earlier than thought previously. Numerous dinosaur specimens have been collected from the area historically, which have usually been identified as massospondylids (Cooper, 1981; Rogers et al., 2004) and we recovered similar material as well as a much larger, more robust sauropodomorph and potential theropod specimens.

Taken together, these results highlight the potential for new palaeontological discoveries in Zimbabwe, which will ultimately provide additional data for understanding the dynamics of the Triassic/Jurassic transition.

References

Barrett, P. M., Sciscio, L., Viglietti, P. A., Broderick, T. J., Suarez, C. A., Sharman, G. R., Jones, A. S., Munyikwa, D., Edwards, S. F., Chapelle, K. E., & Dollman, K. N. (2020). The age of the Tashinga Formation (Karoo Supergroup) in the Mid-Zambezi Basin, Zimbabwe and the first phytosaur from mainland sub-Saharan Africa. *Gondwana Research, 81*, 445-460.

Bond, G., & Falcon, R. (1973). The palaeontology of Rhodesia, with a section on the palynology of the Middle Zambezi Valley. *Rhodesia Geological Survey Bulletin, 70*, 1-121.

Cooper, M. R. (1981). The prosauropod dinosaur *Massospondylus carinatus* Owen from Zimbabwe: its biology, mode of life and phylogenetic significance. *Occasional Papers of the National Museums and Monuments Rhodesia, 6*(10), 690-840.

Griffin, C.T., Wynd, B. M., Munyikwa, D., Broderick, T. J., Zondo, M., Tolan, S., Langer, M. C., Nesbitt, S. J., & Taruvinga, H. R. (2022). Africa's oldest dinosaurs reveal early suppression of dinosaur distribution. *Nature, 609*, 313-319.

Rogers, R. R., Rogers, K. C., Munyikwa, D., Terry, R. C., & Singer, B. S. (2004). Sedimentology and taphonomy of the upper Karoo-equivalent Mpandi Formation in the Tuli Basin of Zimbabwe, with a new $^{40}Ar/^{39}Ar$ age for the Tuli basalts. *Journal of African Earth Sciences, 40* (3-4), 147-161.

Sciscio, L., Viglietti, P. A., Barrett, P. M., Broderick, T. J., Munyikwa, D., Chapelle, K. E., Dollman, K. N., Edwards, S. F., Zondo, M. & Choiniere, J. N. (2021). Sedimentology and palaeontology of the Upper Karoo Group in the Mid-Zambezi Basin, Zimbabwe: new localities and their implications for interbasinal correlation. *Geological Magazine, 158*(6), 1035-1058.

Viglietti, P. A., Barrett, P. M., Broderick, T. J., Munyikwa, D., MacNiven, R., Broderick, L., Chapelle, K., Glynn, D., Edwards, S., Zondo, M., & Broderick, P. (2018). Stratigraphy of the *Vulcanodon* type locality and its implications for regional correlations within the Karoo Supergroup. *Journal of African Earth Sciences, 137*, 149-156.

Technical Session 3: Terrestrial Ecosystems – Early Cretaceous (Saturday, June 10, 2023, 9:15 AM)

A SURVEY OF PALEOPATHOLOGIES IN THE EARLY CRETACEOUS THERIZINOSAURIAN *FALCARIUS UTAHENSIS* FROM CRYSTAL GEYSER QUARRY UTAH

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Paleopathological research provides information on the evolution and epidemiology of disease generally, and can be used to shed light on the behavior of extinct organisms and their state of health or disease at the time of death. Paleopathological survey of mass-death events are especially useful in that they capture a broad snapshot of a species health (including common injuries) in a single time and place, in contrast to attritional assemblages. Such data can be used to understand the frequency, skeletal distribution, and age-distribution of trauma and disease at the population level, a scale that is difficult to study.

One such sample is that of the early-diverging, therizinosaurian dinosaur, *Falcarius utahensis*, recovered from a paucispecific bonebed in the Lower Cretaceous Cedar Mountain Formation of eastern Utah (Kirkland et al., 2005). This bonebed is comprised of hundreds of individuals from hatchlings to subadults hypothesized to have perished in one or two catastrophic events (Suarez, C. et al., 2007; Suarez, M. et al., 2007). Although taphonomic studies have yielded important information on the depositional history of the quarry itself, the cause of this mass mortality event has remained unresolved for over two decades. Here we add new data to the study of the Crystal Geyser Quarry (CGQ) mass death assemblage, and the behavior of *Falcarius utahensis* by surveying the assemblage for evidence of paleopathology.

