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The Challenge of Survival for Wild Infant Baboons

Over the past 40 years, researchers have learned that social relationships can mean life or death for young primates.

Susan C. Alberts

Early dawn in the Amboseli basin of southern Kenya, just south of the equator, can be chilly. Amboseli lies at 1,100 meters elevation; days can be very hot, but it always cools off at night.

On this particular morning in July 2012, an infant baboon named Moon nestled against his mother while he suckled, keeping warm, as the other animals in his social group began to stir. They greeted each other as they woke by grunting, lipsmacking, and embracing.

Several of them, including Moon's mother, Mica, settled down to groom for a few minutes before descending from the "sleeping trees," where they had spent the night. As the grooming continued and sunrise got closer, Moon left his mother's warm hold and explored a bit, encountering a few of his age mates whose mothers slept near Moon and Mica. Moon's mother was low ranking but had two close associates, an adult male and an adult female, with whom she frequently groomed. Eventually they finished grooming and descended from the sleeping trees—a grove of yellow-barked fever trees, *Acacia xanthophloea*—to start the day. Moon and his mother didn't know it, but this was the start of 10 hard weeks for them both.

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Over the course of the next few hours they foraged on grass seeds, fever tree gum, and the fruits of the perennial herb *Trianthema ceratosepala*, which they carefully picked from the plants that grew recumbent on the ground. At some point, something catastrophic happened. We're not sure what it was because we weren't observing Mica's group that morning—it could have been a predator attack, or a less-than-friendly encounter with another baboon group, or something else entirely. Whatever it was, it caused enough chaos that Moon sustained multiple wounds and became separated from Mica and the rest of the group as he fled in panic from the threat.

Moon wandered alone for more than a day. Staying alone too long would be deadly for him; the risks to a lone infant baboon are enormous and include snakes, birds of prey, and mammalian carnivores such as hyenas, lions, and jackals. Dehydration and hunger are also looming threats. Over the course of just a day or so, Moon started to grow thin and dehydrated, and his injuries remained painful. By the time he saw Hokey's group, on the plain quite near him on the second day of his ordeal, he was confused and desperate. Hokey's group was not his own group. He knew none of the animals that lived in it, and trying to join could be risky—their reception of him would be unpredictable. But with no other options he joined them, and within a few hours a remarkable thing happened. A young three-year-old male, Filo, started to play with Moon and carry him, and Moon's relationship with Filo brought him into contact with Filo's mother, Flank, later that day.

Flank was an older, experienced mother who had produced five offspring, three of whom had survived infancy. Her most recent infant was a girl, Fakir, who was old enough to spend most of the day away from her mother. Fakir still suckled at night, however, which meant that Flank had a small milk supply without having a totally dependent youngster. In his desperation, he came close to Flank, reached out to her, moved closer still, and tentatively latched on to her nipple. She accepted him, and Moon stayed latched on to Flank for the next several days. In response to Moon's persistent nutritional demands, Flank's milk came flowing back in life-giving quantities. Over the next few weeks, Moon recovered from his wounds and started to gain weight. Within a couple of weeks he was playing with other kids his age and looking like he would survive.

That Moon survived the separation from his mother was a big surprise: Catastrophic separation from the mother is among the direst of the many threats an infant baboon can encounter. At the Amboseli Baboon Research Project, measuring infant mortality and understanding its causes

For an infant baboon, such as this one clinging to its mother as she crosses a river in Tanzania, surviving the first year of life requires learning to identify and successfully consume more than 250 types of food, identifying and avoiding dangers from other baboons both inside and outside the group, and avoiding fatal disease and predation. The traits that help primates survive infancy tell us much about how natural selection has shaped these animals' behavior.



Charlie Summers/Nature Picture Library



Each baboon group spends the night in a sleeping tree, such as this yellow-barked fever tree towering above the animals it harbors at night in the Amboseli basin of southern Kenya. (Photograph by Courtney L. Fitzpatrick, courtesy of the author.)



are among several important research strands that are woven through the fabric of our long-term research. Our outstanding Kenyan research team is in the field six days a week, 52 weeks a year, observing these remarkable animals up close. Our team members recognize on sight all of the roughly 250 baboons that currently make up our study population. Baboons live in stable social groups, and we name each study group after a notable, recognizable female in the group. The number of groups we observe varies because groups sometimes fission and fuse.

