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Skin pathology in the Cretaceous: Evidence for probable failed predation in a dinosaur

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ABSTRACT

Examination of preserved skin from a duckbill dinosaur revealed disruption of the normal scale pattern and replacement by granulation tissue. Wrinkles radiating outward from the scar document wound contraction similar to that seen in modern injuries. This is the first unequivocal report of dinosaur tissue response to dermal pathology and evidences behavior – escape from a predator.

1. Introduction

Lingham-Soliar (2008) recognized traumatic skin damage in an ancestor of ceratopsia (horned dinosaurs), *Psittacosaurus*. He reported two concave skin indentations with radiating stress fractures, which he related to a tearing impression produced by teeth from an unknown predator or scavenger. This was apparently the first recognition of skin pathology in a dinosaur and perhaps in the paleontologic record (Rothschild and Martin, 2006; Tanke and Rothschild, 2002). He could not distinguish predation and scavenging, as there was no evidence of healing. The injured dinosaur could have been dead at the time of skin injury or may have survived, but died too soon after injury for healing to be recognized—even histologically. We report the first macroscopic evidence of skin wound healing in a dinosaur, evidence of a prior traumatic event, possibly of a predation effort.

2. Methods

The hadrosaur skin (Palm Beach Museum of Natural History PBMNH.P.06.016.T) examined in this paper was found in association with a large adult duckbill dinosaur (*Edmontosaurus annectens*) skull, in Harding County, South Dakota (DePalma, 2010). The specimens were excavated from medium- to coarse-grained crevasse-splay deposits in the Upper Hell Creek Formation (Late Maastrichtian, 67.6–65.5 million years before present) (Hicks et al., 2002). The skin was discovered in juxtaposition to the skull, which bears examples of healed bone following trauma from a predator attack (Fig. 1A and B). The spacing of large tooth drags on the skull bones is consistent with a very large tyrannosaurid, probably *Tyrannosaurus rex*.

3. Results

The patch of preserved skin measures approximately 12.25 cm by 14 cm, and consists of numerous small, polygonal, non-overlapping tubercles (Fig. 1C). The tubercles range in size from 2 to 6 mm, and are of similar morphology to those described for other *Edmontosaurus* specimens (Fig. 2). The normal scale pattern was focally disrupted, where the skin had been punctured/lacerated and replaced by granulation tissue. The oblong scar measures 1.3 cm by 3.5 cm. A series of wrinkles radiating outward from the scar are similar to those that can emerge following final contraction of wounds in modern dermal injuries (Fig. 3). Tubercles are remarkably smaller and arranged in a chaotic pattern around the periphery of the scar, a common characteristic observed in healed modern reptilian skin (Fig. 3A).

