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Are Diatoms in Dinosaur Bones Contamination?

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Diatom fossils are prevalent in fossil sedimentary deposits, certainly from the early Cretaceous (and possibly Jurassic) together with more recent layers across Australia, Asia, Europe, Russia, North Africa, the Americas, and the Arctic poles [1-17]. There is general agreement on the Cretaceous period for their development [1, 8, 11-12, 14-16] but earliest forms are known from Jurassic [12] and possibly pre-Jurassic [1]. Some recent authors still consider their origins enigmatic [11]. They are found mostly in marine sediments but odd examples of diatoms in amber [2-3, 8], and meteorites [7, 10] are recorded. Their geometric shapes preserved in silica are stunning (even Darwin asked, "…were they only created to be admired under the microscope?" [9]. Now we know that their genome is exceedingly complex as is the morphogenesis of those legendary geometric shapes [9]. It has been estimated that only 12% of diatoms have been described and that nearly 1000 years of work at the current rate must be undertaken to describe them all [18]. Fossil diatom layers seem to coincide with deposits known for dinosaurs such as [1-3, 8, 11-12, 14,15]. Nevertheless, the scarce dinosaur fossil reports that make mention of diatoms generally discount any appearance of co-existence between the two. The reader is referred to works that offer deeper background on these compelling organisms [9, 18].

Forensics, a field that has grown immensely by employing microcopy, considers the "diatom test" (or the presence of diatoms in cadaver bones and organs) the "gold standard" of a diagnosis of death by drowning [19-32]. In recent years this has been hotly debated because of the ubiquitous nature of diatoms, both fresh and salt water (even airborne, and in toothpaste, paint, road markings, building materials, etc.), [19-20, 22-24, 26, 28-30]. Thus, in recent years a conclusion of death by drowning (and diatoms in cadavers), as an important forensic metric has become controversial due to contamination possibilities [20-21 24-25 27-29].

Lately, the study of their chemistry and the chemical relationship between diatoms and drowned cadavers has increased in the diatom literature [1, 9-10, 12-15, 18] as well as in the field of forensics [19, 21, 31]. For example, diatoms have been identified on and within bodies (and clothing) that died of natural or some other cause [25, 27-28, 31]. One study submerged porcine bones in diatom-rich water and in the Colorado river. Bone marrow from bones which had mechanically or chemically induced access points were significantly contaminated however no diatoms entered bone marrow that had not been altered.

A valuable report from 2025 has illustrated that even the glass slides microscopists use can be a source of contamination in forensics since some vendors use diatoms to clean slides before they leave production [29]. Further complicating the contamination issue, a compelling dissertation [32] reported the recovery of almost 100 diatoms from the brain, liver, lung, and bone marrow of 13 subjects who died by natural (mostly cardiac) means. The kidneys yielded several hundred diatoms from these subjects [32].

In recent years, the 'diatom test' has been applied to forensic archaeological examination of residual bone marrow. One report illustrated micro-algae recovered from mid-Holocene skeletal human remains (humerus and tibia) found at a 5000-year-old burial site in coastal Chile [24]. Results were positive for pyritised microalgae (Acritarchs) as well as marine sponge spicules. These authors further report that one diatom was recovered from a similar bone marrow study of a 400-year old skeletonized human individual [24].

The present authors have collected dinosaur long bone remains from deposits in Lusk, WY, and at Jordan and Glendive MT for 14 years. Specimens collected include *Triceratops, Nanotyrannus, Edmontosaurus* (such as a nearly complete skeleton named *Ruth* after the discoverer Ruth Terry Armitage - Figure 1) and *T. rex*. To date we have decalcified and microscopically examined decalcification debris from approximately 150 of these bones. Decal debris has revealed the presence of fungal elements (unpublished) somewhat similar to those described by other workers [33]. Other fungal elements present in our solutions are markedly different from those reported by Schweitzer, because a unique, intensely rugose intra-bone fungus appears in many thin sections of *Edmontosaurus* bone collected in MT, (paper in prep). Decal solutions from WY and MT have also contained recent nematodes (Figure 2), insect remains [34] and microbes (not shown). It is curious that we have identified diatoms in these preparations only recently, and could mean that they were not present in our samples or we simply overlooked them.

Roughly the same quantities of bones have been examined by us through ground sectioning. Distinct fusiform shapes that we interpret as recent nematodes are clearly visible within bone canals [35] and match living nematodes we have discovered (Figure 2). However we have not observed or identified diatoms or insect remains within dinosaur bone ground sections.

The large skeletonized remains of an Edmontosaurus at Glendive, MT (Figure 1) has yielded many examples of nematodes, insect wings and diatoms. Diatom frustules (Figures 3-6) from an extinct variety of the freshwater genus *Aulacoseira* were noted and identified (pers. comm. L Bahls) from an *Edmontosaurus* femur collected in Lusk, WY. Figure 7 shows a similar diatom frustule from the rib of *Nanotyrannus* collected in Jordan, MT.