The lost infant named Moon nurses from his adoptive mother, Flank, next to Flank's daughter, Fakir. Over the 40 years of the Amboseli Baboon Research Project, this adoption is the only successful one observed. Even though adults try to help other infants, adoptions are rare because the timing must coincide with a stage when a mother is producing milk but has enough to spare. (Photograph courtesy of the author.)

The detailed observation that results from the daily work of our research team allows us to watch the behavior of individual baboons throughout their lives and to connect the dots between daily behavior and health, reproduction, and survival. Our database, with records going back to 1971, now includes more than 1,800 individuals. The intimate portrait of baboon life that this research has afforded has taught us much about how and why some infants make it and some don't.

Surviving infancy is challenging for all wild primates, as decades of research on species ranging from lemurs to gorillas have revealed. To survive its first year of life, an infant baboon must learn to identify and consume more than 250 types of food, recognize and avoid dangers from other baboons both inside and outside the group, and evade fatal disease and predation. In Amboseli, first-year mortality has averaged about 30 percent over the four decades of our study but has climbed as high as 50 percent during difficult times. Just getting through infancy represents a huge piece of the Darwinian gauntlet that every organism must run.

The traits that help primates survive infancy tell us much about how natural selection has shaped the behavior of these highly social, complex, and charismatic species. We've learned that a young primate's social context is often the most important key to its survival. That is, although the biggest threats to infants in most primate species are nutritional stress, disease, and predators, the most important sources of protection against these threats are social relationships: the nurturing that a young animal receives from its parents, beneficent attentions it may receive from siblings and other group members, and the protection and collective knowledge of the social group as a whole. At the same time, other members of its own species can represent serious threats to an infant's survival. These threats include unfamiliar adults (especially males), competitive groupmates, and other social groups that compete with an infant's group for resources.

The importance of the social environment in both promoting and jeopardizing the well-being of a young primate can't be overstated. Understanding how social relationships influence infant primate survival, in turn, leads to a rich knowledge of the evolution of behavior in primates, including our own species. It also has implications for anticipating the kinds of conservation threats that primates are likely to face if the integrity and structure of social groups shift in the face of climate change and habitat fragmentation.

Adoption and Caretaking

Although adoption is common in human societies, it is quite rare in non-human primates, which means that the survival of the mother is essential for her infant's survival. In 40 years of watching the baboons of Amboseli, Flank's adoption of Moon is the only successful adoption we have seen. This is not to say that baboons aren't motivated to help orphans; both males and females regularly try to do so. Indeed, the frequency of attempted adoptions tells us how strongly evolution has shaped the urge toward parental behavior. But males are unable to provide milk to nursing young, and females are available to do so for only a very short window of time. If a female is lactating, she will virtually always already have a suckling infant of her own. The chance that a needy



Vibrant (*on right*) grew into a beautiful adult male, despite losing his mother at only eight months old. Because a close male associate named Mlozi protected him and let him sit near him while feeding, Vibrant was able to survive. Later DNA sampling showed that Mlozi was Vibrant's biological father. (Photograph by Courtney L. Fitzpatrick, courtesy of the author.)

infant will appear when a female has milk but no dependent infant is slim.

When a young infant named Waugh lost his mother on the first day of his life, he was promptly adopted by Luna, a 20-year-old female with a long and successful history of raising infants. Luna carried and suckled Waugh very attentively, but her most recent living offspring was three years old and long weaned. Luna had no milk for Waugh, and he died within a few days. After he died, Luna carried Waugh for many days. Indeed, she carried him longer than he had been alive, putting him

interrupted while feeding or have his hard-won bits of food taken by larger, stronger baboons. Unlike chimpanzees and humans, baboons don't actively share food, but the opportunity to forage in the shadow of a powerful adult male is the next best thing. Vibrant survived, and although he grew slowly, he eventually matured into a strong adult male who fathered offspring. Several years after Vibrant was orphaned, we perfected the technique of extracting DNA from baboon fecal samples, and we carried out a paternity analysis on DNA from Vibrant

Only 2 of 54 orphaned infants in Amboseli have survived to adulthood.

down while she fed, but carefully lifting the limp, small body whenever she moved, keeping it near her day and night as it slowly decomposed. It was as if she couldn't give up on him.

