THE WINHAM PAPERS
9. Cooperation and Risk (2022)

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In prior essays, we bemoaned the unraveling of cooperative societies as greed and tribalism eroded the social contract. But it is fair to ask whether we really need cooperative societies anyway. If, as history shows us, people can survive the unraveling of their prior cooperative societies, are such transitions really so bad? Are there any reasons why we should prefer a cooperative society over a selfish one? This essay argues that there is at least one very big reason. However, to make the case we need some background. First, an animal example.

Vampire Bats. Vampire bats (*Desmodus rotundus*) are a common inhabitant of the New World tropics. They spend the day in large colonies in caves and hollow trees. At night, they radiate out over the countryside looking for large mammals as prey. When they find a suitable subject like a horse or a cow, but also pigs, tapirs or even people, they land gently on the surface of the animal and after a few minutes begin to gently lick the nearest patch of prey skin. This provides a slightly numbing effect, after which the bats use razor-like teeth to open a small wound. They then begin to lick up the blood, their saliva acting as an anticoagulant. They fill their stomachs until they are swollen like a tick. The minute they start drinking blood, their guts and kidneys begin extracting the water from the blood and urinating it out. They need to reduce their weight if they want to fly back to the roost. Note that at any time, the prey animal may detect some irritation or the movement of the bat on its back or neck and shake or buck it off. The prey animal is more likely to detect harassment if more than one bat is attacking it at the same time.

The advantage of this diet is that blood is a highly nutritious food. It can provide a lot of energy and other nutrients in a very short time. The disadvantage is that it provides little energy storage, and if the vampire bat misses two nights in a row without feeding, it is likely to die. Since finding a suitable prey item every night and managing to get through the full sequence without interruption is challenging, this is a very risky food source. Vampire bats have dealt with this problem by evolving a cooperative society. Each bat has several buddies and when one of them fails to feed on a given night, it begs from a successful returning buddy who regurgitates blood and feeds it. This guaranteed reciprocity makes surviving on such a risky food source feasible. See Carter (2021) for more details.

Early Humans. To see what vampire bats have to do with human societies, we need to take a look at our own evolutionary history. We and our ancestors, collectively called "hominins", evolved in eastern and southern Africa during the last 4.8 million years. During this period, the region experienced major climatic changes. Overall, starting about 3 million years ago, the region gradually became more arid and the initial extensive woodlands were replaced by grasslands. Superimposed on this long-term trend were alternating periods of high variability in rainfall separated by periods of much lower variability. Researchers have noted that most of the major originations and extinctions of hominin species occurred during one of the longer periods of climate variability. These were also the periods when the existing hominins first used new adaptations such as major changes in diet, invention or improvement in tools, or the mastering of fire. The implication is that these periods of high variability imposed strong selective forces on existing species, and only those that acquired mechanisms for greater resistance to variability survived.

It will be useful to note a few of these major transitions. The earliest accepted hominin was *Ardipithecus* with two species occurring between 5 and 4.5 million years ago. These species were partially bipedal, but also clearly spent a fair amount of time in trees. They apparently ate soft foods like fruits and buds collected in the forest. They had small brains, 300-350 cc in volume, which is just slightly smaller than that of modern chimpanzees of similar body size.

Their descendants, the Australopithecines, which first appeared during a major period of climatic variability 4.2 million years ago, essentially put the hominin line on the trajectory that eventually led to us. They responded to the climatic variability by significantly expanding their diets by adding some components from the incipient grasslands such as seeds and tubers, and also increasing amounts of meat. The latter was likely based on small prey such as lizards, or partially decomposed meat scavenged from predator kills. Later species were the first to use stone tools to process foods, making them more quickly digestible. Although they could still climb trees they also first developed the energy-storing foot that made long distance walking economical. This facilitated larger home ranges and the ability to be more selective in what was collected for eating. Finally, learning how to find and utilize a variety of foods favored larger brains, and typical brain sizes increased to 459-500 cc. Most species were sexually dimorphic with males being considerably larger than females. In other primates, sexual dimorphism is associated with polygamous mating systems.

The Australopithecines, once established, enjoyed over 1 million years of fairly stable climate. They eventually produced a half dozen species spread throughout eastern and southern Africa. The next million years, starting about 3.2 million years ago, hosted four successive periods of major climatic variability separated by shorter periods of climatic stability. The second and third bouts of variability were both long and severe, and most of the Australopithecine species went extinct. This was also when the replacement of forest by grassland really accelerated. Because of differences in topography and local rainfall, the result was a patchwork of islands of forest often varying in composition and height, small lakes and river margins, and intervening zones of grassland. Thus on top of the temporal unpredictability of the local climate, there was significant spatial heterogeneity in habitats.

Two new genera emerged between the second and third bouts. The first, *Homo*, simply invoked the standard Australopithecine strategy for dealing with greater unpredictability by increasing body size to access a larger range of habitat patches, changing the diet to include more meat, and enlarging the brain to provide the memory and cognition needed to exploit these more diverse and scattered resources. Three species are known from the fossil record with brain volumes ranging from 510-680 cc. Stone tools were standardized and passed on to successive generations. Unlike its ancestors, this genus had much reduced sexual dimorphism and was probably monogamous. The second genus, *Paranthropu*s, abandoned the Australopithecine playbook, and became a specialist eating sedges and grasses.

