ferrets, suggesting that occlusion of the blade-like carnassial coupled with a hinged TMJ may limit variation in jaw movements in response to different foods. This project was supported by National Science Foundation (USA) grants DIB-0922988 and IOS-1456810.

Untangling the Effects of Internal and External Abrasives on Dental Microwear
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In dental wear research, there is an ongoing debate which ingesta are responsible for observed wear patterns. Internal amorphous silica bodies (phytoliths) in plant tissue are softer than enamel, but have been shown to act as abrasives. External silicate particles, such as dust and grit, are harder than enamel and thus wear teeth. Plant forages often comprise both, internal and external abrasives. It remains unclear which of the two abrasives predominantly causes tooth wear, and whether their respective influence can be identified. To address this question, we performed controlled feeding experiments with guinea pigs (in groups of 6) which either received a natural (plant) feed free of external abrasives in fresh and dried state, or a pelleted feed with addition of different external abrasives (volcanic ash, quartz sand, loess, kaolin). We chose plant forages with increasing phytolith content (lucerne, grass, bamboo: 0.4-3.2%) and mineral abrasives (1-8%) with different mean particle sizes (4-166 μm) and geometry (rounded vs angular). As a measure of tooth wear we are using dental microwear texture analysis employing 46 ISO, SSFA and other surface texture parameters. In the natural diet groups, enamel surface roughness increases with phytolith content, but for grass also depends on hydration state. Fresh grass leads to surface textures with low roughness similar to those of lucerne groups, while dry grass is significantly more abrasive. In the external abrasive groups, surface roughness is found to increase with particle size. Surface complexity is not significantly affected by particle size, but by particle geometry. Angular volcanic ash (96 μm) results in higher complexity as compared to natural feeds, while rounded quartz fine sand (166 μm) results in higher roughness values. This is the first direct evidence of wear parameters quantifying textures caused by coarse-grained external abrasives, thus untangling their effects from internal abrasives.

3D-Visualizations of the Hearing Apparatus in Teleost Fish
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A number of teleost fish exhibit a special connection between swim bladder and the statoacoustic organ (i.e., labyrinth) enabling an excellent hearing capacity. Since the 19th century, various anatomical details of hearing organs have been described, e.g., in clupeids and especially the Weberian apparatus in Otophysi. Corresponding schematic drawings have been circulated among the scientific literature ever since. However, clear 3D-visualizations of this immensely important organ system are still rare. Here, we present 3D-visualizations of the hearing apparatus in three species: Atlantic herring (Clupea harengus), common minnow (Phoxinus phoxinus) and stone loach (Barbatula barbatula) based on X-Ray tomography. This will be complemented by data on the Northern pike (Esox lucius) as representative of the great majority of fish not possessing such structural connection of swim bladder and labyrinth.

Bone Without Minerals in Atlantic Salmon (Salmosalar): Growth, Function and Retention of the Capacity to Mineralize
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Calcium and phosphorus are the main bone minerals. Tetrapods depend on dietary calcium for the mineralization of their skeleton. Calcium intake via the gills makes teleosts independent from intestinal calcium uptake, but dietary phosphorus is required for bone mineralization (Witten & Huyseanne, 2009, Biol. Rev. 84: 315-346). We fed Atlantic salmon a diet with a low phosphorus content for 7 or 16 weeks. These fish developed bone completely devoid of minerals (Witten et al., 2019, J. Exp. Biol. doi: 10.1242/jeb.188763). The growth of the vertebral bodies was not interrupted and bone structures remained regular. Mechanical testing showed vertebral bodies that are highly compressible but not malformed. Interestingly, the large amounts of non-mineralized bone that developed during the time of the experiment retain the capacity to mineralize. The bone mineral content could be restored by feeding animals diets with sufficient P content. Late mineralization can also restore the mechanical properties of the vertebral bodies. It is commonly accepted that osteoblasts produce the bone matrix and actively mineralize the bone. Therefore a surprising result of this study was that late mineralization did not start in the vicinity of the osteoblasts. Instead, mineralization resumed deep inside the bone matrix, continuous with the last mineralized areas. The large distance between the osteoblasts on the bone surface and the mineralization front suggests that osteoblasts do not actively contribute to late mineralization. It is, however, evident that despite the lack of minerals, osteoblasts produce a matrix that is capable to mineralize. Our experiments show decoupling between bone matrix formation and mineralization.

Limb Bone Diversification in Scluromorph Rodents in Light of Scaling, Lifestyle, Homoplasy, and Macroevolutionary Modeling
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Scluromorph rodents are a monophyletic group of more than 300 extant species. Arboreal locomotion is the most likely ancestral