Young infant Vibrant lost his mother at only eight months of age, when he was still nursing frequently but had started to gain foraging skills. Most infants at such a young age would die if they were to lose their mothers; only 2 of 54 orphaned infants in Amboseli have survived to adulthood. But Vibrant had a close male associate named Mlozi, who carried him, slept with him, protected him during tussles with other youngsters, and—perhaps most important—let Vibrant sit near him while he was feeding. The youngster's relationship with Mlozi created a safe haven where Vibrant wouldn't be

and Mlozi. Sure enough, Mlozi was Vibrant's biological father.

Males in many primate species may step in to provide assistance to youngsters, not just orphans but also those facing everyday challenges such as travel and social conflicts. In Amboseli, more often than not males are assisting their own offspring. This result is surprising because female baboons mate with multiple males during each sexual cycle, leading to the expectation that males wouldn't "know" the identities of their own offspring. Nonetheless, our data indicate that Amboseli males often do, although we're not sure how. We suspect that rather than using a single cue, males make a best guess about which kids are their own based on multiple possible pieces of information. Physical, olfactory, or vocal fea-



Adult males often assist kids in their social group, and frequently but not always the juveniles they tend to care for are their own offspring. Here, an adult male defends one kid from the aggression of another. (Photograph by Catherine Markham, courtesy of the author.)

tures may provide a clue. A male may also keep track of whether he mated with the mother when she last cycled and whether he monopolized her fertile time or shared it with other males. Mothers may also provide some information. By spending time near a particular adult male when the offspring is young, a mother may be signaling, “This is a male that you can go to for help.” The male, in turn, may respond

youngsters as well as their own. In addition, the more time a father spends living in a group with his kids during their development, the earlier they tend to mature. This early maturation may happen because a father’s presence simply ensures that his kids get more uninterrupted feeding time than fatherless kids. In addition, a father’s helpful interventions may enhance growth by lowering a youngster’s stress. Whatever

is protecting the infant from a potential attacker or is instead exploiting it. Some studies have shown that the infant’s presence reduces the intensity of the attack on the adult male. Alternatively, the infant’s presence may recruit other animals—even the infant’s mother—to assist the male by attacking his opponent. In these cases, the infant is being exploited in the interests of the male carrying it. Very likely, the truth is that infant carrying during male conflicts has many different root causes; some instances may be benevolent and others exploitative. In either case, ample evidence indicates that infants can be at great risk when carried by males during fights. In Amboseli, two stories illustrate this risk.

Female Lenga lost her mother at the age of six and one-half months. Lenga, like Vibrant, survived her mother’s death because of male protection. In fact, Lenga had not one but three male protectors. With the help of these three “friends” she emerged from the worst of her orphaning ordeal at one year of age as a likely survivor. Two of these male protectors together emigrated from Lenga’s social group on the same day in October 1984, however, and Lenga was dead within 48 hours of their departure. She died on her first birthday, with puncture wounds on her head that matched the canines of a male baboon. Sitting near her body, screaming whenever she was approached, was her third male protector, a low-ranking male named Slik, who had always been quite prone to carry Lenga when other males attacked him. We surmise, although we can’t confirm, that Lenga died during an altercation between Slik and another adult male in the group. We think he picked her up during the fight, as was his habit, and that Lenga took the brunt of the other male’s attack.

Young male Wusten died in a similar manner at 19 months of age. Narasha’s group (in which Wusten and his family were living) encountered Hokey’s group one day on the way to a waterhole that lay in the center of the latter group’s range but on the edge of Narasha’s (the home ranges of baboon social groups frequently overlap). Although most encounters between baboon groups are calm and overt aggression is uncommon, this encounter was different. Hokey’s group rushed at Narasha’s group with a good deal of grunting, apparently attempting to

In Amboseli, more of a juvenile’s support during social conflicts will come from its father than from unrelated males.

to the kid’s persistent presence by forming a bond; in this way, paternal recognition would be a passive outgrowth of behavior transferred from a mother to her daughter or son. Probably none of these mechanisms is sufficient on its own, but together they may add up so that a male can make a pretty good guess about which kids are his.

