A preserved distal articular cartilage capsule at a humerus of the sauropod dinosaur *Cetiosauriscus greppini* and its taphonomical and palaeobiological implications

Oliver WINGS[1], Daniela SCHWARZ[2] & Christian A. MEYER[2]

[1] *Institut für Geowissenschaften, Universität Tübingen, Sigwartstrasse 10, D-72076 Tübingen, Germany, e-mail: oliver.wings@web.de*; [2] *Naturhistorisches Museum Basel, Augustinergasse 2, CH-4001 Basel, Switzerland, e-mail: Daniela.Schwarz@bs.ch, Christian.Meyer@bs.ch*

Re-examination of the holotype of the sauropod dinosaur *Cetiosauriscus greppini* Huene, 1922 (Reuchenette Formation; Kimmeridgian, Late Jurassic) from northwestern Switzerland has revealed a well-preserved cartilage capsule at the distal extremity of the right humerus (Naturhistorisches Museum Basel MH 260). The studied forelimb belongs to an adult individual of approximately 10 m body length. The cartilage tissue was studied macroscopically and microscopically. For a histological study, a core of cartilage and bone material was extracted from the cranial face of the distal extremity of the humerus, processed into a standard petrographic thin section, and examined with light microscopy and SEM-EDX.

The capsule represents hyaline cartilage together with fibrocartilage and can be distinguished by colour, surface structure, and histology from the periosteum of the bone. It is plausible that the preserved cartilage represents the growth zone of the bone with only the underlying layer of mineralized cartilage being fossilized. This is the first evidence for fossil articular cartilage in a sauropodomorph dinosaur. Hitherto, mineralized cartilage in sauropods was only known from sternal or distal rib elements. None of the other limb bones shows similar cartilage preservation, although it its most likely that all limb bones in sauropods were covered by articular cartilage at their epiphyses.

The taphonomical reasons leading to the cartilage preservation are puzzling. The bones of *C. greppini* are strongly compressed and fractured, but the surrounding sediment with rhizoliths indicates very limited transport. *In vivo* mineralization of the cartilage surely enhanced its preservation potential. The missing cartilage on other bones of *C. greppini* may be explained by different diagenetical conditions, pathologic mineralization at this bone caused by a metabolic disease, or an accidental removal of preserved cartilage during the original preparation.

The position of the cartilage around the distal limb surface allows its interpretation as a remnant of the articular cartilage of the distal humerus. In life, this cartilage would most probably have been in contact with similar articular cartilage of the ulna and radius. The reconstructed articular cartilage capsule extends approximately from one sixth to one third of the distal side of the humerus, and suggests that sauropod dinosaurs possessed large articular limb capsules.

The reconstructed articular cartilage capsule covers all insertion scars (e.g. medial and lateral ridge, olecranon fossa, ent- and ectepicondylus) present at the distal humerus. Limb muscles must have inserted at the distal humerus tendinously or aponeurotically. If the mineralization of the hyaline cartilage and tendon fibres is not pathologic, it might have been an adaptative mechanism in response to mechanical forces acting on this joint.

The present humerus verifies the assumption that limb lengths of sauropods must have been larger than apparent from the bones alone. Although the distal cartilage capsule is not completely preserved, we estimate an overall cartilage thickness of at least 3-5 cm between humerus and antebrachium. Comparisons with extant archosaurs imply that the humerus length of *C. greppini* was 6 to 10% larger than previously thought. It is plausible that the height to shoulder, and possibly hip, of all sauropod dinosaurs has been hitherto under-estimated, making these largest of land animals even larger.