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Biology of Death

Vanishing vultures: the collapse of critical scavengers

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Quick guide

Vultures

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What are vultures? Vultures are large, obligate scavenging birds that eat dead vertebrates. There are 23 species of vulture, inhabiting diverse biomes from the Amazonian rainforest and East African savannahs, to the Sahara Desert and high Himalayas. There are two main groups of vultures: Old World vultures of the Accipitridae family, found in Europe, Africa, and Asia, and New World vultures of the Cathartidae family, found in North and South America. It was long believed that New World vultures were more closely related to storks than to Old World vultures. However, recent molecular evidence indicates that they are likely to be sister taxa. Either way, the scavenging habits of these groups are thought to have evolved independently, leading to adaptations like large bodies, broad wings, powerful beaks and featherless heads.

Figure 1. Vultures.
Critically Endangered white-backed vultures (*Gyps africanus*) in Ethiopia.

How do vultures find and feast on rotting flesh? Carrion is a temporally and spatially unpredictable resource, which vultures are uniquely adapted to exploit. They soar to search for food over vast areas with minimal energy expenditure. Accordingly, vultures have some of the largest ranges of any animals on Earth. While only three of 23 vulture species are true long-distance migrants (turkey, black and Egyptian vultures), others, such as those in the genus *Gyps*, *e.g.* Eurasian griffon vultures, have individual foraging ranges of hundreds of thousands of square-kilometers (approximately the size of Spain). Vultures are also among the largest birds in the world, which enables them to store sufficient energy while covering vast distances in search of their next meal. For example, the Andean condor weighs over 11 kg and has an impressive wingspan of up to 3.2 m. Even more impressively, the extinct vulture *Argentavis magnificens* had a wingspan of approximately 7 m and a mass of around 80 kg.

Efficient energy management is a key adaptation of vultures. For instance, vultures' featherless heads were long thought to be an adaptation to keep clean while foraging on rotting flesh. But, new research suggests that when vultures change posture, they can expose or cover large swaths of skin with their neck feathers allowing them to manage thermal radiation. Another unusual heat management adaptation is urohydration — or the New World vultures' habit of defecating and urinating on their legs, which provides evaporative cooling.

To efficiently locate carrion, vultures use cues from their cohorts. From their vantage point, high in the sky, most vulture species rely on vision to find food. This poses a challenge because carcasses are not moving and may be obstructed from view. However, when one bird finds and circles a carcass, it alerts its comrades of a potential meal. Soon, more curious vultures investigate, forming a 'kettle', a group of vultures circling a carcass, which indicates an impending feast to scavengers far and wide. Furthermore, New World vultures in the genus *Cathartes* also have a keen sense of smell: turkey vultures can locate carrion under dense rainforest canopies or buried beneath leaf litter and can lead their relatives, the black and king vultures, to hidden meals they otherwise would not find. Mammalian scavengers, such as jackals and hyenas, also follow vultures, making them a keystone species of the scavenger community. Once they drop to a carcass, a group of feeding vultures, known as a 'wake', can facilitate ripping through tough hide, fend off competitors, and warn of potential threats.

Interestingly, vultures have highly specialized feeding niches. In the African savannah, Ruppell's and white-backed vultures gorge on internal organs; lappet-faced vultures use their powerful beaks to dine on ligaments and hide; white-headed and hooded vultures circle the feeding frenzy picking up scraps; and then the massive bearded vulture, the world's only vertebrate osteophage (bone-eating specialist), swallows large chunks of the skeleton whole or carries and drops the bones at an ossuary to break them into

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smaller pieces. After the vultures' wake, often little remains of the carcass.

How are vultures doing? Nine of 23 vulture species (39%) are classed as 'Critically Endangered', i.e. on the brink of extinction (Figure 1). An additional three species are Endangered, four are Near Threatened, and seven are Least Concern. Over the past three decades, vultures have declined catastrophically, especially in Asia and Africa, and are now the most threatened group of bird in the world. Persecution, decreasing food availability, habitat destruction, and collision with energy infrastructure all threaten vultures. However, poisoning is the most imminent and dire threat, as it is incredibly effective at killing vultures. For example, in 2013, a single contaminated elephant carcass in Namibia killed 600 vultures.