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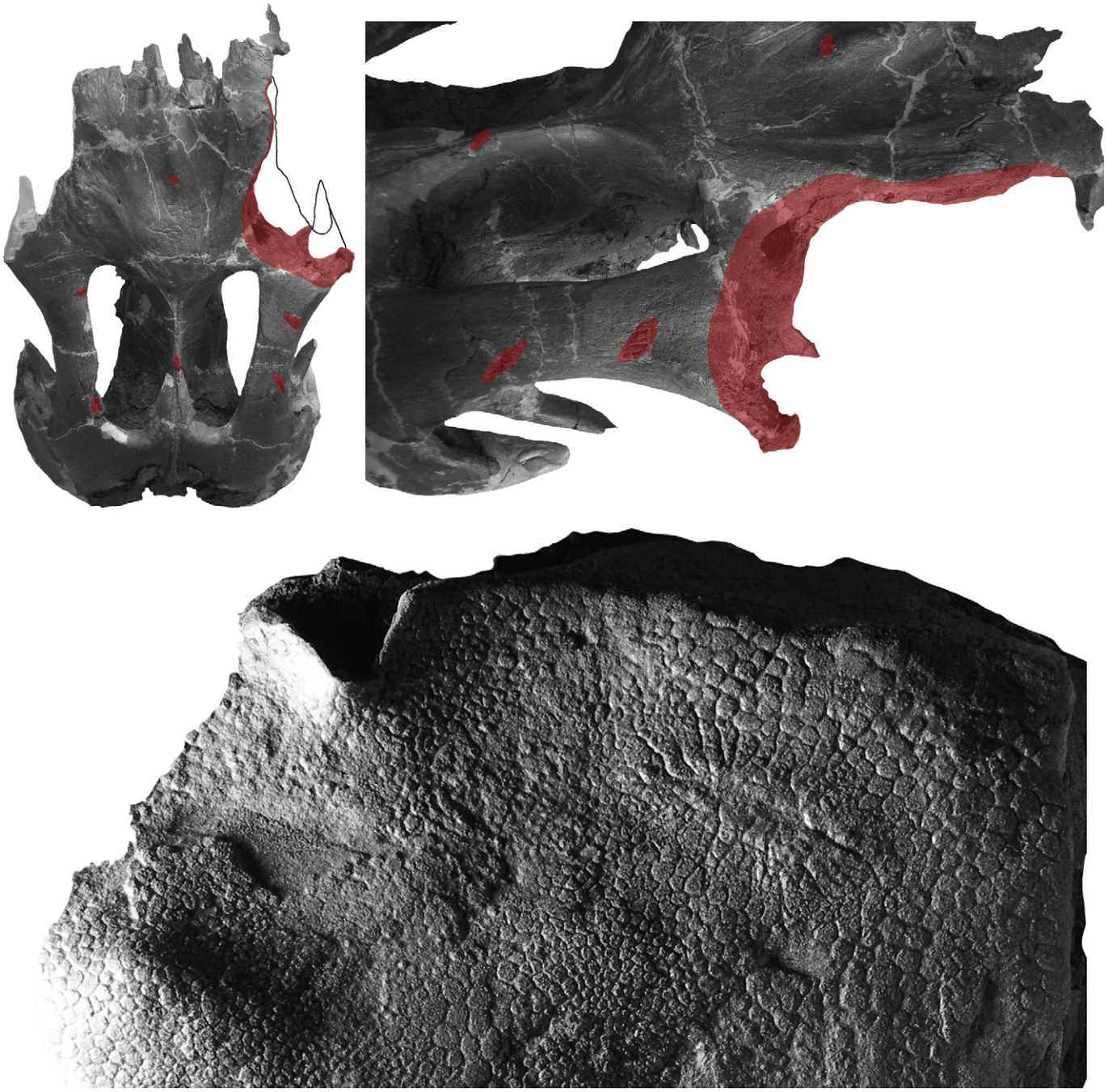

Fig. 1. A, dorsal view of an *Edmontosaurus* braincase, showing extensive healed trauma from a predator attack. Red highlights indicate affected areas, and bold black line indicates the normal skull outline for the right side. B, the same braincase in dorsolateral oblique view, with arrows pointing to individual healed tooth drag marks. At the tip of the center arrow is a ~3 cm diameter abscess. C, a patch of fossil skin from the same animal, showing a ~3.5 cm oblong area of healed dermal trauma. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

4. Discussion

Studies on mammals have been the major source of information on wound healing. Once the external body layer (skin) is compromised, wound healing is initiated in a series of sequential, but overlapping phases. Platelets migrate to the wound to establish hemostasis. Bacteria and debris are phagocytized in the inflammatory phase, which sets the stage for granulation tissue formation. This phase, which reaches peak in 1–2 weeks in mammals and which is slowed by wound edge movement, allows recovering of the wound (epithelialization, which takes between 17 and 30 days in humans) and subsequent wound contraction (which lasts several weeks), restoring skin strength (Nguyen et al., 2009; Stadelmann et al., 1998). The last maturation phase may last as long as a year (Mercandetti and Cohen, 2008).

Reptilian skin wounds heal in a manner similar to that observed in mammals, but more slowly, with wound cohesiveness restored only at 4–6 weeks (Ballard and Cheek, 2003; Bennett, 1089a,b; Frye, 1981; Mitchell and Diaz-Figueroa, 2004; Smith and Barker, 1988; Smith et al., 1988). Cohesiveness implies that the freely movable edges of the wound are now immobile, as occurs in the inflammatory phase of wound healing. Lizards have minimal scab