Metastatic cancer in the Jurassic

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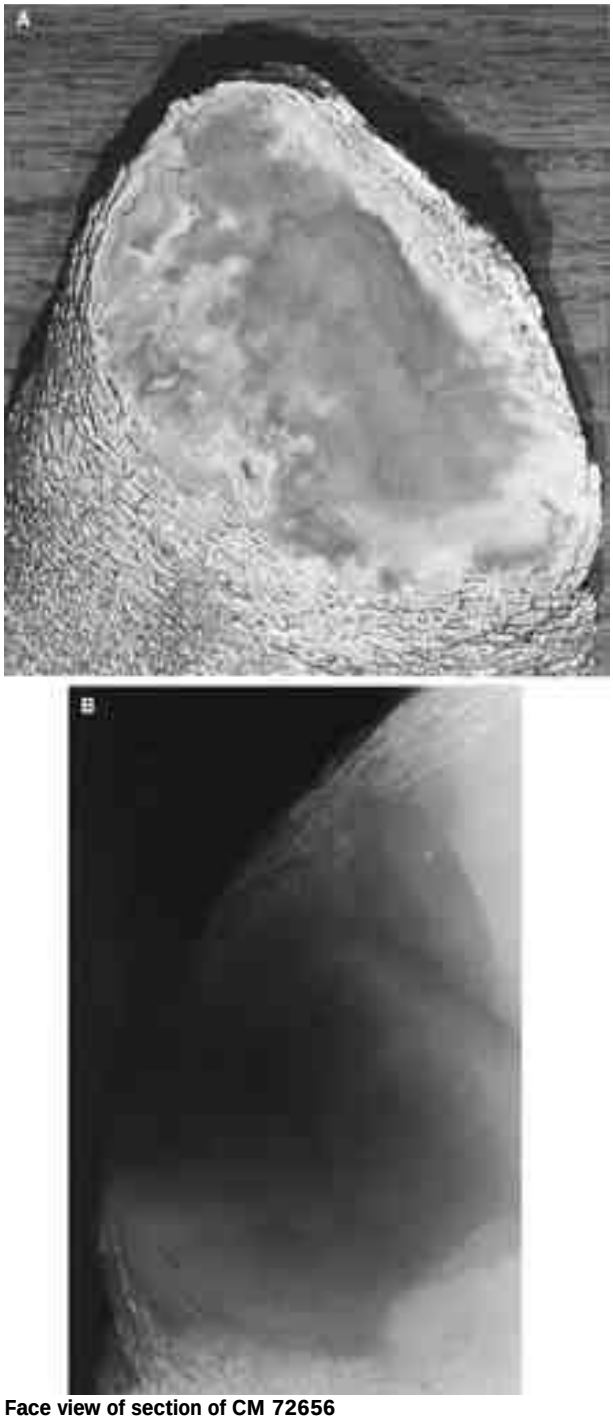
Recognition of cancer in extreme antiquity has been limited to osteomas in mosasaurs and haemangiomas and growths of unclear origin in dinosaurs. We describe a metastatic cancer in a dinosaur.

Recognition of cancer in extreme antiquity (Mesozonic vertebrates) has been limited to osteomas in mosasaurs and haemangiomas and growths of unclear origin in dinosaurs.[1,2] Metastatic cancer has only occasionally been recognised in ancient human remains, and only documented in the very recent palaeontological record.[1]



Face view of section of CM 72656
A: There is a large agate filling within a lytic zone.
B: Radiograph shows cortical bone invasion with residual cortical shell.

CM 72656 is a section of dinosaur bone from the Upper Jurassic Morrison Formation collected at an unspecified locality in western Colorado. It was provided by Raymond G Bunge of the University of Iowa, who originally suspected an osteosarcoma. The specimen consists of a sawed section that measures 16·5×13×2–4 cm. The fragmentary nature of the bone precludes species identification. The specimen has characteristic dinosaur bone structure (dense Haversian bone) and only dinosaurs had bones of sufficient size to have left this fragment in the Morrison Formation. The perminerlised bone contains an ovoid agate filling, occupying an 11·5×7·5 cm hole in the bone (figure). The appearance is that of a lytic zone that seems to have resulted from an expansile mass. Such a phenomenon characterises lesions that originally contained a mass of soft tissue or other non-osseous material, and thus results from a space-occupying process.[1,3] The lytic lesion is slightly ellipsoid in shape, penetrated by irregular, minimally remodelled trabeculae. Surrounding cortical bone is invaded leaving only a thin residual cortical shell at the outermost margins. There is a zone of transition between normal bone and the tumorous space, characterised by a pattern of bone destruction, which ranges in thickness from 2 cm to 1 mm. The appearance of CM 72656 resembles that of metastatic cancer.[1,3,4] A widened zone of transition, irregular trabeculae, and a residual cortical shell are characteristic of metastatic cancer.[3,4] BYU 5099, an *Allosaurus* humerus, which was reported as having cancer, has been examined. There is no evidence of the type of bone destruction expected with cancer.[1,3,4] The pathology was actually a healed fracture that was infected.

The pathology in CM 72656 is easily distinguished from the lesions of myeloma, which have a "punched out" appearance.[1,3,5] Preservation of a residual cortical shell also helps to distinguish metastatic cancer from multiple myeloma. The lesion is distinguished from superficial solitary and coalescing (1–3 mm) pits of leukaemia; sclerotic-rimmed lesions of gout; zones of resorption characteristic of tuberculosis; "fronts of resorption" of fungal granulomas; sclerotic features of gummatous lesions of treponemal disease; the expansile, soap bubble appearance of aneurysmal bone cysts; sharply defined unicameral bone cysts; enchondromas; osteoblastomas and chondromyoxoid fibromas; the radiolucent nidus of osteoid osteoma; the epiphyseal "popcorn" calcifications characteristic of chrondroblastomas; the "ground glass" appearance of fibrous dysplasia, the onion-skin periosteal reaction and ill-defined margins of Ewing sarcoma and osteosarcoma; and the space-occupying-mass appearance of eosinophilic granuloma.[1,3] This observation extends recognition of metastatic cancer origins to at least the mid-Mesozoic, and is the oldest known example from the fossil record.

1 Rothschild B, Martin L. Paleopathology: disease in the fossil record. London: CRC Press, 1993.
2 Rothschild BM, Tanke D, Hershkovitz I, Schultz M. Mesozoic neoplasia: origins of haemangioma in the Jurassic age. *Lancet* 1998; **351:** 1862.
3 Resnick D, Niwayama G. Diagnosis of bone and joint disorders. Philadelphia: Saunders, 1988.
4 Rothschild BM, Rothschild C. Comparison of radiologic and gross examination for detection of cancer in defleshed skeletons. *Am J Phys Anthropol* 1995; **96:** 357–63.
5 Rothschild BM, Hershkovitz I, Dutour O. Clues potentially distinguishing lytic lesions of multiple myeloma from those of metastatic carcinoma. *Am J Phys Anthropol* 1998; **105:** 241–50.

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