Osteopathologies (abnormalities in the bone) are observed in a right metatarsal II, left humerus, right tibia, and left tibia of *Falcarius* individuals. The metatarsal and humerus were collected approximately 52 meters apart, and the tibiae vary in size, making it unlikely that any of these elements are from the same individual. Interpretation of bone pathologies are based on macroscopic and histologic analysis, and computed tomography (CT) of

Table 1. Paleopathological survey of therizinosaur, theropod and hadrosaurid dinosaurs

Taxon	No. of elements examined	No. of pathological elements	Pathologic element(s)	Suspected pathological cause	Reference
Falcarius utahensis	521	4	Right metatarsal II Left humerus Right tibia Left tibia	Healing fracture Osteomyelitis, infectious Reactive bone deposition Reactive bone deposition	This study
Albertosaurus sarcophagus	190	6	1 Left dentary 2 Ribs 3 Pedal phalanges 1 Gastralia	Bite wounds Healing fractures Enthesiophytes Healing fractures	Bell, 2010
Edmontosaurus sp.	>6000	13	Most caudal vertebrae 1 Left tibia 2 Pedal phalanges	Osteochondrosis Healing fractures	Gangloff & Fiorillo, 2010
Mapusaurus rosea	176	5	1 Cervical vertebra 2 Ribs 1 Pedal phalanx 1 Ilium	Infectious Healing fracture +/- infectious Infectious Unknown	Bell & Coria, 2013
Edmontosaurus annectens	1806	45	Most caudal vertebrae Ribs Pubic blade Presumed Tibia Manual ungual Pedal ungual	Healing fractures Osteochondrosis Unknown	Ullmann et al., 2017
Edmontosaurus annectens	3013	55	44 Caudal vertebrae 3 Dorsal vertebrae 4 Chevrons 2 Ribs 2 Manual phalanges	Healing fractures General bone remodeling Hypertrophic ossification Tooth traces Unknown	Siviero et al., 2020
Lambeosaurine	350	1	Partial ilium	Langerhans cell histiocytosis	Holland et al., 2021

the fossilized lesions, coupled with comparative pattern recognition analysis of histomorphologic and radiographic features in vertebrate pathologic processes.

Macroscopically, both right metatarsal II and left humerus exhibit irregular, nearly circumferential bulbous expansion in the mid-diaphyseal region. Similar irregular bulbous expansion is observed on the distal end of the left tibia in the region between the medial and lateral condyles. The right tibia exhibits a focal region of periosteal reactive bone growth on the caudal aspect of the diaphysis approximately 86 mm from the distal end.

Histologic examination of the right metatarsal II reveals two healing fractures stabilized by a chronic callus; however, one region of the callus is disrupted by a large fragment of necrotic bone (sequestrum). Large sequestra are documented to complicate fractures and delay healing by causing instability at the fracture ends, thereby inhibiting the normal development of a callus (Craig et al., 2016). The histomorphologic features in this metatarsal II provide evidence that this was a complicated fracture in the pes of a subadult individual with delayed healing. Histologic examination of the left humerus reveals lesions most consistent with chronic osteomyelitis with microabscess formation, cortical bone destruction/death, and both subperiosteal and endosteal reactive bone formation. The pattern and distribution of these lesions strongly suggest an infectious cause. Histologic features of the right tibia are characterized by a focally extensive region of periosteal reactive new woven bone formation oriented perpendicularly to the cortex. Within this same region, there is disruption and loss of the endosteal compact lamellar bone and replacement by similar reactive woven bone deposition. Although this element is distorted taphonomically, an increased diameter of the

medullary cavity and circumferentially decreased thickness of the cortex is evident on both macroscopic and histologic examination. The exact cause of this lesion is currently unknown. Reactive new woven bone formation is considered a generalized response of the bone, and can be seen associated with several different types of disease processes and trauma (Craig et al., 2016). Lastly, the pathology observed in the left tibia is characterized by irregular bulbous expansion of the distal end in the middle region between the medial and lateral condyles that macroscopically resembles abundant intramedullary reactive bone deposition. Evaluation of these latter two lesions via additional histology and CT scanning is necessary to further identify pathologic features.