Whatever the mechanisms are that allow males and their offspring to establish a relationship, we know that it matters for youngsters. In Amboseli, more of a juvenile’s support during social conflicts will come from its father than from unrelated males, even though male baboons help unrelated

the cause, a male’s protective behavior can give a young baboon a flying start on its reproductive life. In Vibrant’s case, the presence of a father was even more important—it quite literally made the difference between life and death.

Exploitation and Death

Male baboons are not always benign presences in the lives of young baboons; they can also represent grave danger. One risk comes in the form of a complex behavior that might appear benevolent at first glance: Adult males sometimes pick up and carry infants during fights with other males. It’s not always obvious whether the male

push them away from the waterhole. When Narasha's group didn't back off, Hokey's group erupted in screams and launched an assault. Wusten got picked up and carried by an adult male groupmate, who became the target of an attack by Hokey's group members. Wusten sustained multiple puncture wounds on his head and abdomen. He was dead within an hour. Although probably accounting for less than 1 percent of infant deaths in our population, infant carrying during conflicts is a particularly interesting example of a social behavior that offers potentially acute costs and benefits to an infant and to its male friend. These kinds of behaviors highlight the many complex ways in which males can play a central role in infant survival.

Sexually Selected Infanticide

Another threat from adult males is more direct. In 1974, anthropologist Sarah Hrdy of the University of California, Davis, first provided an evolutionary explanation for cases of infanticide by male Hanuman langur monkeys who were new immigrants into social groups. She proposed that this behavior has evolved in species in which the death of an infant results in restarting the mother's reproductive cycle, thus shortening a newly immigrant male's wait to reproduce. At the time, many researchers could not believe that the behavior was anything but pathological, perhaps caused by unnaturally crowded conditions. Nonetheless, the hypothesis has stood the test of time, and this phenomenon—termed *sexually selected infanticide*—is well understood today in species as diverse as lions and spiders and is particularly well known in primates, including baboons.

In the Okavango Delta of Botswana, for instance, Ryne Palombit of Rutgers University and Dorothy Cheney and Robert Seyfarth of University of Pennsylvania have documented that 38 percent of all infants die at the hands of immigrant males. In a recent conversation, Cheney and Seyfarth described immigrant male baboons in Okavango persistently stalking infants with evident sinister intent. As a consequence, mothers with dependent young show elevated stress hormones when new males enter their social group. They also remain particularly close to protective male "friends" who were resident when the offspring was conceived, whether or not those males are the fathers of their infants.



The 19-month-old baboon Wusten died during an altercation between two groups, when a male from his group picked him up and carried him while under attack. Males may sometimes do so to protect the juvenile, but just as often they appear to do so exploitatively to reduce the severity of the attack or recruit other adults to help. In the fray, infants may take the brunt of the attack. (Photography by Raphael S. Mututua, courtesy of the author.)

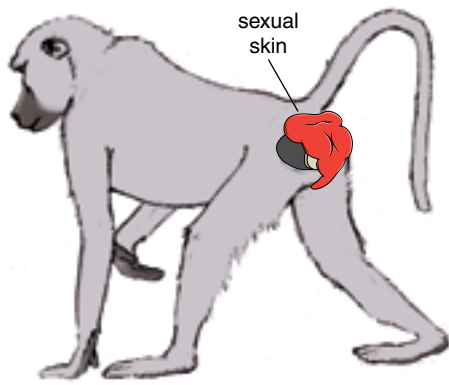
In Amboseli we rarely witness the act of infanticide. Although infant mortality rates are significantly higher after the immigration of high-ranking males, infanticide accounts for only 2–3 percent of infant deaths in Amboseli overall. In Amboseli, males often form coalitions with each other to interfere in the mating of high-ranking males; this behavior never happens in Okavango. Thus, unlike in Okavango, the highest-ranking males in Amboseli don't inevitably get the lion's share of mating. As a result, in Amboseli the payoff to killing an infant and bringing its mother back into reproductive cycling is lower than in Okavango. Our multiple decades of data indicate that Amboseli males are most likely to commit infanticide when population density is low, so that they don't have many choices of groups to join. When given the choice, they appear to simply choose to move into groups with more females that are reproductively available.

