**Arbour Summary: ‘A new ankylosaurine dinosaur from the Judith River Formation of Montana, USA […]’**

Recent palaeontological discoveries have made great strides in elucidating the anatomical structures of the ankylosaurine dinosaur. ROM 75860, the most well-preserved ankylosaurid specimen recovered to date, was recently discovered from the Coal Ridge Member of the Judith River Formation featuring an exceptionally complete skeleton, skull, and tail club [x]. This discovery led to a new genus and species of ankylosaurine dinosaur, *Zuul crurivstator.* Due to the remarkable integument preservation of the specimen, with a conserved outer layer featuring *in situ* osteoderms, skin impressions, and dark films hypothesized to represent preserved keratin, *Z. crurivastator* is an ideal example to represent ankylosaurine anatomy more broadly [1].

The recovered tail club features the entire tail, including the knob, made of a cluster of enlarged, modified osteoderms, and the handle, made of interlocking distal caudal vertebrae. These vertebrae interlock tightly with one another, forming a rigid and inflexible structure [1]. Long, ossified tendon bundles were discovered along the lateral regions of the handle, eight stacked together on either side, passing through the terminal handle vertebrae to the medial surface of the osteoderms found at the knob [1]. Notably, these tendons are closely appressed to the handle vertebrae and do not spread laterally, while the opposite is true for the anterior part of the club. Blows (2001) hypothesized that the presence of tendons splayed laterally in the caudal (anterior) region of the tail may have been an adaptation for increased lateral tail swinging [2] - therefore, it is possible that while the tail anterior primarily contributes to lateral tail movement, the tail handle plays a more prominent role in vertical movement. A feature of the tail handle unique to ROM 75860 was the five pairs of *in situ-*preserved osteoderms running along its length, the first such occurrence found in a North American ankylosaurine. However, this is largely attributed to taphonomic causes resulting in fossilization decay rather than morphological gain or loss as a result of evolution [1].

These large, triangular osteoderms were found covered in a shiny black material, hypothesized to indicate the original keratinous sheath. Though defined as a soft tissue, keratinous materials are among the toughest biological substrates. Constituting epidermal appendages such as hair, nails, claws, beaks, body armour, and horns, keratin possesses both high toughness and high modulus [3] Keratinous materials report high durability, toughness, and chemical inertness to their environment due to their high concentration of cysteine, allowing for the formation of disulfide bridges which enhance tissue strength [4].

Meanwhile, the tail club knob is defined by two major osteoderms, enveloping the terminal caudal vertebrae laterally, ventrally, and dorsally, while the posterior tip is enclosed by a variable number of smaller osteoderms [1]. This structure is well-preserved across ankylosaurs. While knob sizes vary depending on the specimen, ROM 75860 returns a maximum width of 368 mm, length of 525 mm, and height of 80 mm, allowing for the major osteoderms to contribute to the vast majority of knob mass [1]. While the caudal osteoderms return a lightly pitted texture, the knob osteoderms are spongy, pitted, and highly rugose [1]. Despite the similarities of overall tail knob structure across ankylosaurins, there are proportional differences: while the *Dyoplosaurus* has a narrow, elongated knob, *Euoplocephalus* and *Scolosaurus* have approximately circular knobs, and *Zuul* possesses a relatively flattened knob [5]. Such morphological variation may have taxonomic and phylogenetic significance, related to the various functions evolutionary processes and genetics.

References

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