossils, while nests should remain within the trace fossils category (A. Uchman, pers. comm.). The title of my paper is "Dinosaur nesting ground...", of course, it does not mean that any structure can be now interpreted as a "dinosaur nest".

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EXPLANATIONS OF PLATE

PLATE I

Fig. 1. Cross-section of a part of infilling of the object C (G. Pieńkowski, 1998, pl. III, fig. 2). Note laminated sediment in the lower part of the infilling (arrow l), bioturbations (arrow b) and side concavity occurring on the contact with neighbouring object B (arrows) (G. Pieńkowski, 1998, pl. III, fig. 2). Note that the structure is infilled by laminated or structureless sediment. Secondary character of ferruginous concretions, which do not form a coating around the whole structure but develop around some local centres (c) is clearly visible. Scale bars = 1 cm

Fig. 2. Upper part of infilling of the structure A (G. Pieńkowski, 1998, pl. III, fig. 2), showing parallel lamination. After rotation against the tectonic tilt, the lamination is horizontal. Similar orientation of lamination can be observed in two other structures. Scale bars = 1 cm

Fig. 3. Typical nodule from the same outcrop. Note concentric structure of the ferruginous lamina. Scale bars = 1 cm

Fig. 4. Another two clusters (II and III) of rounded objects found 20 cm apart from the cluster described in the previous paper (G. Pieńkowski, 1998). Cluster II (objects 1–6) form a semi-ring, cluster III is of an arcuate shape. Structures are approximately of the same size, object 2, 5, 6 look smaller because of intersection (objects 2 and 6 are placed deeper in the sediment, while object 5 is placed more shallow). Structures 7, 8, 9, 10 represent four of five structures forming an arcuate cluster and are placed generally somewhat deeper in the sediment. Compare with Fig. 5. Scale bars = 1 cm

Fig. 5. General view of the exposed surface with spherical structures (clusters I–IV) interpreted as dinosaur nesting ground. Location of the four objects described previously (G. Pieńkowski, 1998, pl. III, fig. 2, A–D) is dashed (part of the cluster I). Note two semi-ring and two arcuate clusters of the spherical objects. All objects are shown in vertical projection, disregarding local intersections. Compass is 10 x 10 cm. Scale bars = 1 cm

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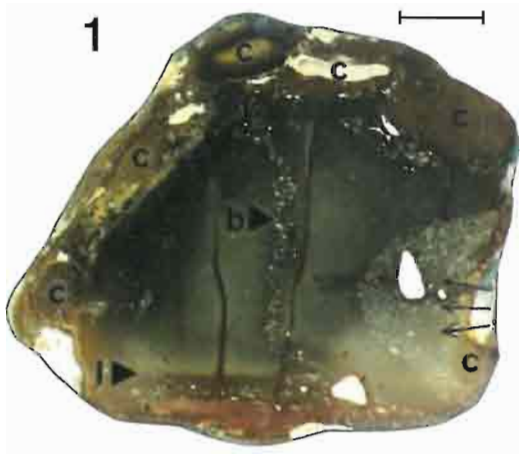

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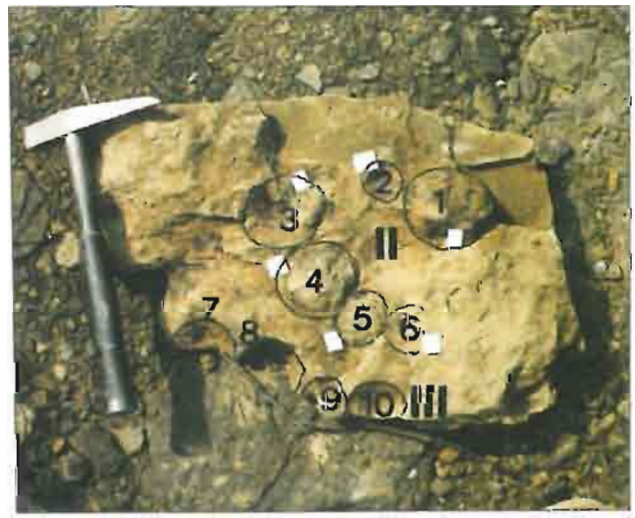

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