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Bioluminescent backlighting and signaling in squids

Cephalopods that inhabit the tenebrous depths of the ocean use pigmented cells called chromatophores embedded in skin to communicate through visual signaling. However, the level of sophistication in such visual signals is unclear. Benjamin Burford and Bruce Robison (pp. 8524–8531) used high-definition video cameras mounted on remotely operated vehicles to examine visual signaling in 30 Humboldt squids (*Dosidicus gigas*) at depths between 266 and 848 m in the Pacific Ocean's California Current, the squids' natural daytime haunt. At these depths, the squids put on flashing and flickering color displays when foraging with other squids of the same species. Together with other patterns, pale and dark illumination along the longitudinal axis of the squids' bodies suggested signaling of intent during competitive foraging. Despite the density and frenzy of foraging shoals, the squids appeared to avoid jostling for prey, suggesting a perceived response to visual signaling of foraging intent. Analysis of pigmentation patterns during pursuit and capture of prey suggested a role for syntax in the squids' signaling that evoked linguistic elements such as message signifiers, modifiers, and positionals. While the squids' pigmentation patterns are produced by the overlying layer of chromatophores in skin, hundreds of subcutaneous photophores, which illuminate the muscles of the fins, mantle, arms, and head from within, are strewn across the squids' bodies. Analysis of captured squids suggested that the social messaging encoded in the squids' pigmentation patterns unfolds against a glowing backdrop of photophore-enabled bioluminescence, which enhances pattern visibility under low light. According to the authors, the findings raise the possibility of a previously undescribed level of semantic complexity in visual communication among denizens of the deep ocean. — P.N.

A Humboldt squid shows its colors in the lights of a remotely operated vehicle 300 m below the surface of Monterey Bay. Image credit: © 2010 Monterey Bay Aquarium Research Institute (MBARI).

Sex differences in aging and lifespan

Women typically live longer than men, but determining whether this phenomenon also occurs in other species is challenging. Jean-François Lemaître, Victor Ronget, et al. (pp. 8546–8553) collected demographic data to compile and reconstruct age-specific mortality estimates for 134 populations of 101 species of mammals. Juvenile mortality was not included in the analysis, and the onset of adulthood for each species was defined as the earliest age at which a female can reproduce. Whereas the lifespan of women is on average 7.8% longer than that of men, wild female mammals had an, on average, 18.6% longer lifespan than their male counterparts. Wild female mammals had longer lifespans compared with wild male mammals in 60% of the analyzed populations. However, the authors did not did find significant sex-dependent differences in aging rates. The results suggest that local environmental conditions may influence sex differences in mortality patterns. Further, longer adult lifespans in wild female mammals compared with wild male mammals may result from lower mortality at all ages rather than a lower rate of aging, according to the authors. — M.S.

Fish storage architecture in ancient Florida

The Calusa were a politically complex fisher-gatherer-hunter society that lived in southwest Florida in the 16th century. Several Calusa archaeological sites contain subrectangular constructs built from shell and other sediments around a central flooded area, known as watercourts, the purpose of which remains unclear. Victor Thompson et al. (pp. 8374–8381) performed detailed field studies of watercourts found at the Calusa capital of Mound Key, Florida. Each watercourt had an opening in the wall facing the settlement's central canal, which the authors believe was the location of gates made from perishable materials. The authors found fish scales in sediments from the courts corresponding to the period when it would have been in use. Scales were not found in sediments from the surrounding bay, outside of Mound Key. Excavations of the edges of one watercourt revealed material evidence of earlier fishing-related activity, such as drying and smoking racks. The results suggest that the watercourts were used to store live surplus fish for later processing and that surplus fish production might have supported the centralized political authority of Calusa rulers, according to the authors. — B.D.

Archaeological specimens of mullet (*Mugil* sp.) fish scales recovered from a surplus storage area at Mound Key, the capital of the Calusa Kingdom in southwest Florida. Image credit: Zachary S. Randall (Florida Museum of Natural History, Gainesville, FL).