If such conditional infanticide occurs in other primate species, it raises an obvious specter for population viability: In the face of declining populations and smaller group sizes, infanticide

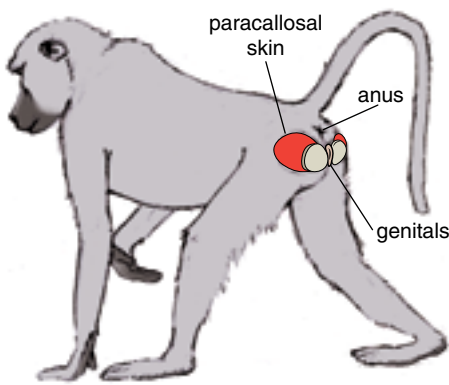
may increase in frequency, contributing to a downward population spiral. Although this particular negative feedback loop has not yet been documented for primates, a similar type of negative feedback is well described for African lions. Male lions routinely kill dependent cubs when they take over a pride. More than a decade ago, researchers documented that, although trophy hunting of older, past-prime males has no negative population consequences, trophy hunting of males in their prime, who are actively fathering offspring, is a different story. Successful hunting of prime males, who are critical defenders of their cubs, is not only a certain death sentence for dependent young, but it can create a negative feedback loop of just the sort described here.

Equally sinister as infanticide is the tendency of new immigrant males in Amboseli to commit feticide by aggressively attacking pregnant females, persistently harassing and injuring them to the point that they terminate their pregnancies. We have observed several obvious cases of such attacks, but our long-term data tell us that feticide, like infanticide, happens more

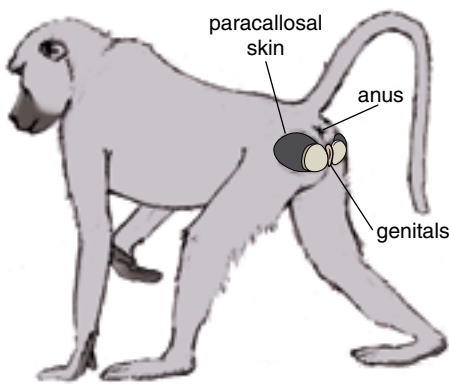
ovarian cycling



pregnant



postpartum ammenorhea



The visible sign of pregnancy in female baboons may help adult males know which offspring they fathered. Although males tend to assist their own offspring, it is unclear how they know which babies they sired, since fertile females will mate with multiple males. Several behavioral and sensory cues may be involved to tip off fathers, including the timing of the pregnancy sign after a male has mated with a female. This obvious sign of pregnancy has also helped the Amboseli Baboon Research Project understand the frequency and role of feticide in baboons.

often than we observe. As with infanticide, males are more likely to attempt feticide when they don't have easy alternatives of other groups to join. Feticide seems to happen at a somewhat higher rate than infanticide: It may be easier to aggressively harass a pregnant female than it is to kill an infant.

the infanticide and consequently never had the chance to mate with Nymph's mother when she began cycling again a few weeks after her infant's death. Instead, we think that Plato simply saw Nymph, who was not a member of his social group and was completely unrelated to him, as an easy meal.

It remains an open question whether the benefits of the pregnancy sign—perhaps in recruiting protectors and caretakers of the infant to come—outweigh its costs.

Feticide has rarely been reported in other primates, perhaps because pregnancy and fetal loss are difficult for observers to detect in some species. Female baboons, however, show clear signs of pregnancy, including a patch of skin on their hips that starts to turn pink within a few weeks of conception. This pregnancy sign seems risky to display if feticidal males are on the prowl. It remains an open question whether the benefits of the pregnancy sign—perhaps in recruiting protectors and caretakers of the infant to come—outweigh its costs.

