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***CSF flow dynamics in Alligator mississippiensis: The role of the myodural bridge***

Despite its clear clinical significance, the underlying flow dynamics of the CSF remain poorly understood. The study was intended to quantify some of the physiological features that contribute propulsive force to the CSF. Juvenile American alligators (*Alligator mississippiensis*) with a body length of approximately 180 cm were physically restrained on an inversion table. Using a cuffed tracheal tube the animal was connected to a mechanical ventilator and anesthetized with Isoflurane. Fluid pressure catheters were surgically implanted into the spinal and cranial subdural spaces. Surface EKG electrodes were placed on the ventral scalation on either side of the heart. The suboccipital muscles of the myodural bridge were surgically exposed on one side, implanted with bipolar EMG electrodes, and activated with a stimulating probe. In the first round of the experiment CSF pressure was recorded simultaneously with heart rate, ventilatory airflow, myodural bridge contraction, while the animal was exposed to varying gravitational gradients. FFT analysis of the pressure recordings was used to examine the relative contribution of the ventilatory movements and arterial pulsations. During the second round of the experiment ultrasonography was used to test for displacement of the dural sheath during contraction of the myodural bridge. During the third round of the experiment, artificial microspheres were introduced into the CSF and their pattern of movement studied using laser Doppler ultrasonography. All three rounds of the experiment provided support for the hypothesis that the myodural bridge functions as a CSF pump.

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***Matrix Models for Logistic Plate Growth in Sea Urchins***

The coronal skeletons of modern sea urchins comprise 20 columns of plates, of two basic types (ambulacral and interambulacral), in five paired sets. Following an initial plate configuration derived from the rudiment, plates are added to each column over the lifetime of the animal. The growth of individual plates of a sea urchin can be accurately modeled by logistic functions. The addition and growth of plates in a single column can be envisioned as a stage-structured density-dependent Markov chain, where stages represent plate cohorts. The parameters of the Markov model, represented on a life cycle graph, can be used to define a tridiagonal transition matrix. Inclusion of density-dependent factors results in a model of logistic growth. The model has the general form $\boldsymbol{X}(t+1) = \boldsymbol{QAX}(t)$ where $\boldsymbol{X}(t)$ is an n-dimensional size vector at age t, $\boldsymbol{A}$ is an n×n tridiagonal transition matrix, and $\boldsymbol{Q}$ is an n×n density-dependent damping matrix. The model thus assumes that the growth of a plate at a given stage is dependent on the state of the previous plate stage and some function of plate density. The transition matrix and damping coefficients are unknown *a priori* and require solution of an inverse model using a Monte Carlo approach. The inverse models are derived from estimated plate growth series (beginning with the classic Deutler model of *Echinus esculentus*) and adult plate size distributions measured from 3D scans of species representative of major clades of regular sea urchins. The Markov model is shown to generate the stable plate size distributions of these different clades of sea urchins. This offers a new approach to quantifying the growth of these organisms.

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***Zoo Versus Wild: Trabecular Bone Architecture in Captive and Wild Xenarthra***

Captive (zoo) specimens in natural history collections allow researchers to inspect the morphologies of rare or CITES-listed taxa, but the lifestyles, diets, and lifespans of captive animals differ from those of their wild counterparts. To quantify these differences, we compared trabecular bone architecture (TBA) of dorsal vertebrae in captive and wild specimens of xenarthran mammals (anteaters, armadillos, and sloths). Because TBA develops following in-vivo bone force regimes, it reflects ecology and behavior, but this also means that it may differ between captive and wild specimens of the same species. We collected µCT scans of the last six presacral vertebrae in 15 species of fossorial, terrestrial, and suspensorial xenarthrans ranging in body mass from 120g (*Chlamyphorus*) to 35kg (*Myrmecophaga*). For each vertebra, we measured bone volume fraction (BVF), trabecular number (TbN), mean trabecular thickness (TbTh), degree of anisotropy, and trabecular orientation. We found that wild specimens generally have a greater BVF, TbN, and TbTh than captive specimens, but that these metrics differ by species, vertebral position, ecology, and pathology. Wild specimens of *Dasypus* have greater BVF, TbN, and TbTh than captive specimens in the three most posterior lumbar vertebrae, but have much closer metrics in the anterior three vertebrae. In *Choloepus*, BVF, TbN, and TbTn are greater in wild specimens in the anterior vertebrae and more similar in the posterior vertebrae. Arthritis in captive *Tamandua* increased BVF and TbTh, whereas wild specimens had greater TbN. Our results add to overall understanding of variation in mammalian vertebral trabecular bone, and suggest caution when including captive specimens in research on the relationship between TBA and ecology.

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***Bioaccumulation of lead (Pb) in songbirds following the Flint, Michigan drinking water crisis***

Pollutants, including heavy metals, can interact with animal physiologies in ways that negatively impact fitness. Human activities emit unnatural levels of metal pollutants such as lead into the environment in various ways, including historical use of leaded gasoline, current vehicular emissions, industrial production and other types of catastrophes. Lead is a neurotoxin that is highly persistent in the environment and is thus of particular concern for humans as well as wildlife. From 2014 to 2017 the Flint, Michigan drinking water crisis caused lead to leach from pipelines into the drinking water in some neighborhoods. While human residents were belatedly alerted to avoid ingestion of lead-contaminated water, there was not a similar caution taken when watering lawns or otherwise allowing the drinking water to exit Flint homes and enter the environment. Although water levels are now reduced, lead is highly persistent and tends to remain in the upper layers of soil where it is bioavailable to wildlife. Foraging differences, however, may drive patterns of lead exposure across species and may influence bioaccumulation despite the fact that species may forage in the same site. Omnivorous songbirds forage for invertebrates by digging into the soil, potentially exposing them to soil lead, while granivores forage at the tops of plants for seeds or in feeders. This research explores bird blood lead levels of both omnivores and granivores in Flint, MI in watered and unwatered sites in comparison to reference sites within southeast MI. This study investigates the impact of the Flint, MI water crisis on lead exposure of urban songbirds, as well as how diet impacts lead accumulation.