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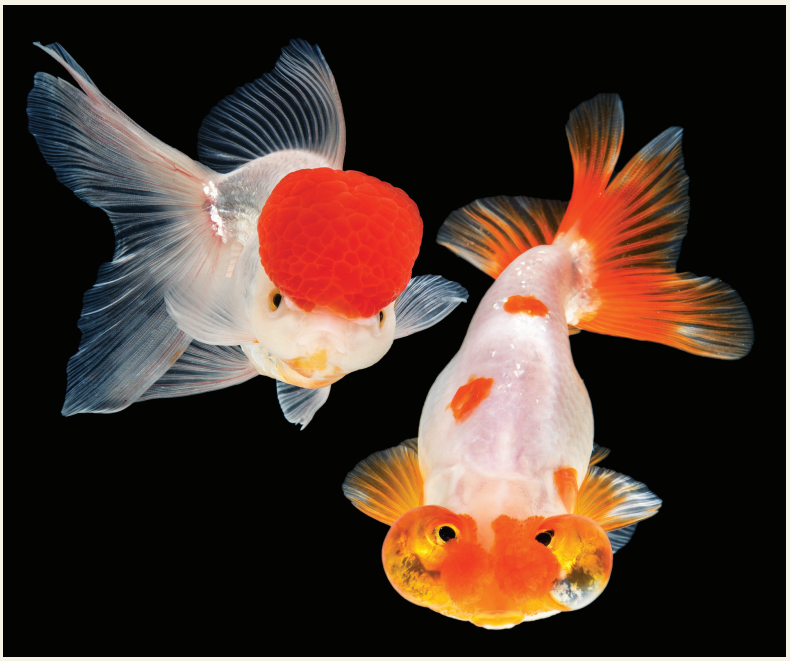
Goldfish genome lends insight into their origin and domestication

Considered the same species as crucian carp, modern goldfish have been subjected to more than a millennium of strong artificial selection for coloration, eye style, and other aesthetic features. Duo Chen, Qing Zhang, Weiqi Tang, Zhen Huang, Gang Wang, et al. (pp. 29775–29785) report the goldfish genome sequence and pinpoint genomic regions subjected to selection during approximately 1,000 years of breeding. Comparative genomic analysis revealed that the goldfish, *Carassius auratus*, originated from two different progenitor species, and a whole genome duplication was introduced before the goldfish diverged from the common carp, around 13–16 million years ago. The copies provided by this genome duplication may have enabled artificial selection for traits such as fin shape, while shielding goldfish from deleterious mutations in essential genes. The authors resequenced 185 different goldfish varieties, including prized ornamental lines, and 16 wild crucian carp. Additionally, the authors identified a tyrosine protein kinase receptor as a candidate causal gene for a trait exemplifying classic Mendelian inheritance in goldfish, namely the transparent mutant, which is thought to have been recorded as early as 1579. According to the authors, the genome sequences could enable the use of goldfish as a model for examining natural mutations, artificial selection, and domestication. — T.H.D.



Eggfish (*Left*) and Wen goldfish (*Right*). Wen goldfish sport a fancy tail and a dorsal fin, whereas Egg goldfish have an egg-shaped body but no dorsal fin.

Mercury from human activity in deep-sea animals

Mercury is a pollutant that is toxic to the nervous system, accumulates in fish consumed by humans, and is found both in the atmosphere and on land. Relatively little is known about mercury levels, sources, and dynamics in oceans, particularly at deep locations. Joel Blum et al. (pp. 29292–29298) collected six snailfish and 25 crustaceans called amphipods from the ocean floor at depths ranging from 6,000–10,250 meters in the Mariana Trench and Kermadec Trench, both located in the Pacific Ocean. The authors analyzed mercury concentration and isotopic composition in the samples, and measured Δ^{199}Hg, the magnitude of a specific isotopic signature of mercury. The Δ^{199}Hg values for samples from the trenches ranged between 1.13‰ and 2.31‰, with an average of 1.54‰. These values are close to the previously reported average value of 1.48‰ for fish that feed in the central Pacific Ocean at a depth of approximately 500 meters, where mercury primarily originates from human emissions. According to the authors, the findings suggest that sinking carrion may transport large amounts of mercury, likely originating from human activity, from near-surface waters to bottom-dwelling animals inhabiting the deepest reaches of the world's oceans. — J.W.