North Carolina Museum of Natural Sciences crews have logged approximately 1,795 specimens (including some sauropod elements) from the CGQ since 2012, and of those *Falcarius* specimens collected, approximately 521 elements have been prepped, and 325 cataloged with a total of 26 metatarsals, 15 humeri and eight tibiae identified. Of these, only four elements show evidence of osteopathology. Therefore, the frequency of pathology in the assemblage is low (<1% of elements). It is also markedly unevenly distributed. To date, no osteopathologies are observed on the axial skeleton or phalanges; all are localized to the appendicular skeleton. Moreover, the frequency of osteopathology in *Falcarius* tibia is highest (25% in our sample), with 75% of the pathologies observed localized to the hind limb. This is in contrast to results observed in other paleopathological bonebed surveys of theropod and hadrosaur species that report a greater percentage of pathology in the axial skeleton with the caudal vertebrae and ribs being overrepresented (Table 1). Additionally, nearly all of these studies report pathologies in the phalanges.

Further research is required to evaluate the prevalence of additional osteopathologies, and if these pathologies have any correlation with the mass mortality event(s). This data will ultimately help us piece together key components in the paleobiology of this enigmatic dinosaur, and may also reveal potential mechanisms of mortality that may have resulted in such a unique mass death assemblage.

References

Bell, P. R. (2010). Palaeopathological changes in a population of *Albertosaurus sarcophagus* from the Upper Cretaceous Horseshoe Canyon Formation of Alberta, Canada. *Canadian Journal of Earth Sciences, 47*, 1263-1268.

Bell, P. R., & Coria, R. A. (2013). Palaeopathological survey of a population of *Mapusaurus* (Theropoda: Carcharodontosauridae) from the Late Cretaceous Huincul Formation, Argentina. *PloS One, 8*, e63409.

Craig, L. E, Dittmer, K. E., & Thompson, K. G. (2016). Bones and Joints. In M. G. Maxie (Ed.), *Jubb, Kennedy, and Palmer's pathology of domestic animals* (pp. 16-163). Elsevier.

Gangloff, R. A, & Fiorillo, A. R. (2010). Taphonomy and paleoecology of a bonebed from the Prince Creek Formation, North Slope, Alaska. *Palaios, 25*, 299-317.

Holland, B., Bell, P. R., Fanti, F., Hamilton, S. M., Larson, D. W., Sissons, R., Sullivan, C., Vavrek, M. J., Wang, Y., & Campione, N. E. (2021). Taphonomy and taxonomy of a juvenile lambeosaurine (Ornithischia: Hadrosauridae) bonebed from the late Campanian Wapiti Formation of northwestern Alberta, Canada. *PeerJ, 9*, e11290.

Kirkland, J. I, Zanno. L. E., Sampson, S. D., Clark, J. M., & DeBlieux, D. D. (2005). A primitive therizinosauroid dinosaur from the Early Cretaceous of Utah. *Nature, 435*, 84-87.

Siviero, B. C., Rega, E., Hayes, W. K., Cooper, A. M., Brand, L. R., & Chadwick, A. V. (2020). Skeletal trauma with implications for intratail mobility in *Edmontosaurus annectens* from a monodominant bonebed, Lance Formation (Maastrichtian), Wyoming USA. *Palaios, 35*, 201-214.

Suarez, C. A., Suarez, M. B., Terry D. O., & Grandstaff, D. E. (2007). Rare earth element geochemistry and taphonomy of the Early Cretaceous Crystal Geyser Dinosaur Quarry, east-central Utah. *Palaios, 22*, 500-512.

Suarez, M. B., Suarez, C. A., Kirkland, J. I., González, L. A., Grandstaff, D. E., & Terry, D. O. (2007). Sedimentology, stratigraphy, and depositional environment of the Crystal Geyser Dinosaur Quarry, east-central Utah. *Palaios, 22*, 513-527.

Ullmann, P. V., Shaw, A., Nellermoe, R., & Lacovara, K. J. (2017). Taphonomy of the Standing Rock Hadrosaur Site, Corson County, South Dakota. *Palaios, 32*, 779-796.

Poster Session 2 associated with the Theme Session: Global Perspectives on Mesozoic Lacustrine Ecosystems (Thursday, June 8, 2023)

FISH DIVERSITY AND LAKE BASIN TYPE FROM TRIASSIC RIFT BASINS OF ARGENTINA

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