Many death scenarios are postulated for the enigmatic demise of the dinosaurs, including climate change, severe competition for resources, predation, disease, and natural disasters like asteroid impacts, flooding, landslides, extreme drought and ice. Literature supporting this is found by simple Internet searches and in popular books and magazines. Most death scenarios however do not generally include death by drowning. This discovery of extinct diatom frustules in the bone marrow of two differing species of dinosaur located at burial sites separated by over 370 miles may simply be contamination, however it certainly warrants further investigation via examination of decalcification solutions for diatom frustules.

The images shown here were acquired while examining unwashed (and therefore cloudy) decal solutions. Exact identification (currently underway) requires separation of diatom frustules from such solutions. More careful work therefore is required to perform dialysis of solutions in addition to the use of certified clean glassware and high refractive index mounting medium.

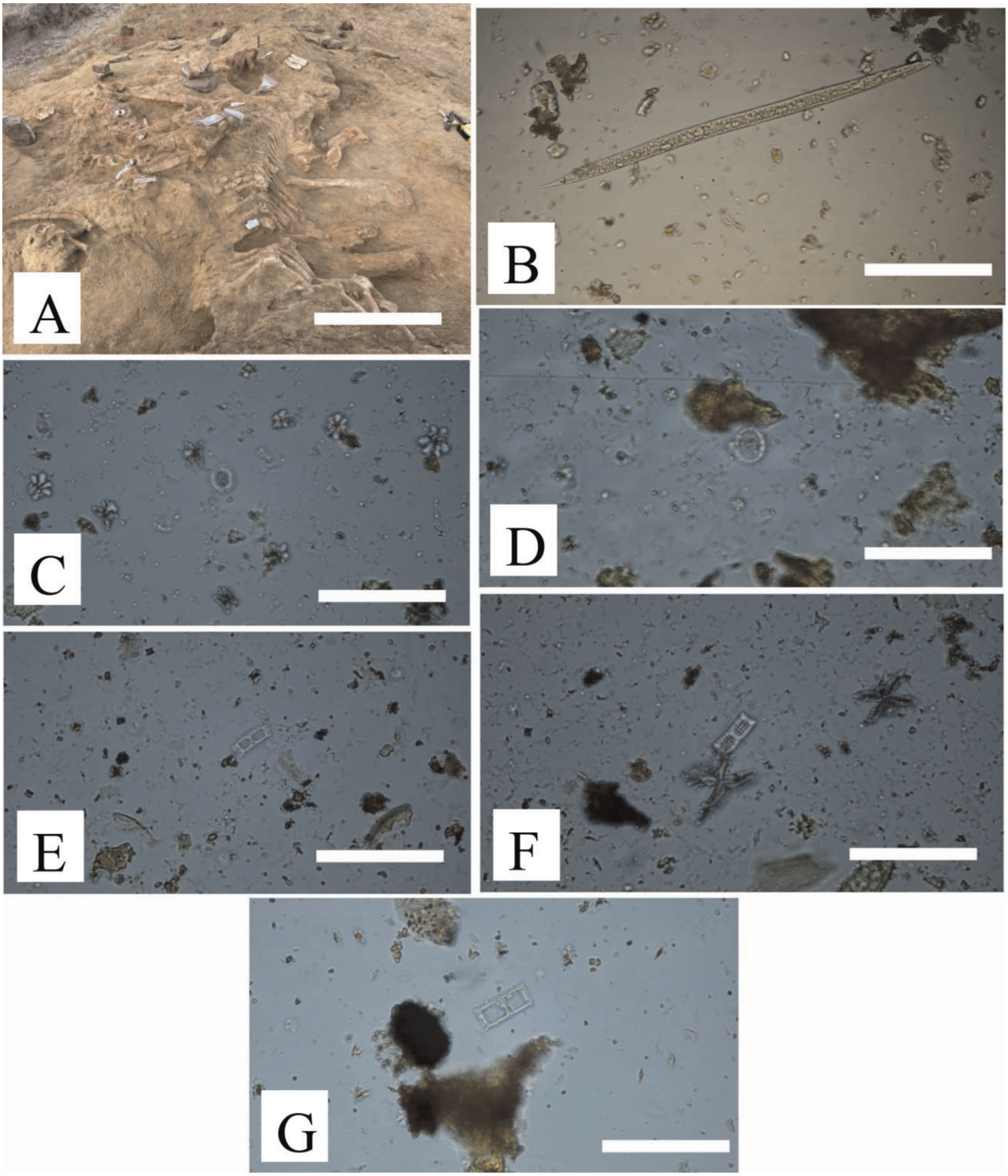

Fig. 1. (A) Uncovered skeleton, *Edmontosaurus annectens*, Glendive, MT. Scale bar = 1 meter. (B) Extant nematode worm from *E. annectens*, Lusk, WY, Scale bar= 55u. (C-F) Probable *Aulacoseira* diatom frustules, *E. annectens*, Glendive, MT; (C) Scale bar = 45u, (D) Scale bar = 45u, (E) Scale bar = 65u, (F) Scale bar = 55u; (G) Possible *Aulacoseira* diatom frustule, *Nanotyrannus*, Jordan, MT, Scale bar = 40u.

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