Throughout Africa, vulture populations are crashing. Over three generations, the bearded vulture declined by 70%, while seven other species declined by 80% or more. Accordingly, four African vulture species were classed as Critically Endangered in 2015. The deliberate poisoning of mammalian carnivores, such as jackals, hyenas, and lions, to avenge livestock loss, has led to widespread unintentional poisoning of vultures. And now, with the boom of illegal rhino and elephant hunting across the continent, poachers are intentionally poisoning vultures because their carcass circling cues can quickly lead authorities to the scene of the crime.

The current acute situation in Africa is a worrying *déjà vu* of the extreme declines in South Asia, where populations of three vulture species declined by >95% between 1992 and 2007 due to poisoning from the anti-inflammatory veterinary drug Diclofenac. This drug, widely used to treat pain and swelling in sacred cattle, causes kidney failure in vultures after ingestion. Because of the drug's lethality and vultures' social foraging, only <1% of livestock carcasses would have needed to contain the drug to account for these declines. Encouragingly, India, Pakistan and Iran have banned the use of the drug for veterinary purposes, but it remains on the market in many other countries, including throughout Europe.

Why should we care about vulture declines? By quickly locating and consuming carrion, vultures outcompete and control problematic facultative scavengers (like feral dogs and rats), insects, and microorganisms. When vulture populations decline, carrion becomes increasingly available to other organisms, in a form of terrestrial eutrophication. Currently, many facultative scavenger populations are increasing worldwide, causing significant top-down ecosystem effects via predation, invasion and competition. Furthermore, carcasses provide a reservoir and vector for many diseases, including rabies, chronic wasting, anthrax, bubonic plague, mad cow, foot and mouth, etc. Vultures have extremely acidic stomachs (pH = 1.0) where most viruses and bacteria cannot survive. When vultures eat carcasses, they actively remove these pathogens from the environment, as well as preempt the colonization and reproduction of pestilent insects.

Vultures offer valuable ecosystem services and are a fascinating group of birds highly adapted for their unique lifestyle. They have often been portrayed as malevolent creatures preying on the sick and weary. But the reality could not be further from the truth: vultures are the "soap of the savannah", quickly and efficiently removing waste, controlling pests, and preventing disease outbreaks — all free of charge. And, as true apex carnivores — eating all animals in the food chain, including lions, tigers, and bears — they are excellent indicators of ecosystem health.

Where can I find out more?

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Quick guide

Microbiology of death

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When a mammal dies, what happens? Decomposition happens. When a mammal dies its immune system shuts down, internal temperatures change, and internal bacteria begin to grow in ways impossible while under the constraints of a living host. The internal environment then experiences another major event: rupture — a break in the skin that allows air, microbes, and insects to enter, and bodily fluids to exit. A carcass releases large amounts of nitrogen into the environment, mostly in the form of ammonia, as well as carbon, phosphorous, and other nutrients important for life. A dead body becomes a hotspot of nutrients, water, and ecological activity.

How do we study mammalian decomposition? What is an anthropological research facility? You may have heard the term 'body farm' in the news or on popular forensic science shows like *Bones* or *CSI*. In the scientific community, these research centers are more appropriately called 'anthropological research facilities', and are important for studying the anthropological, ecological, and forensic science implications of mammalian decomposition. Because of the interest in human decomposition for anthropology and its practical importance in forensic science, these facilities use human donors for field experiments to test the effects of different variables on taphonomy — the processes of decomposition. Some facilities also use pigs, which are good biological proxies for humans and allow for more replicates and better control over factors such as age, weight, and sex.

What organisms are involved in decomposition? Decomposition is one of the most important ecosystem processes — if it were not efficiently