When the fourth episode of climatic instability hit, roughly 2 million years ago, one of the early *Homo* species went extinct, a second that might have been more arboreal survived for a bit longer, and the third invoked the standard Australopithecine gambit by further increasing both body size and brain size, the latter to an average of 1000 cc. This new species is known as *Homo erectus*. There were two problems with simply scaling up these features. The first is that large brains and home ranges are expensive energetically. Trying to collect food in small portions over a large area was no longer sufficient. The alternative was to focus on high-profit foods such as large mammals. These were reasonably abundant both in woodlands and grasslands, but achieving a successful hunt was tricky and dangerous. Still, like vampire bats, this was the solution adopted by early *Homo erectus*. And like the bats, successful hunters brought meat back to share with the rest of the group, including those who had failed to hunt successfully. Unlike the bats, it was feasible for multiple individuals to work together on a hunt.

The second problem was also generated by having a larger brain. In great apes, and likely in early hominins, each mother is obligated to take care of her own child until it is independent. They therefore cannot get pregnant again until this occurs. Larger brains require longer periods of dependent childhood. The longer the interval between a mother's successive births, the lower the reproductive rate of the species. For a mammal about the size of early *Homo*, 700 cc is the largest adult brain size at which the parents can replace themselves in the population if the mother must wait for her current child to mature. *Homo erectus* clearly crossed this line and would have gone extinct had they not evolved some sort of shared childcare. This allowed a mother to get pregnant again after a much shorter interval than without such help. The fact that food was also being brought back to recent mothers also insured that she and her offspring would be fed even if she could not go foraging on her own.

The adoption of team hunting, food sharing, and cooperative childcare made *Homo erectus* an extremely resilient species despite unpredictable variations in climate and landscape structure. Their collective approach facilitated the accumulation of cultural strategies, including a redesign of stone tools to better fit their needs, the ability to use fire to cook foods, making them more digestible and storable, and eventually the use of caves and constructed shelters as central places for true hunter-gatherer economies. It is not surprising that they were the first species of hominin to move out of Africa, eventually getting as far east as Indonesia and the Philippines.

Populations of *Homo erectus* that remained in Africa continued to deal with episodes of climatic change. A major bout of instability about 1 million years ago included a long period of much wetter weather. This allowed the previously receding woodlands to reclaim large areas from the grasslands. This reduction in preferred habitat and competition with large mammal herbivores prove to be too much for *Paranthropus*, and the genus went extinct. *Homo erectus* adapted well to these changes, and subsequently to the later return of the grasslands. They went on to produce several descendent species including the Neanderthals, the Denisovans, and our own species, *Homo sapiens*, all of which continued to expand brain size while relying on cooperative food sharing and childcare. These later forms also eventually moved out of Africa and colonized the entire planet except Antarctica.

Modern Humans. You may be thinking that all of this is interesting but irrelevant: we have moved so far beyond these early species with our technologies, cultural achievements, agriculture, and social complexity. But focusing on these achievements misses the point. Our hominin ancestors were continually challenged by unpredictable crises. The forms that survived were the ones that steadily increased flexibility and adaptability. They did this by expanding their brains to solve problems and cooperating to implement solutions. And the legacy of these adaptations remains with us. It is still the case that some of us collect or produce the food that the rest of us eat. To stay healthy, humans still need to eat a lot of high-energy food. Our brains are still large and it takes a decade and a half before an offspring can be considered independent. Without childcare and provided food, women could not have as many babies as needed to maintain our populations.

And we still live in an unpredictable and risky world. The best buffer against unexpected challenges has always been a smart and cooperative society. When such a society unravels, it is much more vulnerable to such crises. The fall of the Roman empire is a case in point. From its peak at the end of the first century CE, there was a steady erosion of cooperation due to greed and corruption, increased financial inequality, and eventually internal tribalism. In subsequent centuries, the empire faced a series of crises: disease, invasions, and climate change. It initially dealt with them, but over time as civil strife and polarization became acute, it could no longer deal with both internal and external forces ripping it apart. Other empires in China, Central America, the Middle East, and India also fell due to inadequate responses to pandemics, invasions, or climate changes.

We may like to think that we are immune from such instabilities. But does it not give you pause to consider the number of people in the United States and elsewhere who refused to cooperate by becoming vaccinated and wearing masks during the current pandemic? How about all the resistance particularly by businesses to curbing the serious climate change that the planet is facing? And while there does not currently appear to be an imminent invasion by aliens, the rising tensions between Russia, China, and the United States do not inspire optimism.

Vampire bats have flourished for 20 million years. They have surely faced their own crises, and yet survived with a fairly simple pattern of cooperation. Our species has evolved a much more complicated set of cooperative behaviors. So, can we hope to survive for as long as the bats? Given current trends, you have to wonder. And the sad irony is that if our species goes down because it failed to undo all the damage it has done to the planet, it will likely take the vampire bats with it.

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