Exploitative leadership in banded mongooses

Banded mongooses are territorial mammals that live in small social groups in burrows, foraging together, defending offspring, and occasionally launching

internecine attacks on other groups. Female mongooses enter estrus as a group, within 7–10 days of one another, and several females in a group deliver pups on the same day. Males fiercely guard female group members in estrus, constantly shadowing females and fending off rival mates. Rufus Johnstone et al. (pp. 29759–29766) analyzed data from a population of wild mongooses in Uganda's Queen Elizabeth National Park and found that females that act as group leaders incite fights with rival groups, exploiting the chance to mate with males from other groups during unguarded moments in the ensuing melee when they are out of sight of mate-guarding males. Such a strategy, the authors suggest, helps female mongooses avoid inbreeding and boosts their genetic fitness, despite the resulting violence and physical harm inflicted on group members. Analysis of all adult deaths due to intergroup violence over a 16-year period revealed that death due to fighting occurred almost exclusively in males. Comparison of the rate at which surviving offspring were produced by 499 adult males and 377 adult females revealed that the rate rose more steeply with the number of intergroup interactions for females, compared with males, suggesting that females pay lower costs but accrue greater benefits from intergroup interactions. Rates of encounters with other groups increased—rather than decreased—when females were in group estrus, suggesting that female mongooses—rather than males—initiate and lead groups into fights; the authors reason that male mongooses are unlikely to initiate fights when their own group members are in estrus. Additionally, comparison of rates of death due to intergroup fighting for an array of species, including wolves, lions, and chimpanzees, revealed that banded mongooses die at rates comparable to other mammals capable of extreme belligerence. According to the authors, the study suggests that the lopsided division of the costs and benefits of war between warmongering leaders and the soldiers who wage war is not unique to human societies. — P.N.

Battle lines of banded mongooses. Image credit: Harry Marshall (University of Roehampton, London, United Kingdom).

Evidence of mounted horseback riding in ancient China

Mounted horseback riding in ancient China supported trade along the Silk Road and boosted the country's military prowess, among other societal impacts. However, sparse archaeological data and fragmentary historical records have hampered understanding of the precise time of emergence of equestrianism in China. Yue Li, Chengrui Zhang, William Timothy Treal Taylor, et al. (pp. 29569–29576) analyzed an assemblage of eight horse skeletons dating from around 350 BCE, before the establishment of Silk Road trade across the region, from a pair of adjacent sites in Xinjiang in northwestern China. The sites, Shirenzigou and Xigou, lie to the east of the Tianshan corridor, indicating their significance to transcontinental trade. Excavated from burial chambers and sacrificial pits, the horse bones exhibited signs of extensive human use. Osteological analysis revealed multiple abnormalities, including excessive enlargement or growth of parts of the vertebrae, pathological fusion of components, and horizontal fractures, with most abnormalities occurring on the vertebrae of the lower back and suggesting chronic use of pad saddles for riding. An apparent leftward bias in vertebral abnormalities may have stemmed from frequent mounting and reining from the left side. The authors also found deep lateral grooves on the bones that indicate bridling, ossification reminiscent of ridden horses, and dental anomalies tied to metal bit use. A fragment of a jointed metal snaffle, a type of iron bit, unearthed from one of the chambers further attested to the horses' use in riding, along with signs of enamel and dentine exposure and chipping on the horses' premolar teeth. Riding-associated skeletal defects in at least one human buried with the horses bolstered the findings. Additionally, 15 bone arrowheads found under the right hand of a horseman buried at Shirenzigou suggested evidence of mounted archery. Together, the findings provide early evidence of mounted horseback riding

Lumbar vertebrae of horses from burials at Shirenzigou.

in ancient China and suggest that the region may have played a crucial role in the spread of equestrianism to the heartlands of China's early settled civilizations, according to the authors. — P.N.

Forest trajectories after drought

The vulnerability of forests to drought-induced tree mortality is expected to rise in a changing climate, but the characteristics of the vegetation that arises following mortality are unknown. Enric Batllori et al. (pp. 29720–29729) examined 131 sites across multiple biomes that experienced drought-related tree mortality between 1 and 23 years prior to the study to determine the tree and shrub species that replaced affected forests. In 21% of the sites, the tree species dominant before drought remained dominant after drought, and, in 10% of the sites, forests and woodlands shifted to nonwoody vegetation. Relatively wet postdrought conditions favored less pronounced ecosystem changes than dry conditions. Conversion of trees to shrubs frequently occurred in sites where tree pathogens were a cofactor in tree mortality. Although forests generally shifted after drought to species that require little water, some forests were replaced with species with similar water needs than former dominants, and multiple paths of ecosystem replacement were observed. Multiple factors, including drought characteristics, species environmental preferences, and plant traits, influenced the postdrought ecological trajectories of forests. According to the authors, increases in drought-related forest mortality may result in major ecosystem reorganization in coming decades. — P.G.

Lack of replacement by woody vegetation after drought-related mortality in *Pinus edulis* forests, New Mexico, United States.