Cortisol and aging in chimpanzees

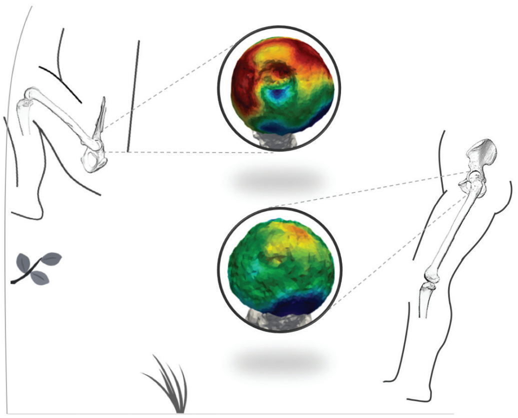
Compared with other animals, humans have unusually long lifespans. In humans, aging affects the ability to regulate the stress response, but there is limited research on the effect of the stress hormone cortisol on other hominids. Between 1997 and 2017, Melissa Emery Thompson et al. (pp. 8424–8430) examined age-related changes in urinary cortisol, a key product of the stress response, in 59 adult wild chimpanzees from Kibale National Park, Uganda. The authors also observed the chimpanzees' behaviors. Because age-related deterioration of the hypothalamic–pituitary–adrenal (HPA) axis leads to increased cortisol exposure, the authors tested the chimpanzees' urine for a blunted diurnal rhythm, increased average cortisol levels, and enhanced response to stressors—all of which are features of

At 53 years of age, Big Brown is one of the oldest living chimpanzees in the wild. Image credit: Ronan Donovan (photographer).

HPA aging in humans. Aging was associated with increased cortisol levels and blunting of the diurnal rhythm, which could not be explained by changes in social status. Males had approximately 33% higher urinary cortisol levels than females. Although males experienced their highest cortisol levels when exposed to sexually attractive females, this effect decreased with age. Conversely, females experienced their highest cortisol levels when they were sexually attractive, and this effect increased with age. The results suggest that the stress response ages similarly in chimpanzees and humans, according to the authors. — M.S.

Deducing fossil hominin locomotion from trabecular bone

Bipedalism is a key development in the evolution of modern humans, but where bipedalism emerged in the hominin lineage remains a source of debate. To reconstruct locomotor behavior in fossil hominins, Leoni Georgiou et al. (pp. 8416–8423) compared the structure of trabecular bone—the porous bone inside the ends of long bones—from the femoral heads of two fossil hominins from the Sterkfontein Caves in South Africa with that of humans and of great apes. One fossil hominin specimen, 2.8–2.0 million years old and attributed to *Australopithecus africanus*, exhibited a trabecular bone distribution resembling that found in both recent and fossil *Homo sapiens* and that is consistent with bipedal hip



Inferred locomotor behaviors of Sterkfontein hominin specimens StW 311 (*Top*) and StW 522 (*Bottom*) based on bone volume fraction distribution.

loading. In contrast, a younger specimen of uncertain taxonomy exhibited a distribution resembling that observed in gorillas, chimpanzees, and orangutans and that is consistent with regular use of highly flexed hip postures associated with climbing. The results suggest that the *A. africanus* specimen had a predominantly bipedal, human-like gait, whereas the younger specimen may have regularly engaged in both bipedalism and climbing. According to the authors, the results provide evidence for diverse locomotion among ancient hominins. — B.D.

Draft genome of water lilies

Around 140 million years ago, shortly after flowering plants evolved, water lilies underwent a major evolutionary change, losing their ancestral woody tissues in favor of herbaceous forms. The change was enabled by loss of the vascular cambium, a group of cells in the meristem that give rise to secondary xylem, or wood, and phloem that together increase stem and root girth. Rebecca Povilus et al. (pp. 8649–8656) sequenced and assembled a draft genome of the water lily (*Nymphaea thermarum*) and compared it with the genomes of other seed-bearing plants with and without a cambium. The comparison yielded a picture of lineage-specific gene loss and divergence that reveals insights into the evolution of herbaceousness—a key factor in the diversification of flowering plants. The water lily genome is marked by a reduced repertoire of HD-ZIP III gene switches, including the loss of *REVOLUTA*, which controls differentiation of secondary vascular tissues and vascular cambium activity. Additionally, the genome shows divergence of a highly conserved amino acid in the CLE family of signaling peptides, which regulate vascular tissue differentiation. Vascular cambium loss is associated with the transition from terrestrial

N. thermarum.

to aquatic habitats in flowering plants. Thus, the genomic findings might reflect the jettisoning of traits tied to mechanical reinforcement and enhanced fluid transport by a group of plants that are close to or submerged in water, according to the authors. — P.N.