Cannibalism

Another unsavory scenario for infant mortality that is probably quite rare is when adult male baboons hunt them. In their arid and calorie-poor landscape, hungry male hunters have been known to see infants as a free meal. One such case involved an encounter between Linda's group and Nyayo's group. Out of the blue, we witnessed an adult male, Plato, who lived in Nyayo's group at the time, grabbing a five-month-old infant female named Nymph from Linda's group. Within a few minutes after we first saw Plato with Nymph, he began eating the young female, stripping the skin off her head and eventually consuming most of her body. Nymph's mother had bleeding wounds on several parts of her body when we found her, suggesting a violent attack that had separated mother and infant.

But this attack did not fit the classic profile of sexually selected infanticide; Plato lived in Nyayo's group and did not immigrate into Linda's group after

This view is strengthened by the fact that Plato was an unusually dedicated and successful hunter of vervet monkeys. Young infant baboons are similar in size and appearance to infant vervet monkeys. Relatively few male baboons acquire the habit of hunting and eating vervet monkeys, but at least one other dedicated vervet hunter, several decades earlier, mortally wounded a young two-year-old female baboon named Pooh. In that case, a male protector rescued Pooh, and she lingered for several days before dying from her wounds. But observers speculated that if she had been caught she would have been eaten.

The similarities in these two cases suggest that some sort of spillover of behavior can result in males occasionally killing and eating young baboons if they have previously become vervet monkey hunters. Despite the rarity of cannibalism, it provides another complex example of how male behavior toward infants can vary, with crucial effects on infant survival.

Moon's Fate

In the case of the adopted infant Moon, he was, ironically, doomed by the intense protective instincts of his mother and other members of his original group. He thrived as Flank's adopted infant, and when Hokey's group next encountered his birth mother's group, Moon was strong and independent enough to voluntarily return to his mother. He'd been gone seven weeks, but he seemed to recognize his natal group and his mother, and they him. Immediately upon his return Mica picked him up, carried him,



The social context of young baboons can mean life or death, and studying infant behaviors as well as those of adults toward them reveals insights about the evolution of parenting and friendship. It also is essential information for managing their populations in conservation areas in an informed manner. (Photograph courtesy of the author.)

and groomed him, as a mother would. Several others in the group were also intensely interested in Moon's return and were very protective toward him, including Mica's closest male friend, her daughter, and several other adolescent females. Mica had ceased to lactate during Moon's absence, however, and he quickly grew thin and dehydrated. Several times when he saw other baboon groups he tried to leave his group and join them, perhaps hoping to find Flank. Each time he tried to do so, Mica and her friends and family would zealously prevent him from leaving, obviously trying to protect him. Moon died within three weeks, ironically a victim of his success in reuniting with his mother.

Although the adults' behavior toward Moon was ultimately harmful to him, in the vast majority of cases such behaviors would enhance, rather than endanger, an infant's life. It is the average effect of a behavior over time that determines whether it will be selected or not: Even if a behavior is harmful in a few rare instances, thousands of generations of Darwinian "payoffs" will result in strong tendencies of adults to restrain and retrieve wandering infants. The general insight gleaned from Moon's predicament is that primate infants are remarkably vulner-

able and must rely on the benevolence of many adults in their lives for survival. In other words, evolution has produced a lineage—one that includes our own species—in which infants remain dependent on and vulnerable to multiple adults for an extended period. This period is at least a year in the case of baboons and much longer in some species (including humans). The saying that "it takes a village to raise a child" turns out to have strong resonance throughout our primate family tree. The social fabric plays a critical role in survival for all primate societies: Social ties can determine whether an animal lives or dies just as surely as an outbreak of disease or a lurking predator. Understanding how friends and foes contribute to success or failure in infancy is shedding new light on the evolution of parenting and friendship. It also provides a compelling rationale for protecting sufficient primate habitat for social groups to remain intact and social ties to remain undisrupted: To ensure that our primate cousins avoid extinction, we must recognize that they, like us, are essentially social creatures in the deepest sense of the word.

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